Prediction of the Heat Supply Daily Diagram

The method is applicated on the course of energy time series such as for example HSDD with trend component (spring, summer, autumn, fall), weekly periodicity (working days, weekends) and daily periodicity (morning, noon, afternoon, night) with the one hour sampling $z^*_{t^*}$, where $t^* = 1, 2, ..., N^*$, N^* is the number of samples.

The long-standing calculations and evaluations of model in the form result in the use of models for the prediction in the form

$$\Phi_P(B^s)\varphi_p(B)\nabla_s^D\nabla^d z_t = \Theta_Q(B^s)\theta_q(B)a_t$$

result in the use of models for the prediction in the forms

$$\varphi_3^{**}(B)\nabla_7^1\nabla^1 z_{t^{**}}^{**} = a_{t^{**}}^{**}$$

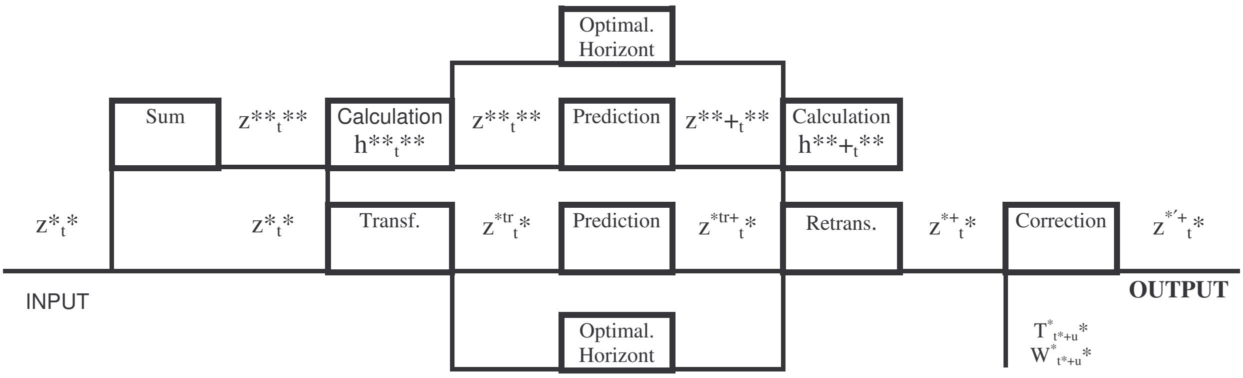
and

$$\varphi_3^*(B)\nabla_{24}^1 z_{t^*}^{*tr} = a_{t^*}^*$$

The calculation of optimalization in the form

$$S(\Phi_P, \varphi_p, \Theta_Q, \theta_q = \sum_{t^*=1}^{N^*}(a_{t^*}^*)^2$$

is not described, but it is possible.



The calculation of HSDD is as follows

$$z_{t^{**}}^{**} = \sum_{i=1}^{24} z^*_{(t^{**}\times 24)+i} \quad \text{for } t^{**} = -1, 0, 1, \ .... \ , 17,$$

(negative index means left shift from the begining of time axis)

$$t^{**} = \text{ent}\left(1 + \frac{t^*-1}{24}\right).$$

The calculation of correction coefficients

$$z^{**}_{med} = \frac{1}{N^{**}} \sum_{i=1}^{N^{**}} z^{**}_i$$

$$h^{**}_{t^{**}} = \frac{z^{**}_{med}}{z^{**}_{t^{**}}} \qquad \text{for } t^{**} = 1, 2, \; .... \; , N^{**}.$$

The transformation of time series

$$z^{*tr}_{t^*} = h^{**}_{t^{**}} * z^{*}_{t^*} \qquad \text{for } t^{*} = 1, 2, \; .... \; , N^{*}.$$

The process of calculation of $z^{**+}_{t}{}^{**}$ is done by a) substitution $z_t = z^{**}_{t}{}^{**}$, with parameters $N = N^{**} = 17$, $d = d^{**} = 1$, $D = D^{**} = 1$, $s = s^{**} = 7$, $p = p^{**} = 3$, $q = q^{**} = 0$, $L = L^{**} = 3$, $B = B^{**} = 0$, $K = K^{**} = 4$, $U = U^{**} = 0$.

The process of calculation of $z^{*tr+}_{t}{}^{*}$ is done by b) substitution $z_t = z^{*tr}_{t}{}^{*}$ with parameters $N = N^{*} = 408$, $d = d^{*} = 0$, $D = D^{*} = 1$, $s = s^{*} = 24$, $p = p^{*} = 3$, $q = q^{*} = 0$, $L = L^{*} = 24$, $B = B^{*} = 0$, $K = K^{*} = 4$, $U = U^{*} = 90$.

The calculation of prediction of time series z_t is the well-know Box-Jenkins methodology, where the calculation of seasonal and nonseasonal differencing, mean, variance, autocovariance and autocorrelation functions, autoregressive parameters ϕ_p, moving average parameters θ_q, residual variance and predictions of time series z^{+}_{t} with upper and lower probability limit are done.

Next the substitution follows a) with parameters $z^{**+}_{t}{}^{**} = z^{+}_{t}$ and b) $z^{*tr+}_{t}{}^{*} = z^{+}_{t}$.

The calculation of backward transformation is as follows

$$h^{**+}_{t^*+u^*} = \frac{z^{**}_{med}}{z^{**+}_{t^{**}}} \qquad \text{for } u^{**} = 1, 2, \; .... \; , L^{**},$$

$$z^{*+}_{t^*+u^*} = \frac{1}{h^{**+}_{t^{**}}} * z^{*tr+}_{t^*} \qquad \text{for } u^{*} = 1, 2, \; .... \; , L^{*},$$

$$t^{**} = \text{ent}\left(1 + \frac{t^* + u^* - 1}{24}\right).$$

The correction of prediction is done in a form

$$z^{*'+}_{t^*+u^*} = T^{*}_{t^*+u^*} * W^{*}_{t^*+u^*} * z^{*+}_{t^*+u^*} \qquad \text{for } u^{*} = 1, 2, \; .... \; , L^{*}.$$

The correction coefficient $W^{*}_{t^*+u^*}$ includes the weather influences, such as for example outdoor temperature and humidity of air, speed and direction of wind, solar radiation, rainfall, etc.

The correction coefficient $T^{*}_{t^*+u^*}$ includes irregular calendar influences, for example statutory holiday in working day, working day at weekends, etc. The prediction is calculated on the basis of the course of past time series, therefore it is necessary to calculate the backward correction of the past time series in the form

$$z^{*kor}_{t^*} = \frac{z^{*'}_{t^*}}{T^{*}_{t^*}} \qquad \text{for } t^{*} = 1, 2, \; .... \; , N^{*}$$

done the substitution $z^{*}_{t^*} = z^{*kor}_{t^*}$.

This way the irregular calendar influences do not cause the calculation of wrong prediction.

The aim of the prediction is to improve the quality of the control of the district heating system. Fuel and energy is saved, which contributes to economy and ecology.