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Directload control experiments and case studies in Qatar Foundation Community Housing

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Energy security is one of the main national concerns, with population's growth and energy demand increase it becomes critical for countries to address the issue. Increasing energy production is extremely costly and could require investments to modify the power network infrastructure that is also expensive. Demand Side Management is a collection of methods and strategies that helps modifying the demand of consumers in order to cope with the limited energy production, avoiding tremendous expenses. DSM is often associated with the residential load profile in order to determine two aspects. Firstly the residential energy load profile is the main component that is required in order to understand how to apply DSM effectively. The load profile is often too complex, it exhibits unique patterns and characteristics as it is influenced by a number of social and economic factors, climate and the local policies also impacts the profile. Secondly the residential load profile has a useful role that helps us identify the viability of using solar photovoltaic and storage systems in households. The residential energy consumption represents a large portion of Qatar's total energy consumption and it is growing larger. By monitoring the energy profiles of 10 households chosen from different accommodation types, we can log and plot actual load profiles that can represent the domestic household energy profile of a province. The monitoring of the loads has to cover a yearlong period in order to demonstrate the climate impact on the load profiles. The energy consumption is represented by household appliances and mostly by HVAC or heating depending on the country's location. The loads are split into two categories, an elastic load that can be fixable for the user to operate at various times. The other type of loads is inelastic loads that have priority that impacts

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the comfort level of the user and cannot be shifted. These loads play a role in determining the shape of profile and the extent of degree to which it can be changed. The best way of monitoring the loads is through nonintrusive appliance load monitors in order to keep occupants disturbance at minimum. Smappee is a nonintrusive appliance load smart monitor that offers precision in energy reading as well as a remarkable user interface. These monitors measure the total energy consumption using current transformers. It logs power readings with a five minutes interval and uploads it to the cloud. The data can then be downloaded to a local server in order to be plotted into the load profiles. Ten Smappee monitors were installed in ten different houses and apartments in Doha during June and July 2017 and are expected to run for a year. The data will be used to plot a representation of Qatar's typical domestic load profile and to investigate the two aspects of DSM and the viability of PV and storage systems.
A simple case study is carried out to assess the potential of DLC in the Education City Community Housing (ECCH). The ECHH accommodates the QF employees in a high-quality villas and apartments that ensure a high living standard. The ECHH consists of two lots that made of totally 639 housing units classified into five different dwelling types. Furthermore, the AC units installed have three different capacities (18, 11, 8 kW) and the capacity of the AC unit depends on the type of the housing unit. Table 1 EC Community Housing units by type of unit, area, and AC unit capacity Housing Type Area (m2) No. of Units AC Load (kW) Total Load Standalone V. Type 1 408 52 18 936 Standalone V. Type 2 389 17 18 306 3 Bedroom Attached V. 315 118 11 1,298 2 Bedroom Attached V. 219 108 11 1,188 3 Bedroom Apt. 256 72 11 792 2 Bedroom Apt. 161 200 8 1,600 1 Bedroom Apt. 109 72 8 576 Figure 1 Peak demand reduction achieved by the three different scenarios in the total electricity demand in Qatar.The case study comprises three scenarios; the first scenario is assuming 15-minute cycling for all buildings is performed. The second scenario is assuming 50% of the residents went on summer vacation, and their AC is cycled for 1 hour and 50% stayed here and their AC is cycled for 15 minutes in 4 groups such that the first group is cycled in the first 15 minutes of the hour, then the second group in the second 15 minutes of the hour and so on. It is believed that more than 50% of the residents leave the country for summer vacation, so the third scenario is similar to the second however, it is assuming 80% of the residents went to summer vacation and 20% stayed in Qatar. The results of these three scenarios are presented in Figure 1. Around 1.674 MW demand reduction could be achieved in the first scenario, while it could be increased if the long summer vacations are taken into consideration as seen in the 2nd and the 3rd scenarios where 3.557 MW and 5.44 MW demand reduction is achieved respectively. Such results provide critical insights in assessing demand reduction potential of Qatar and determining associated economic savings.