



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

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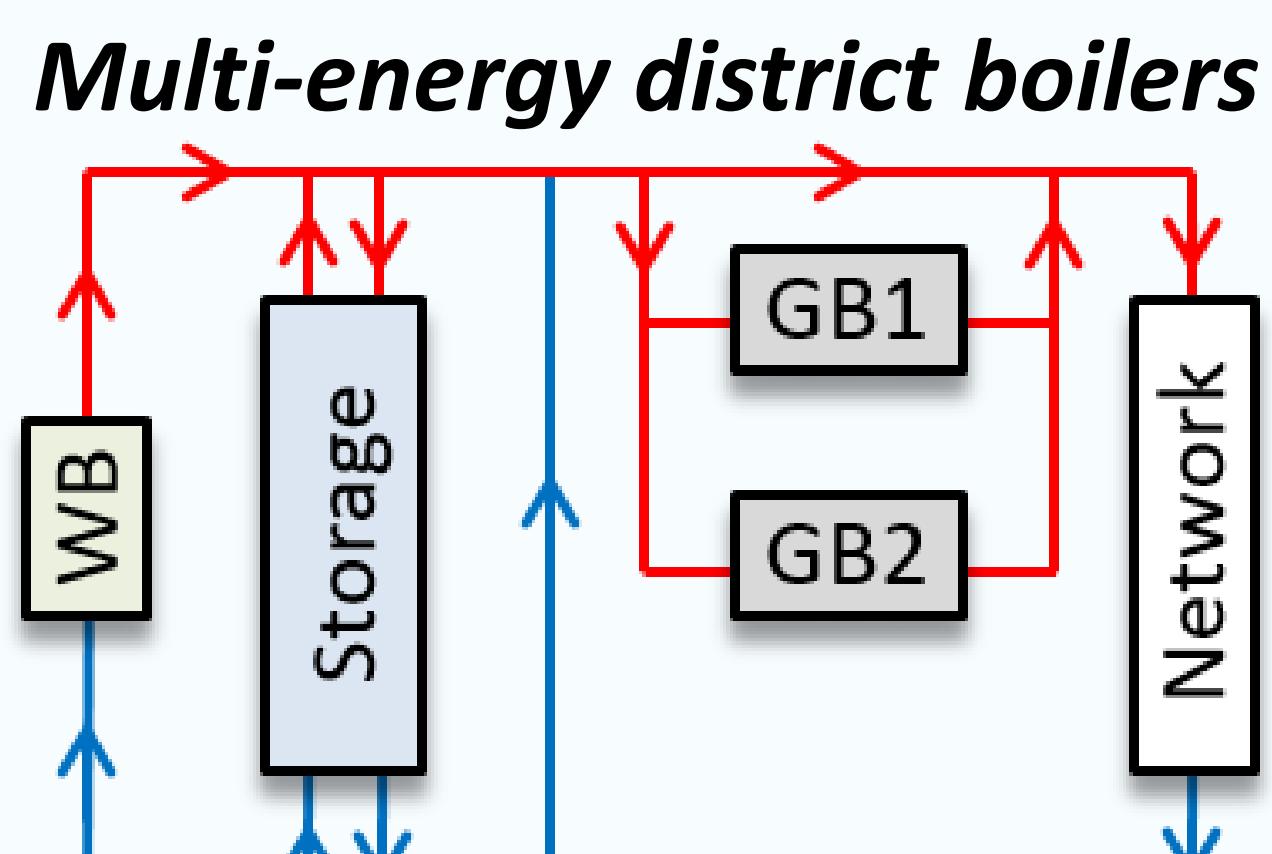
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Objectives

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



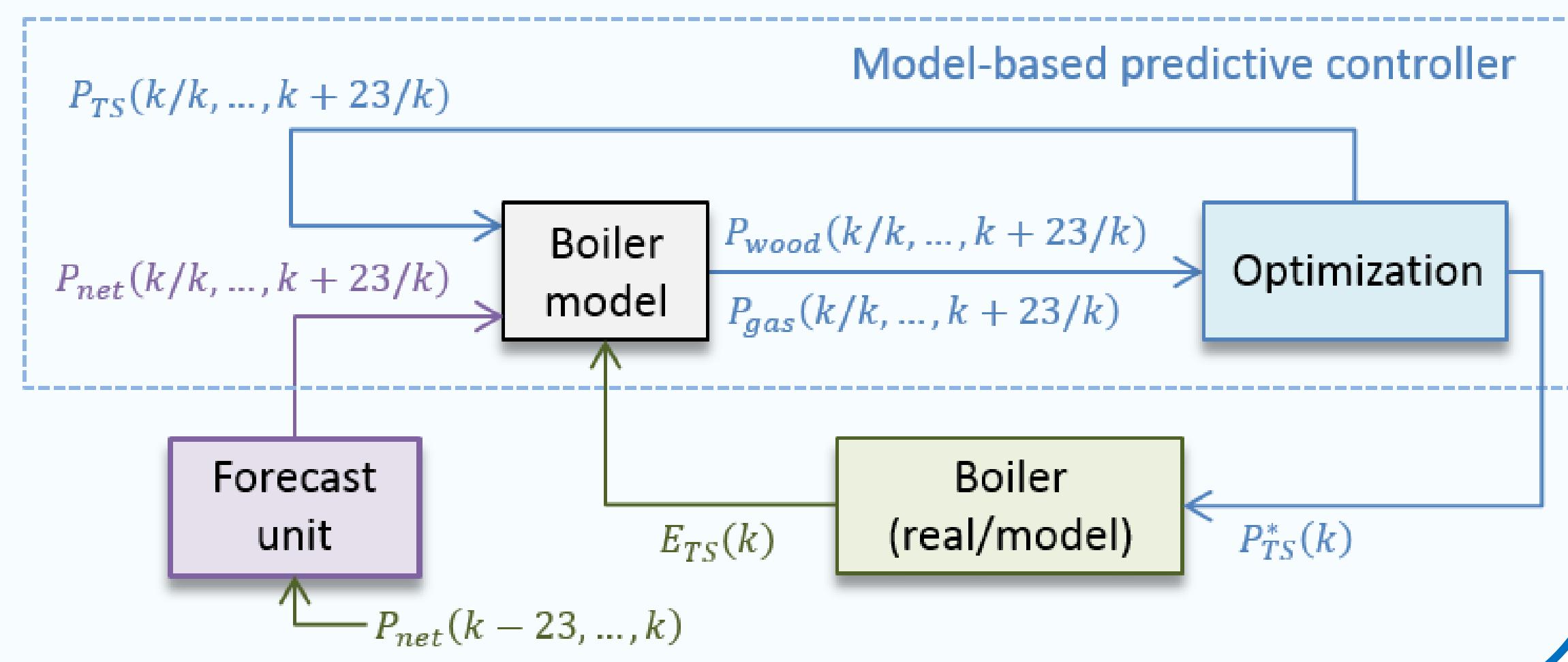
Component	Description
WB	Wood boiler [1050 ; 4200] kW
GB1	Gas boiler [140 ; 7000] kW
GB2	Gas boiler [180 ; 9000] kW

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

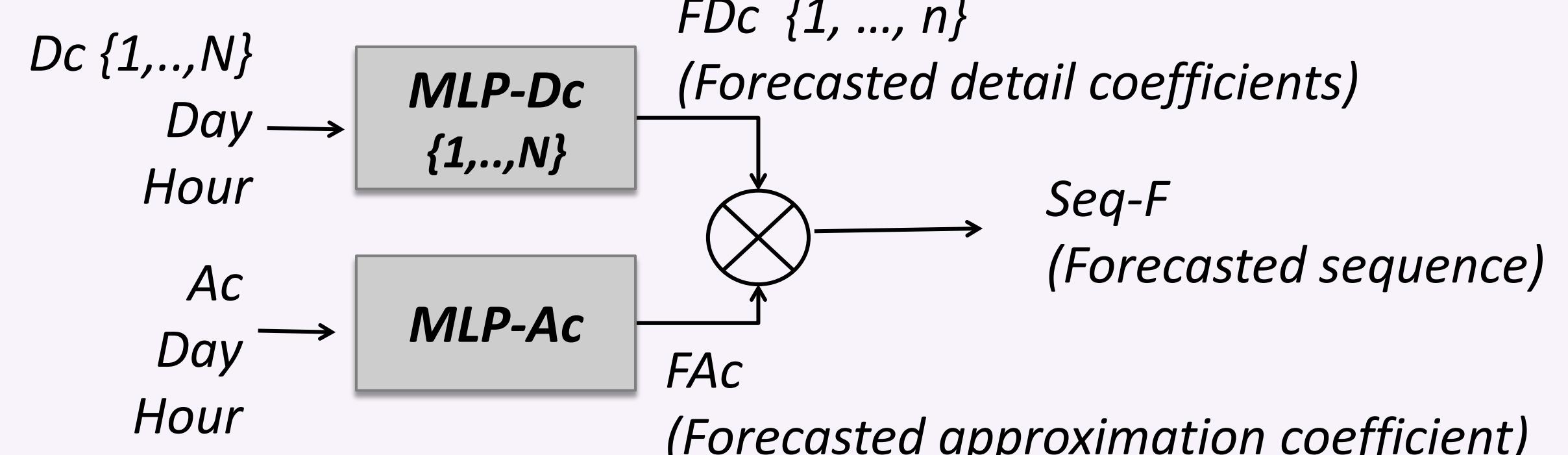
Seq {1,..M} →
(original signal)

Decomposition at level N

- Dc {1,..N}
(N detail coefficients)
- Ac
(Approximation coefficient at level N)

2

Multi-layer Perceptron (MLP) for forecasting future sequences



3 A parametric study is carried out to optimize the:

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

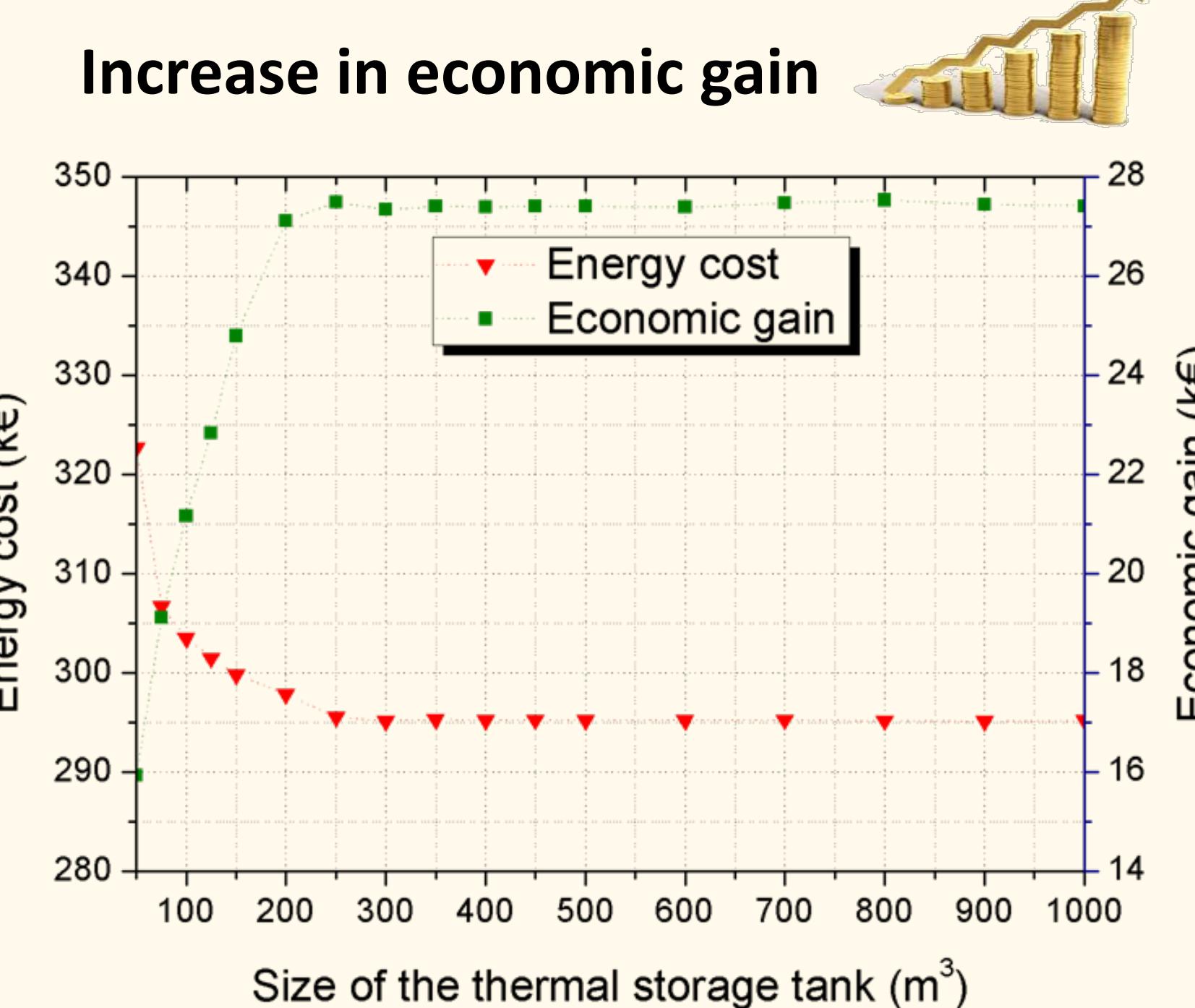
Simulations Results

Hourly forecast model (April to September)

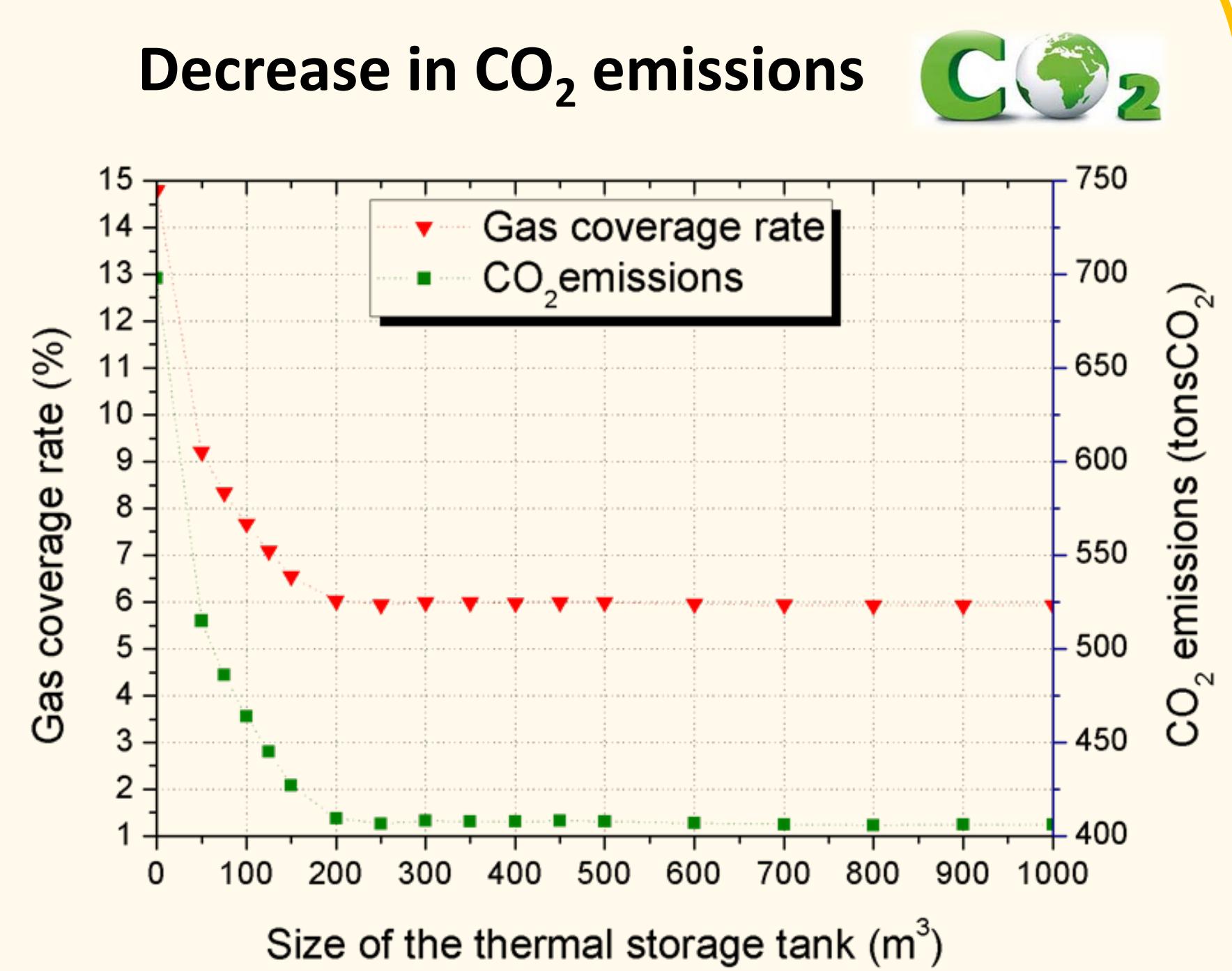
OPTIMAL CONFIGURATION

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%

Impact of the predictive controller



Decrease in CO₂ emissions



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

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