Chapter 7
Battery Management Based on Predictive Control and Demand–Side Management:
Smart Integration of Renewable Energy Sources

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ABSTRACT

The chapter is intended to introduce the predictive control based energy management strategy for the grid connected renewable systems in order to achieve an effective demand side management strategy. Grid connected Photovoltaic battery system as being popular and extensively used has been discussed in this chapter .Conventionally, battery storage has been used to store surplus energy produced and meet the load demand with this stored energy. However, such systems do not respond to the grid conditions and violate grid constraints of permissible grid voltage and frequency limits. The operation of the battery depends on the forecast of photovoltaic output and the load demand and as such a predictive control based energy management strategy is needed. A simple optimization problem for such scenarios has also been formulated in great detail to provide readers with an idea for solving such problems. The results of simulations are also discussed.

The list of symbols and mathematical notations consistent throughout the chapter are listed as follows.

DSM: Demand side management
MPC: Model Predictive Control
PV: Photovoltaic system
$\mathbf{E_{DU}}$ **:** PV energy directly used
$\mathbf{E_{BC}}$ **:** PV energy used for charging battery
$\mathbf{E_{PV}}$ **:** Total PV energy production
$\mathbf{E_{BD}}$ **:** Total energy from battery discharge
$\mathbf{E_{L}}$ **:** Total energy demand
P: Active power
Q: Reactive power
AC: Alternating Current
f: Alternator frequency
Hz: Herz
$\mathbf{V}$ **:** Voltage
$\mathbf{I}$ **:** Current
Z: Distribution line Impedance
$\mathbf{R_{L}}$**:** Distribution line resistance
$\mathbf{X_{L}}$**:** Distribution line reactance
$\mathbf{C_{batt}}$**:** Battery capacity in Kwh
LTC: Load Tap Changing, in context of transformers
P: Number of poles of alternator
$\mathbf{N_{s}}$**:** Rotational speed of alternator in rpm (rotation per minute)
$\mathbf{P_{batt}}$**:** Battery power flow
$\mathbf{P_{v}}$**:** calculated PV output
Pgrid: Grid power flow
$\mathbf{P_{L}}$**:** Load demand of the household
$\mathbf{P_{c}}$**:** Active power curtailment
SOC: State Of Charge of the battery
SOH: State of Health of the battery
$\mathbf{\Delta t}$ **:** Duration of sampling interval
$\mathbf{N}$ **:** Length of Prediction horizon
$\mathbf{N_{u}}$ **:** Length of Control horizon
Ah: Ampere hour
W: Watt
KW: Kilowatt
GW: Gigawatt

Other mathematical notations and symbols specific to a certain paragraph or section are mentioned in the respective section.

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