TRAFFIC 3E: An Online Platform to Manage Real Traffic Emissions

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Background

Atmospheric pollution poses a severe risk to human health and the environment, and road traffic contributes with up to 80% of total emissions in urban areas (Madrid Air Quality and Climate Change Strategy, 2006-2012).

In order to improve air quality, The European Union has passed various legislation that must be adopted by all the member states. For instance, the emissions of newly manufactured cars have limits commonly known as “Euro Standards” (Regulation [EC] No 715/2007 of the European Parliament and of the Council) and motor vehicles must pass periodic emissions tests (Directive 2000/30/EC of the European Parliament and of the Council) to demonstrate compliance.

However, traffic emissions remain the main source of air pollution in our cities. The inefficiency of the current system is based primarily on inadequate emissions control system; the vehicles are not measured under real driving conditions and only carbon monoxide (CO) and opacity are tested.

Also, traffic emissions studies show that less than 10% of the fleet contributes over 50% of any given contaminant (US National Academy of Sciences, 2001) and these vehicles are generally defined as “High Emitters” (HE) or “Gross Polluters”. These studies also show that reasonably new vehicles (such as “Euro 4/IV and Euro 5/V) are not exempt from becoming high emitters (Technet, 2010). Therefore, the most efficient approach to reduce traffic emissions would be identifying and repairing these HE.

Remote sensing has emerged as a suitable technology to address the limitations of the current emission control model. The RSD (Remote Sensing Device) uses ultraviolet-infrared spectroscopy and it is able to audit large numbers of vehicles without the driver having to stop. These devices are deployed by the roadside and they record the emissions and the licence plates of the vehicles passing by. RSDs measure hydrocarbons (HC), nitrogen oxides (NO_X), particulate matter (PM), carbon monoxide (CO) and carbon dioxide (CO_2) and merge the exhaust measurements with a picture of the vehicle´s license plate, kinetic conditions (speed and acceleration) and weather conditions. A complete RSD measurement is captured and stored in less than one second, allowing hundreds of vehicles to measured hourly, traffic permitting.

Figure 1: RSD deployed roadside. From left to right: spectrophotometer, speed/acceleration bar, digital camera

Technet-Bivento is an environmental consultancy based in Madrid and specialised in sustainable mobility. The company holds the exclusive rights to market the RSD technology (Remote Sensing Devices) in Europe. Since 2007 Technet-Bivento has carried out numerous traffic characterization studies, both for public administrations (Madrid, Barcelona, Valencia…) and projects for private companies (Mahou-San Miguel, Repsol, EMT-Madrid…) recognised by several environmental awards.

In order to boost the RSD potential, Technet-Bivento has created an on-line platform to analyse emissions data in real time. It will be possible to assess current emission levels and, more importantly, instantly identify the HE. This tool will offer great opportunities and a new approach towards efficient and cost effective mobility policies.

General Methodology of Traffic Characterizations

Data Acquisition

The RSD´s are deployed from mobile vans at locations offering mid-high traffic volume at a slight upward slope to maximize the number of valid measurements of representative loaded-mode emissions.

At the end of the day the data are stored and ready to be uploaded into the database. Later, specialised software is used to read the vehicle photographs and obtain their alpha-numeric readings. The list with the license plates is sent to the Traffic Authority, which returns the technical specifications of the queried vehicles (fuel type, engine size, vehicle class…).

Finally both the emission records and the technical specifications of the vehicles are uploaded into a custom database where all the calculations and statistical analysis can be done.

Data Filtering and Normalization

Firstly, the invalid records in the database are discarded. Unreadable plates, insufficient plume size due to the engine not being loaded and vehicles passing by too close to each other may cause the record to be filtered out.

Additionally, only records captured within a calculated specific power (VSP) range that represents stable loaded-mode vehicle operation are considered for further analysis. Generally, the VSP range applied is comparable to the load range observed during vehicle certification tests, thereby, representing the range under which the vehicle's emissions should be controlled and within legal limits (US-EPA, 2002).

Also, when there are several readings for a same plate, the emissions values are averaged. This avoids false identification of a vehicle as a HE due to a "cold start" (the engine had not reached the optimal operating temperature) or other abnormalities.

Finally, the emission values are converted to meaningful units: g/l, g/Km and g/KWh (only for heavy duty vehicles with diesel engines). The roadside RSD measures the ratios of contaminant/CO_2, and these are converted directly to g/kg of fuel by applying stoichiometry. Other conversion values specific for each vehicle class (fuel efficiency, fuel consumption…) allow the calculation of g/Km and g/KWh.

Emissions Distribution and Cut-Points

The filtered data are sorted by decreasing emission values and put into distribution charts, one for each vehicle class. As mentioned before, for all the vehicle classes and for any given pollutant there is always a small portion of the fleet that is responsible for a large percentage of the total emissions. This fact can be easily observed in these charts.

The emission cut-points for the high emitters are set based in these charts. The ultimate objective is to achieve maximum emission reductions while affecting the minimum number of vehicles.

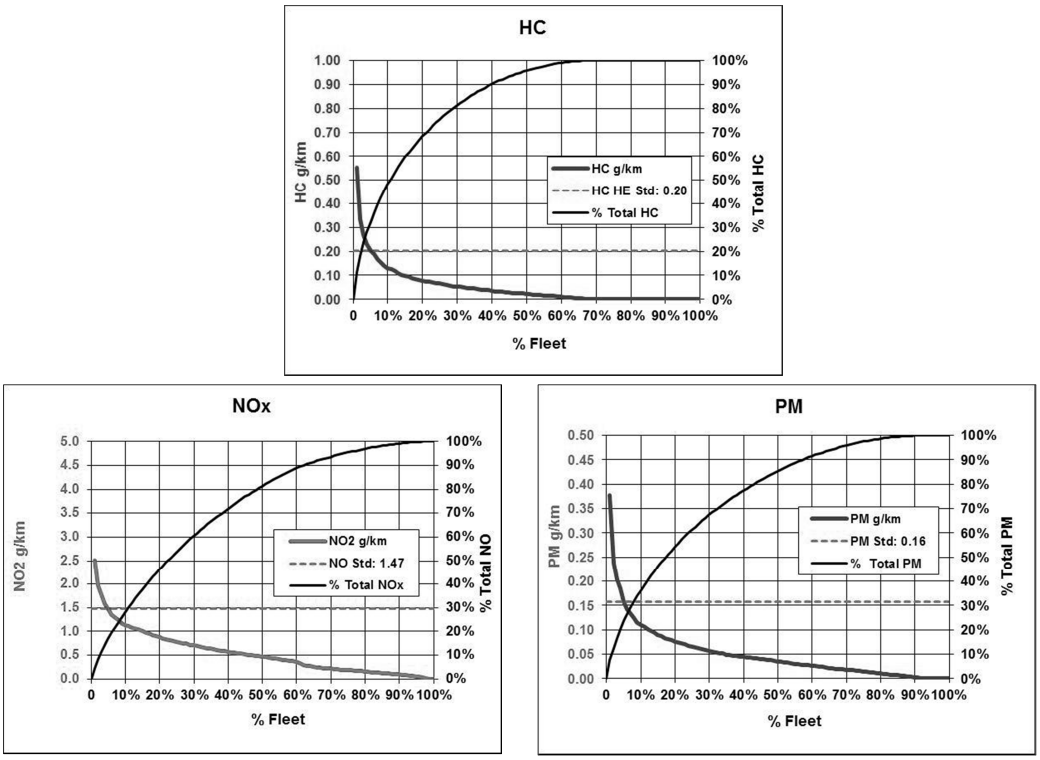

Figure 2: Emissions distributions for diesel passenger cars. Barcelona traffic characterization study. Technet, 2010-2011.

In the examples above, the cut-points were calculated for the top 5% of the highest emitting vehicles (HE) in all three contaminants. Their contribution of the HE was 22% of total PM, 16% of total NO_X and 30% of total HC.

The cut-points may be flexible and depend on the needs of the final client (public administration, fleet operator…), or fixed, if the emission limits were set by the current legislation.

Emissions Management and Decision Making

Once the cut-points are set for each of the vehicle categories, the plates of the HE can be extracted. Although the analysis yields much more information, identifying the HE is definitely the most important outcome.

Finally, a report is presented to the client. The client decides what action to take based on the given recommendations and the empirical data, and also depending on different scenarios and whether it is a public administration or a fleet operator. Usually HE are repaired, adapted or scrapped so their excess emissions are greatly reduced.

Emissions Control and Management with TRAFFIC 3E

The online platform that Technet-Bivento has developed is generally based on the methodology described above. Technet has signed a partnership agreement with Microsoft in order to be able to use state-of-the-art technology and have support from the world´s leader in software distribution. Also, Technet-Bivento is currently investing in adapting the RSD to fixed locations (e.g. motorway ramps) and to operate in a multi-lane environment.

The emission records are gathered in the same fashion as in the traditional traffic characterization studies, however now the data transmission is done in real time via 3G. All the records are instantly uploaded to a Microsoft Azure Database that is the foundation of the reporting system and the on-line platform.

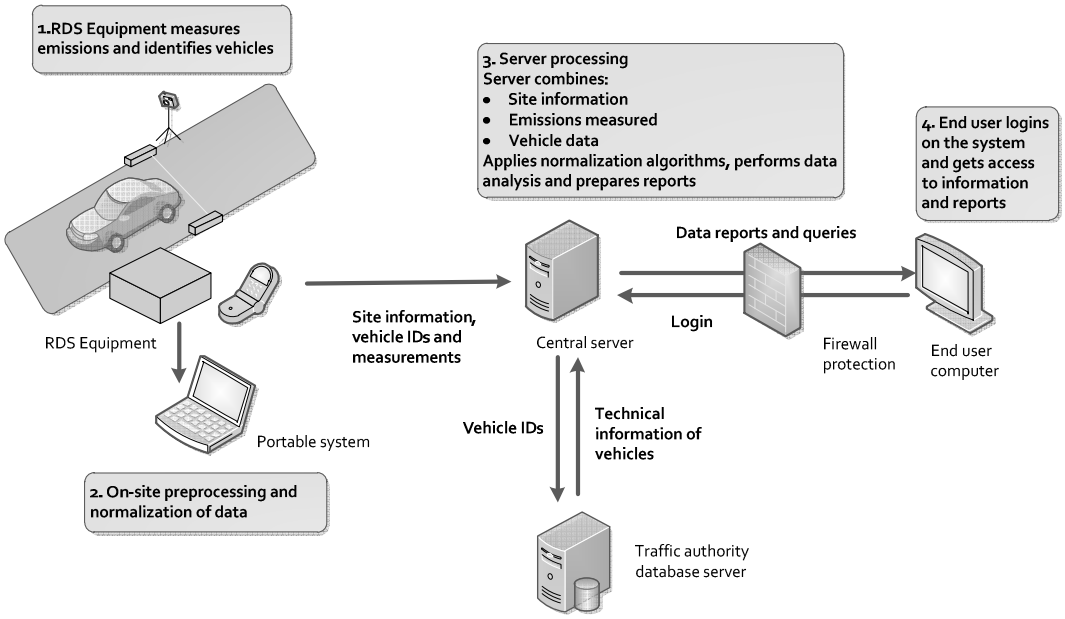

Figure 3: Data transmission and system architecture

When the records are available in the database, the vehicle photographs are processed by specialised OCR software (Optical Character Recognition) and therefore vehicle list is updated constantly. When a new plate is recorded, it is automatically sent to the Traffic Authority to obtain the technical specifications of that vehicle. Also, all the additional processes (unit conversion, data filtering…) are carried out in the "cloud" as the information arrives.

With this new system the data acquisition process has been largely improved, however the readiness of the information is not the only advantage of this system.

TRAFFIC 3E has been designed as an Emission Control & Management tool than can be easily used by public administrations and fleet operators, so the decision making process does not need to wait for a final audit report.

Technet-Bivento and Microsoft have developed a system able to perform all the analysis of the "classic" traffic characterizations, but accessible via internet. The client logs into a secure server and they have access to the emission records 24/7 and with information updated virtually in real time.

The reporting system have been programed with numerous analysis templates and useful tools (filters, pre-set charts, interactive buttons…) that allow users to evaluate the status of the fleet on the spot and therefore improve and sped up the decision making process. Most importantly, now it is possible to identify a high emitting vehicle and within minutes automatically send a notification to the owner.

Also the system include several tools for scenario and "what-if" analysis, emission reduction projections and trend assessments, amongst many others, so it becomes a complete emission management tool.

The main modules of the emission control and management system can be briefed as follows:

Reporting Tools	
Home	General information: number of records, number of unique plates, dates, sites…
Fleet Characterization	Composition of the audited fleet: by vehicle type, age, Euro Standard…
Traffic Intensity	Number of vehicles per hour and average speed

Emissions	General information about emission values, average by vehicle class, age, fuel type
Distributions and cut-point calculation	Emissions distribution for each contaminant and vehicle class. These charts are usually the base to define the emissions cut-points
Vehicle scores	Each vehicle is assessed according to their impact on human health (Emissions Score) and their fuel efficiency (Fuel Score)
Contribution – Emission Inventory	Total emissions (ton/year) are calculated for each vehicle class
Management Tools	
HE Identification	A list of the plates of the HE is automatically generated
Scenarios	Projections on emissions reductions and fuel savings depending on actions chosen by client
Trend analysis	Data is represented along a timeline to assess the efficiency of previous actions

Figure 4: Summary of TRAFFIC 3E Modules

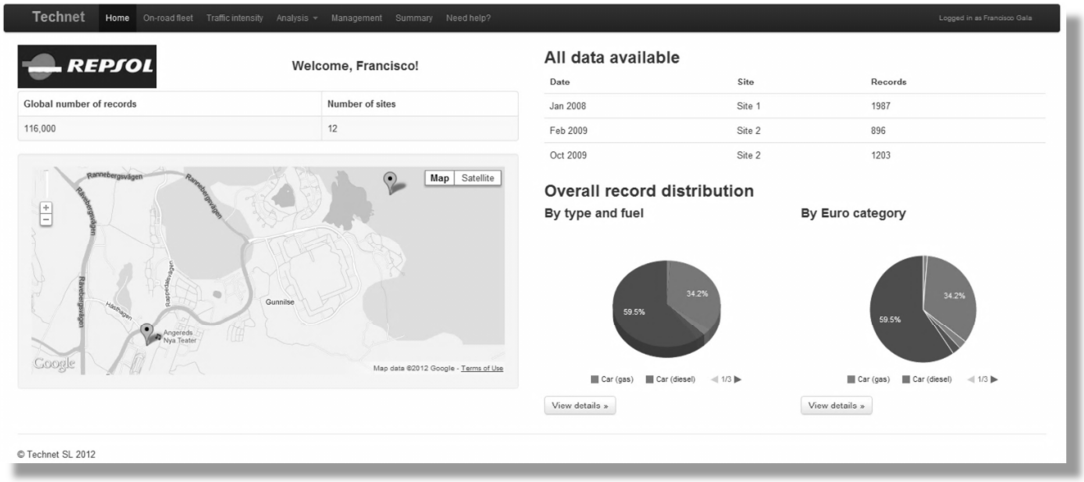

Figure 5: Screenshot of TRAFFIC 3E "Home" report

Conclusions

Traffic is the main source of air pollution in urban areas. Although stricter legislation is being passed, the current emission control model is not efficient.

For any given fleet, there is always a small portion of the fleet that emits disproportionately; these high emitters should be the priority target of air quality policies. The RSD technology presents a unique cost effective approach to maximize emission reductions while burdening the least number of vehicles.

Technet-Bivento is currently making efforts to spread the use of the RSD technology and has created an innovative Emission Control and Management System: TRAFFIC 3E.

TRAFFIC 3E incorporates state of the art technology, that combined with the large amounts of real emissions reading gathered by the RSD, opens a new approach to air quality policies based on empirical data. Most importantly, data acquisition and analysis is virtually done in real time, and therefore high emitting vehicles can be sent for repairs in a short amount of time.

It also offers a unique opportunity to create more accurate traffic emissions inventory and it is able to assess the reduction of the emission of the fleet and therefore the efficiency of the current control measures.

References

De la Fuente, Josefina - Technet (2010). *Estudio de caracterización del tráfico rodado en materia de emisiones en la ciudad de Barcelona*, 182-184

Various Authors - Comunidad de Madrid (2007). *Plan azul. Estrategia de calidad del aire y cambio climático de la Comunidad de Madrid (2006-2012)*, 54-56.

Various Authors - National Research Council (2001). Evaluating Vehicle Emissions Inspection and Maintenance Programs , 22.

Various Authors – US-EPA (2002). *Guidance on Use of RemoteSensing for Evaluation of I/M Program Performance*, 22-27.