Energy Management Strategy and Solar Energy Utilization in Oversized Solar Array and Grid-tied Photovoltaic Systems

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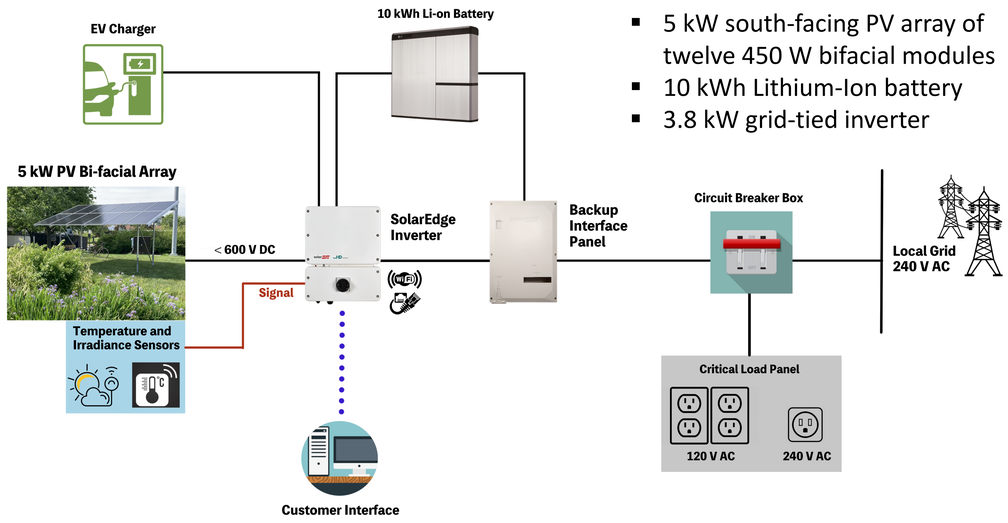
Introduction

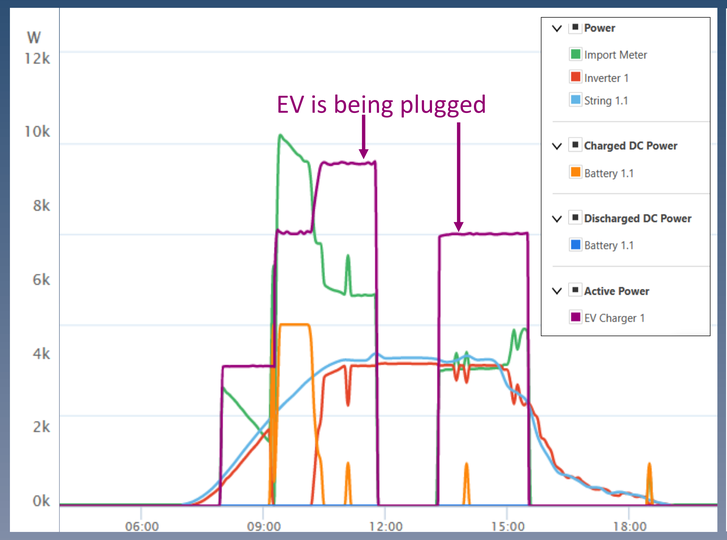
- Photovoltaic (PV) technology is one of the most promising alternatives to energy resources that produce CO_2
- A decrease in PV module cost leads to over-sizing where DC power exceeds the inverter AC rating, causing energy to be wasted
- The impact of inverter clipping is observed to address issue of over-sized PV
- The energy management strategy is evaluated to mitigate the clipping loss

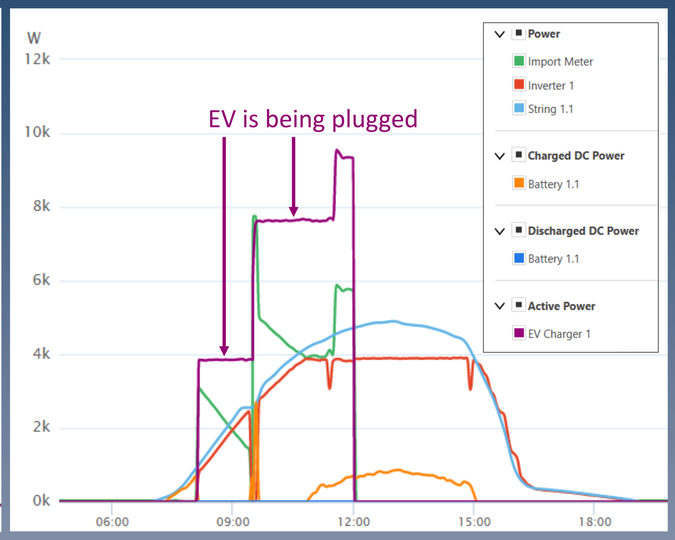
Experimental Setup



- 5 kW south-facing PV array of twelve 450 W bifacial modules
- 10 kWh Lithium-Ion battery
- 3.8 kW grid-tied inverter

Results





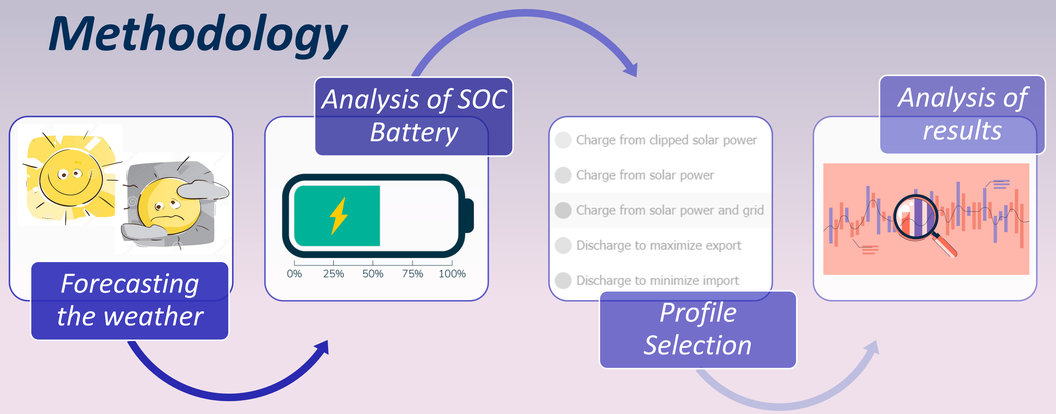
Battery is charged from solar and grid

- PV power clips since PV power > inverter capacity
- PV production more than 3.8 kW is wasted
- The clipping loss occurs from 10:30 to 14:30
- Battery will be charged from PV and grid
- When EV is plugged and battery is being charged, power imported from the grid is very high

Battery is charged from clipped solar power

- PV power > inverter capacity but does not clip
- PV production more than 3.8 kW is not wasted but is charged to the battery
- Battery charging is more predictable
- EV does not affect the battery charging profile
- Successfully avoid high grid import
- Battery can be discharged during peak demand

Methodology



✓Monitoring portal provides six different profiles to control the battery

✓Profiles are assigned based on the weather, time-of-use, and preferences

Conclusion

- The clipping loss potentially occurs in summer on sunny days from 10am to 2pm.
- Winter has less clipping but will still be seen on a very sunny day.
- The energy control can be environmentally and economically profitable to homeowners.
- It also helps mitigating the grid consumption, peak demand, and CO_2 emissions.

Future Works

- Weather forecast and real time analysis via Modbus and machine learning to charge the battery when clipped power is experienced.
- Battery discharge to reduce peak demand using the clipped power and Peak Load Shaving (PLS) as energy management strategy.
- Improvement of the performance of DC coupled PV + Battery systems.

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