How we made our sensor

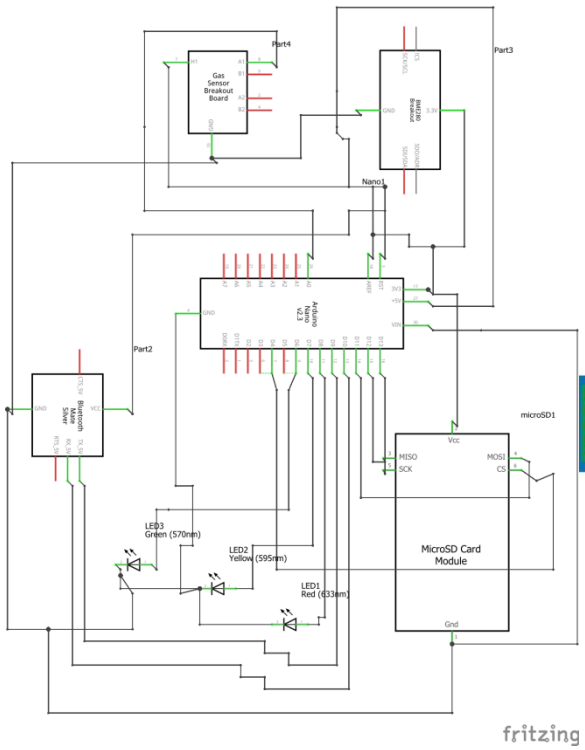
1. Modules used

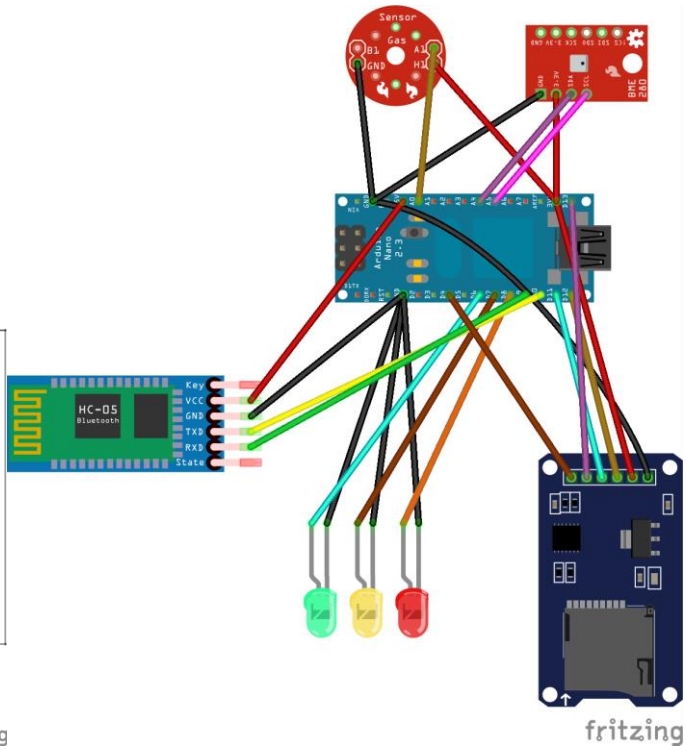
   - Arduino Nano
   - Sensor
   - MQ-135
   - Bluetooth Module
   - SD card Module
   - Leds






2. Assemble the circuit



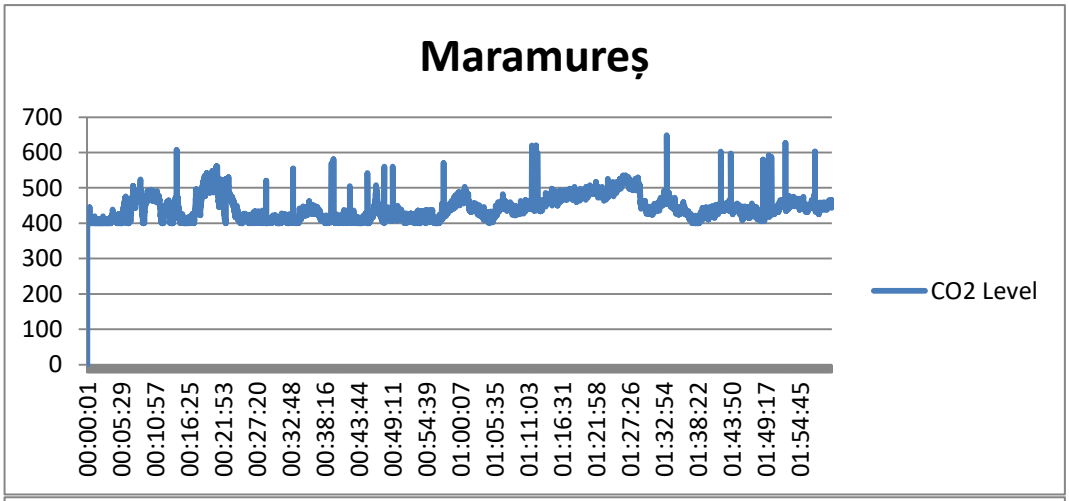


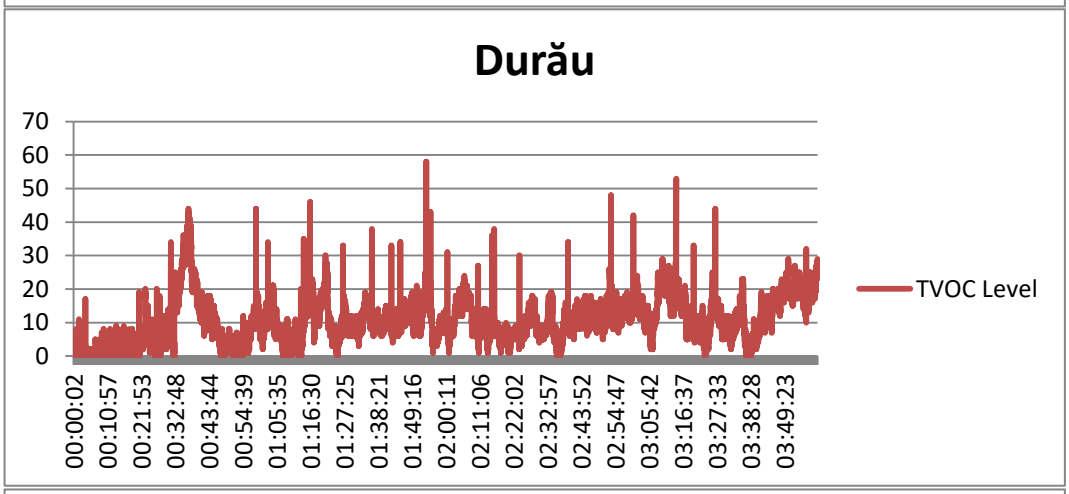
3. Write the code

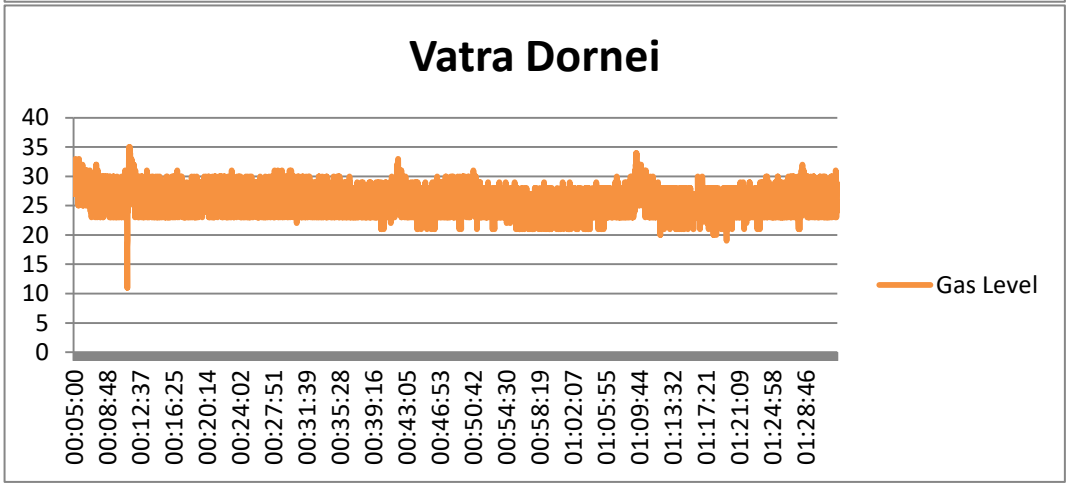
4. Take measurements

We wanted to detect what the sensor is capable of

Before making an analysis about air pollution, the well-known climate change and how the human can reverse it or slow it down, we have to examine how clean the air in some places is. For example, we went in three different mountain-surrounded areas, where we measured the followings:



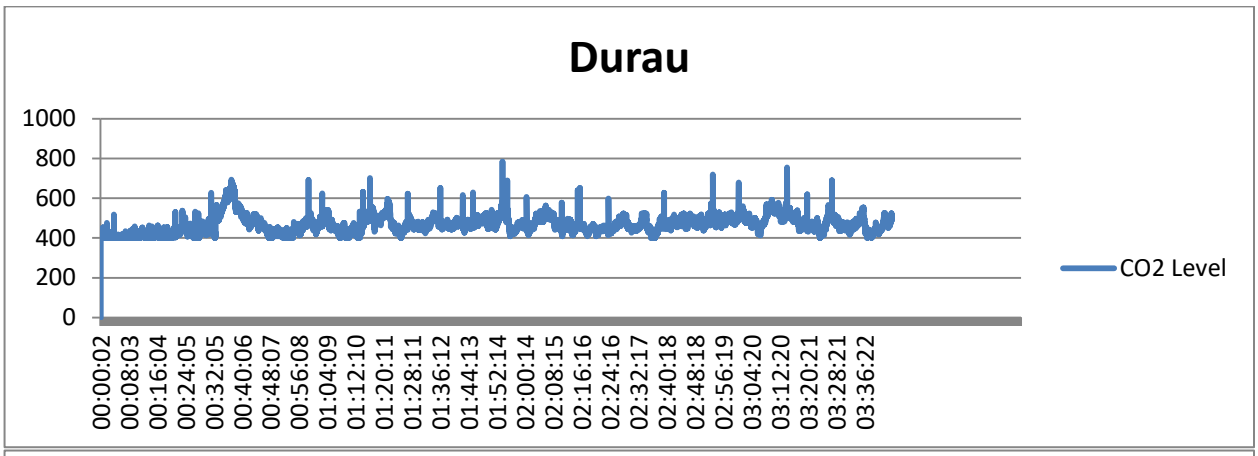


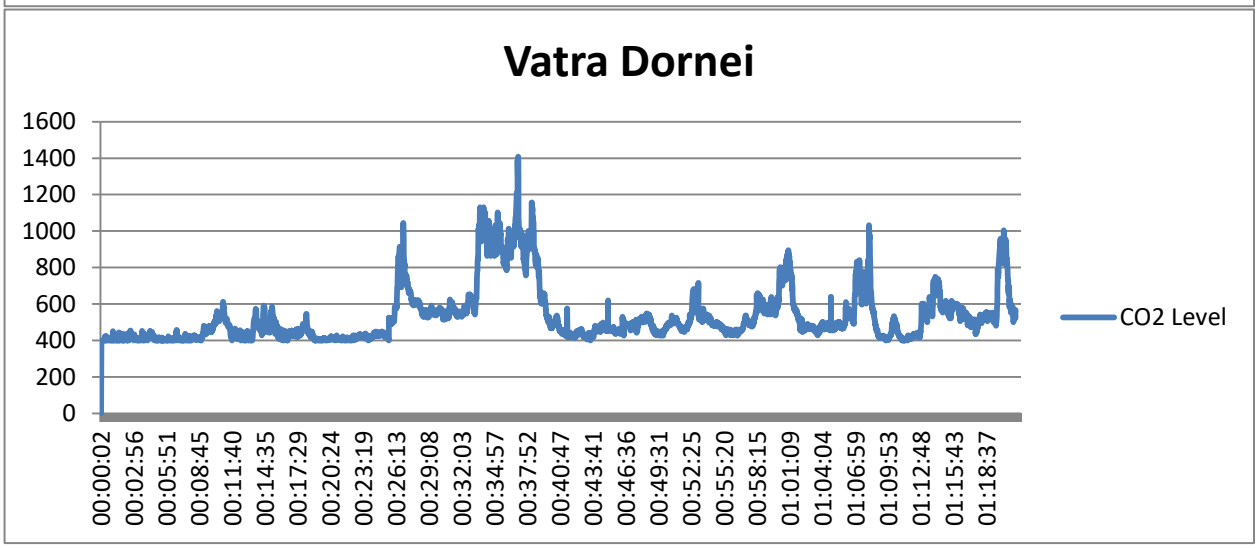


Time for testing

We wanted to show how clean the air is in different places far from the city. However, we didn't take in consideration an important factor: the smoker.

Thus, we can notice what the effect of smoke to the nature is.

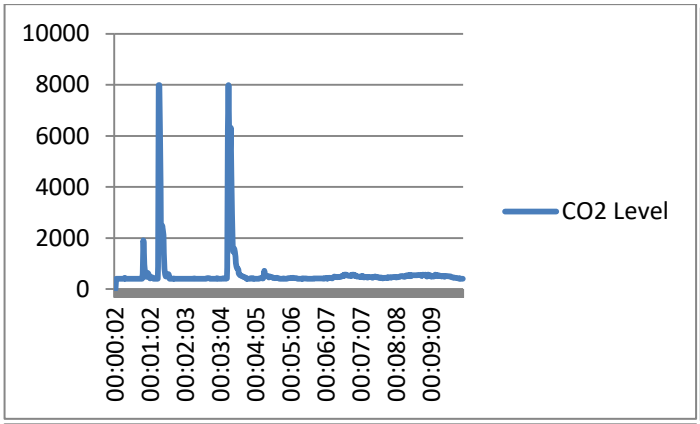


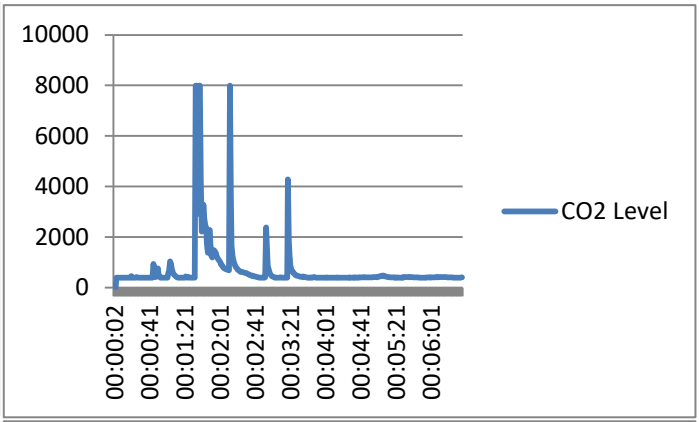


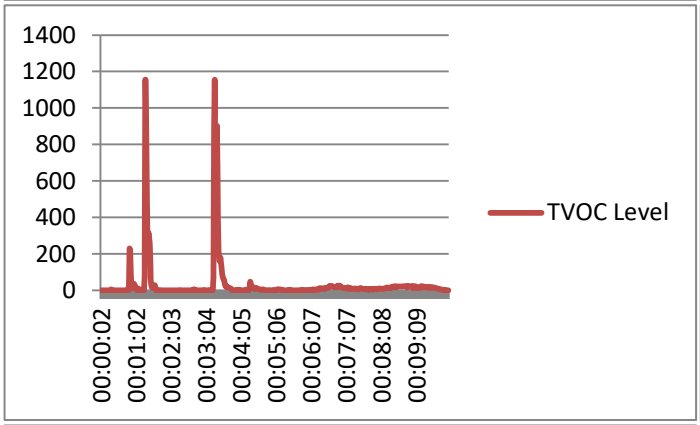
Smoking; bad just for you or for everybody?

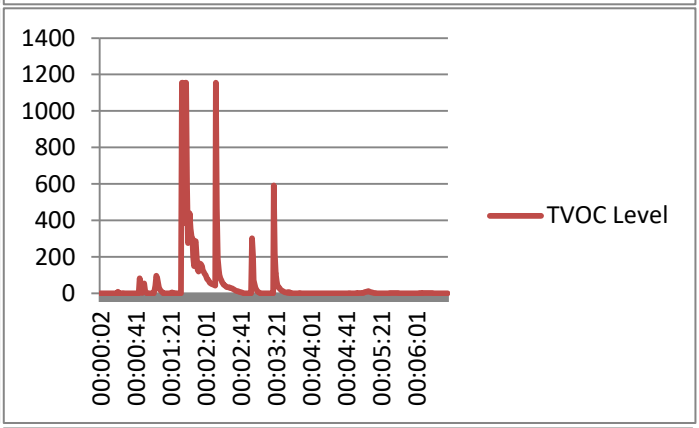
Those measurements show how dangerous passive smoking is. While I was talking with some friends in a smoking lounge for about 10 minutes on 2 different days, I took data in order to analyse it. Those spikes come from blowing smoke directly into the sensor, as if you were talking pretty close to somebody that just smoked a cigarette.

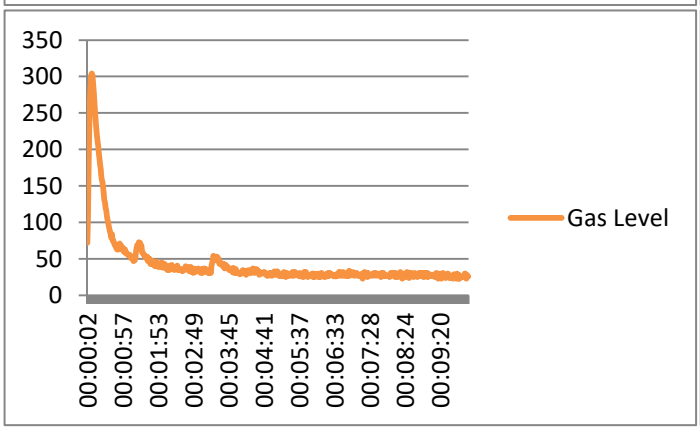
In normal conditions, the **CO2** level should be around 400 ppm (parts-per-million), the **TVOC** level should be between 300 and 500 ppb and the **gas** level should be around 30.

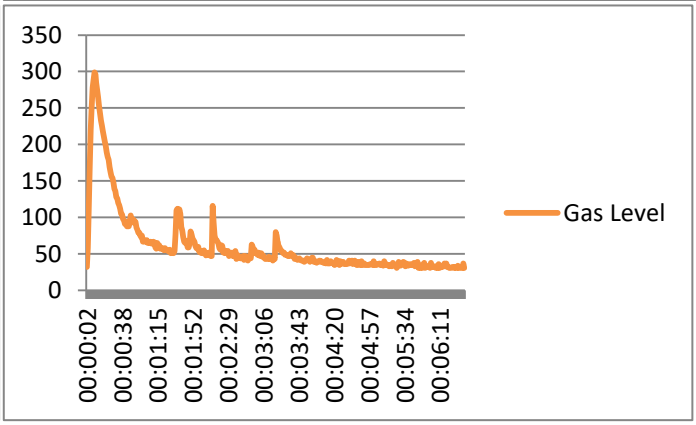






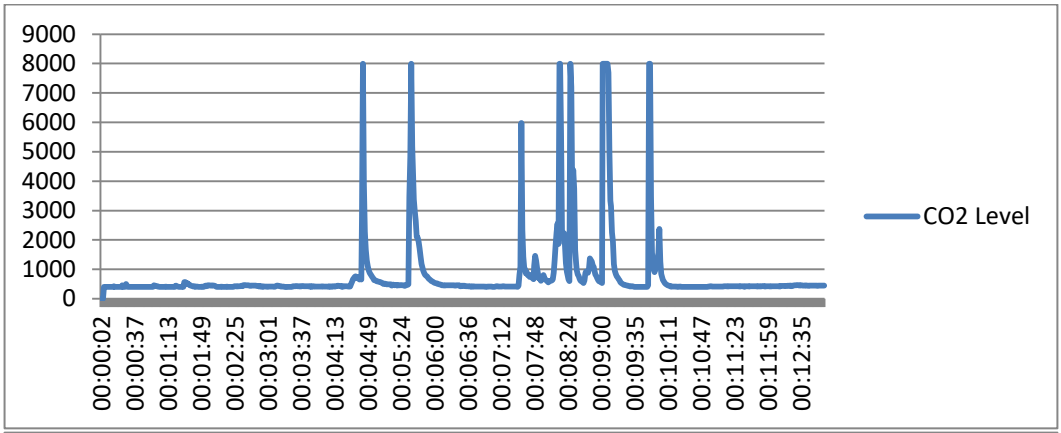


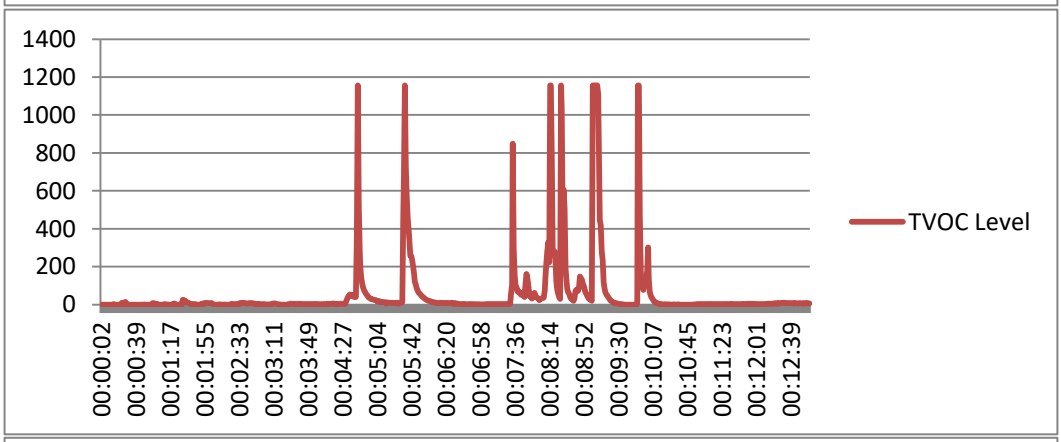


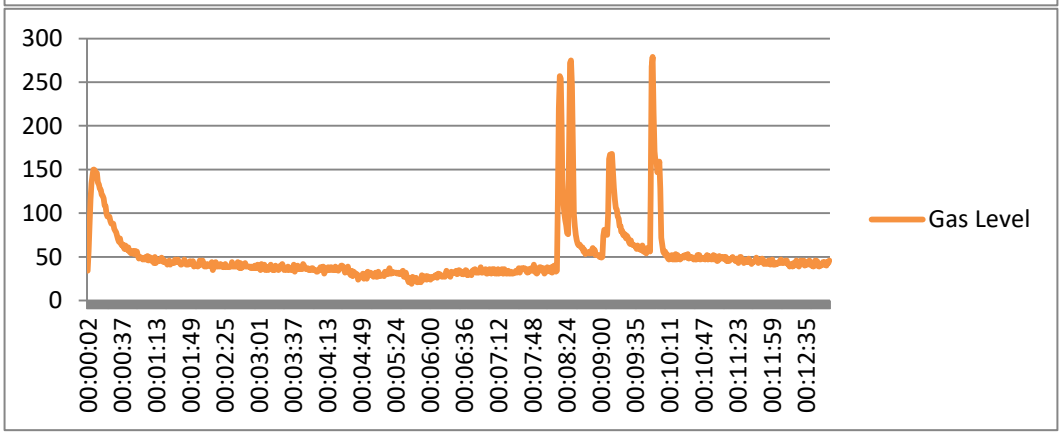


Are ecological products better?

Those measurements were recorded in our school, precisely on our chemistry laboratory. I was curious if all the substances from the laboratory could affect in any way our sensors and I definitely got some results. The outcome is way higher than I thought it would be. This exposure may harm the chemistry teachers if they spend too much time around those substances. These substances are found in most of non-ecological home products. We take as an example cleaning products. The normal detergents contain lots of chemical compounds that are really harmful for us.

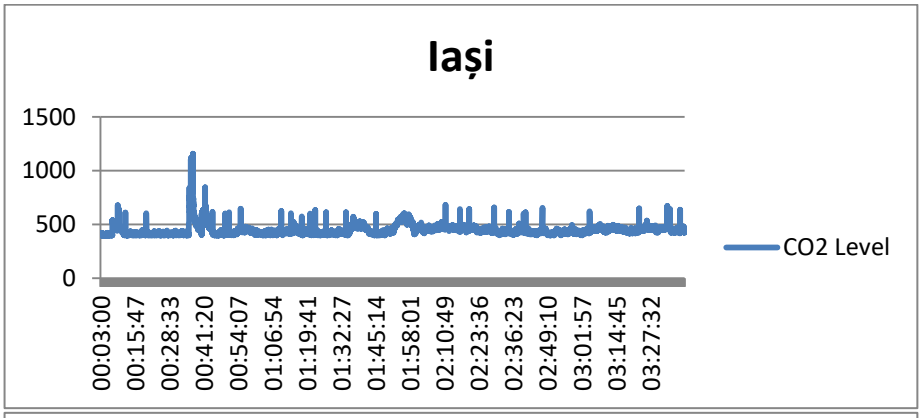


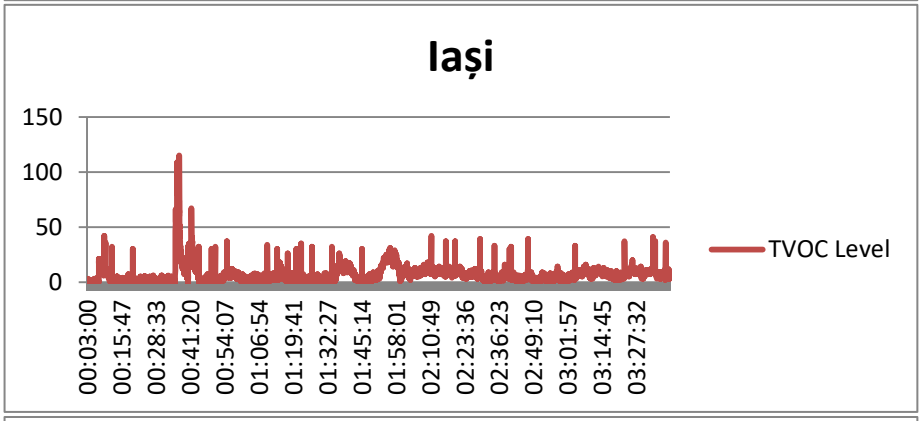


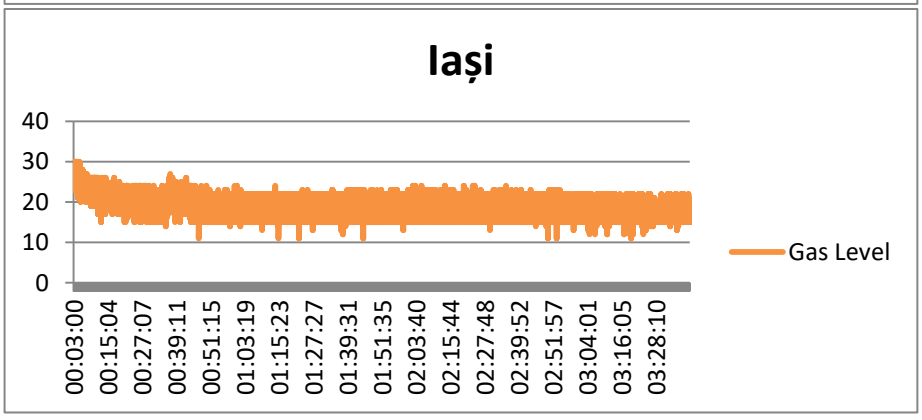


How about our city?

We googled how polutted our city is and all we found was that it is one of the most polluted cities in our country. We didn't really believe those informations(/numbers) so we went on searching for ourselves. As you can see, the numbers aren't that bad, considering that the carbon emissons(CO2 level) are about 447 ppm (parts-per-million) and the typical concentrations of occupied indoor spaces with good air flow are between 350 ppm and 1000 ppm . The tvoc level (Total Volatile Organic Compound) in Iasi is 6.7 (parts-per-billion), and the "excelent" value confirmed by studies is between 0 ppb and 65 ppb. And the gas level is also into the average gas level (20 ppm).

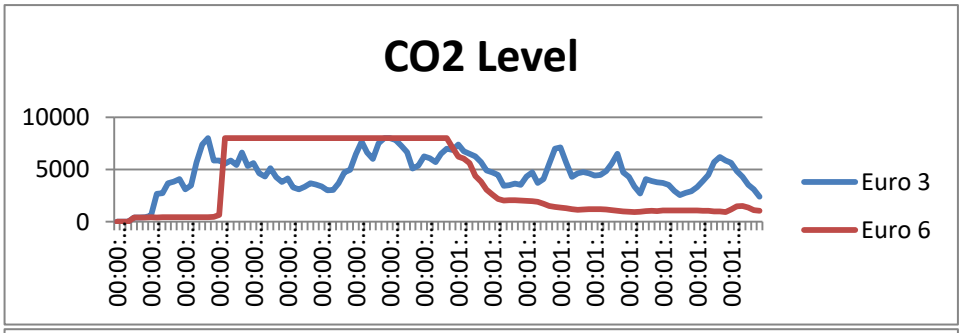


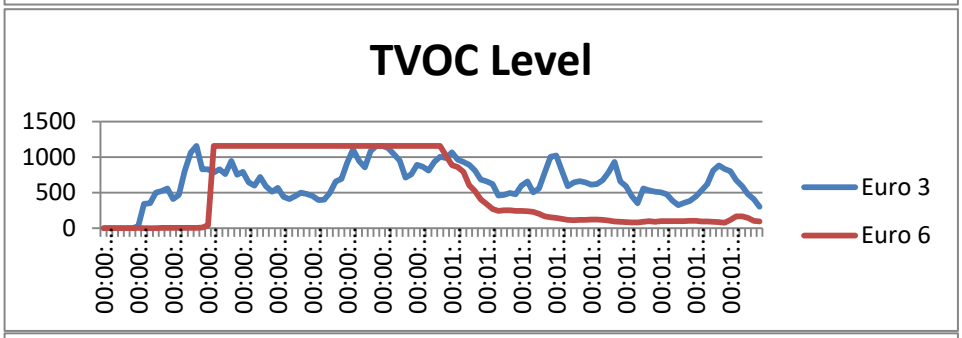


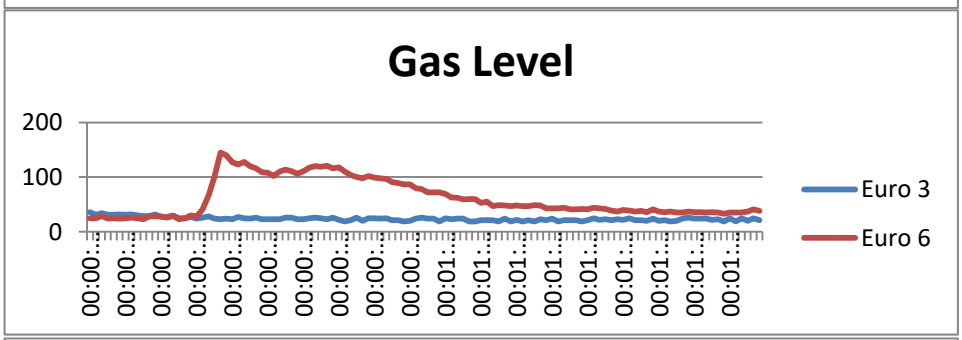


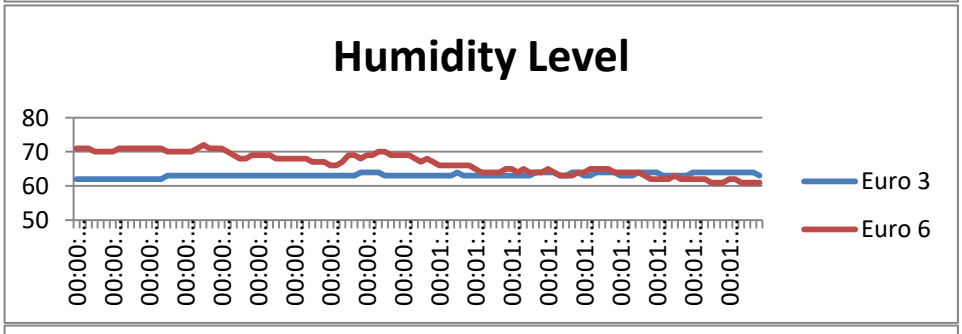
Walking may be a better solution…

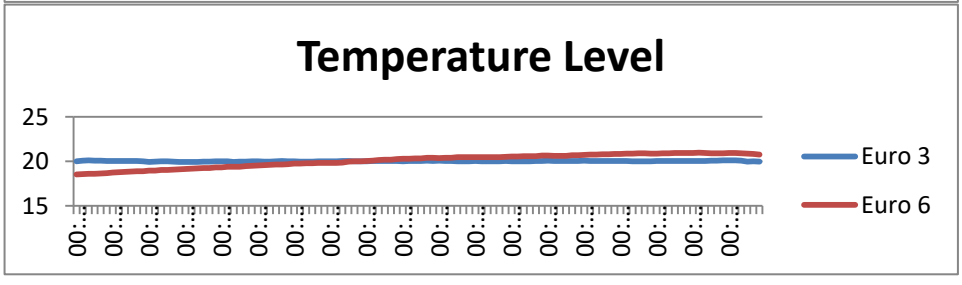
One of the biggest flaws in cities is the carbon emissions from cars. The Environmental Defense Fund (EDF) estimates that on-road vehicles cause one-third of the air pollution that produces smog. So I compared the smoke that came out of an Euro 6 motor car with an older version, the Euro 3 motor car. The results came out pretty engaging:





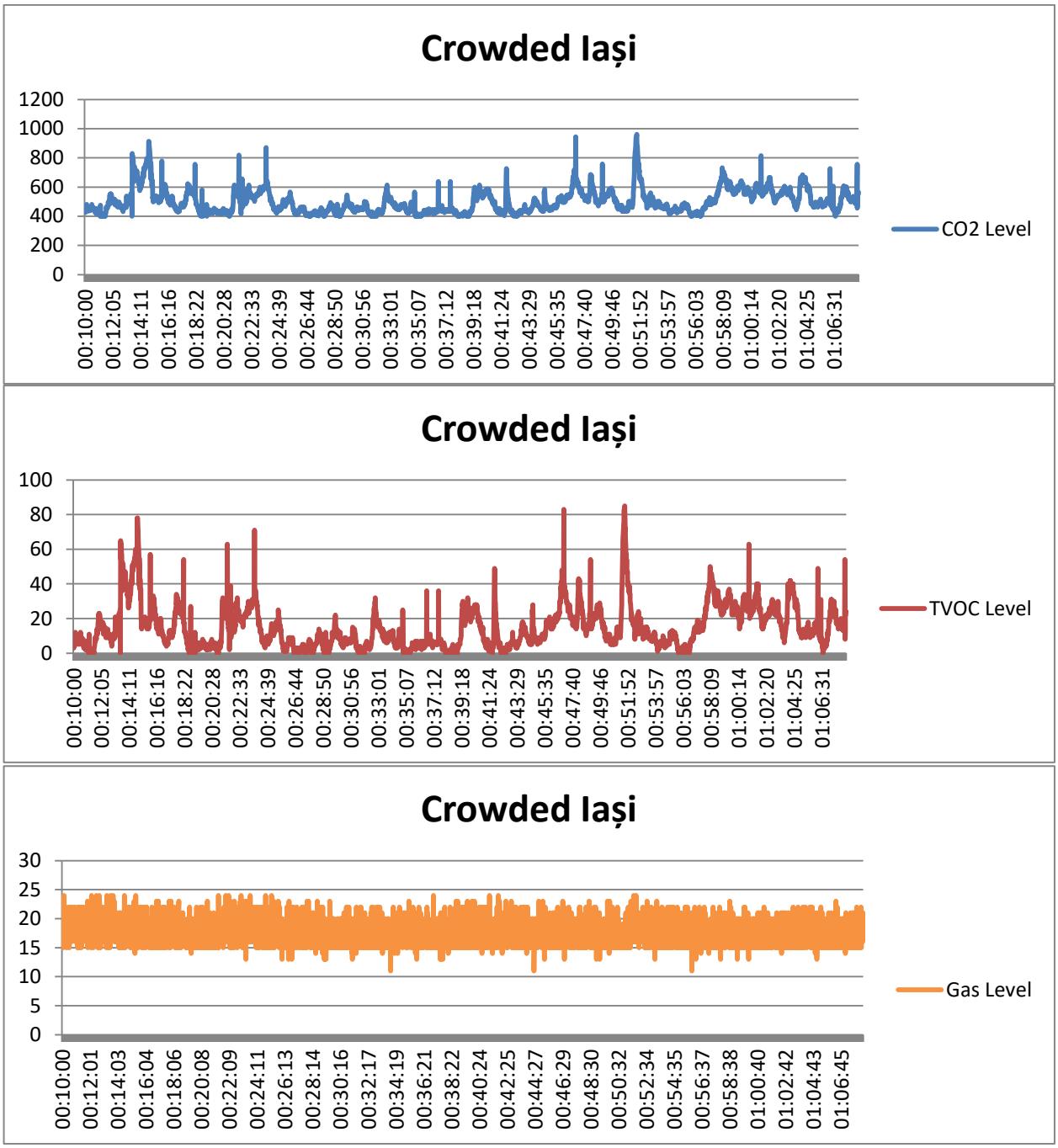






How much do we pollute the air every moment?

We also wanted to see how polluted a pedestrian zone is, mainly beacause there are a lot of people going back and forth, which makes it very crowded, therefore very polluted . As you can see, the results are still pretty normal.



CO2

250-350ppm	Normal background concentration in outdoor ambient air
350-1,000ppm	Concentrations typical of occupied indoor spaces with good air exchange
1,000-2,000ppm	Complaints of drowsiness and poor air.
2,000-5,000 ppm	Headaches, sleepiness and stagnant, stale, stuffy air. Poor concentration, loss of attention, increased heart rate and slight nausea may also be present.
5,000	Workplace exposure limit (as 8-hour TWA) in most jurisdictions.
>40,000 ppm	Exposure may lead to serious oxygen deprivation resulting in permanent brain damage, coma, even death.

Source: www.kane.co.uk

What Are VOCs?

The widespread use of new products and building materials has resulted in increased concentrations of indoor pollutants, in particular volatile organic compounds (VOCs). Nowadays, most people spend more than 20 hours per day indoors where VOC concentrations are more than five times higher than outdoor concentrations[1]. VOCs originate from a number of different possible sources, like building materials, tobacco smoke, people and their activities, and indoor chemical reactions. Exceptionally high VOC levels are typically found in new buildings or after renovation. Further, when using products that contain VOCs, such as air fresheners or cleaning agents, people expose themselves and others to high pollutant levels that can persist long after the activity has finished. VOCs include a wide range of chemical compounds, the most common of which are listed in **Table 1** below.

Typical VOC Sources	Compound Class	Example Compounds
Cleaning agents	Aliphatic hydrocarbons, organochlorides	Tetrachloroethylene
Solvents	Aliphatic and aromatic hydrocarbons	Heptane, decane, toluene, xylene
Cosmetics	Terpenes, ketones	Eucalyptol, limonene
Consumer products	Terpenes, aromatic hydrocarbons	Limonene, α-Pinene, toluene
Carpets and flooring	Esters, aliphatic and aromatic hydrocarbons	Butylacetate, heptane
Paints	Alcohols, aldehydes	Isobutanol
Human occupants		Acetone, methanol, ethanol

Table 1 *Typical indoor VOCs and their sources[2]*

Guidelines for VOCs and the TVOC Concept

The term total VOC (TVOC) refers to the total concentration of VOCs present simultaneously in the air. The TVOC concept is used as a practical time and cost-effective method of surveying indoor environments for contamination. Global consensus has resulted in the emergence of guidelines for TVOC standards of indoor air quality (IAQ) issued by governmental organizations in different countries (e.g. Australia, Finland, Germany, Hong Kong, Japan). Recommended TVOC levels of IAQ that are considered acceptable range from 0.6 to 1 mg/m³. The German Health Department defines TVOC levels as shown in **Table 2**. The TVOC levels and the corresponding recommendations are based on the results of a large number of controlled exposure studies that established a relationship between increased TVOC levels and adverse health effects.

Level	Hygienic Rating	Recommendation	Exposure Limit	TVOC [ppb]
5 Unhealty	Situation not acceptable	Use only if unavoidable / Intense ventilation necessary	hours	2200 – 5500
4 Poor	Major objections	Intensified ventilation / airing necessary Search for sources	< 1 month	660 – 2200
3 Moderate	Some objections	Intensified ventilation / airing recommended Search for sources	< 12 months	220 – 660
2 Good	No relevant objections	Ventilation / airing recommended	no limit	65 – 220
1 Excellent	No objections	Target value	no limit	0 – 65

Table 2 *TVOC guidelines issued by the German Federal Environmental Agency[7]*

Source: www.repcomsrl.com