## Proposal by San Cernin School, Pamplona

**How to proceed with the temperature measurements in the classrooms:**
Creating Student awareness about the energy consumption that is produced by ventilating classrooms between classes as required by law to preserve the health of students.

### A. Sampling method or procedure (measurements collection).

a. Measurements have to be done in December to make sure that temperatures are low .
b. The first measurement of temperature is made at the moment the students arrive in the morning to school and before the start of the first class (indoor temperature should reach 19 or 20 degrees, following the energy policy stated in each country, but is good to measure it to increase the accuracy of these calculations).

Enter the value in column T0 within the enclosed Excel document.

c. At the end of the first class, windows are 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).

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

Measure the temperature again and register it in column T1.

### 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), depend on the volume of the measured room.

1. Air density (d=1.225 kg/$m^3$).
2. Air heating capacity (c=1,012 Joules/Kg/)
3. Mass (m)= d x V = 1.225 kg/$m^3$ x 150$m^3$= 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.
    1. 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. Multiply this value by the number of times you open the windows per day and again, multiply this value by the number of school days per year, 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 neme many other ways of wasting energy at school.

i. If you are brave enough, with a sensor of $CO_2$ or $O_2$, you can 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.

*by Arantxa Hernández, San Cernin*