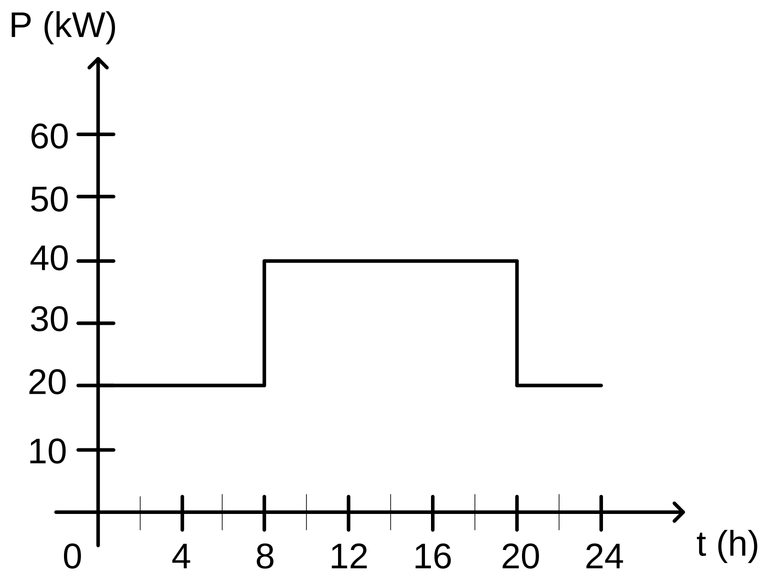
Example 1:

From the daily load profile determine consumed electric energy, maximal, average and minimal load, time of full loading and utilization time.

Solution:



Daily consumed energy:

$$W = \int_0^T P(t) \cdot dt = 20 \cdot 8 + 40 \cdot 12 + 20 \cdot 4 = 720\ kWh$$

Average, maximal and minimal load:

$$P_{avg} = \frac{W}{T} = \frac{720}{24} = 30\ kW$$

$$P_{max} = 40\ kW$$

$$P_{min} = 20\ kW$$

Time of full load:

$$\tau = \frac{W}{P_{max}} = \frac{720}{40} = 18\ h$$

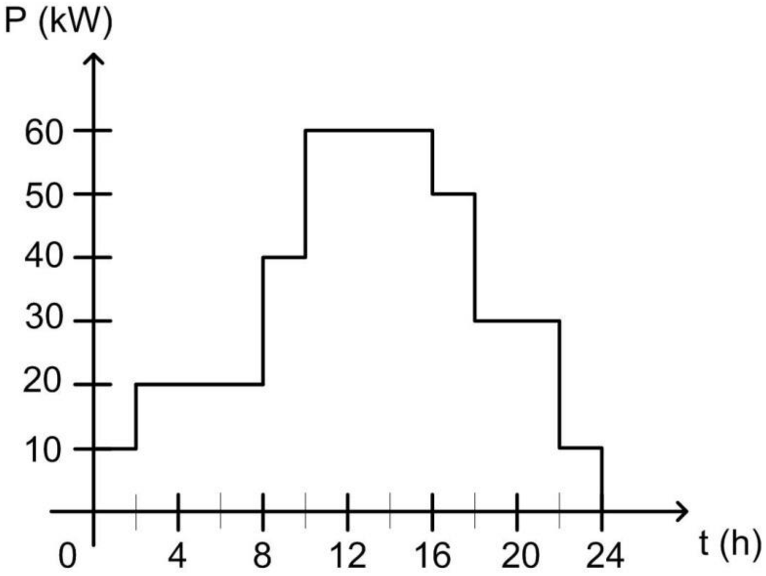
Utilization time:

$$\tau_Z = \frac{\int_0^T P(t)^2 \cdot dt}{P_{max}^2} = \frac{20^2 \cdot 8 + 40^2 \cdot 12 + 20^2 \cdot 4}{40^2} = \frac{24\,000}{1\,600} = 15\ h$$

Example 2:

From the daily load profile determine consumed electric energy, maximal, average and minimal load, time of full loading and utilization time.

Solution:



Daily consumed energy:

$$W = \int_0^T P(t) \cdot dt = 10 \cdot 2 + 20 \cdot 6 + 40 \cdot 2 + 60 \cdot 6 + 50 \cdot 2 + 30 \cdot 4 + 10 \cdot 2 = 820\ kWh$$

Average, maximal and minimal load:

$$P_{avg} = \frac{W}{T} = \frac{820}{24} = 34.2\ kW$$

$$P_{max} = 60\ kW$$

$$P_{min} = 10\ kW$$

Time of full load:

$$\tau = \frac{W}{P_{max}} = \frac{820}{60} = 13.7\ h$$

Utilization time:

$$\tau_Z = \frac{\int_0^T P(t)^2 \cdot dt}{P_{max}^2} = \frac{10^2 \cdot 2 + 20^2 \cdot 6 + 40^2 \cdot 2 + 60^2 \cdot 6 + 50^2 \cdot 2 + 30^2 \cdot 4 + 10^2 \cdot 2}{60^2} = \frac{36\ 200}{3\ 600} = 10\ h$$

Example 3:

Hydroelectric power plant with installed power P_{ins} = 85 MW produces 180 GWh electric energy for each year. How are average value of power and time of installed power?

Solution:

Average value of power:

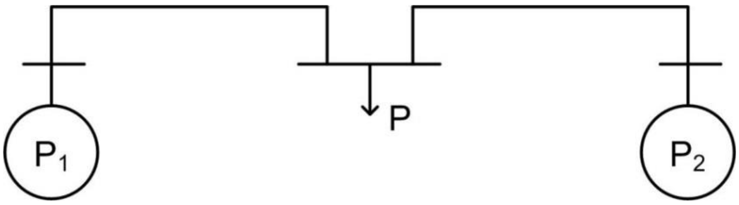
$$P_{avg} = \frac{W}{T} = \frac{180 \cdot 10^3}{365 \cdot 24} = 20.55\ MW$$

Time of installed power:

$$\tau = \frac{W}{P_{max}} = \frac{180 \cdot 10^3}{85} = 2117.65\ h\ \approx 88.24\ days$$

Example 4:

Determine economically effective distribution of load in electrical power system according to figure. Neglect losses.



Average increments of costs are given by :

$$b_1 = 4 + 0{,}25 \cdot P_1 + 0{,}005 \cdot P_1^2$$

$$b_2 = 3 + 0{,}12 \cdot P_2 + 0{,}003 \cdot P_2^2$$

Total load of power system P = 90 MW.

Solution:

The condition of economically effective distribution of load will be fulfilled if $b_1 = b_2$ and $\varphi = P_1 + P_2 - P = 0$

The P_2 can be then expressed as:

$$P_2 = P - P_1$$

And from the substitution to the equation $b_1 = b_2$ we can get:

$$4 + 0{,}25 \cdot P_1 + 0{,}005 \cdot P_1^2 = 3 + 0{,}12 \cdot (P - P_1) + 0{,}003 \cdot (P - P_1)^2$$

After rearrangement of the equation:

$$4 + 0{,}25 \cdot P_1 + 0{,}005 \cdot P_1^2 = 3 + 0{,}12 \cdot P - 0{,}12 \cdot \mathrm{P}_1 + 0{,}003 \cdot P^2 - 0{,}006 \cdot P \cdot P_1 + 0{,}003 \cdot P_1^2$$

The final form is quadratic equation:

$$0{,}002 \cdot P_1^2 + 0{,}91 \cdot P_1 - 34{,}1 = 0$$

By solving this equation the effective loading of first power plant can be determined:

$$P_1 = \frac{-0{,}91 + \sqrt{0{,}91^2 + 4 \cdot 0{,}002 \cdot 34{,}1}}{2 \cdot 0{,}002} = 34{,}84\ MW$$

The loading of second power plant is then:

$$P_2 = P - P_1 = 90 - 34{,}84 = 55{,}16\ MW$$

The check, whether the calculation is correct:

$$b_1 = 4 + 0{,}25 \cdot 34{,}84 + 0{,}005 \cdot 34{,}84^2 = 18{,}74$$

$$b_2 = 3 + 0{,}12 \cdot 55{,}16 + 0{,}003 \cdot 55{,}16^2 = 18{,}74$$