EMEE Ex. 9

Power goods as the exchange subject on the energy market.

Determination of the price for electricity consumption in ES supplies system, equipped with continuous metering of the Load Diagram.

Objectives:

I) How to determine the required amount of consumed goods (electricity) if we are able to define our consumption diagram (Load Diagram)?

II) How to calculate the price we will pay for the quantity taken by us?

1. **Enter the example:**

- Calculate the average price of electricity per 1 kWh and the total price for the invoiced period T, if the customer (drinking water treatment plant) is classified in category B in terms of classification (metering point equipment) and period T one month is in winter.
- Carry out the calculation according to the methodology that applied in the environment of regulated prices in the Czech Republic (2003).
- The course of LD for one day (D) of period T is shown in Fig. 2.
- Perform the calculation for those variants:

  a) the regulation of the consumed maximum power is not regulated,

  b) the customer has an agreed value of P_{max},

  c) the customer will consume constant power.

- As this is a supply of drinking water to the water supply system, it can be assumed that the LDD in period T will always be the same in every day.
- Reactive power consumption will take place within the permitted limits.
- The total quantity taken in T took place approximately in the contractual value between the customer and the supplier.

Ad I) Determination of consumption diagram

The power consumption of the drinking water treatment plant is presented in Fig. 1
The amount of the inputting power is mainly loaded by power supply of power pumps for water pipelines which supply to the water supply system, washing pumps and washing blower.
These appliances cause a significant peak consumption - Fig. 2, which can reach the value: Pmax = 650 kW.
Because POM is equipped with continuous measurement, the customer knows the course of consumption relatively accurately, and can easily compile consumption diagrams for different time periods T (day, week, month, quarter, year).

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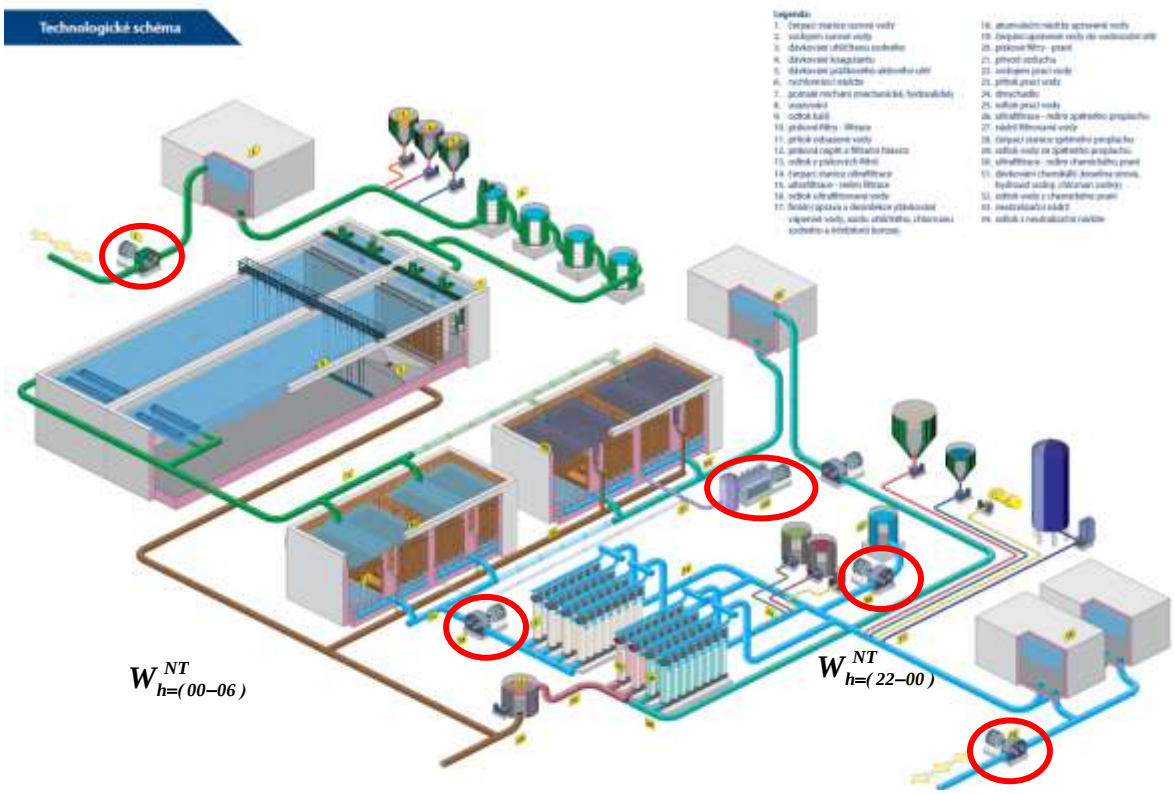


Fig. 1: Technology scheme of the drinking water fragment.

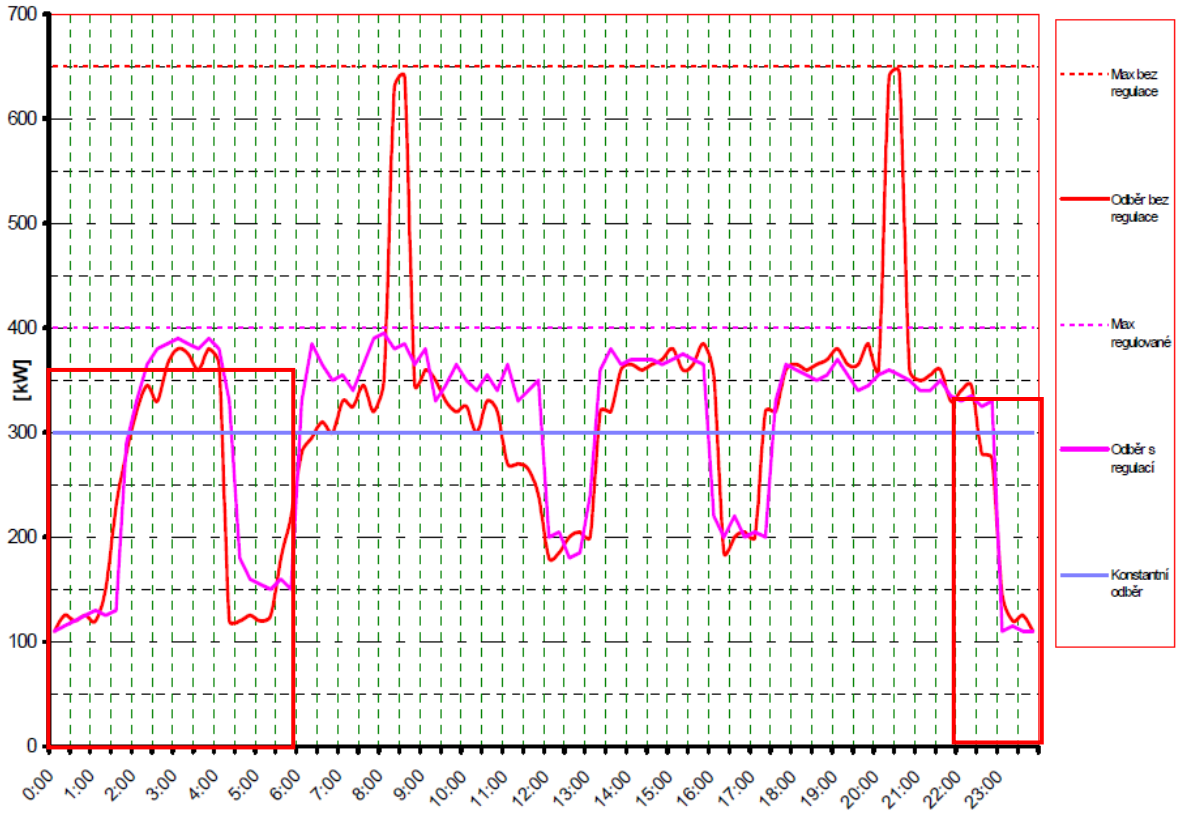


Fig. 2: Load Daily Diagram of the water treatment station.

2. Load point definition:

- The customer is connected to the distribution network at the HV level - with his own transformer station and therefore he can be included in the category of wholesale customers, which are most often industrial customers and wholesale customers. Electricity consumption from Distribution Systems at HV levels takes place at lower voltage levels than 52 kV, which in the Czech Republic are levels of 35 kV, 22 kV, 10 kV, 6 kV.
- The consumption from the HV level, according to the conditions given by the Decree (currently in CZ it is Decree No. 359/2020 Coll., Decree on Electricity Measurement), must be equipped with continuous measurement (i.e. type A or B measurement). The installation of continuous measurement is performed by the distribution system operator.
- Currently, this type of customers is assigned a distribution rate only with respect to the voltage level to which they are connected. For this reason, and also thanks to continuous measurement, the individual subjects are approached (from supply side) individually. The supplier usually sets a specific tariff for each one separately to suit the widest possible portfolio of such customers. Suppliers set a lower business margin for large customers than for small customers, so large customers have better prices for electricity than small customers.
- Large customers with metering type B receive bills for electricity consumption for period T, usually more often than 1 year (which is carried out for customers on LV, small consumption - consumption points with metering C). They have a better overview of electricity consumption and costs. Invoicing is performed in T = 1 month.

Ad II) Determination of payment for the invoicing period

- In general, the price for electricity has more component, but at least it is composed of components respecting:
  - ***Total price, in currency unit, for consumed goods (W_T) in T period***:
    $C_{W,T}\ [c.u./\ for\ T\ period]$, [1]
    - The basic evaluation interval for the payment for the amount taken (power electricity) is **1 hour = h of the day D of** the course of LDD. The first hour starts from 00:00:00 and the end is 01:00:00 of the calendar day.
    - The price for accounting period **T** is done by sum prices in each hour of period:

$$C_{W,T} = \sum_{h=1}^{T} c_{h,T} = W_T . c_{W,h}\ [c.j.] \qquad [2]$$

The price in single hours of the day D can be different, i.e. **the price is tariffed** – peak tariff PT, high HT, low tariff LT:

$$C_{W,T} = \sum_{h,PT} c_{W,h}^{PT} + \sum_{h,HT} c_{W,h}^{HT} + \sum_{h,LT} c_{W,h}^{LT}\ [c.u./Whours]$$

- ***Price for maximal value of consumed electricity P_{max} is defended by maximal level of the consumed value in T***:

  $$C_{P\,max,T}\ \left[c.u./in\,T\right] \qquad [3]$$

  The price for power consumption is composed of the price for the value of the technical maximum in the period T - $\mathbf{P_{max,\,T}}$ [kW] (instantaneous P_{max} in T) and the price for the average value P_{max} measured in 1/4-hour of power consumption during time T (power accumulated in one 1/4-hour):

  $$C_{P\,max,T} = C_{P\,max,} + C_{,1/4h,P\,max} =$$
  $$c_{P\,max}.P_{max} + c_{1/4h,P\,max}.\frac{1}{4}hP_{max}\ \left[c.u./in\,T\right] \qquad [4]$$

  The amount of the technical maximum is mutually confirmed in the purchase contract for a period of at least one year.
  The value of 1/4hPmax can be provided by the customer contractually or it is directly measured.

  - The basic measured interval for evaluate P_{max}, is therefore ¼h with start point 00:00:00 an end point 00:15:00, of each D in T.

- ***Price for consumed reactive power Q***:

  $$C_{Q,T}\ \left[c.u./in\,T\right] \qquad [5]$$

  - The price is defined by extra price in each h each price price $c_{W,h}$, if the reactive consumption tolerance falling into the condition is not observed - see surcharge prices, the consumption must be at most in the range of power factor cosφ = (0.95 - 1).
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- In addition to the basic fees for the quantity and power taken, fines (surcharges) for non-compliance with the contractual conditions (CC) for the consumption of electrical work may be assigned to the price of electricity for period T.

  - ***Price for exceeding 1/4hPmax values:***

    $$C^{+-}_{1/4H,P\,max} = c^{+-}_{1/4H,P\,max}.P^{+-}_{1/4h,P\,max}\ \left[c.u./in\,T\right] \qquad [6]$$

  - ***Price for non-consumption (-) or overdraft (+) of contractual values of consumption:***

    $$C^{+-}_{SM,T} = C^{+-}_{W_{SM},T} = c^{+-}_{W_{SM},T}.W^{+-}_{SM,T}\ \left[p.j./za\,T\right] \qquad [7]$$

    $c^{+-}_{W_{SM},T}$ ***a*** $c^{+-}_{1/4h,P\,max}$. unit prices for power [c.u./kW] and work [c.u./kWh].

    where $c^{+-}_{W_{CC}}$ ***and*** $c^{+-}_{P\,max,CC}$. are unit prices off CC.

3. Provided rates for type B customers in a regulated price environment - year 2003:

The rates are set for one year by the relevant regulatory authority regulating the relevant sectors. In the case of electricity in CZ, it is the ERU.

Rates for consumers with with P_{max} 150 kW till 800 kW:

B3 – two-tariff rate with a salary for the agreed maximum		**B3a**	**B3b**	**B3c**
Winter (october – march)				
For the technical maximum and the month	[Kč/kW]	26,5	71,5	113,5
Monthly maximum for the agreed 1/4 hour	[Kč/kW]	59,3	160,1	254,3
For exceeding 1/4 of the agreed monthly maximum	[Kč/kW]	107	289,1	459,2
For the consumed el. energy at the time of HT	[Kč/kWh]	2,55	1,55	1,09
For the consumed el. energy in time of LT	[Kč/kWh]	1,52	1,12	0,94
Summer(other prices for these items)				
Monthly maximum for the agreed 1/4 hour	[Kč/kW]	46,5	125,7	199,7
For the consumed el. energy at the time of HT	[Kč/kWh]	1,54	1,11	92
For the consumed el. energy in time of LT	[Kč/kWh]	1,38	1,03	0,86

B4 – two-tariff rate with a salary for the measured maximum		**B4a**	**B4b**	**B4c**
Winter (october – bmarch)				
For the technical maximum and the month	[Kč/kW]	26,5	71,5	113,5
Monthly maximum for the agreed 1/4 hour	[Kč/kW]	59,3	160,1	254,3
For exceeding 1/4 of the agreed monthly maximum	[Kč/kW]	107	289,1	459,2
For the consumed el. energy at the time of HT	[Kč/kWh]	2,55	1,55	1,09
For the consumed el. energy in time of LT	[Kč/kWh]	1,52	1,12	0,94
Sumer				
Monthly maximum for the agreed 1/4 hour	[Kč/kW]	54,8	148,2	235,4
For the consumed el. energy at the time of HT	[Kč/kWh]	1,54	1,11	92
For the consumed el. energy in time of LT	[Kč/kWh]	1,38	1,03	0,86

Rates for consumers till P_{max} 150 kW:

B5 – dvoutarifová sazba s platem za naměřené maximum		**B5a**	**B5b**	**B5c**
Zima (říjen – březen)				
For the technical maximum and the month	[Kč/kW]	26,5	71,5	113,5
Monthly maximum for the agreed 1/4 hour	[Kč/kW]	59,3	160,1	254,3
For exceeding 1/4 of the agreed monthly maximum	[Kč/kW]	107	289,1	459,2
For the consumed el. energy at the time of HT	[Kč/kWh]	2,55	1,55	1,09
For the consumed el. energy in time of LT	[Kč/kWh]	1,52	1,12	0,94
Sumer				
Monthly maximum for the agreed 1/4 hour	[Kč/kW]	54,8	148,2	235,4
For the consumed el. energy at the time of HT	[Kč/kWh]	1,54	1,11	92
For the consumed el. energy in time of LT	[Kč/kWh]	1,38	1,03	0,86

4. Calculation

Tariff validity:

period of validity LT in D	t_D^{LT}	[hours]	22:00 - 06:00
hours number LT in D	h_D^{LT}	[hours]	8
period of validity HT in D	t_D^{HT}	[hours]	06:00 - 22:00
hours number HT in D	h_D^{HT}	[hours]	16
D number in T	D_T	[day]	31

Summary table of electricity consumption and prices for the billing period 1 month from the deducted values of DDZ - ¼ h, Pmax, W_{HT}, W_{LT},

	Jednotková cena **c**	Odběr bez regulace		Odběr s regulací		Konstantní odběr	
	[Kč/kWh]	[KW/kWh]	[Kč]	[kW/kWh]	[Kč]	[kW/kWh]	[Kč]
Pmax[kW]	71,5	650	46475	400	28600	300	21450
1/4 h [kW]	160,1	645	103264,5	395	63239,5	300	48030
W_{VT} [kWh]	1,55	163050	252727,5	159150	246682,5	144000	223200
NT [kWh]	1,12	52950	59304	56850	63672	72000	80640
Celkem [kWh]		**217295**	**461771**	**216795**	**402194**	**216600**	**373320**
Průměrná cena [kWh]			2,13		1,86		1,72

It is clear from the results that the unit, by regulating the value of P_{max}, can achieve significant savings in the cost of electricity consumption. As a result, customers make sure that they do not exceed 1/4 hmax and usually have a maximum regulator installed, which can switch on or off the respective power of the appliances.