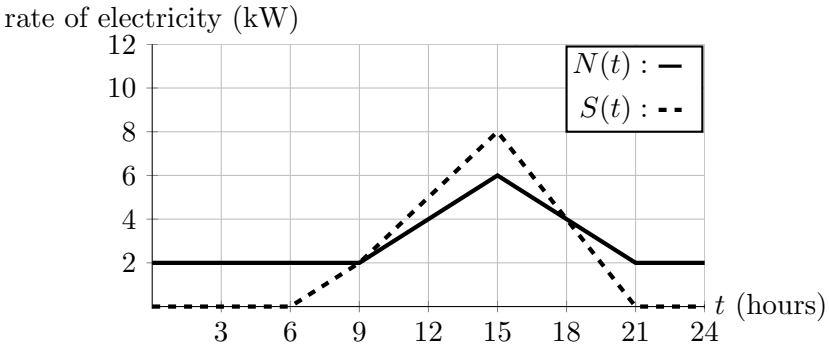
9. [10 points] Nikki's electric company charges her \$0.20 per kilowatt-hour (kWh) that she uses. Suppose that, during a typical 24-hour period, the rate at which Nikki uses electricity, in kilowatts (kW), t hours after midnight, is given by the function $N(t)$, the solid graph shown below. Note that Nikki's electricity usage over a given time interval is given by the integral of $N(t)$ over that interval.

Nikki is considering installing solar panels. Energy generated by the solar panels can be used free of cost, but when the panels produce more energy than Nikki uses, the energy is sent back into the electric grid, and the electric company pays Nikki \$0.05 per kWh for that energy.

Suppose $S(t)$ is the rate at which the solar panels would generate electricity, in kW, over the same 24-hour period, t hours after midnight. The function $S(t)$ is shown by the dashed graph below.



a. [2 points] Write an expression, using a definite integral involving $S(t)$ or its derivative, for the amount of electricity, in kWh, Nikki's solar panels would generate over this 24-hour period.

Answer: $\int_0^{24} S(t)dt$

b. [2 points] Write an expression, using a definite integral involving $N(t)$ or its derivative, for Nikki's average rate of electricity use, in kW, between 9:00am and 3:00pm. Do not compute the average value.

Answer: $\frac{1}{6}\int_9^{15} N(t)\ dt$

c. [2 points] How much would Nikki pay the electric company for the energy used between 6:00pm and 9:00pm, if she installed the solar panels? Include units.

Answer: \$0.60

d. [4 points] How much would Nikki's electric bill be over this 24-hour period, if she installed the solar panels? The cost of energy supplied by the electric company and used by Nikki is added to the bill, and the amount the electric company pays Nikki is subtracted from the bill. Be sure to clearly show all of your work to receive full credit. Include units.

Solution: Amount of electricity taken from the grid: $12 + 3 + 9 = 24$ kWh
Amount of electricity sent back to the grid: $6 + 3 = 9$ kWh
This means Nikki will owe $24(0.20) - 9(0.05) = \$4.35$

Answer: \$4.35