

## Possible Application of GridOptimizer™

- Peak Levelling
- Renewable Output Smoothing
- Time of Use Optimization
- Custom Power Output Profiles

## Application Example

The increasing integration of distributed renewable energy has increased stress on the power grid. By their very nature, photovoltaic (PV) energy fluctuates dramatically with weather. This fluctuating power output from these renewable sources cause line regulators, tap changers, and switched capacitors to switch much faster than before. PV and inverter instabilities can also contribute to transients, harmonics, and flicker in the distribution system. For example, if a PV string was generating 100 kW and a cloud passed over the array, this power could drop to under 50kW in less than 30 seconds. This can be very disruptive to the stability of the grid.

The GridOptimizer can mitigate this disruptive behavior with curve smoothing. This would be accomplished by charging the storage when excess power is generated and discharging the storage when diminished power is seen in the PV output. Custom power profiles can be achieved by similar methods. This would consist of the user inputting a desired output power curve, after which the system would adjust its charge and discharge characteristics to meet the curve. This would be beneficial to the user if the demand curve is known. A solid 24 hour output could also be implemented by modifying the curve into a flat line.

## Experimental Result

In the morning, while the sun is rising, the PV is used to charge the energy storage when the power is too low to run an inverter. The system then waits to detect if the power is enough to turn on the inverter for normal operation. This system then slowly ramps up the output power, reducing the harmful effect on the grid of an inverter rapidly becoming active. When the inverter is running, the system uses a cloud anomaly identifying algorithm to decide when to inject power. If an increase in power output to the grid is necessary, the storage will inject the correct amount of power. The experimental results of this process can be seen in the figure above. A solid output power (dark blue line) can be seen even though the PV is being varied between 10kW and 20kW (red line). The energy output from the storage unit is shown as a light blue fill.

