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Estimation of Time-series Data of Electricity Demand in Distribution Network based on Public Statistical Data

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Abstract

In order to realize effective asset management of a number of distribution networks, not only the current utilization status but also the future status in consideration of high penetration of renewable energy generators, electric vehicles, stationery storage batteries, etc. should be evaluated. Because of the recent mass deployment of smart meters, affluent data is getting available. Such the data is useful for estimating the current status of electricity demand characteristics in a certain area. However, in order to take into account the influence of social aspect on the change in electricity demand, it would be practically preferable to estimate the electricity demand based on publically available statistical data such as a national census.

As a first step for this purpose, this study develops an electricity demand estimation model in distribution network based on Grid-square Statics provided by Statistics Bureau of Japan and some other statistics in order to estimate the demand in each 500m square mesh. The electricity demand of residential and commercial sector is calculated by multiplying the hourly unit value with the total floor space calculated from the number of households and employees. Nighttime and industrial electricity demand is simply calculated by distributing the total demand in utility service area based on the actual sales to each mesh in consideration with the distribution of households and land-use, respectively. The total electricity demand in the distribution network is calculated by summing the demand of each consumer type in meshes in the concerned distribution network territory.

The hourly electricity demand in a year was estimated for three areas (residential, residences-factories complex, rural), and compared with the observed demand in these area. The observed demand was adjusted by adding the estimated power output of photovoltaic (PV) power generation based on the sunshine duration data at the nearest observation point. As a result, it is revealed that the proposed method basically works well to estimate the time-series of electricity demand excepting midnight demand especially during winter season. It is expected that the estimation accuracy of midnight demand would be improved by taking into account the recent penetration of electric heat pump water heaters, the change in lifestyle, etc.

Based on this model and assuming the scenario of future penetration of photovoltaic power generations, electric vehicles, etc. the time-series of future electricity demand can be estimated. Such a data would be useful for the asset management of distribution networks toward the future.