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FlexPower WP5 summary

Introduction

Work package 5 is concerned with forecasting from a consumer perspective, i.e. assuming that the user receives a price signal representing the electricity price for the coming five minutes, what forecasts would the consumer require in order to take near-optimal actions in relation to the consumption? WP5 is concerned both with addressing this general question and with developing actual forecasting models and services. The forecasts are used by the local controller (WP4) and for simulation purposes in WP6. Also, forecasts are, via WP7, supplied to the demonstration work packages.

Forecast requirements

In order to identify the characteristics of the forecasts to be produced forecast requirements are addressed in references [1,7]. In [1] a controller for the space heating of a single family house is considered. Clearly, actions in one time step affect the range of possible actions in future time steps. For this reason the controller should consider both the time step for which the action must be implemented and future time steps which are affected by the action. Essentially, this is the reason why forecasts are required and the controller uses these in a rolling horizon setup [1, page 7-8]. The report considers different kinds of stochastic criteria functions. It is argued that it is of main interest to minimize the expected cost and in this case the controller requires forecasts as expected values. If the variance of the cost is included in the criteria function the controller requires information regarding the covariance of future prices; such information could be supplied as scenarios of future prices. In [7] the global optimality of the rolling horizon principle is discussed and an exact solution for a simplified EV charging problem is presented. It is argued that, in the general case, global optimality cannot be ensured and this leaves room for adding heuristics on top of specific algorithms based on the rolling horizon principle.

Heat load forecasts

Heat load forecasts for single family houses are described in [6], where models are developed and evaluated. The forecasting results are analysed thoroughly to give insight into the sources of error, for example unpredictable behaviour of the residents and uncertainty in the inputs, especially from the solar radiation weather forecasts. The heat load for water heating is forecasted and the results are thoroughly analysed. It is found that the predictability of the hot tap water load depends heavily on how regularly the peaks in the signal occur, which is presumably when the inhabitants take shower baths. Finally, the space and hot tap water load forecasts are combined to forecast the (total) heat load and compared to forecasts of the total heat load without splitting. It is found that there is only little difference between these forecasts.

Reference [5] describes the API for communicating with the PRESS web-service which can be used for heat load forecasting as considered above. The document includes examples of how to communicate with the service using Curl (http://curl.haxx.se) and the build-in web client. The web-service supports controllers controlling the indoor temperature via forecasts of the consumption demand as defined in [1], page 9. Meteorological forecasts are handled internally by the web-service and the controller only needs to upload measurements of consumption and indoor temperature, hereafter forecasts of the consumption demand can be downloaded. The web-service is available at https://host2.enfor.dk/press-service/<user>. The task of initializing new user instances is very simple; only the location of the house is required. In a full scale setup additional information such as the ground floor area, number of inhabitants, and approximate yearly consumption could be used in order to initialize the models.

Price forecasts and simulation

Price forecasting is considered in [2,4] and 5 minute price simulation is considered in [3]. The simulated 5 minute prices are supplied to WP6 for system simulations and online simulated prices are, via WP7, supplied to the DER-units. The report [3] describes a method for simulating 5 minute prices based on actual spot and regulating prices. The method is used for simulation of 5 minute prices for 2001-2011 for the two Danish Nordpool price areas DK1 and DK2. Features of the method are that a limited number of shifts occur within each full hour and that the extremes of the simulated prices equals the actual regulating prices at least once each full hour. As a consequence, when the number of shifts is low the simulated 5 minute prices stay quite close to the actual hourly regulating prices. The simulations are characterized by a parameter controlling the frequency of intra-hour price changes and a parameter controlling the size of these changes. Three levels are selected for each of these parameters and simulated prices are provided for each of the nine combinations of these. The resulting simulations are characterized for sub-periods allowing system simulations to zoom in on specific features and perform sensitivity analyses.

In the operational setup the simulated 5 minute prices are forecasted for horizons up to 12 hours and these forecasts are updated every 5th minute. Via WP7, these forecasts are made available to

the DER-units [4, page 28]. Similarly, each of the offline simulated price series, are forecasted and the forecasts are made available to WP6 [4, page 26-27]. Also, [4] contain analysis of forecast performance for sub-periods and for each of the 2x9 simulated series, which can be used for system simulations as outlined above. Furthermore, a method by which the system simulations can perform sensitivity analyses w.r.t. forecast performance is suggested.
Reference [2,4] also address forecast performance for actual prices. Focus is on the difference between each of the regulation prices and the spot price. This quantity is called the imbalance unit cost. It is argued that the conditionally expected values of these cost is of main interest [4, Sec. 2]. Such forecasts will be non-zero for both the down- and up-regulation penalties simultaneously, although this is not possible for the actual prices. Although, the noise level is high, the forecasts seems to be capable of reproducing correct expected values [4, page 11-13]. This is most predominant for the shorter horizons relevant for the FlexPower setup. Also, since for these horizons the spot-price is known, the conditionally expected values of the imbalance unit costs can be used in order to obtain conditionally expected values of the regulation prices. Furthermore, the conditionally expected imbalance unit costs could be used as inputs to procedures generating scenarios of the imbalance unit costs.

References

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