LYCEE GAUDIER BRZESKA

Electrical energy in the home & community

Td

Year 20-20

P.TORSET

1 Application 1 - Electric energy consumption

a) Calculate the kWh power consumption of a 500W halogen spot running for 4 hours.

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b) The Millau viaduct is highlighted at night by 16 150W projectors each. The projectors are lit from 8 p.m. to midnight and from 6 a.m. to 8 a.m. Calculate the cost of consumption based on a rate of 0.10 euros/kWh

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2 Application 2 - Electric energy consumption

The Place de l'Étoile in Paris is composed of 12 crossroads lights, each with 6 light bulbs for cars and 4 light bulbs for pedestrians. The fires operate 24 hours a day, 365 days a year.

The lights currently operate with incandescent lamps with a power of 10W, they cost 4.60 euros to purchase and have a lifespan of 3 years on average.

The Paris City Council wants to replace these lights with Leds with a power of 1.6W which cost 15.95 euros to purchase and have a lifespan of 10 years on average.

The objective is to determine whether the operation to replace all the lamps at the crossroads is profitable after 10 years.

1) Calculate the investment for these two technological solutions.
2) Calculate the electricity consumption of each solution in kWh
3) Using the basic option kWh price of EDF's blue tariff (for subscribed power of more than 12 kVA), calculate the cost of consumption of both solutions
4) Taking into account consumption and investment, compare the two technological solutions. Does the Paris city hall have an interest in replacing all incandescent lamps in the light of the Place de l'Étoile with LEDs?

3 Application 3 - Electrical energy consumption

In his main home, an individual is fully equipped with electric energy. To simplify the study we will consider the two largest sources of expenditure: heating and hot sanitary water.

The apartment has 4 radiators of 750 W each and an electric water heater of 1800 W. The owner has subscribed to a blue fare option option /full hours at EDF with a power of 6 kVA.

In this contract, off-peak hours are set from midnight to 6 a.m. and from 1:30 p.m. to 3:30 p.m.
Heating works from 5 a.m. to 8 a.m. and from 5 p.m. to 9 p.m. on weekdays and from 9 a.m. to 9 p.m. on weekends. It is lit from October 15 to March 15.

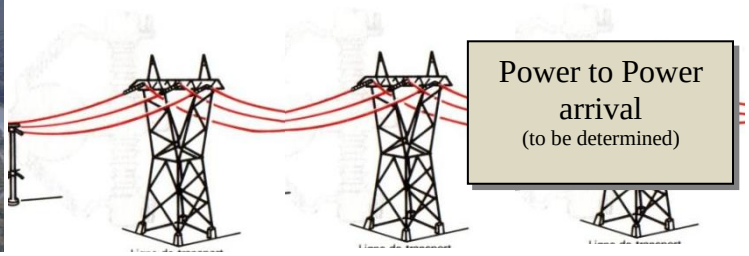
The electric water heater is programmed to engage during off-peak hours.

The owner shuts down the electrical system when he goes on vacation in August for 3 weeks.

1) How much does this installation cost the owner with his current contract?
2) How much would the same installation have cost him with a basic option contract?

4 Application 4 - Electricity transport

"Why transport electrical energy under very high voltage?"



Power to Power arrival
(to be determined)

Central
P_D - 120 MW

L - 30 km and U 400,000 V

It is proposed to study the transport of electricity under 240V (used voltage) and 400,000V commonly used by ERDF. To simplify the exercise, we assume that the current is monophase (2 wires only). One for the go and the other for the return.

Exercise data:

- The power supplied by the plant is 120 MW (P_D - 120 MW.)
- The transport voltage is 400,000 V.
- The length of the airline is 30 km.
- The section of the cable is S - 120 mm2
- The resistance of copper ρis $1.8.10^{-8}$ Ω m.

- Definition of cable R resistance:

$$R = \rho \frac{L}{S}$$

Resisting
The length of the cable
S - Cable Section

- Power formula :

$P = U \times I$

P - Watt Power
U - Tension in Volt
I - Intensity in Ampere

Work requested:

1. *Calculate cable strength (watch out forunits):*

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2. *Clight the intensity I in the cable for a voltage of U - 400,000V and then U-230V*

For 400,000V

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For 230V

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3. *Calculate online power losses (also known as **Pj-RI2 joule**loss) for each previously calculated value:*

For 400,000V

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For 230V

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4. *Calculate available power on arrival (Pu) and transportation performance η*

For 400,000V

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For 240V

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5. *Conclude on the results obtained*

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5 Application 5 - Electricity transport

"Why transport electrical energy in a three-phase?"

On wants to get a maximum loss of power in the cables of 2% which corresponds to 230 kW of losses per joule effect.
Is it better to use electricity in a three-phase or single-phase form: U - 15000 V or V - 8660 V

Exercise data:

The cables are made of copper: ρ17 10^{-9} Ω m.
The distance from the cables is 3 km.
The phase-shift (cos φ - 0.85)

1. *Calculate the starting power of the plant*

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2. *Complete the following table*

	Phase		Phase	
	Formula	Value	Formula	Value
Current I	$I = \frac{P}{V\ cos\ cos\ \varphi}$		$I = \frac{P}{\sqrt{3} \times U cos\varphi}$	
Resistance R	$R = \frac{P_j}{2 \times I^2}$		$R = \frac{P_j}{3 \times I^2}$	
Cable section	$S = \rho \frac{L}{R}$		$S = \rho \frac{L}{R}$	

3. *Conclude:*

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6 Application No.6 Electricity transport

The focus is on the transmission of electricity between a 900 MW nuclear power plant and a city 150 km away.

The transmission of electricity is done in 400,000 Volts, in alternating three-phase. A load that imposes a phase-out (cos φ -0.85) is considered.
Maximum eligible joule losses are 4% of the starting power.

1. *Calculate the section of cables needed to transport electricity.*

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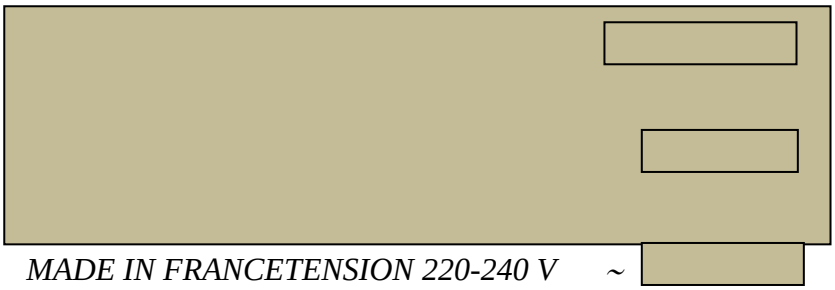
7 Application 7 - Electrical consumption

The owner of a 3-room apartment currently has a 6kW power contract.
His apartment is heated by an electric heating consisting of 5 identical radiators whose nameplate is given below.



The heating is started on October 15 and stays on until March 15.
A control system allows radiators to be turned on only from 6 a.m. to 8 a.m. (off-peak rate) and from 4 p.m. to 9 p.m. (full hour rate)

a) *What is the annual energy consumed by the heating system?*
b) *Based on EDF data, indicate the annual cost of this heating system. (This calculation must be made for both EDF's blue tariff options.*