

# Energy Management

## Practical lesson 4

Table 1 shows the regulated tariff schemes operating in Portugal for regular consumers in low voltage with low contracted power. The hours presented reflect the daily cycles of the dual and triple tariff for the Winter period. For simplicity, assume that it is the same for all the year.

Table 1 – Regulated tariff schemes for Baixa Tensão Normal and contracted power < 10.35 kVA

|         |         | Simple tariff   | Dual tariff (daily cycle Winter) |                 | Triple tariff (daily cycle Winter)                            |                 |
|---------|---------|-----------------|----------------------------------|-----------------|---------------------------------------------------------------|-----------------|
| Periods | All day | 0.1393<br>€/kWh | Peak: from 08:00<br>to 22:00     | 0.1551<br>€/kWh | Peak: 09:00 to 10:30<br>and 18:00 to 20:30                    | 0.1706<br>€/kWh |
|         |         |                 | Off-peak: 22:00 to<br>08:00      | 0.0833<br>€/kWh | Full: 08:00 to 09:00,<br>10:30 to 18:00 and<br>20:30 to 22:00 | 0.1442<br>€/kWh |
|         |         |                 |                                  |                 | Off-peak: 22:00 to<br>08:00                                   | 0.0833<br>€/kWh |

Table 2 – Contracted power costs for the regulated simple, dual and triple tariffs

| Contracted power (kVA) | €/day  |
|------------------------|--------|
| 3.45                   | 0.1748 |
| 4.60                   | 0.2268 |
| 5.75                   | 0.2788 |
| 6.90                   | 0.3308 |

1. The Silva family intends to buy a refrigerator, selecting the following two in a supermarket:

- Brand Bosch (model KDV29V13): Volume of refrigeration and freezer of 199 l and 68 l; Price 399 €; Energy classification of A+; Annual consumption 250 kWh/y.
- Brand Samsung (model RT25): Volume of refrigeration and freezer of 161 l and 56 l; Price 319 €; Energy classification of B; Annual consumption 423 kWh/y.

Assuming that the daily power consumption of a refrigerator is 25% off-peak (vazio) and 75% in peak hours (não vazio), give aid to the Silva family in respect of electrical consumption:

- Best solution for simple tariff
- Best solution for dual tariff
- In how many years would the additional investment be paid off?

2. Identify the best heating solution for a house with the following heat needs:

- 0 kW between 22h00 - 8h00; 4 kW between 8h00 - 10h30; 2 kW between 10h30 - 18h00; 4 kW between 18h00 - 22h00

Solution A is electric heating by heat accumulation. The consumption is done during off-peak, releasing heat during the day. Solution B is based on heat pump heating with a COP of 2. Consider that the house has a contract of 6.9 kVA and triple tariff with daily cycle.

- a) What is the electrical power required in each solution?
- b) What is the most economical solution?
- c) And what if the tariff scheme was simple instead of triple?

3. António moved to a new apartment and decided to change the lighting of the living room. He is contemplating the following options:

- 1 Incandescent light bulb of 100 W: unit cost of 0.60€ and life time of 1000h.
- 5 Halogen light bulbs of 50 W: unit cost of 1.45€ and life time of 4000h.
- 1 Fluorescent light bulb of 25 W: unit cost of 6.45€ and life time of 8000h.

Assume simple tariff and 4h of daily use.

- a) If António rents the house for half year, what lighting should he choose?
- b) And if he buys the house?
- c) If the contract is dual tariff and all consumption occurs in the “Off-peak” period, would each of the previous decisions change?

4. The heating of a house can be done by one of the following methods:

- Electrical heating using the Joule effect
- Central heating (burning natural gas in a furnace with a 90% efficiency)
- Heating using a heat pump with COP = 3

Suppose that electricity has a production efficiency of 50% and costs 0.1373 euros per kWh. Consider also that natural gas is transported with a 99% efficiency, has a PCS of 39 MJ/m<sup>3</sup> and costs 0.8 € per m<sup>3</sup>. Compare the alternatives in terms of primary energy, final energy and cost for 1 kWh of thermal energy.

5. The average daily electricity consumption of a family is the following:

- Washing machine: 0.6 kW between 20h00 – 21h00; 0.1 kW between 21h00 – 22h00.
- Dishwashing machine: 0.7 kW between 20h00 – 21h00; 0.6 kW between 21h00 – 22h00.
- Rest: 0.8 kW between 00h00 – 01h00; 0.6 kW between 01h00 – 08h00; 1.2 kW between 08h00 – 11h00; 1.4 kW between 11h00 – 18h00; 2.0 kW between 18h00 – 20h00; 3.0 kW between 20h00 – 23h00; 2.0 kW between 23h00 – 24h00.

- a) What should the contracted power be for this family? Assume that 0.9 kW = 1 kVA.
- b) How much would the family spend per year if they had a simple tariff scheme?
- c) Should the family have dual tariff?
- d) If the family shifts all the consumption of the washing and dishwashing machines to the 01h00 – 03h00 period, how much would they be able to save?