An MPC Energy Management System with Storage Integration for Office Buildings

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Background and Motivation

Development of an energy management system for office buildings with photovoltaic and storage system

Main Goals:

- Self consumption optimization - Optimal usage of the energy produced by photovoltaic panels of the building
- Optimal usage of storage system installed in office building
- Avoidance of load peaks
- Island operation in case of back out

System Overview

An intelligent energy management system calculates with the aid of forecasted production and consumption values, as well as with weather forecasted data, the optimal course of the state of charge of a battery storage.

The usage of the so-called MPC (Model Predictive Control) controller has proved to be very useful and reliable.

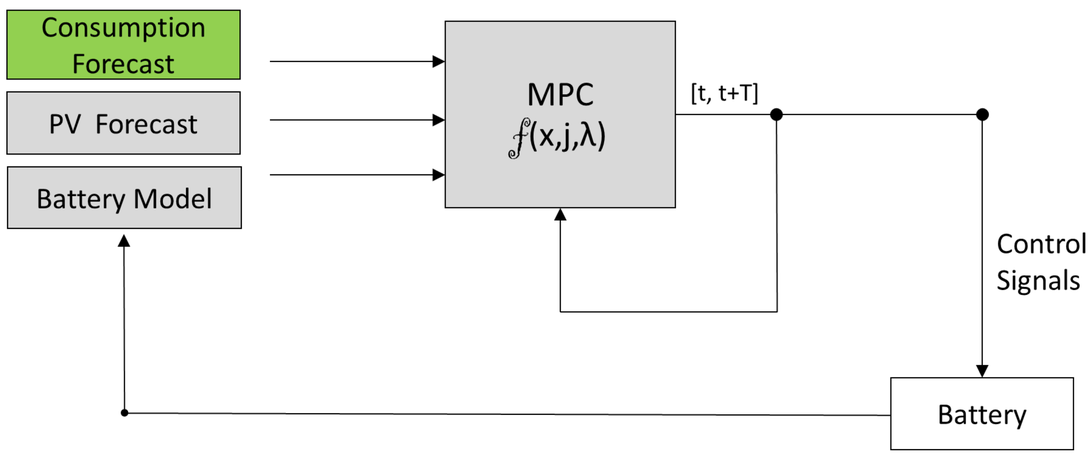

Figure 1 System Overview

Energy Consumption Forecast

The consumption forecast has a very important role in the energy management system:

Knowing the energy demand of the next hours or days, the operation of the battery in combination with the PVs, can be efficiently and optimally planned.

Consumption forecast methods can be classified in various categories:

- engineering methods-physical models,
- statistical, and the
- artificial intelligence methods.

Physical models can be very accurate, however, the difficulties lie in the absence of the necessary information about each part of the system, as well as on the poor transferability to other objects.

Engineering methods introduce usually a very long process and require a lot of computing power.

The statistical approach relies on periodicity and the fading of outliers in the crowd.

Artificial Neural Networks

Artificial intelligence and specifically Artificial Neural Networks (ANNs), have the ability to solve nonlinear and very complex problems and offer a relatively high accuracy.

They learn from a set of training data, they can make high speed predictions and generalizations, they don't require detailed information about the system and they are fault tolerant.

In Figure 2 the architecture of the consumption forecast system is depicted.

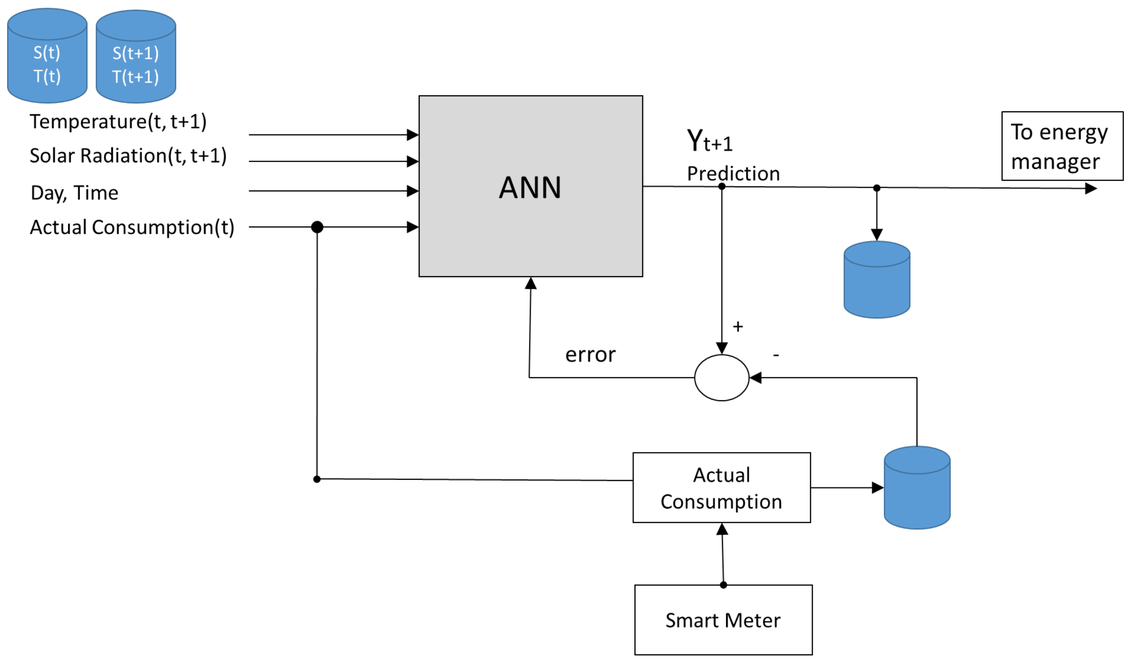

Figure 2 Forecast consumption system architecture

Necessary inputs for the ANN model are the solar radiation and temperature, present as well as predicted values, since these are main parameters that affect directly a great part of the energy consumption of an office building, such as the heating and ventilation or lighting.

Data storages are necessary in order be able to calculate the error of the model and feed it back to the network, as an extra input, which indicates the goodness of the result.
The forecasted data, as well the recorded present data are delivered from the chosen weather API e.g. once per day, and are imported in the database.

Therefore it is possible to use a static training for the ANN, triggered every N number of days, and in this way avoid a complex dynamic training.

After the training period, the model can be used for predictions in a horizon that the input forecasted weather data define.

Outlook

Prediction models are a great contribution to the proactive energy management of buildings.

The selection of the modelling method and its parameters is an important step in the development of the model.

Challenge is to design prediction models that are precise enough to deliver reliable results but also generalized enough to be applied to various buildings.

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