

Wavelet-based Decomposition and Artificial Neural Networks for Short-Term Prediction of Power Demand in District Heating

Mouchira LABIDI^(1,2,3), Julien EYNARD^(1,2), Olivier FAUGEROUX^(1,2), Stéphane GRIEU^(1,2)

(1) PROCédés, Matériaux & Energie Solaire Laboratory, PROMES-CNRS UPR 8521, Rambla de la thermodynamique, Tecnosud, 66100 Perpignan, France.

(2) University of Perpignan Via Domitia, 52 avenue Paul Alduy, 66860 Perpignan cedex 9, France.

(3) Cylergie, Centre de Recherche de Cofely GDF-Suez, 18 avenue Tony Garnier, 69007 Lyon, France.

mouchira.labidi@promes.cnrs.fr, julien.eynard@promes.cnrs.fr, olivier.faugeroux@promes.cnrs.fr, stephane.grieu@promes.cnrs.fr



Poster in my pocket
 ELSEVIER

View this poster with the Poster in my Pocket app

Install the free iPhone/Android app via: www.posterinmypocket.com

Objectives

The present work is directed towards improving the operation of multi-energy district boilers by adding to the plants optimally sized and controlled thermal storage tanks. The proposed strategy is based on a Model Predictive Controller (MPC).

Predictive Control of Thermal Storage Systems for Multi-energy District Boilers

Multi-energy district boilers

CASE STUDY

Component	Description
WB	Wood boiler [1050 ; 4200] kW
GB1	Gas boiler [140 ; 7000] kW
GB2	Gas boiler [180 ; 9000] kW

Why a predictive controller ?

Generate optimal command sequences to manage the amount of thermal energy to be stored or released by the hot water tank.

To implement such a controller, one needs to **forecast the heat network power demand.**

Structure of the proposed predictive controller

Forecast methodology

A model is developed to forecast the power demand as follows:

1 Discrete wavelet transform

Seq {1,...,M} (original signal) → **Decomposition at level N** → Dc {1,...,N} (N detail coefficients) and Ac (Approximation coefficient at level N)

2 Multi-layer Perceptron (MLP) for forecasting future sequences

Dc {1,...,N} (Day, Hour) → MLP-Dc {1,...,N} → FDc {1, ..., n} (Forecasted detail coefficients)

Ac (Day, Hour) → MLP-Ac → FAc (Forecasted approximation coefficient)

FDc and FAc are combined to produce Seq-F (Forecasted sequence).

3 A parametric study is carried out to optimize the:

- Number of observation sequences (M)
- Decomposition level (N)
- MLP topology (number of hidden neurons)

Simulations Results

Hourly forecast model (April to September)

OPTIMAL CONFIGURATION

Parameter	Value
Wavelet decomposition level	1
Number of observation sequences	1
Number of hidden neurons	17
FIT (similarity criterion)	72.26
MAE (mean absolute error)	299.57 kW
MRE (mean relative error)	5.9%

- Results highlight the ability of such an approach to achieve the task of forecasting with high accuracy

Impact of the predictive controller

Increase in economic gain

Decrease in CO₂ emissions

- The proposed control scheme allows the fossil energy consumption to be significantly reduced
- The same remark applies to the functioning costs and CO₂ emissions