RESEARCH SERIES AIR QUALITY

CAN WE PREVENT ANOTHER DIESELGATE?

FIA FOUNDATION

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The FIA Foundation is an independent UK registered charity which supports an international programme of activities promoting road safety, the environment and sustainable mobility, as well as funding motor sport safety research. Our aim is to ensure 'Safe, Clean, Fair and Green' mobility for all, playing our part to ensure a sustainable future.

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Written by: Chelsea Baldino, Rachel Muncrief, Drew Kodjak, The International Council on Clean Transportation.

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CAN WE PREVENT ANOTHER DIESELGATE?

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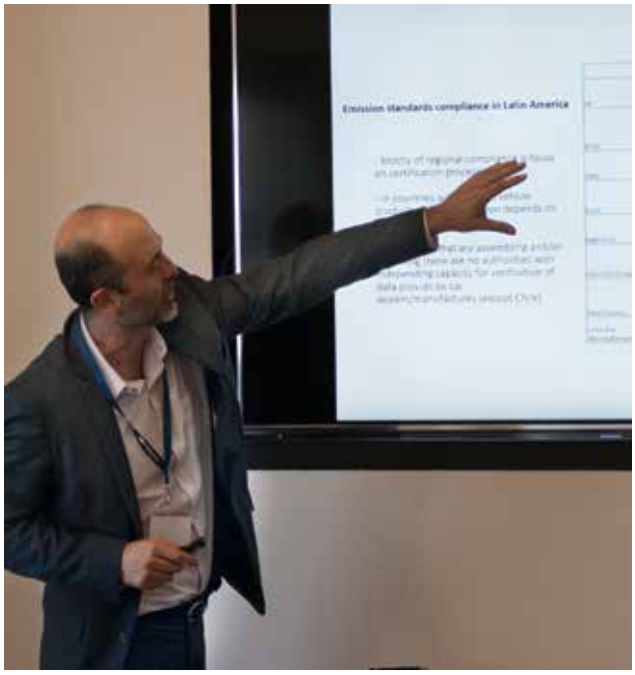
INTRODUCTION AND WORKSHOP PARTICIPANTS

In June 2016, a group of experts in vehicle safety, vehicle emissions ratings and regulations, and real-world emissions testing technology and methods met to discuss how civil society could contribute towards ensuring vehicles comply with emission legislation and consumers provided with reliable information. *(For a full list of attendees at the seminar please see Appendix 1 on page 21).*

The meeting was held in part in response to the "Dieselgate" scandal, where vehicles have been shown to be emitting more pollution on the road than in the off-road type approval tests. The suggested reasons for this discrepancy vary, although it is generally agreed that a perceived lack of strong regulatory enforcement and inadequate testing protocols have been the main contributors. Regardless of the cause, this has led to extremely high real-world NO_X emissions from diesel passenger cars in Europe and elsewhere with all of the negative environmental and health impacts which are known to ensue. It is also known that cars have wide discrepancies between test and real-world results for fuel economy and CO_2 emissions in many regions.

The workshop was organized and hosted by the FIA Foundation, with support from the International Council on Clean Transportation (ICCT), Global NCAP, and Transport & Environment (T&E). The focus of discussion at the workshop was how, given evidence on cheating, testing technologies and methodologies, and associated costs, to develop a global initiative to accurately inform governments, the public, and the auto industry about real-world emissions from in-use vehicles.

Sheila Watson, representing the FIA Foundation, and David Ward of Global NCAP opened the meeting with introductory remarks. Sheila described the FIA Foundation's commitment to road safety and clean vehicles, as well as its dedication to catalyzing valuable partnerships in the sustainable mobility sector. David then described the current state of affairs in passenger vehicle emissions, concluding that consumers are confused because regulations have led to a lack of trust. This problem needs to be addressed, ideally by regulatory authorities, but by other trusted independents, to help and encourage governments to act.



THE REGULATORY LANDSCAPE IN EUROPE AND THE U.S.

The workshop focused on the U.S. and Europe first because vehicle emissions standards around the world are based on those in these two regions (Figure 1). Drew Kodjak of ICCT examined passenger vehicle regulations in the U.S., highlighting how they differ from Europe, as well as how the discovery of the VW defeat device came to fruition based on ICCT's real-world testing of diesel cars in California. His theme - that non-compliance with vehicle emission standards is a global crisis that includes all major markets, all types of vehicles, all pollutants including fuel economy and CO_2 emissions, and all manufacturers, not just VW – is a key conclusion of this note.

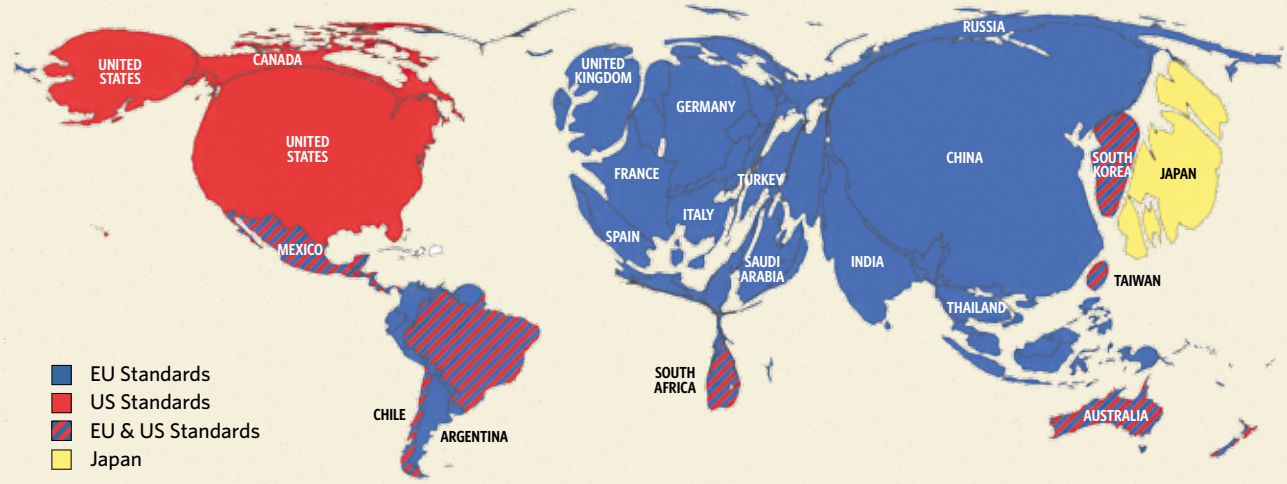
Greg Archer of Transport & Environment, provided an overview of the European response to "Dieselgate", including several lessons for improved regulation. These lessons included bringing transparency to the way that testing is done, including the type approval process, as well as bringing proper penalties to those companies that break the law.

Luca Pascotta of FIA ended the session with a description of the consumer's perspective of "Dieselgate." He reinforced earlier messages about the importance of reliable and consistent information regarding vehicle emissions and regulations. He also offered the thought that a joint task force that communicates a clear message might be a useful way forward.

Gianni Lopez of Centro Mario Molina Chile and Anumita Roychowdhury of the Center for Science and Environment in Delhi, India brought a less developed nation perspective to the discussion during the second session, which covered compliance programmes in India and Latin America. These regions will see the greatest growth in the global car fleet by 2020 (Figure 2). Both speakers described how, under current regulations, governments in emerging markets are highly dependent on the car manufacturers for vehicle certification, leaving room for loopholes and potential illegal activity. They also mentioned that lack of resources and political will hinder systemic changes in Latin America and India. Section II of this note considers the regulatory and compliance landscape in the U.S., Europe, Latin America and India in more detail.

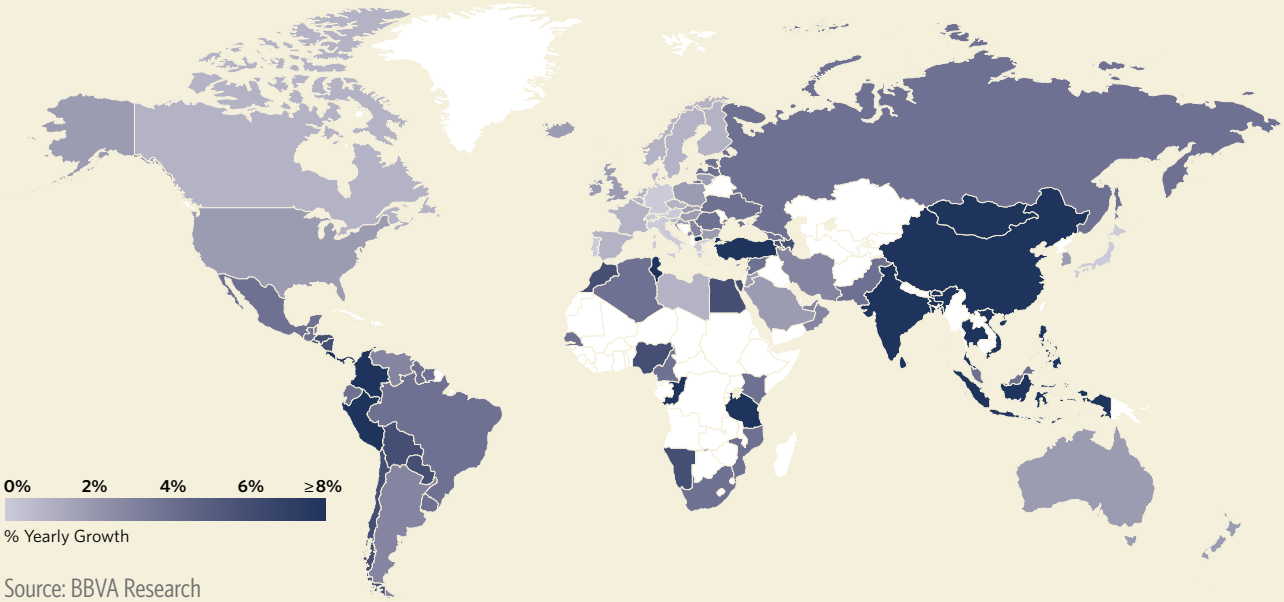
The workshop then transitioned to an overview of methodologies and technologies that an initiative could employ to test vehicles globally, as well as current vehicle emission rating schemes. The outcomes of this discussion are described in detail in Section III. Gabriel Branco of EnvironMentality started with a discussion of how little governments know about vehicle calibration but how important it is that they improve their understanding. He described how recording and analyzing on-board diagnostics (OBD) has the potential to discover anomalies in vehicle behavior, which could demonstrate abnormal behavior during testing. However he noted that the current systems of OBD in operation

FIGURE 1: BASIS OF VEHICLE EMISSIONS STANDARDS AROUND THE WORLD



Sources: ICCT, AECC, Cummins, Daimler, Transport & Environment

FIGURE 2: PERCENT ANNUAL INCREASE IN WORLD CAR FLEET BETWEEN 2010 AND 2020



Source: BBVA Research

in some vehicles were open to manipulation and not fit for purpose. Nick Molden of Emissions Analytics then discussed the potential for Portable Emissions Measurement Systems (PEMS) testing, which involves equipping the vehicle with portable, on-board analyzers, to deliver highly representative, and relatively inexpensive, real-world driving emissions when carried out under everyday driving conditions (see image bottom right). Karl Ropkins of the University of Leeds then presented a related technology, the Integrated Portable Emissions System (iPEMS), developed by the 3DATX Corporation, which uses sensors to quickly collect a lot of vehicle emissions data in an inexpensive way. James Tate, also from the University of Leeds, concluded the technology discussion by describing how remote testing of vehicle emissions provides a snap-shot insight into emissions for individual vehicles, as well as emissions on a fleet level.

Following these technical discussions, Reinhard Kolke of ADAC, a compliance testing organization in Germany, presented information about ADAC's EcoTest. The EcoTest provides "comprehensive consumer information regarding the eco-friendliness of vehicles" assessing fuel consumption (i.e., CO_2 emissions) and pollutant emissions.[1] Daniele D'Onofrio of CITA, the International Motor Vehicle Inspection Committee, then provided an overview of the results from CITA's "Sustainable Emissions Test" (SET) report (2015). A key conclusion of this report is that both on-board devices and tailpipe tests are important for testing compliance with emissions standards, reinforcing the idea that a mix of technologies and techniques are important for effective testing programs.

Participants concluded the workshop by discussing issues that the leaders of an international testing network would need to consider for it to be successful, as well as what should be included in a proof of concept for an international testing initiative. Section IV of this report summarizes those considerations. Before turning to those details we consider in more detail the current status of vehicle emissions, standards and compliance around the world.

PEMS unit attached to a passenger vehicle (photo courtesy of Luca Pascotto)

CURRENT STATUS OF VEHICLE EMISSIONS, STANDARDS, AND COMPLIANCE

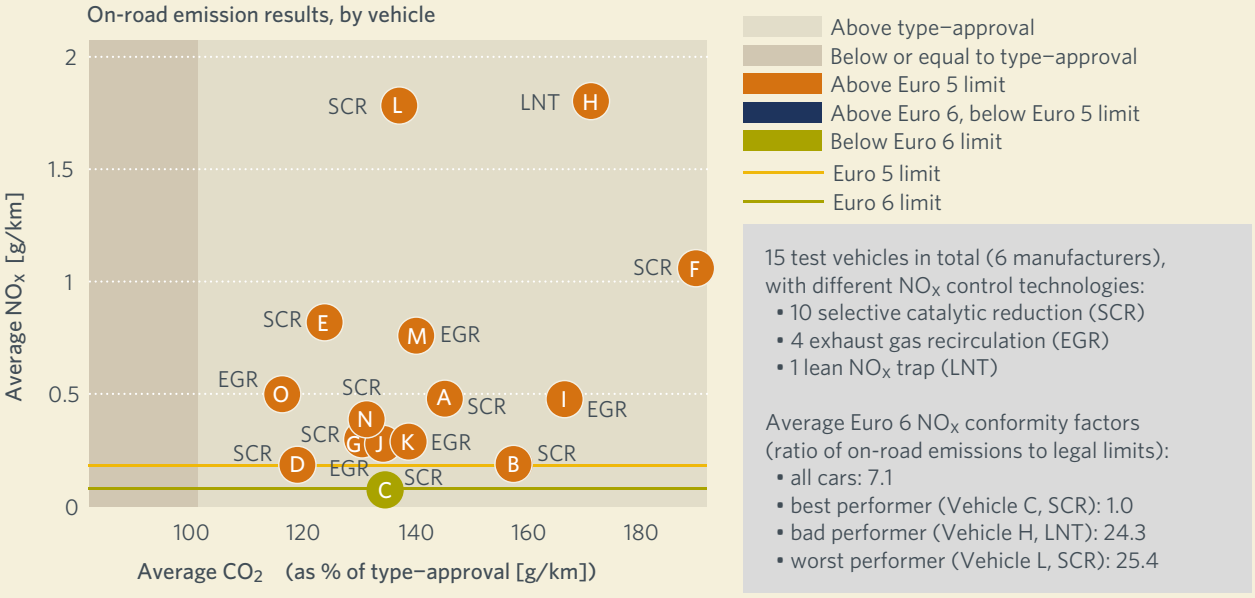
BACKGROUND ON ELEVATED REAL-WORLD EMISSIONS FROM DIESEL VEHICLES

Prior to the "Dieselgate" scandal, several studies had already shown strong evidence of a real-world NO_X compliance issue for Euro 3, 4, 5 and 6 diesel passenger cars in Europe.[2] For example, one study found that the average, on-road emission levels of NO_X were approximately 7 times the emission limit for Euro 6 diesel vehicles (Figure 3).[3] Typical exceedances have now declined to typically 4-5 times.

Because of these findings, ICCT collaborated with the California Air and Resources Board (CARB), and contracted with researchers at West Virginia University (WVU) to conduct vehicle testing using PEMS on several light-duty diesel cars. This led to the discovery of an extreme discrepancy in real-world NO_X performance.[4] The US EPA and CARB investigated, and on September 18, 2015, EPA and CARB announced that Volkswagen had employed an illegal defeat device on nearly half a million diesel cars sold in the U.S. The following week, VW revealed that 11 million diesel cars worldwide were outfitted with such defeat devices.

Excess CO_2 emissions from passenger cars are also a concern. In the EU, a "gap" between CO_2 type approval values and real-world CO_2 emissions has grown from less than 10 percent in 2001 to more than 40 percent in 2014.[5] For light-duty vehicles in the U.S., a similar discrepancy level has been found, but with a significantly smaller increase of the gap

FIGURE 3 – ON-ROAD VEHICLE EMISSIONS, GROUPED BY AFTER-TREATMENT TECHNOLOGY. EURO 5 AND EURO 6 LIMITS ARE IDENTIFIED.



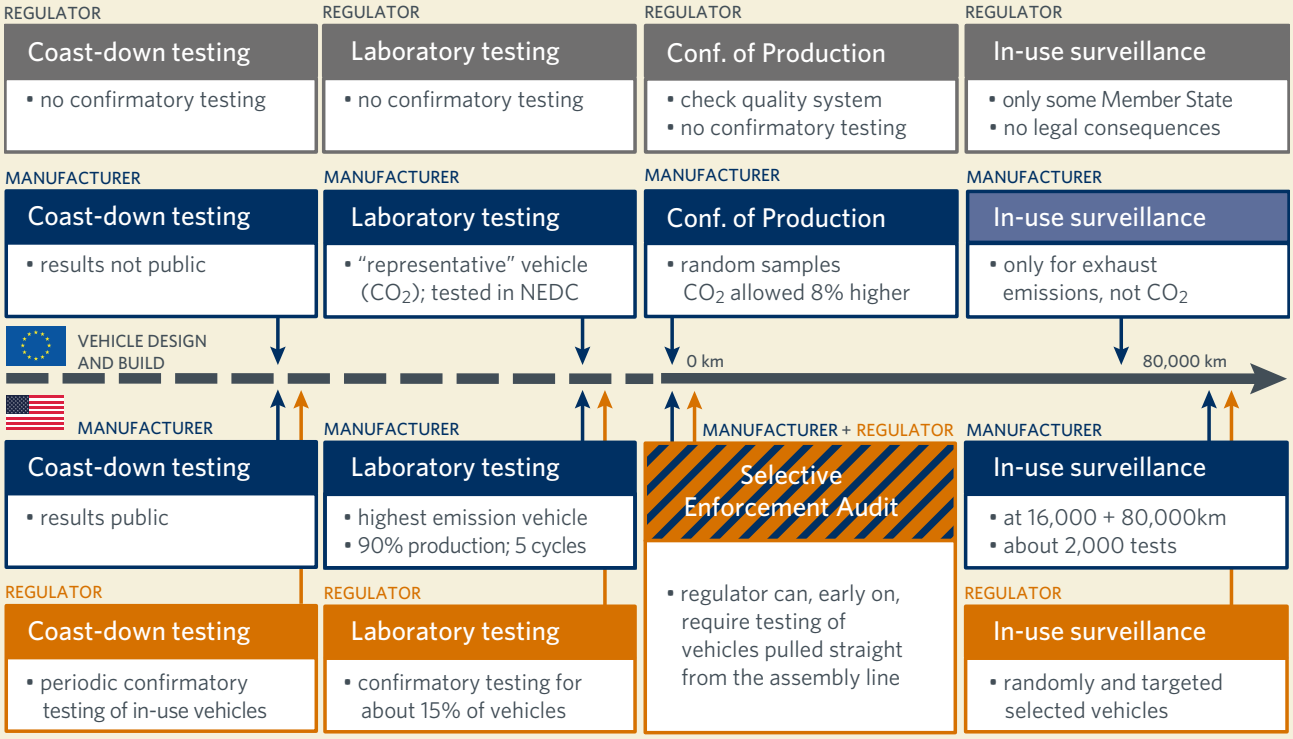
Source: International Council on Clean Transportation (ICCT)

over time (from about 20 percent in 2004 to about 35 percent in 2012).[6] Cheating on CO_2 tests has also made headlines, with Mitsubishi, for example, announcing its use of falsified fuel efficiency tests for the past 25 years.[7]

COMPARISON OF EMISSIONS REGULATIONS ACROSS EUROPE, THE U.S., LATIN AMERICA, AND INDIA

The "Dieselgate" scandal has not only highlighted the extent of some car manufacturers cheating, but has also highlighted significant differences in effectiveness of compliance and enforcement programs around the world. As a recent ICCT white paper highlighted, the biggest difference between the U.S. and Europe is the strong focus on independent government conformity testing coupled with enforcement authority in the U.S. (Figure 4). In the EU, by contrast, this element of independent re-testing is largely absent from the implementation of the regulations. In addition publicly accessible information is far more restricted in the EU than the US. For example, the

FIGURE 4 – OVERVIEW OF THE EU AND U.S. VEHICLE EMISSIONS TESTING AND ENFORCEMENT SCHEMES



Source: International Council on Clean Transportation (ICCT)

road load coefficients of vehicles type-approved in the EU are not publicly available, and few authorities and independent organization in the EU carry out independent re-testing of vehicles.[8]

In Latin America, regional compliance with air emission standards is focused primarily on the certification process. Unfortunately, in most Latin American countries where vehicles are assembled and/or imported, governmental authorities can lack the capacity to verify certification data, which is provided by the manufacturers. Latin American countries face problems regarding vehicle emissions that are similar to the EU (e.g. a lack of independent testing), but experts in this region argue that capacity to test vehicles is worse in this region. The exception is Chile, where, after manufacturers were caught cheating with

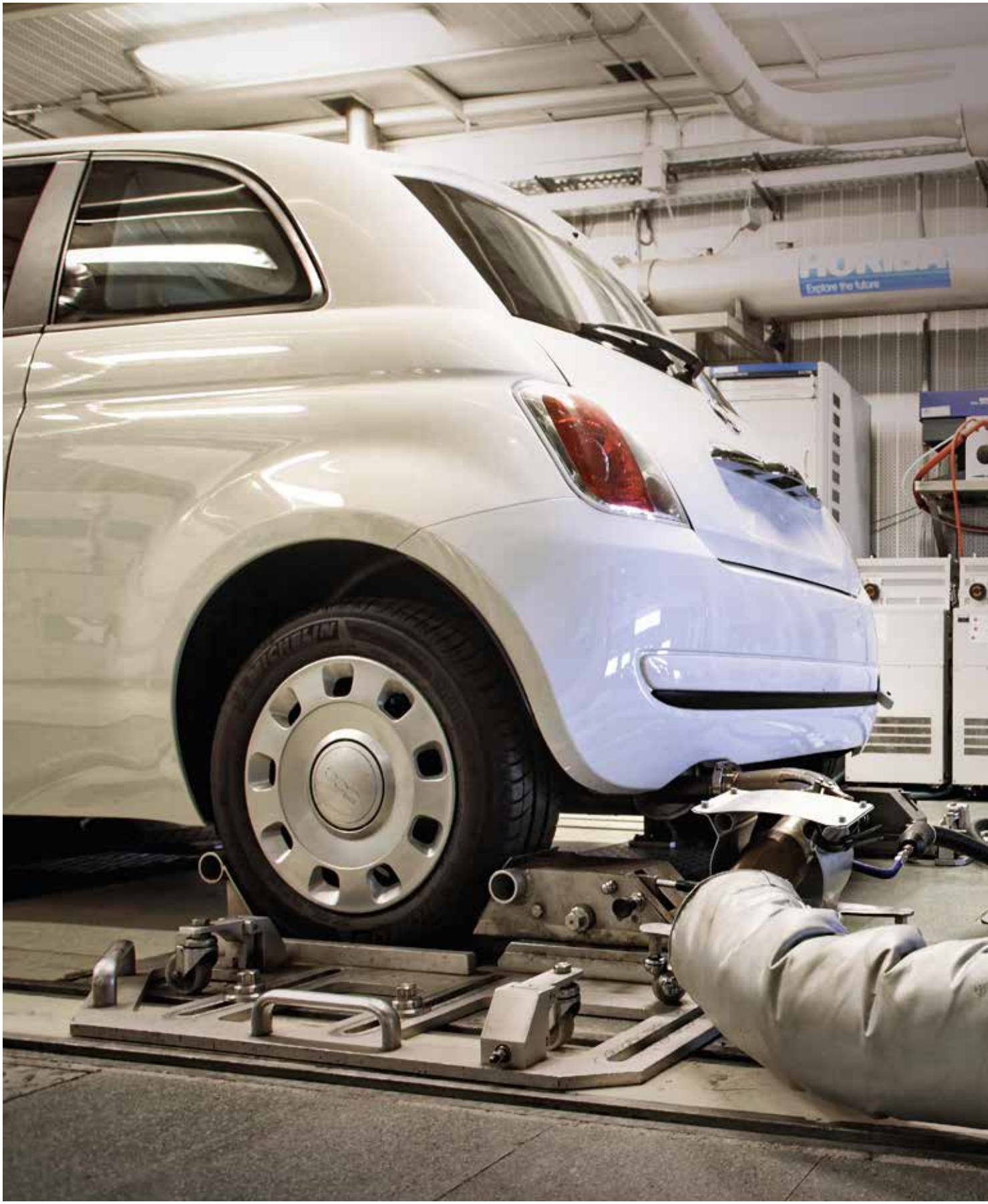
TABLE 1: COMPARISON OF LABORATORY TESTING, PRODUCTION COMPLIANCE, AND IN-USE SURVEILLANCE PROCEDURES IN SEVERAL LATIN AMERICAN COUNTRIES [9]

	LABORATORY TESTING	PRODUCTION COMPLIANCE	IN-USE SURVEILLANCE
Chile	Authority tests for 100% of the vehicles	Random samples tested by the authority	Not in place
Brazil	Tested by manufacturer under Federal Test Procedure (U.S.) cycle	Samples tested by manufacturers in Brazil (weak audit by the authority)	
Argentina	Tested by manufacture under NEDC	Not in place	Not in place
Colombia / Uruguay	Authority reviews certificates and data provide by dealer/ manufacture	Not in place	Not in place
Peru / Ecuador	Authority requests a sworn declaration of compliance made by the dealer/ manufacturer	Not in place	Not in place
Costa Rica / Bolivia / Paraguay	Not in place	Not in place	Not in place

vehicle certification in the 1970s, the government established an independent, state-owned vehicle emission testing laboratory. Table 1 provides a comparison and summary of laboratory testing and compliance measures in several Latin American countries.

In India, vehicle certification is conducted by an independent agency, but the manufacturer is responsible for providing the vehicles. The national government has the power to reject a vehicle's certification, but in practice this has never happened. The federal government has stated that the responsibility for testing and type approval is the responsibility of the state governments, but these local governments' resources are scarce and outdated.

Worldwide, a lack of adequate government resources and legal authority to ensure compliance with motor vehicle emission standards is a major challenge. In Europe, the European Commission has proposed a new framework for centralized oversight of member state testing centers as well as confirmatory testing and authority to execute recalls, but this groundbreaking proposal would have to be approved by the European Parliament and Council.[10]



VEHICLE TESTING TODAY

As of today, laboratory testing is the most common method used by regulators and manufacturers to type approve pre-production vehicles and to ensure in use compliance with regulations. The car is tested on a chassis dynamometer in a specially-designed testing facility, and the exhaust of the vehicle is collected and analyzed to calculate emission levels and fuel consumption for the test cycle. Details of the test cycle (speeds, accelerations, etc.) and test procedure (ambient temperature, etc.) are defined in a test protocol (for example, New European Driving Cycle in the EU).

The exclusive use of pre-defined laboratory testing has opened up a number of loopholes that manufacturers can exploit - especially in a regime where governmental enforcement is generally seen as weak. For example, most diesel car manufacturers in Europe admit to reducing the effectiveness of their emissions control system at temperatures outside the ambient temperature window required during laboratory testing, claiming that this protects the engine.[11] Additionally, during pre-production type approval testing it is common practice for manufacturers to submit "golden vehicles," i.e., those that are customized for testing. In addition, the type approval tests for NO_x and CO_2 are not tested simultaneously. In practice, this means that the vehicles the manufacturers submit for type approval testing are likely optimized for each pollutant that is being tested. Finally, there is ambiguity in the regulations that may be exacerbated in places like the EU where up to 28 different authorities must interpret and implement the standard. For example, there are currently multiple ways of measuring road load (an important factor that directly impacts emissions results in dynamometer testing), in the new WLTP test. This enables manufacturers to optimize the test to the vehicle and contributing to the discrepancies between laboratory and in use CO_2 emissions .

As a first step in meeting these criteria, participants in the workshop concluded that a financially independent, expert testing initiative would provide consumers with robust information about the environmental performance of vehicles and highlight gross discrepancies between test and real-world performance that may highlight the possible use of defeat devices and excessive test optimisation. Lab testing alone, with all its shortcomings and potential for loopholes, cannot achieve the goal of delivering real-world improvements; thus, this testing should be based upon real-world emissions testing.[12] For reference, in the 1990s, real-world remote-sensing of emissions was one of the means for discovering gross emissions non-compliance by heavy-duty vehicles in the US. Owing to that discovery, heavy duty vehicle manufacturers have been obliged to conduct in use PEMS testing to ensure compliance since as early as 2010. In the EU similar real-world tests for air pollution emissions will begin shortly – but not for CO_2.

REAL-WORLD VEHICLE TESTING TECHNIQUES

A portfolio of technologies and techniques are available for real-world emissions testing, and the ones outlined here are only those discussed at this exploratory meeting; they do not represent an exhaustive list. Any real-world testing program would most probably include a mix of these technologies and techniques.

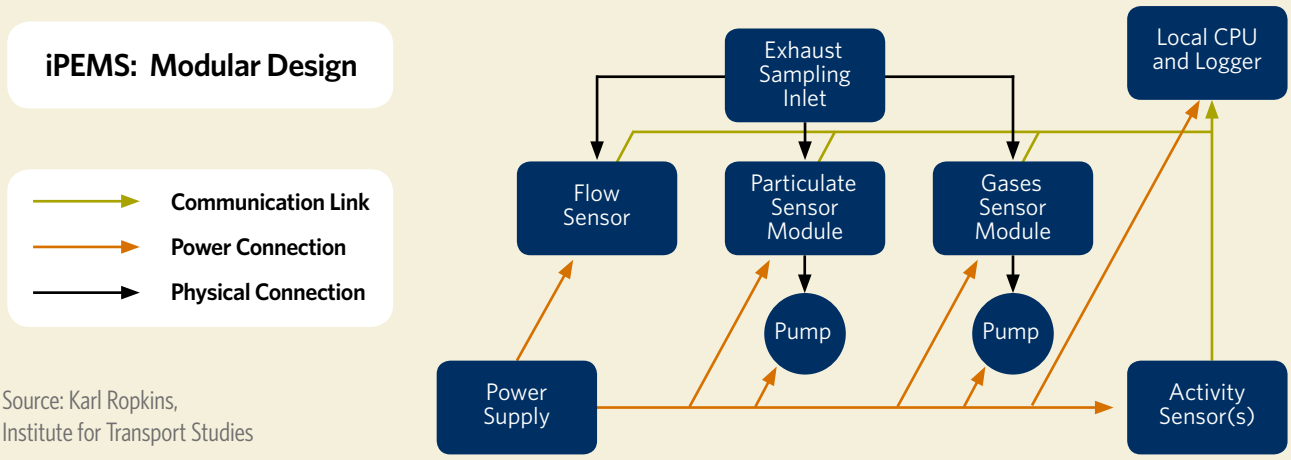
ON-ROAD TESTING

On-road testing is carried out on a vehicle while driving in normal traffic conditions. The most widely used technique for on-road emissions testing is a portable emissions measurement system (PEMS), where a main PEMS unit is temporarily attached to the back of the vehicle to collect, analyze, and record data from the vehicle exhaust as the vehicle is driven.[13]

On-road testing results can be are highly representative of real-world driving when carried out under everyday driving conditions, and they are excellent tools for linking specific driving conditions to emission rates and identifying shortcomings in the control of certain pollutants.[14] When compared to testing on a chassis dynamometer, PEMS testing is significantly cheaper, but the results are not as reproducible. PEMS' proponents also point out the possibility for the test to be conducted with no connection between the vehicle engine management system and monitoring equipment. So the vehicle operation cannot be influenced by the vehicle's on-board software detecting a test. However, the results are influenced by uncontrolled sources of variability (e.g., traffic or weather conditions), and they are thus not easily reproducible; e.g., testing the same vehicle at two different locations will produce two different results.

Another related technology is the Integrated Portable Emissions System (iPEMS), developed by the 3DATX Corporation, which is an integrated sensor-based system. The key difference between iPEMS and PEMS is that the iPEMS system utilizes less costly sensors while the PEMS system utilizes analyzers to measure the concentration of various emissions.[15] In general, analyzers have higher accuracy and responsiveness than sensors, however there have been large advances in sensor technology in recent years. Figure 5 illustrates how this technology collects and processes emissions samples. This technology can quickly collect a lot of data at a lower cost than using PEMS. It is possible that results from both PEMS and iPEMS measurements could be used to not only measure real-world emissions levels, but also give insight into the reasons for high emissions.

FIGURE 5: SCHEMATIC OF IPEMS DESIGN

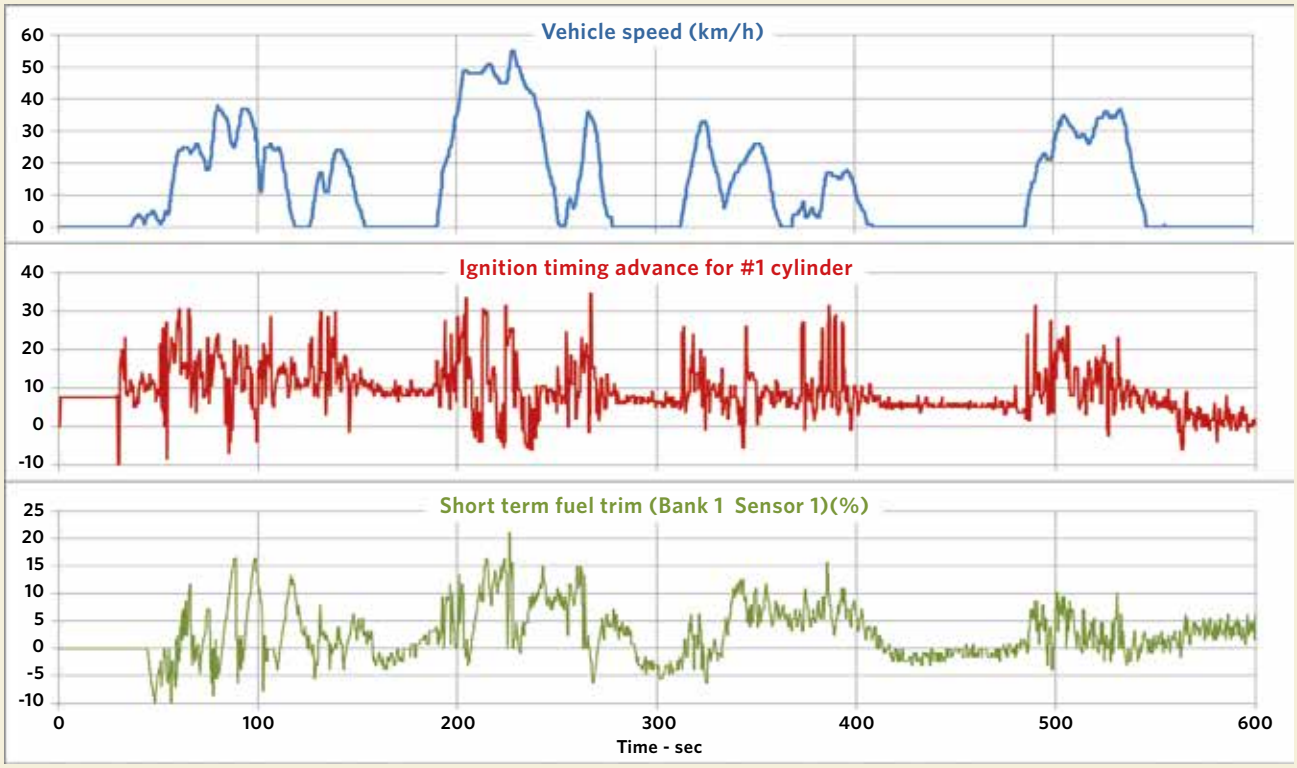


Source: Karl Ropkins, Institute for Transport Studies

ON-BOARD DATA ANALYSES

As vehicle technology has evolved over time, there has been an increased reliance on electronic and computer controls. Using appropriate sensors a modern vehicle can detect driving habits, weather conditions, fuel composition, etc., and optimize the engine calibration and emissions. Data recording from a car's computer can provide important insights[16] into the emissions and highlight anomalies in vehicle behavior and, possibly, abnormal behavior during testing. Figure 6 shows an example of how vehicle parameters can be downloaded and displayed to compare them to each other; one can see in this figure that there is a dependency between the parameters, which one can interpret through statistical analyses. There are several analytical procedures that have been shown to be powerful tools for detecting biases in vehicle systems. Further, it is possible to augment PEMS testing with on-board data recording to do further analysis of vehicle parameters and instantaneous emissions values, in order to gain a better understanding for the cause of unexpectedly high emissions.

FIGURE 6: EXAMPLE OUTPUT FROM A LOGGING DEVICE RECORDING OBD



Source: Gabriel Branco, Environmentality

REMOTE SENSING

Another form of real-world testing is remote sensing (RS), which can provide a snap-shot insight into emissions for individual vehicles, as well as emissions on a fleet level. Vehicle RS is a non-intrusive technique to determine the concentration of certain pollutants in situ. When a vehicle crosses a beam of light that is placed across a road, the attenuation of light is measured in its exhaust plume. The stronger the attenuation in a specific wavelength, the higher the concentration of a particular absorbent. The concentration difference relative to the measured background concentration is ascribed to the vehicle that has just passed.[17]

RS offers the potential to screen a large sample size of vehicles at a relatively low per-vehicle cost. RS is particularly useful for providing accurate results on fleet averages and can also offer coarse statements about an individual vehicle's emission rate. RS could be an effective tool for screening purposes to determine when more in depth testing of a particular vehicle

model may be necessary.[18] For example, recent research using this technology illuminated that once vehicles surpass load limits under current regulations (indicated by vehicle specific power), NO_X emissions go up.[19] Like the other real-world testing technologies, RS of vehicle emissions should not be used in isolation; but it provides a relatively inexpensive and fast way to gain a snapshot of emissions.

Table 2 summarizes the testing techniques that were presented and discussed at the workshop, including their associated pros and cons.

TABLE 2: STRENGTHS AND WEAKNESSES OF TESTING TECHNIQUES

TESTING TECHNIQUE	DESCRIPTION	PROS	CONS
Laboratory (chassis dynamometer)	Exhaust of the vehicle is collected and analyzed to calculate emission levels and fuel consumption for the test cycle	High repeatability and reproducibility of tests	Opportunities for manufacturers to exploit loopholes in testing; least representative of real-world conditions; Expensive
Portable Emissions Measurement System (PEMS)	PEMS unit is temporarily attached to the back of the vehicle to collect, analyze, and record data from the vehicle exhaust as the vehicle is driven	Highly representative of everyday driving conditions; link specific driving conditions to emission rates; low cost	Only representative of driving conditions of individual tests so lacks reproducibility;
iPEMS	Integrated sensor-based system to measure the concentration of emissions	Devices are smaller and cheaper than PEMS equipment	Sensors not as accurate as PEMS
On-board data recording	Data on vehicle parameters (e.g. engine ignition timing) can be downloaded from vehicle's computer, using, for example, a logging device connected to vehicle's On-Board Diagnostics (OBD)	High representativeness; possible to discover vehicle behavior anomalies during testing	Results from an individual trip and individual vehicle not reproducible. Does not actually measure the emissions
Remote Sensing	As vehicle crosses a beam of light that is placed across a road, the attenuation of light is measured in its exhaust plume	High sampling rate at a low cost; provides course overview of emissions in an inexpensive way	Only provides a "snapshot," does not report emissions in same units as regulations (mass/distance), only an emission factor (mass/mass)

CONCLUSIONS

The seminar concluded that an independent, global, real-world emissions testing initiative is a necessary, important step towards providing improved consumer information regarding emissions; and would also help to improve regulations and compliance by highlighting where official tests deviate widely from on-road performance. Such an initiative must be financially independent of the carmakers and involve accredited expert testers for the initiative to be credible. Such an approach would bring transparency in a way which lab testing alone, with all its shortcomings and potential for loopholes, cannot.

THE NEED FOR AN INDEPENDENT WATCHDOG

One of the most prevalent shortcomings of vehicle emission regulations and compliance around the world are the lack of resources to conduct tests of cars on the road. This prevents any verification of their actual performance and has allowed testing for regulatory purposes to deviate further and further from on-road performance. It has also allowed, in some regions regulatory capture and a loss of true compliance scrutiny. An independent, global testing initiative would enable civil society organisations to perform a watchdog role that is essential to counter the evasive influence of the global automotive industry and leeds to environmental regulations being circumvented not effectively implemented in many regions.

THE GEOGRAPHIC SCOPE OF THE INITIATIVE

Interest and concern about vehicle emissions and fuel economy varies globally between regions such that a campaign that works in one region may not work in another. In some regions, momentum for testing might be more of a supply-side push (from manufacturers keen to demonstrate the efficiency of their vehicles such as the recent initiative of Peugeot Citroën with Transport and Environment); whilst in other places, the consumers might drive the improvement (demand-side). Governments in some regions are more concerned by CO_2 emissions, in others air quality; in a third energy security. Any such testing initiative should operate in more than one region of the world to have the maximum influence on a global automotive industry. For example, if the initiative were to test vehicles in Europe only, governments in developing countries might believe real-world emissions from diesel passenger vehicles is only a "European" problem. Such a regional programme can also be tailored to local vehicles, fuel and driving conditions.

THE ROLE OF CONSUMERS AND CIVIL SOCIETY

Consumers need to know how cars perform in the real-world. Non-compliance with regulations also has a direct effect on drivers and citizens in terms of air pollution for example. One of the key outcomes of an independent testing programme must be to establish a parallel structure to provide information to the public to aid better decision making. In doing so it is appropriate the information is tailored to needs, relevant to the region and does not overwhelm citizens with multiple information streams or technical details. Where serious issues with compliance are identified it should be the manufacturer not the driver that is responsible.

As the network develops a global strategy, it will be important to identify groups, such as environmental NGOs and other civil society organizations, with whom the testing agents can partner, and to recognize early on where potential partner institutions are lacking. The originators of a global monitoring network must consider what role, if any, key civil society groups should play. For example, the Global and Regional New Car Assessment Programmes (NCAPs). These programs conduct and promote independent research and testing programs to evaluate the safety and environmental characteristics of motor vehicles, and they promote the development of new car assessment programs.[20]

THE ROLE OF GOVERNMENT

Whilst the independence of testing is essential, any initiative will ultimately need government engagement to leverage its influence and effectiveness and help to ensure it contributes to enforcement of rules and leads to systemic changes in vehicle testing across the world. In order to convince governments to act, test results must

be relevant to local conditions – as a minimum regionally. For example, vehicles in India comply with older standards, so government officials might question, "Even if defeat devices are used in the U.S., how do we know they're used in India?" Additionally, in some regions, like India, it is important that the emissions information is linked to the wider human health story. This requires a civil society campaign to run alongside the testing programme.

The monitoring programme should also assist cities, such as those that have initiated their own vehicle bans to tackle emissions from vehicle. For example, Delhi and Paris have recently made efforts to phase out some diesel vehicles.[21,22] By mobilizing cities there can be a direct influence on local air pollution that will also help to leverage more national action. For example, in 2014, the International Institute for Applied Systems Analysis conducted remote sensing of vehicle emissions in Zurich.[23]

THE ROLE OF INDUSTRY

Another important interaction is the one between the testing initiative and the auto industry. As a minimum the independent tests needs to be sufficiently robust that the industry cannot reject the findings out of hand. Ultimately industry needs to recognize the value of independent tests for providing credibility regarding environmental claims and for marking purposes. Workshop participants emphasized the need to maintain open communication with the industry, whilst retaining independence. As one participant commented, the testing initiative should help change the industry's narrative from merely complying with regulation to saying, "We want to be the best." It is likely that companies that invest heavily in emission standards compliance will express interest in supporting this testing initiative because they value the level playing field promoted by effective regulatory enforcement. The workshop participants also foresaw the possibility that the auto industry would argue that the cost of testing, its potential legal outfall, and the reaction from consumers, might "harm jobs locally." A robust response is needed to such accusations including questioning how better information and enforcement could influence employment.

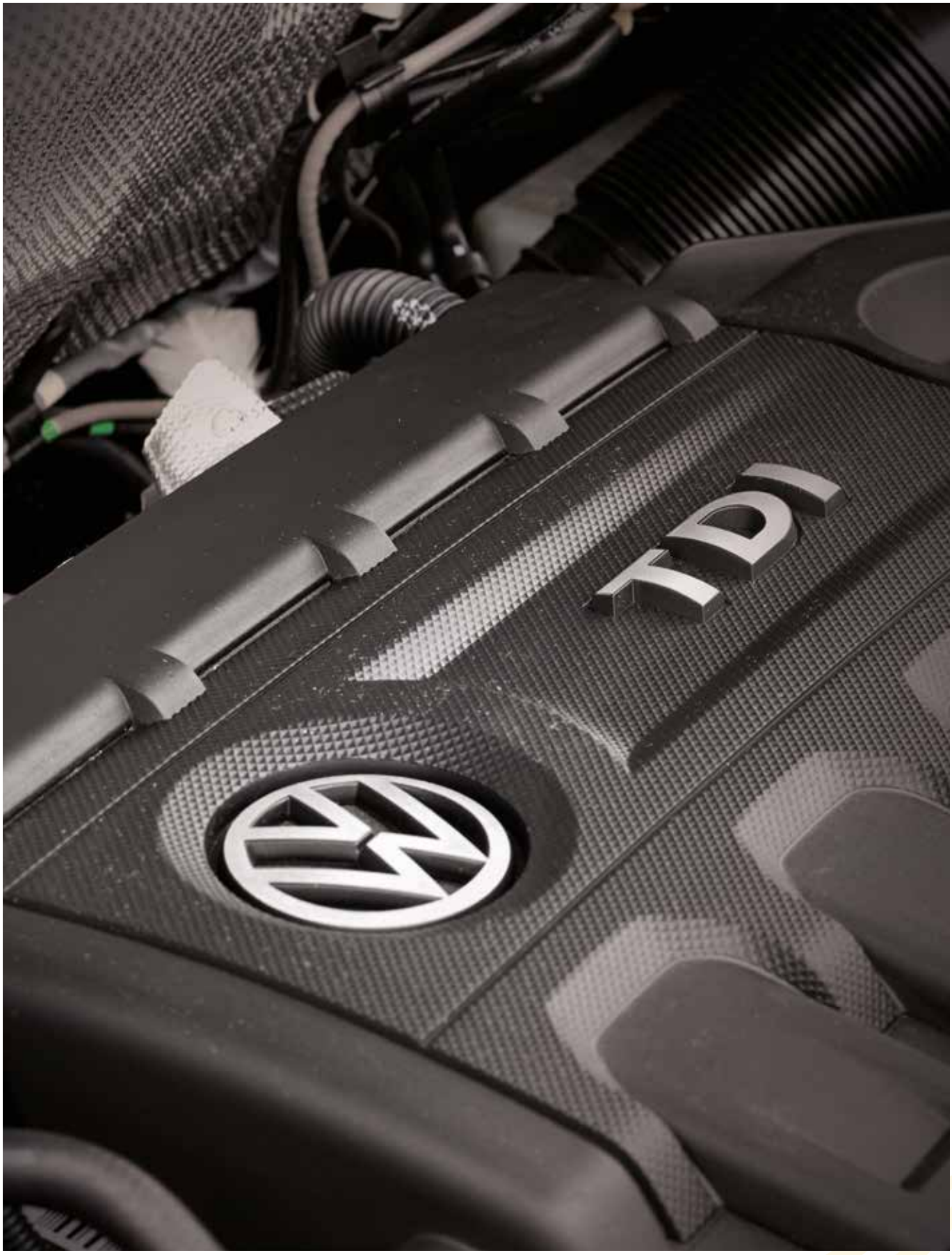
FUNDING

Finally, the workshop addressed the potential cost of funding this international testing initiative. They estimated that this kind of program would require $10 million (USD) per year for a five-year program in 5 regions. Such an initiative could use a combination of PEMs testing equipment, which for one unit ranges from $75,000 to $100,000, and complement this with remote sensing in major cities. After 5 years it is hoped the scheme has developed sufficient credibility that manufacturers will pay for testing as happens with NCAP safety tests.

EXTERNAL CONTEXT AND PRINCIPLES

Given the complex context and issues already described, the workshop considered that any initiative would need to be couched in some key basic global principles for compliance and enforcement. The workshop identified significant failures in most compliance testing globally and also identified how to improve these such as by:

1. Ensuring certification tests are representative of real-world driving in the local region to ensure delivery of environmental goals
2. Cars tests for certification purposes must be typical of those used on the road
3. There must be efforts to end regulatory capture by carmakers and stronger systems to enforce regulations including requiring recall of vehicles
4. Certification schemes must be far more transparent including who and how tests are performed and the results
5. Manufacturers should be required to guarantee to the consumer that emission control technologies are effective and durable over vehicle lifetime
6. Financial penalties should be large enough to deter illegal behavior
7. Government should have political autonomy, i.e. its decisions should not be influenced by effects on corporations
8. Resources need to be available with substantial technical capabilities, expert staff, and strong legal authority to test cars on the road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NEXT STEPS

Overall, the outcome of this workshop was an optimistic one. With a ready availability of multiple, innovative real-world testing technologies, it is possible for a global testing initiative, led by a small number of organisations, to conduct real-world testing of vehicle emissions, and for this to be a game changer for monitoring and reporting vehicle emissions. Such an initiative would make a material contribution to both public health and alleviating climate change. Indeed, with proper planning and execution, this initiative could lead to systemic changes in emission regulations on a global level.

The next key step will be a 'proof of concept' note which will outline:

- A formal statement of intent and scope of this global initiative;
- A list of potential partner organizations, including experts in testing procedures;
- Proposed development of testing guidance
- The creation of a data hub, which gathers data on vehicles to direct the annual testing.
- Regions to be targeted;
- A secretariat
- Identification and securing funders.

APPENDIX 1: LIST OF PARTICIPANTS

FIA Foundation Seminar: Can We Prevent Another Dieselgate?
London, 8 June 2016 - List of Participants

Alex Koerner	Consultant
Alex Furas	Global NCAP
Anumita Roychowdhury	Center for Science and Environment
Beatrice Lopez	UTAC
Chelsea Baldino	ICCT
Chris Carroll	BEUC
Daniel Carder*	West Virginia University
Daniele D'Onofrio	CITA
David Ward	Global NCAP
Dirk Bosteels	AECC
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Drew Kodjak	ICCT
Fabio Branco*	Environmentality
François Cuenot*	Consultant
Gabriel Branco	Environmentality
Gianni Lopez	Centro Mario Molina Chile
Greg Archer	Transport & Environment
Guido Gielen	FIA Region I
James Tate	University of Leeds
Jason Esi*	UK Transport Select Committee
Jaz Cummins*	FIA Foundation
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Lew Fulton	UC Davis
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Mike Walsh	Carlines
Miquel Nadal	RACC
Nick Molden	Emission Analytics
Reinhard Kolke	ADAC
Rob de Jong	UNEP
Saul Billingsley	FIA Foundation
Sheila Watson	FIA Foundation
Steven McCauley*	Pollution Probe

* Online participation

APPENDIX 1: LIST OF PARTICIPANTS

ENDNOTES

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[11] Transport & Environment (T&E) and ICCT blogs: https://www.transportenvironment.org/press/three-new-illegal-defeat-devices-go-unpunished-europe - http://www.theicct.org/blogs/staff/emissions-test-defeat-device-problem-europe-not-about-vw.

[12] Note: Real-world testing is not the same as Real-Driving Emissions (RDE) testing; however, the introduction of the RDE procedure in Europe is expected to yield emission test results that are more in line with real-world driving experience (Franco, et al., 2014). With the RDE, instead of testing the vehicle only in a laboratory, additional testing will be conducted on the road using PEMS during normal driving, but the the raw measurement data will be normalized to account for variation across trips. For example, if CO_2 emissions in a particular section of a trip are especially high, that will be taken as an indication that the trip is relatively demanding, and the raw pollutant emissions will be adjusted down. Conversely, for a trip section with relatively low CO_2 emissions, the measured air pollutant level will be adjusted upwards.

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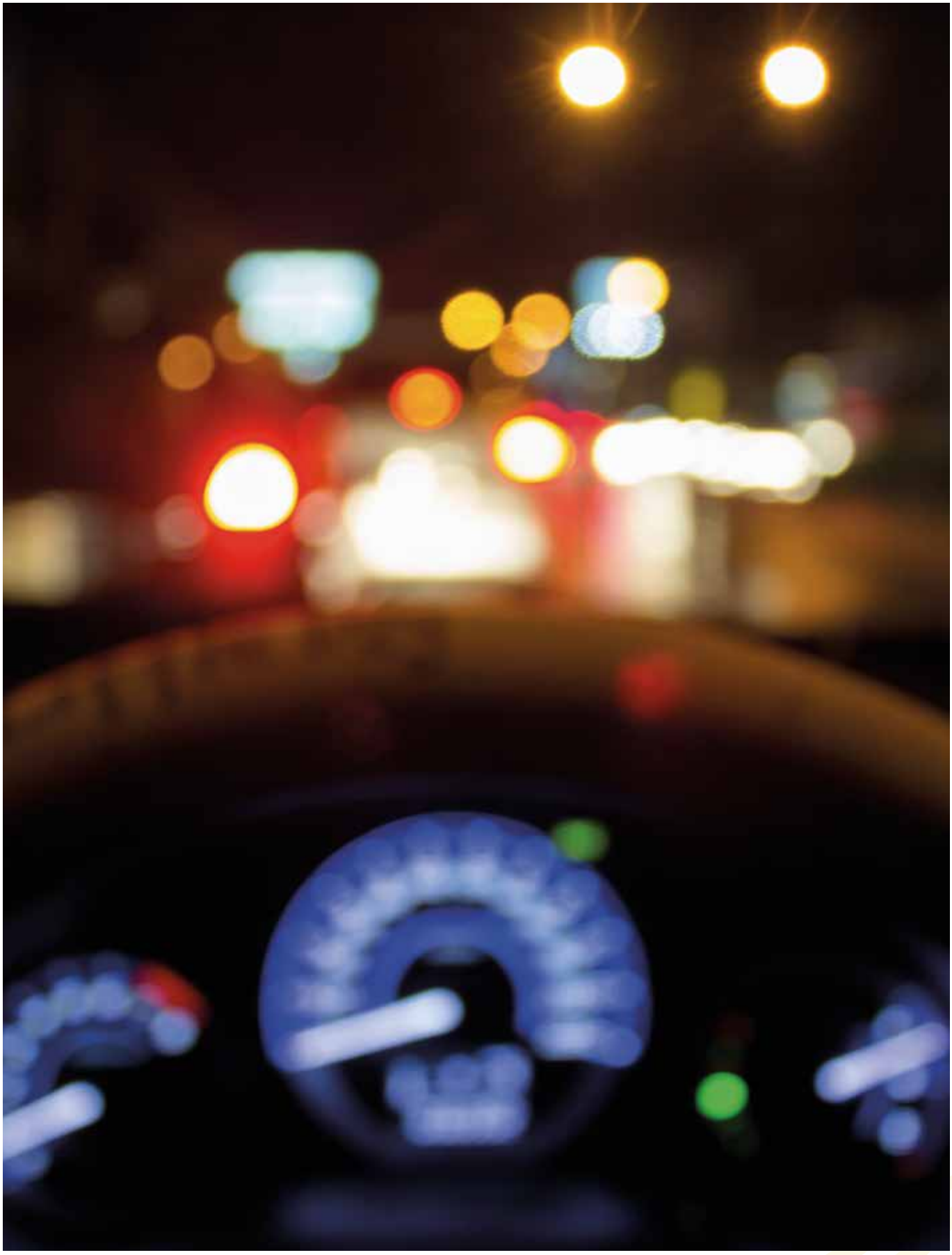
FOUNDATION

The FIA Foundation supports safe, clean, fair and green mobility to improve health and protect lives around the world. It funds an international programme of activities promoting road safety, the environment and sustainable mobility, as well as supporting motor sport safety research.

The Foundation works with a wide range of international partners. It is a contributor to major global action campaigns including the Decade of Action for Road Safety 2011-2020 and played a leading role in ensuring road safety targets were included in the UN's Sustainable Development Goals.



FOUNDATION

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