

## Abstract

The need for decarbonisation of electricity generation has led to an inevitable requirement of new regulations and mechanisms to promote renewable energy integration in the grid. For the last few years there has been a dramatic shift in the mechanisms to consider/account for prosumer based electricity, where a consumer is producer as well as a consumer of electricity. With the onset of 14 smart grid pilot projects in India, there is a need to address the realization of potential underlying various features of a smart grid. The national solar mission of India, aims to achieve 100 GW of solar power by 2022. In view of the aggressive target for photovoltaic (PV) penetration in India and automation of metering infrastructure, the present research explores the impact of the same on small consumers in India. The study includes analysis of net metering and demand side management (DSM) programs through simulation and data analysis. In the smart grid pilot project at Puducherry, India, net metering mechanism has been incorporated. The study of three consumers from the pilot project draws a comparison between net metering and gross metering mechanisms. The analysis signifies the necessity to explore alternative net metering models for a feasible and acceptable net metering policy. Hence to ratify the results, a study of 120 residential consumers in Kharagpur, West Bengal, is undertaken for assessing the pertinence of present net metering policy for residential consumers in India. It is found that the present net metering mechanism is not expedient in most of the cases, owing to low energy requirement of the households. A smart net metering model is proposed as an alternative to the existing net metering policy in order to mitigate its disadvantages for such consumers. The results of the simulation analysis based on the model indicate a high positive net present value and an acceptable payback period, which makes the model feasible. In another study of smart metered consumers from ix x smart grid pilot project, potential of two DSM mechanisms is analyzed. Simulations have been carried out for a price based mechanism as well as an incentive based mechanism. The results of the simulation indicate that there is a definite scope for load balancing as well as financial savings. Further, a scenario analysis is performed to explore how increased solar penetration in the electricity generation mix may impact residential electricity consumer bills. The wholesale electricity rates are simulated and based on them retail rates are designed. Wholesale prices are modeled using a bottom up unit commitment optimization model. It is found that that bill savings achieved in time varying rates is more than time invariant rate. A

similar analysis is performed with net metered consumers and it is found that the value of bill savings decreases more in time variant rates as compared to time invariant rate. Data from consumers in IIT Kharagpur campus has been taken up for similar analysis and suitable recommendations have been furnished in the thesis. With the advent of grid connected solar panels in India and automation of metering infrastructure, the need to update the present energy policy is foreseen.

*Keywords:* PV penetration, Smart metering infrastructure, residential consumers, India, retail rate design.