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DemEcol22 Democracy an Ecology

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AWARENESS CAMPAIGN AT SCHOOL ABOUT THE SOCIO-ECONOMIC AND ENVIRONMENTAL COSTS OF ENERGY:

"HEATING LOSS DUE TO CLASSROOM VENTILATION"

OBJECTIVES

This is the report of the data obtained on the loss of energy that occurs when ventilating classes in winter in 5 educational centers in Germany, Austria, France, Hungary and Spain, all of them belonging to the Erasmus+ DemEcol project. Opening the windows of the classrooms to ventilate preserves the health of people who are in them, and this mandatory action may result in a loss of energy from which conclusions can be drawn on unnecessary energy expenditure, and therefore, the importance of reduce any type of unnecessary consumption.

This measurement will be used as an awareness campaign in schools, so that students can draw their own conclusions about the consequences of energy waste, the economic loss it represents and how important it is to reduce it from the perspective of climate change, when translating this energy waste in carbon dioxide (CO_2) emissions when the energy source comes from the burning of 100% fossil fuels.

PROCEDURE

For this, **the procedure was carried out as follows**:

A. **Sampling method or procedure (measurements collection).**
    a. Measurements were done in December-January to make sure that temperatures are low .
    b. The first measurement of temperature was made at the moment the students arrived in the morning to school and before the start of the first

class (indoor temperature should have reached 19 or 20 degrees, following the energy policy stated in each country, but it was good to measure it to increase the accuracy of these calculations).

We entered the value in column T0 within the enclosed Excel document.

c. At the end of the first class, windows were opened to allow a fresh air exchange to happen (over 5 minutes or the time period estimated to do it properly, because classroom volumes are different in each country).

We measured the temperature again and registered it in column T1.

d. The diference T1-T0 is the ΔT column (the formula was already included within the Excel document).

B. The way we obtain the energy loss through the decrease of temperature is explained below.

a. Calculations for the volume of the classroom (V):
Example. 10 meters length x 5 meters width x 3 meters high= 150 m^3

b. Calculations (also introduced within the Excel document), depended on the volume of the measured room.

1. Air density (d=1.225 kg/m^3). It depended on the height and temperature but we took the value at sea level and 15ºC.

2. Air heating capacity (c=1,012 Joules/Kg)

3. Mass (m)= d x V = 1.225 kg/m^3 x 150m^3= 183.75= 184 kg.

4. 1 kWh is the equivalent energy to 1 kW during 1 hour
1 kWh=(1,000 Joules/second) x 3,600 seconds= 3.6 x 10^6 Joules.

c. Decrease in temperature: T0=19 degrees and T1= 16 degrees.
ΔT= 3 degrees

d. Applying the formula:
Q= m x c x ΔT = 184 x 1,012 x 3 = 558,624 Joules

e. Then, energy consumption for a decrease of 3 degrees is as follow:
Q= 558,624 Joules x (1kWh/3.6 x 10^6 Joules) = 0.155 kWh

f. If this procedure is repeated over 5 days, an average is obtained for energy loss (see the Excel document). Example:

Day 1 (TO=19 and T1= 16 degrees), ΔT1= 3 degrees. Q= 0.155 kWh

Day 2 (TO=19.5 and T1= 15 degrees), ΔT1= 4.5 degrees. Q= 0.233 kWh

Day 3 (TO=19.0 and T1= 14 degrees), ΔT1= 5 degrees. Q= 0. 259 kWh

Day 4 (TO=19.0 and T1= 15 degrees), ΔT1= 4 degrees. Q= 0.207 kWh

Day 5 (TO=19.1 and T1= 16 degrees), ΔT1= 3.1 degrees. Q= 0.160 kWh

Average = (0.155 + 0.233 + 0.259 + 0.207 + 0.160)/5 days = 0.203 kWh are lost each time that the windows are opened to allow the indoor air exchange.

g. kWh lost in every single opening are multiplied by the number of times the windows are opened per day for ventilating, and again, multiply this value by the number of school days with central heating per year. In this way, the number of kWh per year that are lost by opening the windows to ventilate the classroom are calculated.

h. Then, students can multiply this value of the cost of energy per kWh and multiply by the total of classrooms at school. They can calculate the amount of energy and money that are spent by respecting mandatory rules at school (CO2 is toxic and cannot be stored at high concentrations when people stay there, that is why this rule is mandatory, to preserve the health of the students). Then teachers can explain that any innecesary use of the energy at the school can be avoided and name many other ways of wasting energy at school.

i. It was possible, with a sensor of CO_2 or O_2, to fit better the opening period, seeing how long it takes for the classroom to reach the initial CO_2 or O_2 levels (before the start of the first class in the morning), reducing innecessary waste of energy and complying with the ventilation law.

Air temperature was measured in the colder periods (December 2022 to January 2023 in all schools), performed by the students that take part in the project. After the meeting in Eisenberg (Germany), they will be responsible for showing the results to their respective school communities, to complete the objective of this study, which is to raise awareness among students about the unnecessary waste of energy resources, not only at school but in their daily life.

RESULTS

The main results obtained are:

1. In the present study, there were differences in the schools where the measurements of temperature loss due to classroom ventilation were carried out. Table 1. shows these differences regarding the number of daily openings, number of classrooms per school and kWh prices per country.

COUNTRY	Nº of OPENINGS	Nº of CLASSROOMS	KWh PRICE (Euros)
AUSTRIA	6	30	0.2335
SPAIN	6	42	0.2485
FRANCE	2	62	0.1740
HUNGARY	5	51	0.1456
GERMANY	5	30	0.2566

Table 1. Differences in number of openings, classrooms, and kWh price among schools.

2. The average temperatures measured before ventilating in the 5 schools fluctuate between 19.4ºC (France) and 22.6ºC (Hungary). Figure 1.

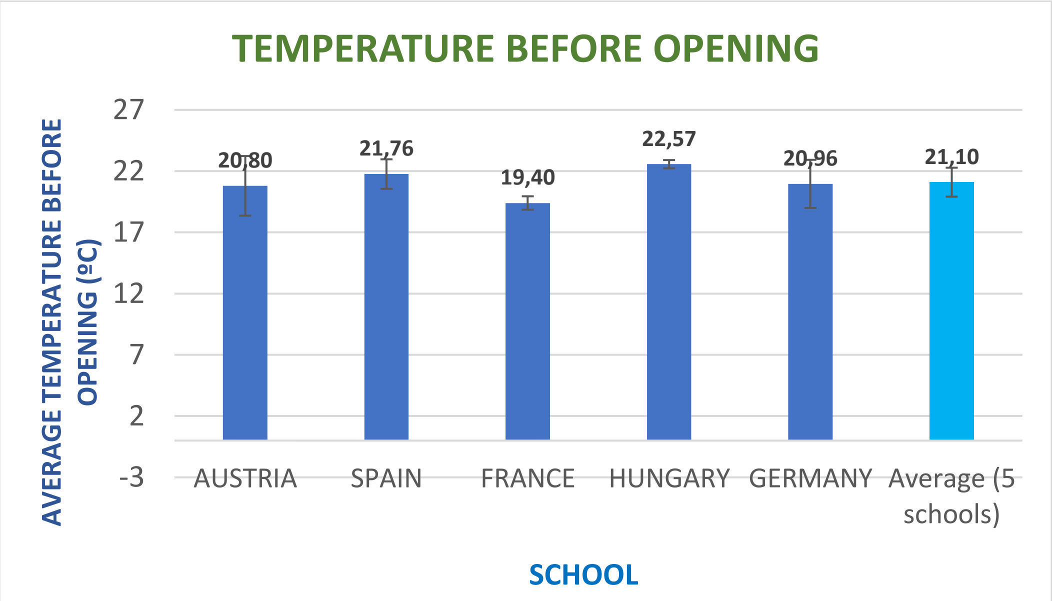

Figure 1. Average temperature before opening in each school.

3. Except for the Hungarian school, the temperature losses generated in the other schools by the opening of windows for the ventilation of the classrooms, are not significantly different from each other, their value being higher than three degrees Celsius. In the Hungarian school, this value is reduced to less than half (Figure 2). In average, a temperature loss of 2.81ºC was registered in the five countries each time that the windows were opened (Figure 2).

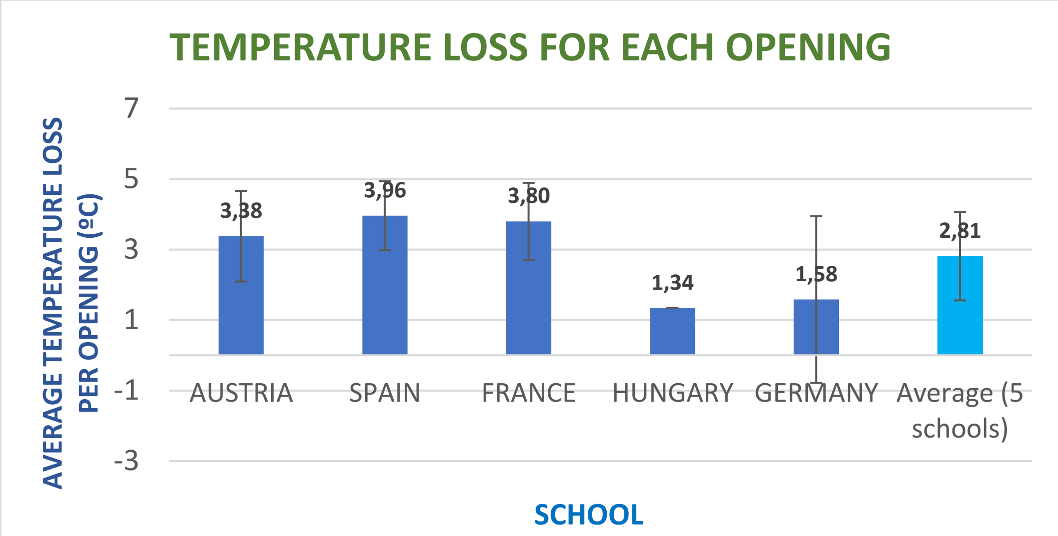

Figure 2. Average temperature loss for each school and considering all of them.

4. Despite the differences in number of openings and number of classrooms, there were no huge differences in energy loss. The lowest value for energy consumption (in kWh), was Austria (3,771) and the country spending the most was Spain (5,783). On average, the energy loss was 4,557 kWh and in total, 22,785.39 kWh consumed across the five countries just by opening the windows for ventilating (Figure 3).

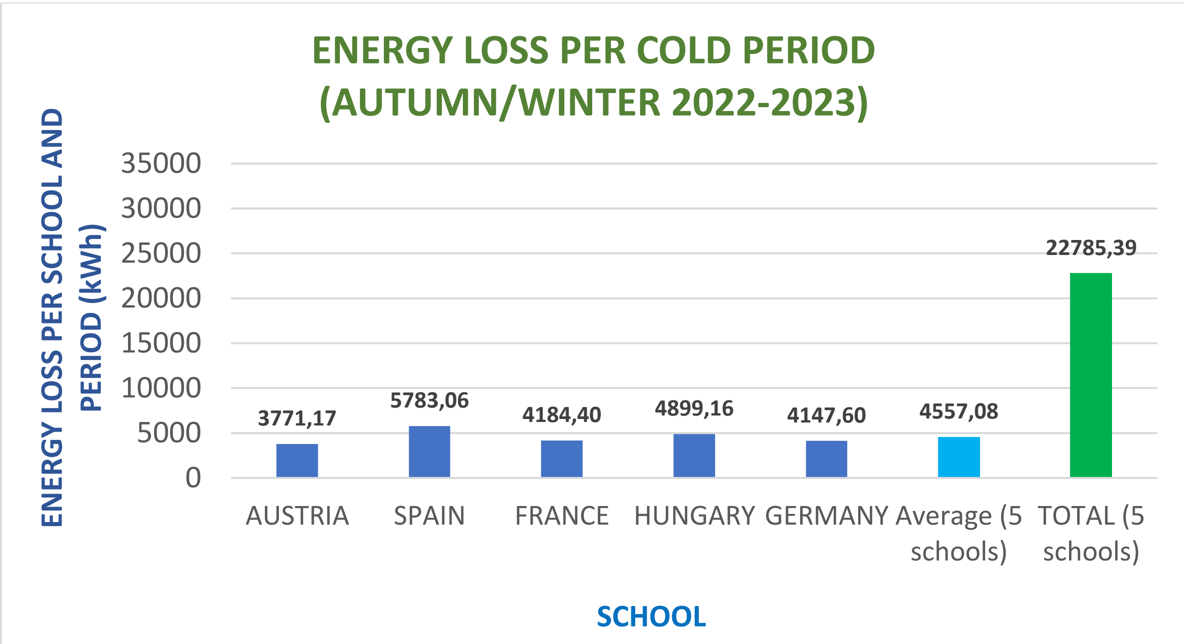

Figure 3. Energy loss in each school, average per school and considering the total energy loss.

Figure below also shows the differences between kWh price (in euros) across the 5 countries.

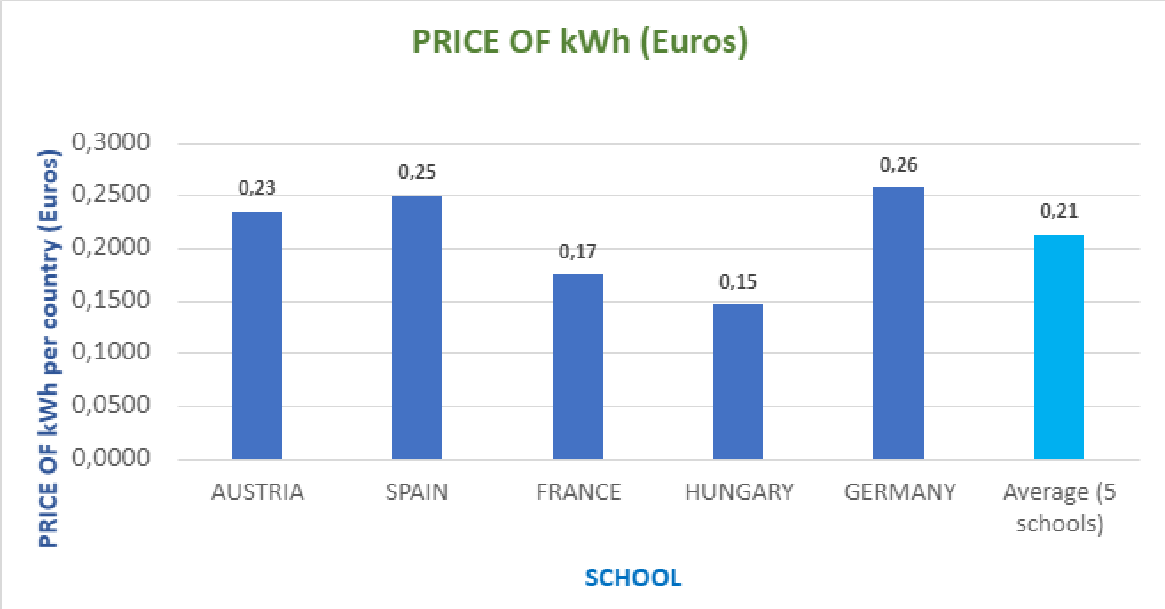

Figure 4. Kwh price in each country.

Figure 5. shows money expenditure (per country and total cost for the 5 schools), in euros. Expenditure varies between 713.17 and 1,437 euros (Hungary and Spain respectively). The average expenditure per country would be 964.64 euros and the estimated total expenditure in the 5 countries, around 4,800 euros.

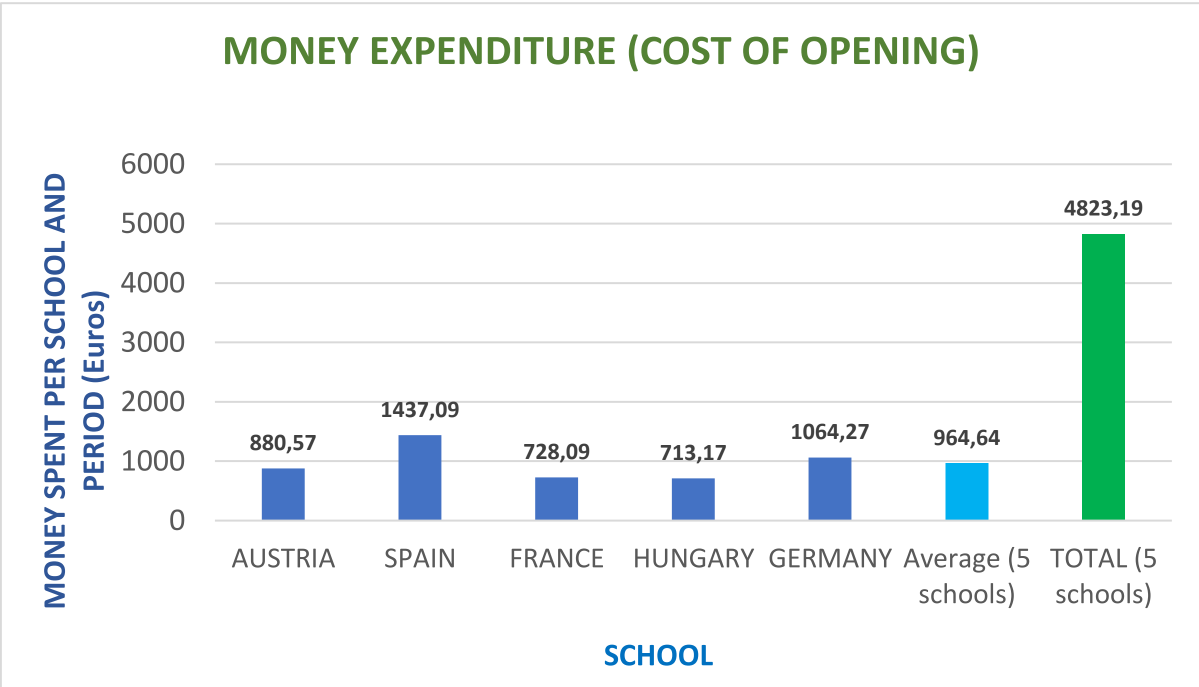

Figure 5. Money expenditure estimated in each school, in average and the total for the five schools.

In the case of all energy expenditure would come from non-renewable resources (which, in fact, is not true; for instance, France relies on nuclear power, 60%, which is not releasing carbon dioxide (CO2) when is producing energy, and about 26 % of energy in Navarra is coming from renewables, wind power mainly), the amount of this greenhouse gas released to the atmosphere would be more than 18,300 kilos (Figure 6).

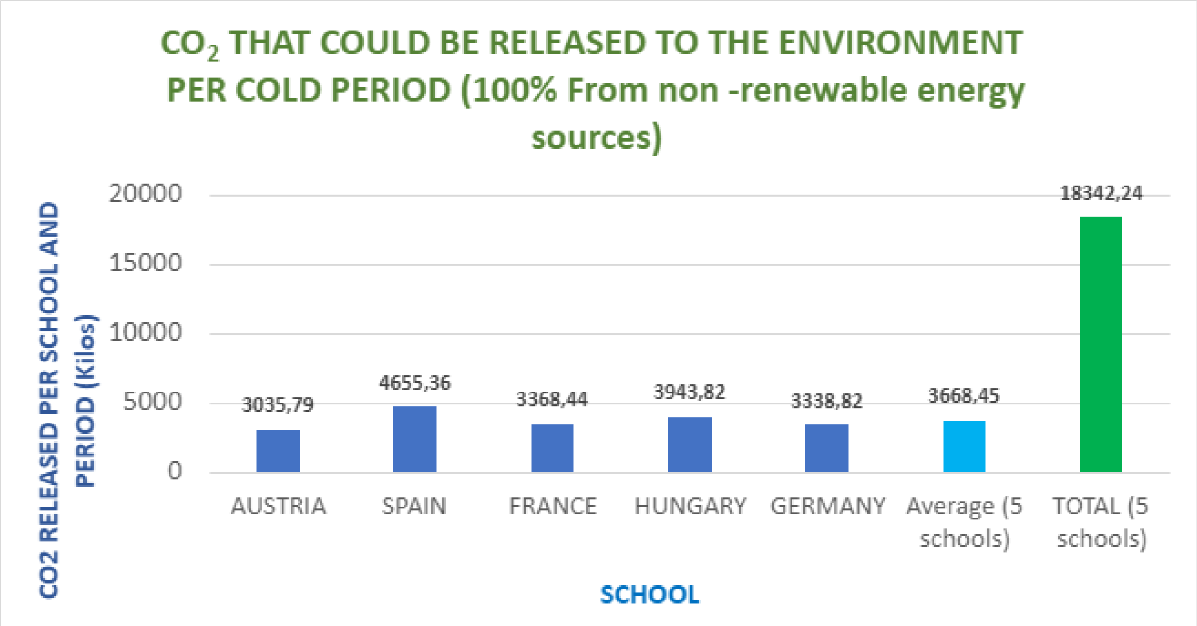

Figure 6. Carbon dioxide released by non-renewable resources as source of the kWh expenditure.

CONCLUSION

The purpose of this study was to demonstrate with data, the way in which small actions that may represent an energy loss, can translate into a significant impact, not only economic but also environmentally.

Throughout these Erasmus+ Meetings, students from 5 countries have learned the costs and impacts of different energy models from different perspectives.

Energy is not free, energy has costs (e.g. carbon dioxide, money, soil and biodiversity losses...) and this is why we must value it more. The global increase in energy demand, its projections for 2030 and 2050 mean that we should not waste this resource (Figure 7).

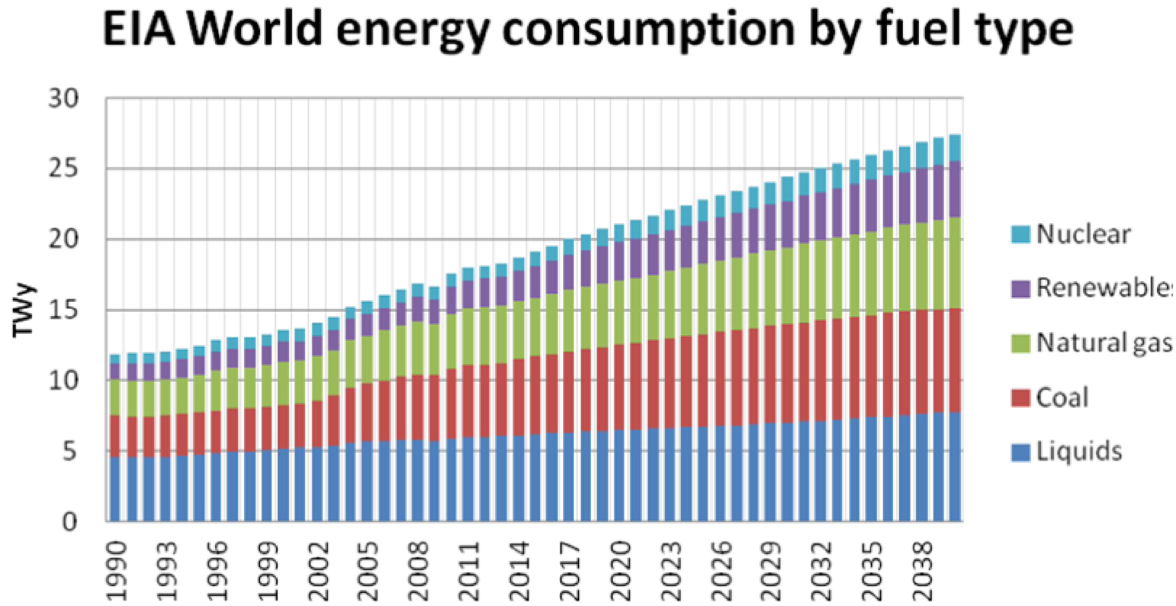

Figure 7. Energy demand by 2030 and 2050 (Sources: EIA, Energy Information Administration and Li, 2017)

These losses come from the electric resource, renewable or not, from which they come, and the planet where we inhabit, is limited.

If only to open the window and let fresh air in to preserve the health of scholar communities and improve their conditions in the classroom is translated in the results of the present study, we can imagine the costs of actions such as not turning the light off, leaving appliances that we are not using on, at school, in our homes, cities or countries, in the world?

This is the reflection for the awareness campaign proposed by the partners that carried out this study within the Project DemEcol from Erasmus+.

REFERENCES

Energy Information Administration (EIA). EIA projection of world energy growth in consumption by fuel type with historical data up to 2013. DOE/EIA-0484(2012) http://www.stratosolar.com/2050-world-energy-sankey-diagram.html

Li, M. (2017). World Energy 2017-2050: Annual Report. Retrieved form https://seekingalpha.com/article/4083393-world-energy-2017minus-2050-annual-report