

A FEW YEARS EXPERIENCE OF ENERGY CONSUMPTION OF A HIGH SCHOOL IN BUDAPEST

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**ARPAD Secondary Grammar
School – 2015
(founded in 1902)**

Aims of this work

Presentation of the energy data – appearance in the field of education

The analysis of the data

Interpretation of the data using didactic examples

Energy-saving options

Features of the building

- No air-conditioning
- Central heating – District Heating Plants of Budapest
- Electric power – Budapest Electricity Works Company

Data for energy consumption

Consumption of electrical and thermal energy -
based on meter readings

Period: April 2012 – March 2015

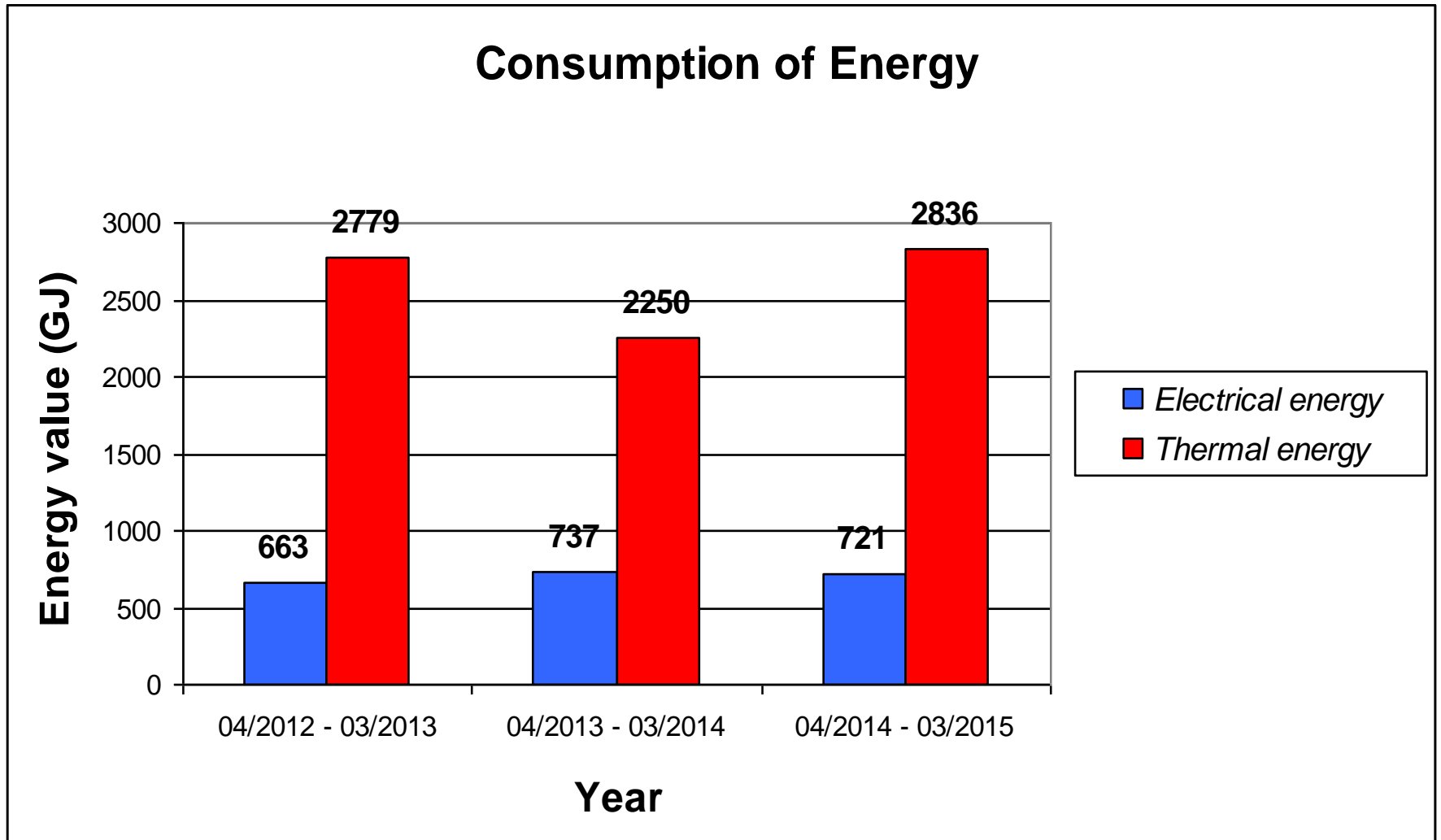
All types of energy in GJ unit

Show details:

Annual and quarterly data charts

Energy values per class and per capita

ANALYSIS AND INTERPRETATION OF DATA



- ratio of electrical and thermal energy → **1:4**



1:3



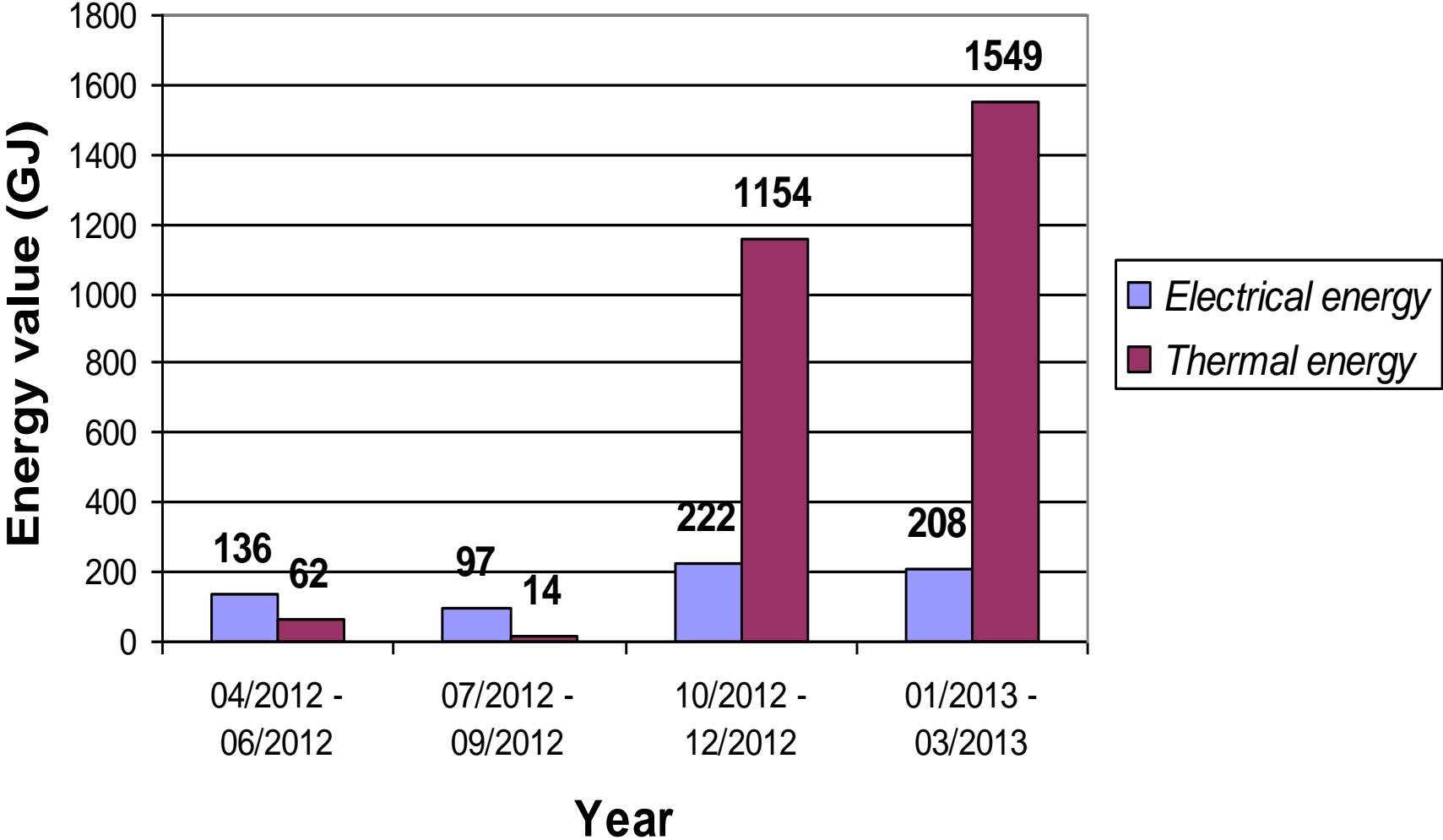
mild winter (2013-14) – temperature 2.5°C
higher than the average

- electrical energy consumption increased

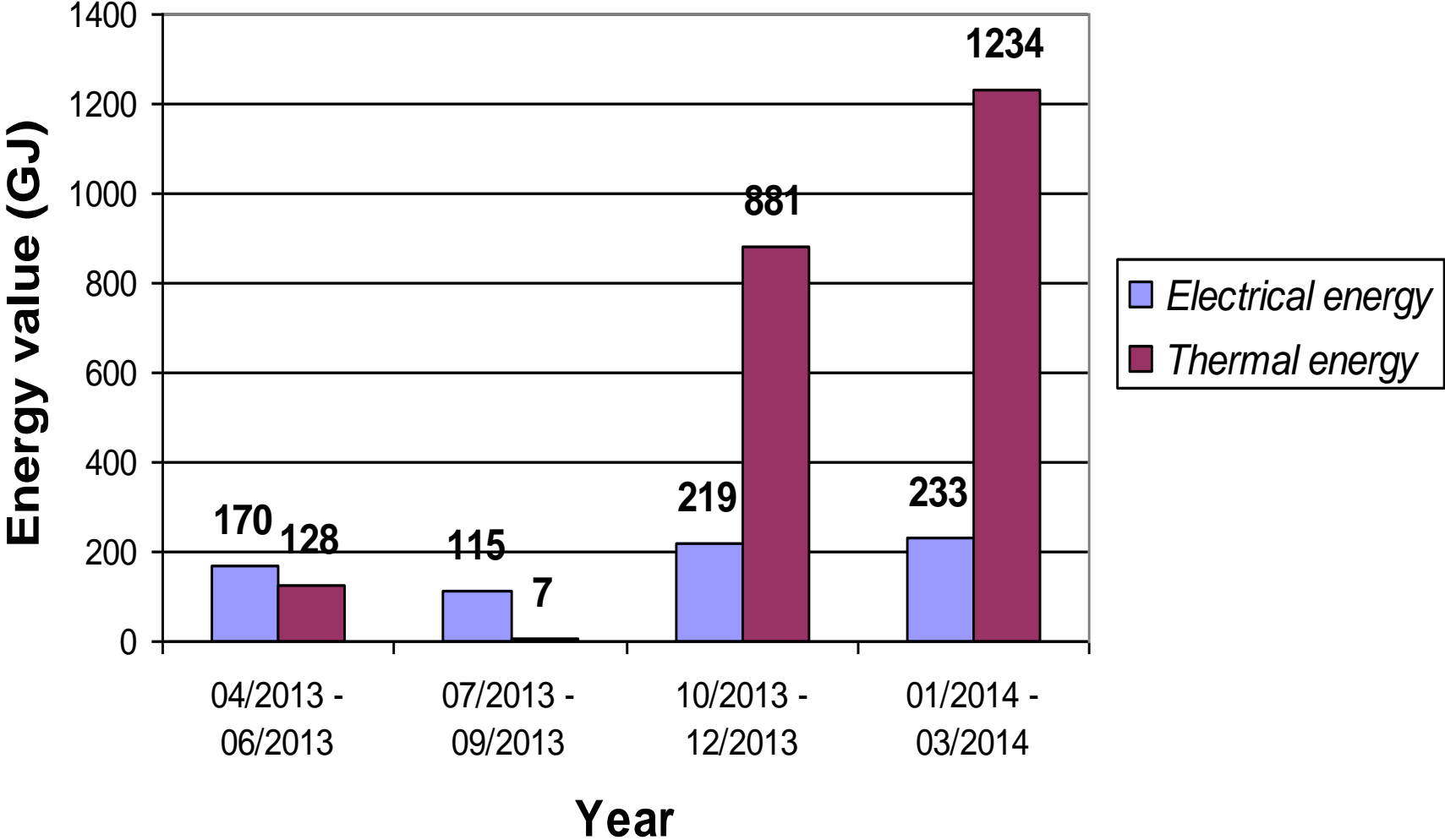


new IT room

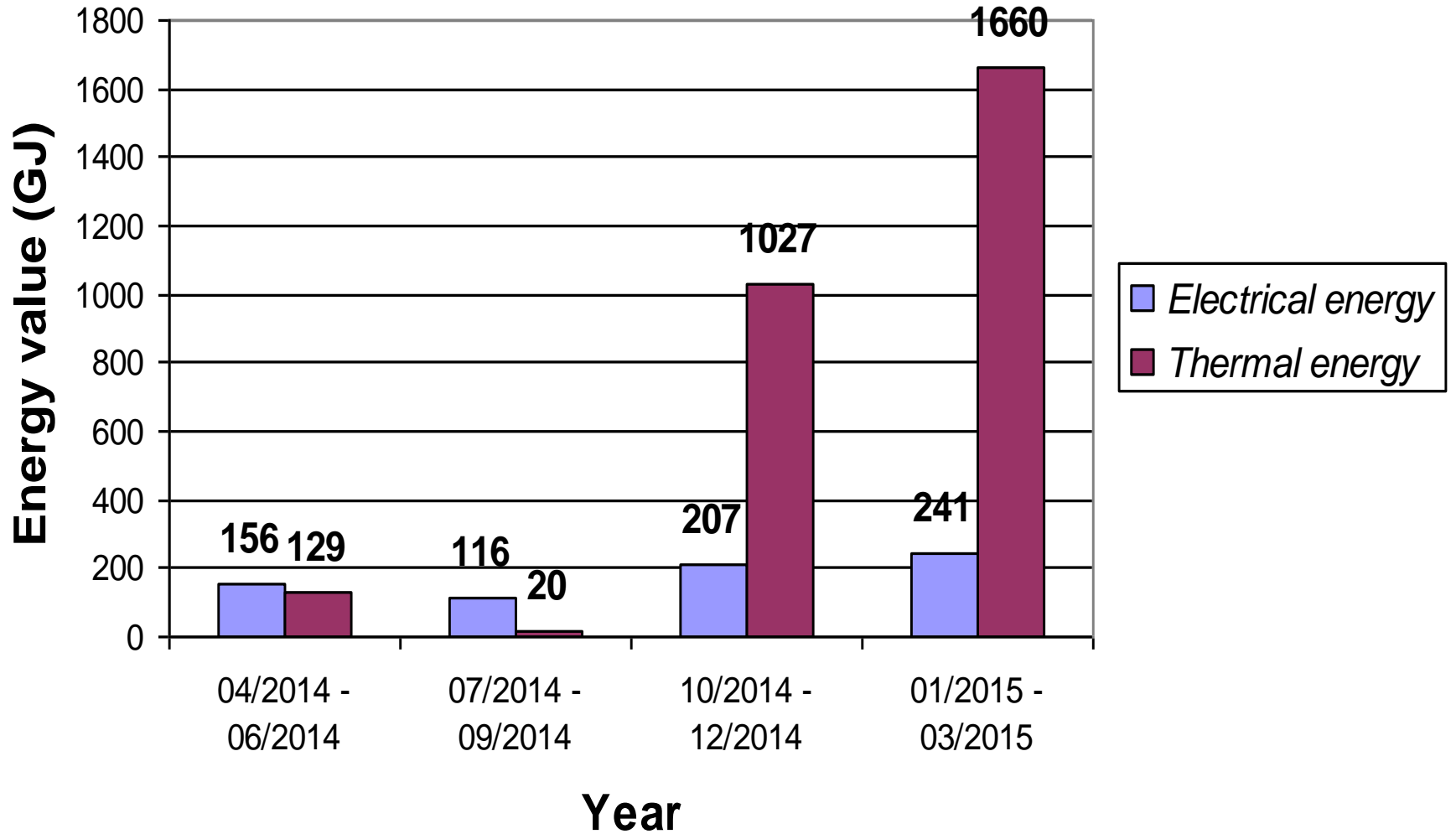
Consumption of energy



Consumption of energy



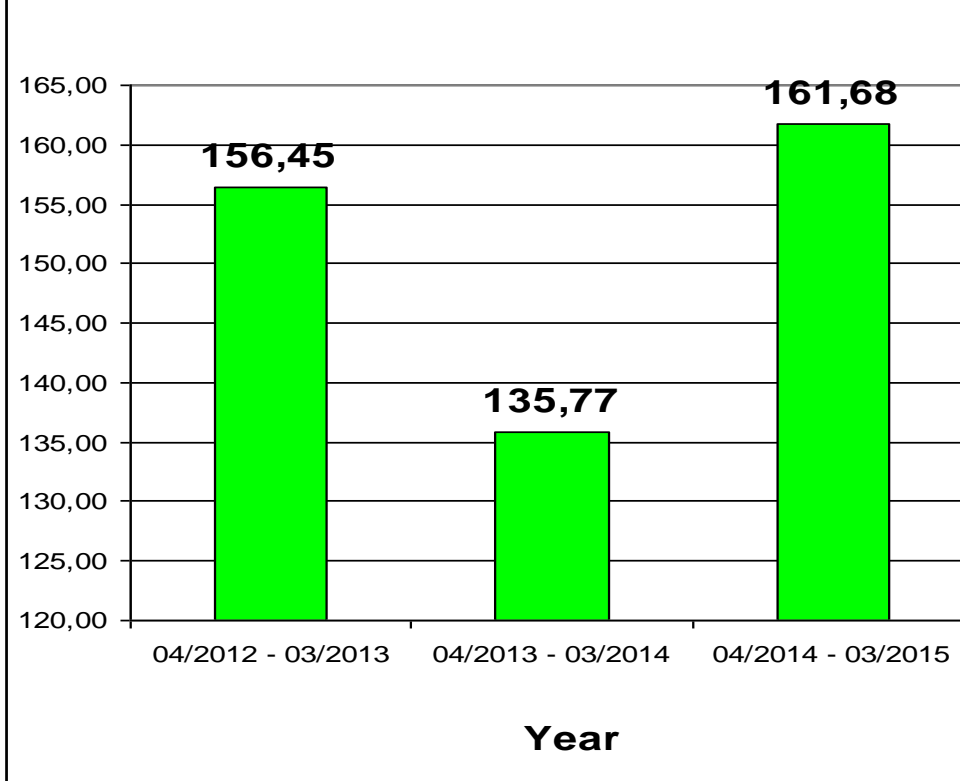
Consumption of energy



- periodicity
- separable seasons
- 5-7 times more thermal energy was used in autumn and in winter

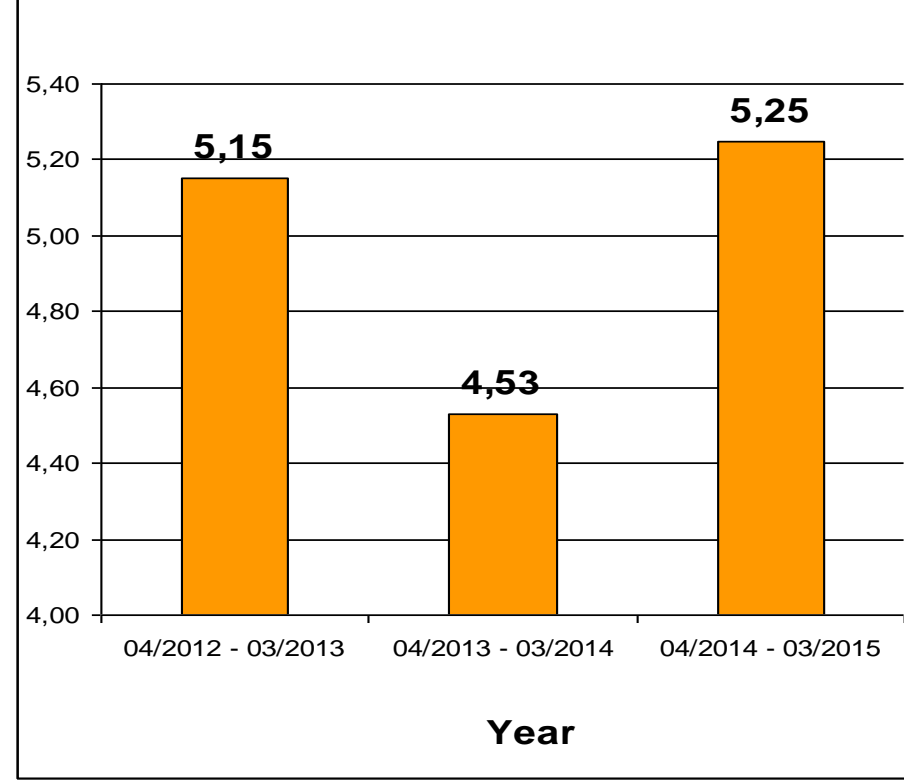
Cumulative annual energy value per class and per capita

Energy value per class (GJ)



≈ 3000 €

Energy value per capita (GJ)



≈ 100 €

TASK

- The human body can use 200 kilo calories during 10 minutes on an exercise bike in case of uniform load. Calculate how much work can be done by a high school student during half an hour on it?



ANSWER

$$Q = 600 \text{ kcal} = 2520 \text{ kJ} = 2,52 \text{ MJ}$$

$$\eta = 0,25 \text{ (Source: Internet)}$$

$$W = \eta * Q = 0,25 * 2,52 \text{ MJ} = \mathbf{0,63 \text{ MJ}}$$

$$\Sigma W = 30 * 0,63 \text{ MJ} = \mathbf{18,9 \text{ MJ}}$$

What is it sufficient for?

$$\Sigma W = E = 18,9 \text{ MJ} = 18900 \text{ kJ} = 18900000 \text{ J}$$

$$P = 900 \text{ W}$$

$$t = \Sigma E / P = 18900000 \text{ J} / 900 \text{ W} = 21000 \text{ s} \approx \mathbf{5,83 \text{ h}}$$

Time is needed to produce the energy
value per capita

$$\Sigma E = 5 \text{ GJ} = 5000 \text{ MJ}$$

$$E = 0,63 \text{ MJ}$$

$$x = \Sigma E / E = 5000 \text{ MJ} / 0,63 \text{ MJ} \approx 7936 \text{ half-hour unit}$$

$$\Sigma t \approx 3968 \text{ h} \approx 165 \text{ day (without interruption)}$$

Achievable?

CONCLUSION

NOT!



Depending on physical condition



***About two orders of magnitude
difference***

Energy-saving options

Switching off unnecessary lights?

Central heating → Gas heating? -
Is it worth?

Alternative sources of energy?

- Geothermal energy
- Photovoltaic system

What quantity of burning natural gas would produce as much thermal energy as the school needs in a year?

$$\Sigma Q = 2800 \text{ GJ} = 2800000 \text{ MJ}$$

$$\eta = 0,85$$

$$L = 34 \text{ MJ/m}^3$$

$$V = \Sigma Q / (\eta * L) = 2800000 \text{ MJ} / (0,85 * 34 \text{ MJ/m}^3)$$

$$\approx 97000 \text{ m}^3$$

Price is about 72% of total heating costs!

PHOTOVOLTAIC SYSTEM

≈ 30 MWh ≈ 108 GJ



SUMMARY

Presented and summarized energy data

Interpreted data

**Compared them with human power →
application in physics teaching**

**Vision – energy-saving options, alternative
energy sources → didactic task**



raising awareness of students

POSSIBLE?



There is always
HOPE.

THANK YOU FOR
YOUR ATTENTION!