EMISSIONS ANALYTICS

Emissions Analytics

RDE performance of manufacturers in Europe to date and potential challenges for RDE in India.

ECMA's 10th International Conference "Enabling Cleaner and Greener India Progressing Towards BS VI Norms"

How do European vehicles perform in ‘real-world’ tests?

What are the potential challenges for RDE in India?

ECMA’s 10th International Conference “Enabling Cleaner and Greener India Progressing Towards BS VI Norms”

November 2nd 2017

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Agenda

- Our background, credentials, company structure
- How are European passenger cars performing in RDE tests to date?
- Will RDE legislation do enough, fast enough?
- RDE in India, potential challenges

Credentials

- Founded in 2011
- Headquartered in UK, with operations in London, Los Angeles, Michigan and Stuttgart
- Specialist in PEMS testing and data analysis
- 1500+ vehicles tested across commercial vehicle, passenger car, NRMM, marine applications
- Largest commercially available database of real-world emissions data endorsed by members of C40
- Partners include; OEMs, Tier 1/2 suppliers, fuel and chemical companies, regulators, consultancies, consumer media
- Emissions Analytics works closely with the Joint Research Council at the European Commission and ICCT

Two core divisions

1) Custom PEMS Testing

- PEMS based testing on behalf of government, OEMs and suppliers to verify fuel consumption and emissions in the ‘real world.’

2) RDE Data

We independently test passenger cars to feed into two separate databases;

- EQUAIndex.com: Public and free to use website providing top line data. Recently endorsed by C40 group led by London and Paris.
- RDE database: Largest commercially available database of real-world emissions data providing detailed test data of fuel consumption and air quality

Custom PEMS testing

- Emissions Analytics privately test on behalf of government bodies, vehicle manufacturers, technology suppliers, fuels and oils and fleets
- Testing conditions, location, parameters, cycles etc. based upon client requests
- Custom test results do not feature as part of our RDE database (unless agreed with client and the test followed our procedures)
- 1065 & Reg 49 compliant

Emissions Analytics Independent RDE Testing Results

Emissions Analytics RDE testing concept

- Similar to RDE…
  - Real roads
  - Realistic routes
  - Normal driving styles
- But crucially different…
  - Vehicles sourced independently
  - Independent drivers
  - Standardised test

Database metrics - Europe

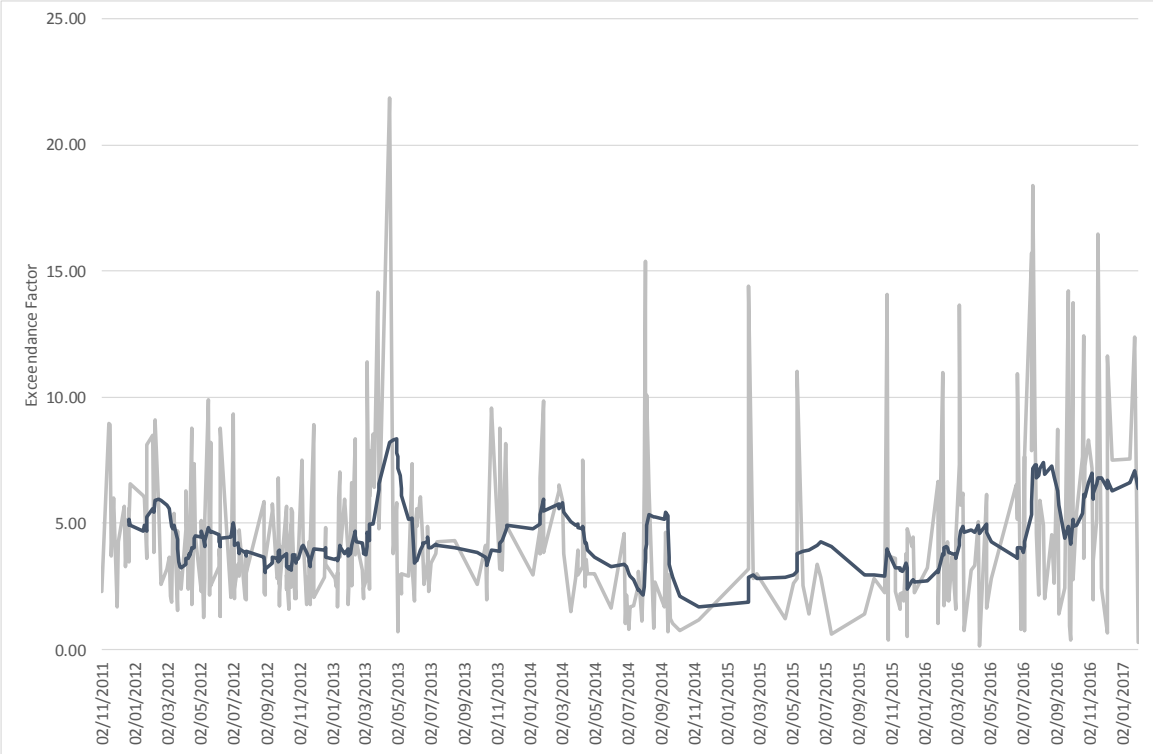
Number of vehicles tested			
	Cars	LCVs	All
Europe	983	40	1023
US	629	11	640
Total	1612	51	1663

By Regulatory Stage			
Europe	Cars	LCVs	All
Unknown	2	0	2
Euro 3	10	0	10
Euro 4	10	1	11
Euro 5	469	24	493
Euro 6	492	15	507

By Segment			
Europe	Cars	LCVs	All
Mini Car (A)	34	0	34
Small Car (B)	152	0	152
Medium Car (C)	282	0	282
Large Car (D)	112	0	112
Executive Car (E)	42	0	42
Luxury Car (F)	30	0	30
Sport Utility/Off-road Vehicle (J)	173	0	173
Multi-purpose Car (M)	88	0	88
Sports Coupe (S)	69	0	69
Cargo Van	0	24	24
Passenger Van	0	10	10
Pickup	1	6	7

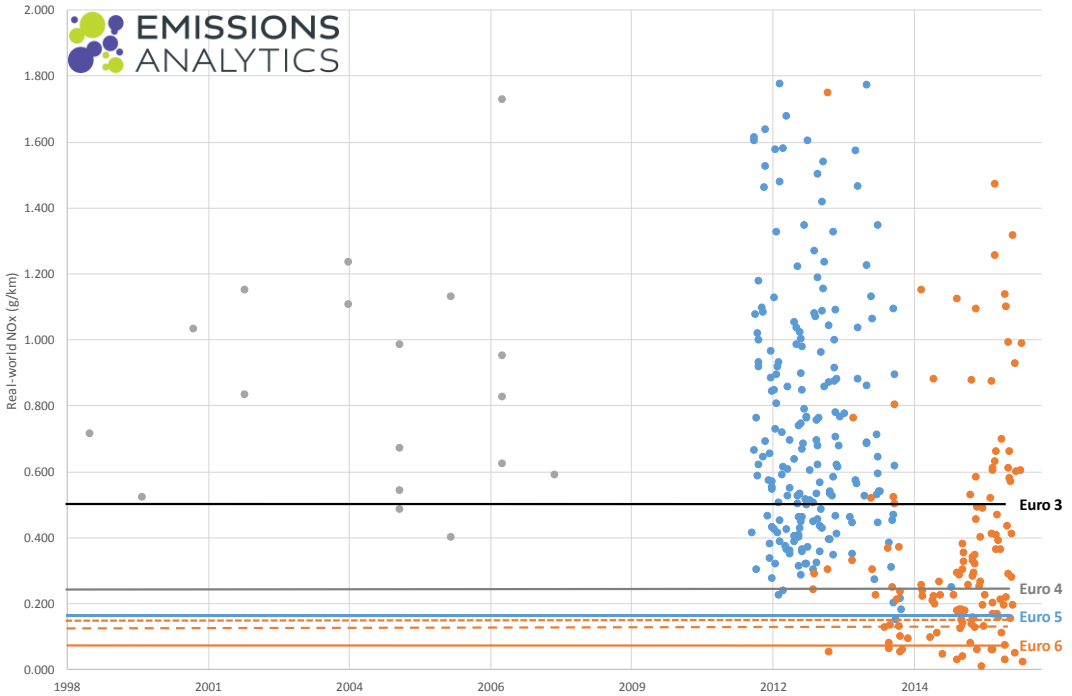
The legacy NO_x problem… bad news

- Average EF now ~7
- Rising since 2015, back almost to Euro 5 peaks
- Despite prospect of Real Driving Emissions
- Growing variability
- Use of thermal management and hot re-start strategies?
- Beating first phase of RDE in 2017?



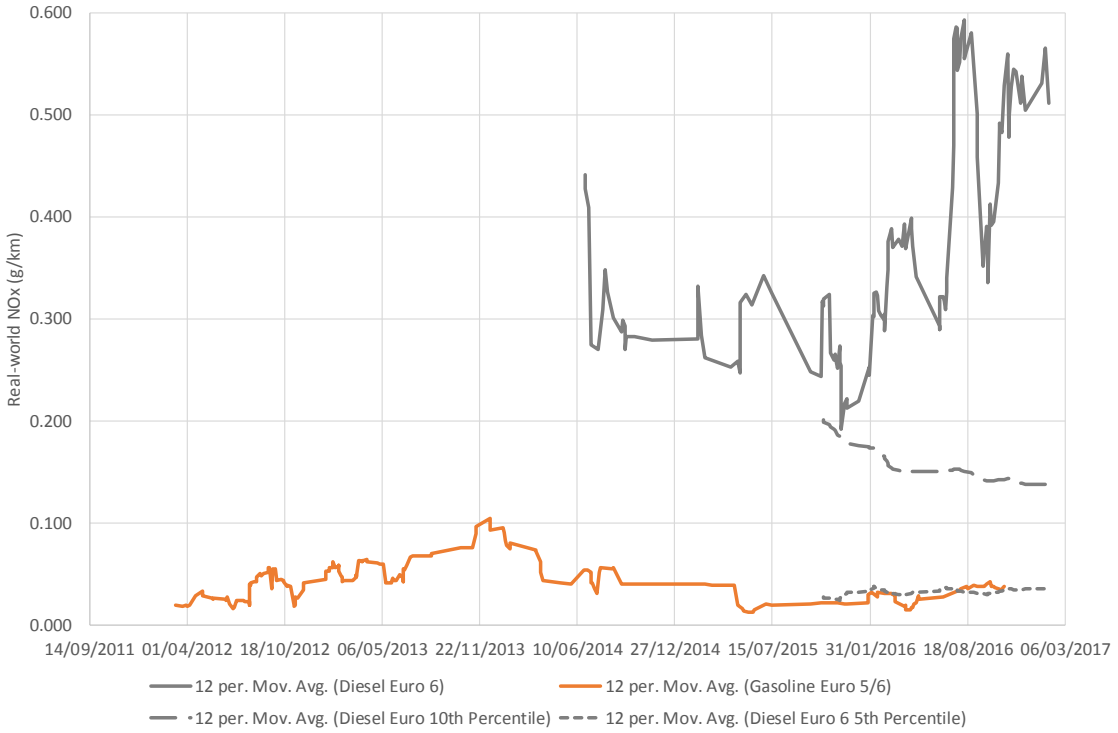
…worse news…

- Dirtiest Euro 6 diesels are 6-7 times worse than cleanest Euro 5
- And are ~3 times worse than cleanest Euro 3/4
- And are about twice as dirty as the average Euro 3/4



But good news… diesels can be clean

- Average Euro 6 diesel 13 times average gasoline car
- But cleanest diesels (5% percentile) are as clean as the average gasoline
- Has been the case for almost 2 years
- Not being able to discriminate within Euro 6 is significant market failure



Key trends: LNT -> SCR

- Vehicle where NOx levels exceeds our market average - all use LNT rather than SCR
- LNT does not = dirty. However, our data suggests they tend to perform less well than equivalent SCR equipped models
- Following the introduction of RDE legislation we expect the majority of vehicles to move from LNT to SCR (perhaps combined with LNT in some instances)
- SCR of course requires AdBlue. Infrastructure a key challenge. There is only 1 AdBlue pump in a 200km radius of my home for example.* Jugs widely available but costly, £1.20 a litre approx., more than diesel.

	Market Average	*0.399*		
19	Ford	0.403	19 –	6 ↓
20	Suzuki*	0.412	20 –	21 ↑
21	Alfa Romeo*	0.455	21 –	
22	Hyundai	0.478	22 –	16 ↓
23	Fiat*	0.573	23 –	23 –
24	Subaru*	0.644	24 –	19 ↓
25	Ssangyong*	0.813	25 –	24 ↓
26	Infiniti*	0.879	26 –	25 ↓
27	Renault	0.961	27 –	27 –
28	Nissan	1.041	28 –	18 ↓

*Source: FindAdBlue.com

Rating bands @ EQUAindex.com

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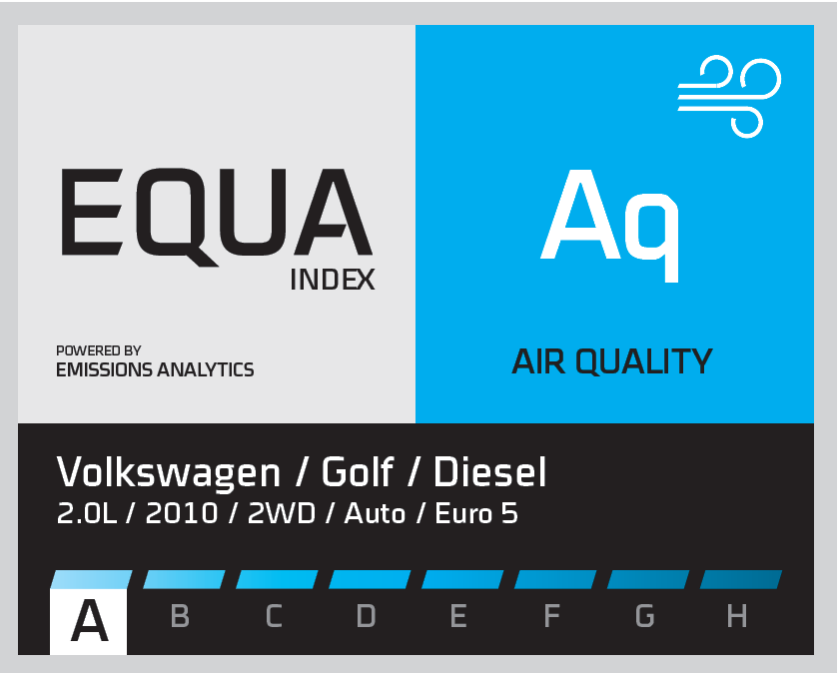
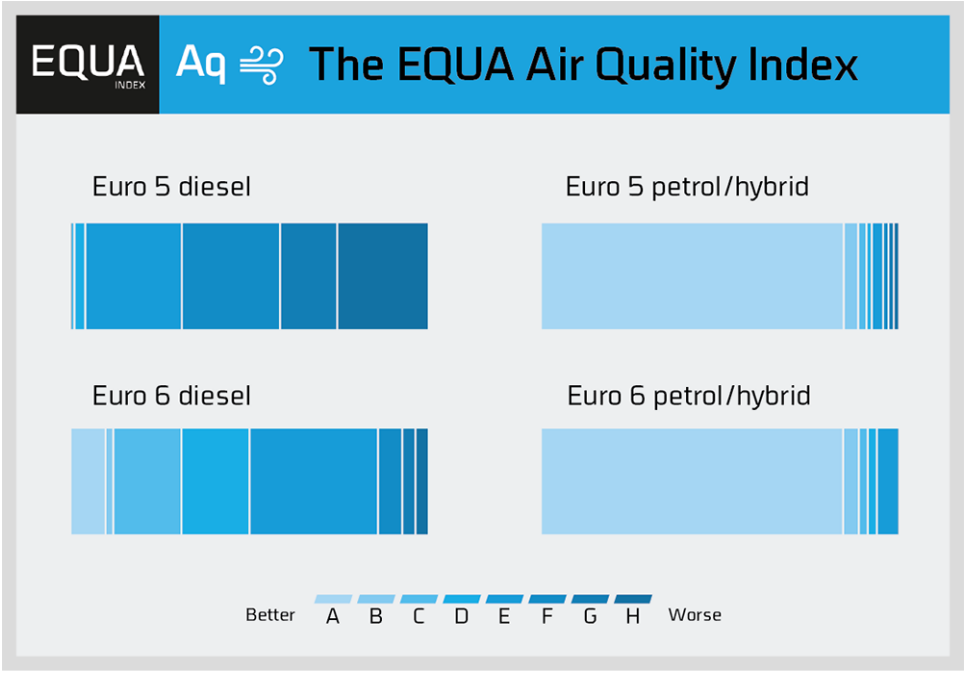
Rating	Lower bound (g/km, exclusive)	Upper bound (g/km, exclusive)	External reference point
A	0.00	0.08	Meets Euro 6 limit for diesels, and meets Euro 4 limit for gasoline
B	0.08	0.12	Meets 1.5 Conformity Factor under Euro 6 Real Driving Emissions regulation
C	0.12	0.18	Meets Euro 5 limit for diesels (and similar to 2.1 Conformity Factor under Euro 6 Real Driving Emissions regulation)
D	0.18	0.25	Meets Euro 4 limit for diesels
E	0.25	0.50	Meets Euro 3 limit for diesels
F	0.50	0.75	No comparable Euro standard: roughly equal to 6-8 times Euro 6 limit
G	0.75	1.00	Roughly equal to 8-12 times Euro 6 limit
H	1.00	None	Roughly equal to 12+ times Euro 6 limit

EQUA labels


EQUA
INDEX
POWERED BY
EMISSIONS ANALYTICS
Aq
AIR QUALITY
Volkswagen / Golf / Diesel
2.0L / 2010 / 2WD / Auto / Euro 5
A
B
C
D
E
F
G
H


EQUA
INDEX
Aq
The EQUA Air Quality Index
Euro 5 diesel
Euro 5 petrol/hybrid
Euro 6 diesel
Euro 6 petrol/hybrid
Better
A
B
C
D
E
F
G
H
Worse

Smaller diesel engines tend to struggle

- There is only 1 diesel vehicle we have tested smaller than 2l that has received an A rating.
- Only 1 received a C rating (meets conformity 2.1)
- India's small diesel engines have a tough task

Make	Model	Fuel Type	Model Year	Engine Size L	Power Bhp	Drive Train	Driven Wheels	Transmission	Euro Stage	EQUA Aq Rating
Make	Model	diesel	Model Year	Engine Size	Power Bhp	Drive Train	Driven Wheels	Transmissi	euro 6	EQUA Aq F
Kia	Rio	Diesel	2015	1.1	74	FWD	2	Manual	Euro 6	G
Volkswagen	Polo	Diesel	2015	1.4	89	FWD	2	Manual	Euro 6	F
Hyundai	i20	Diesel	2015	1.4	89	FWD	2	Manual	Euro 6	E
Mazda	Mazda2	Diesel	2015	1.5	104	FWD	2	Manual	Euro 6	D
Dacia	Sandero	Diesel	2014	1.5	89	FWD	2	Manual	Euro 6	G
Renault	Clio	Diesel	2013	1.5	89	FWD	2	Manual	Euro 6	F
BMW	2 Series Tourer	Diesel	2016	1.5	114	FWD	2	Automatic	Euro 6	G
Ford	Fiesta	Diesel	2015	1.5	94	FWD	2	Manual	Euro 6	C
Mazda	Mazda3	Diesel	2014	1.5	104	FWD	2	Manual	Euro 6	F
Infiniti	Q30	Diesel	2016	1.5	108	FWD	2	Manual	Euro 6	G
MINI	Clubman	Diesel	2016	1.5	114	FWD	2	Manual	Euro 6	C
Mazda	CX-3	Diesel	2015	1.5	104	FWD	2	Manual	Euro 6	D
BMW	1 Series	Diesel	2015	1.5	114	RWD	2	Manual	Euro 6	D
Renault	Megane	Diesel	2016	1.5	108	FWD	2	Manual	Euro 6	G
Nissan	Juke	Diesel	2015	1.5	108	FWD	2	Manual	Euro 6	H
Renault	Captur	Diesel	2013	1.5	108	FWD	2	Manual	Euro 6	H
Renault	Megane	Diesel	2016	1.5	108	FWD	2	Automatic	Euro 6	G

Example impact of congestion on NOx

EQUA Test

Test Description	Regulatory Stage	Real-world NO_x	Official NO_x	Exceedance Factor
2017 Volkswagen Golf 2.0L Diesel 5DR	Euro 6	0.112	0.080	1.400

Driving in London

	NO_x
	g/km
Volkswagen Golf 1.6l	
Route 1	0.226
Route 1 - Congested Section	0.445
Route 2	0.311

Challenges for RDE in Europe

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- Technically sophisticated regulation, with potential for strong in-use surveillance; but…
- 1.5 Conformity Factor only applies to all cars from January 2021
- Equivalent US regulation has been 31 mg/km for a decade
- Not independently conducted
- Boundary conditions could potentially be gamed
- Conflicts results from normalisation tools
- Complex interaction between WLTC and RDE within EMROAD tool

- ➢ RDE will not apply retrospectively
- ➢ “Euro 6” as a label is fundamentally compromised
- ➢ 54% of higher polluting Euro 6s need to be restricted to generate 87% reduction in NO_x

Challenges for RDE in India

- RDE in Europe is based upon a continuous cycle of urban, rural and motorway driving. Should the same approach apply in India, choosing the ‘right’ route will be crucial for manufacturers
- It has been suggested that India RDE testing cycles may be heavily urban focussed to be representative of 6mph average speed
- A non-continuous cycle based upon minutes at an agreed average speed may be required to manage inevitable high traffic and therefore challenges to closely repeat the cycle
- Testing equipment will experience harsh conditions due to high ambient heat and high amounts of dust (comparable to non-road and generator PEMS testing)
- As we all know, electrified vehicles have a great advantage in high traffic. RDE could further accelerate electrified vehicle penetration in India

Emissions inside the vehicle?


DELHI POLICE
DELHI POLICE

World Health Organization…

Ambient (outdoor air pollution) in both cities and rural areas was estimated to cause 3 million premature deaths worldwide per year in 2012; this mortality is due to exposure to small particulate matter of 10 microns or less in diameter (PM_{10}), which cause cardiovascular and respiratory disease, and cancers.

People living in low- and middle-income countries disproportionately experience the burden of outdoor air pollution with 87% (of the 3 million premature deaths) occurring in low- and middle-income countries, and the greatest burden in the WHO Western Pacific and South-East Asia regions.

The Guidelines apply worldwide and are based on expert evaluation of current scientific evidence for:

- particulate matter (PM)
- ozone (O_3)
- nitrogen dioxide (NO_2) and
- sulfur dioxide (SO_2), in all WHO regions.

In cabin emissions measurement

NO2

CO

VOC's

Ozone

CO2

Particulates (0.023 microns)

Ammonia

PIMS
(Pollution in-cabin measurement system)

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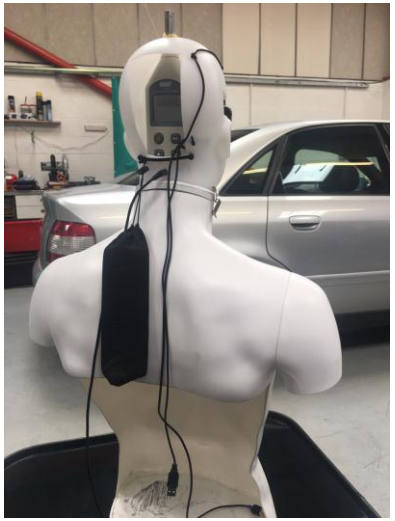

Thank you, questions?

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