Assessment of Solar PV penetration limits in distribution networks

Issue
Due to the falling price of Photovoltaic (PV) panels and the shift in focus of many countries from fossil fuels to renewable energy resources, the percentage of PV penetration is expected to see a rise in the near future. This can lead to a wide range of power quality problems in the power system, such as an increasing number of tap operations, over-voltages, and large and frequent voltage fluctuations. Therefore, it is key to understand the effects of PV penetration on the distribution system to mitigate these negative effects. The integration of Photovoltaic (PV) systems in Qatar’s power distribution network can help Qatar achieve its targets for renewable energy of 2% of total electricity generation by 2020 and 20% by 2030 in a cost-effective manner. This can only be achieved with a well-planned step-by-step integration of both distributed and centralised photovoltaic integration into the electrical network.

Solution
The approach is to carry out simulations using realistic models and the latest load and PV profiles. However, even with the most accurate model and the most recent data, the process of simulation is not straightforward, as the distribution systems consist of a sizeable number of loads and each load has a varying power demand throughout the day. Also, the power supply from a PV unit changes from time to time, depending on environmental factors such as: solar irradiance, ambient temperature, cloud coverage, etc., creating numerous variations. Manually entering all these variations into the simulation model is unpractical. Therefore, the process of importing the data into the simulation software and performing the load flow calculations needs to be automated. Using an algorithm to obtain the load and PV profile data, simulate the outcome for each case and analyse the results as a whole for the system taking into account each possible variation.

Impact
These simulations are evaluated to observe the impact of medium-sized PV channelled through the Medium Voltage (MV) distribution network on the power system as a whole, for a set of typical years, through simulations in hourly time steps. This information helps develop guideline and policy recommendations for interconnecting medium-sized PV systems to the MV power network. These recommendations will form the basis for the development of grid codes that specify the parameters that PV applications connected to the national electric system have to meet to ensure safe, secure and cost-effective functioning of the electric system.