

Providing clean DPF technology for Iran

Soot-free Teheran



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Vehicle Regulations, R&D**



SCANIA since 1891



Premium products



Modular system



The world of Scania

44,400 employees
2015

- Sales and services
- Production units
- Regional Product Centres
- Research and development

Production units

- 1891 Sweden
- 1957 Brazil
- 1964 Netherlands
- 1976 Argentina
- 1992 France
- 1993 Poland
- 2014 Finland
- 2015 India



Sales and services units

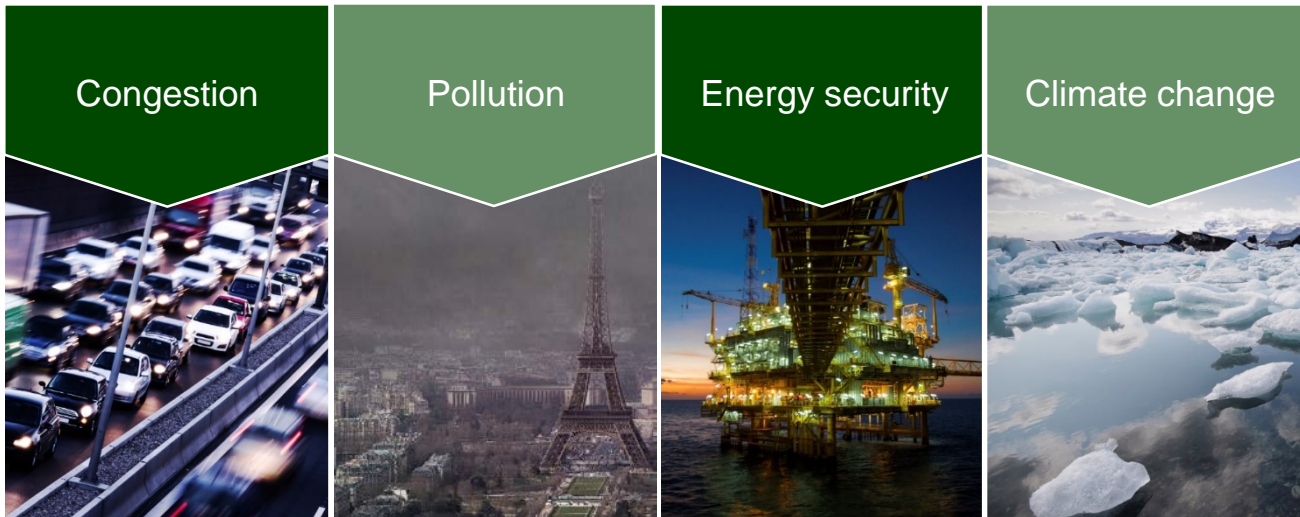
1,000 sales points

1,600 workshops

More than 95% parts availability

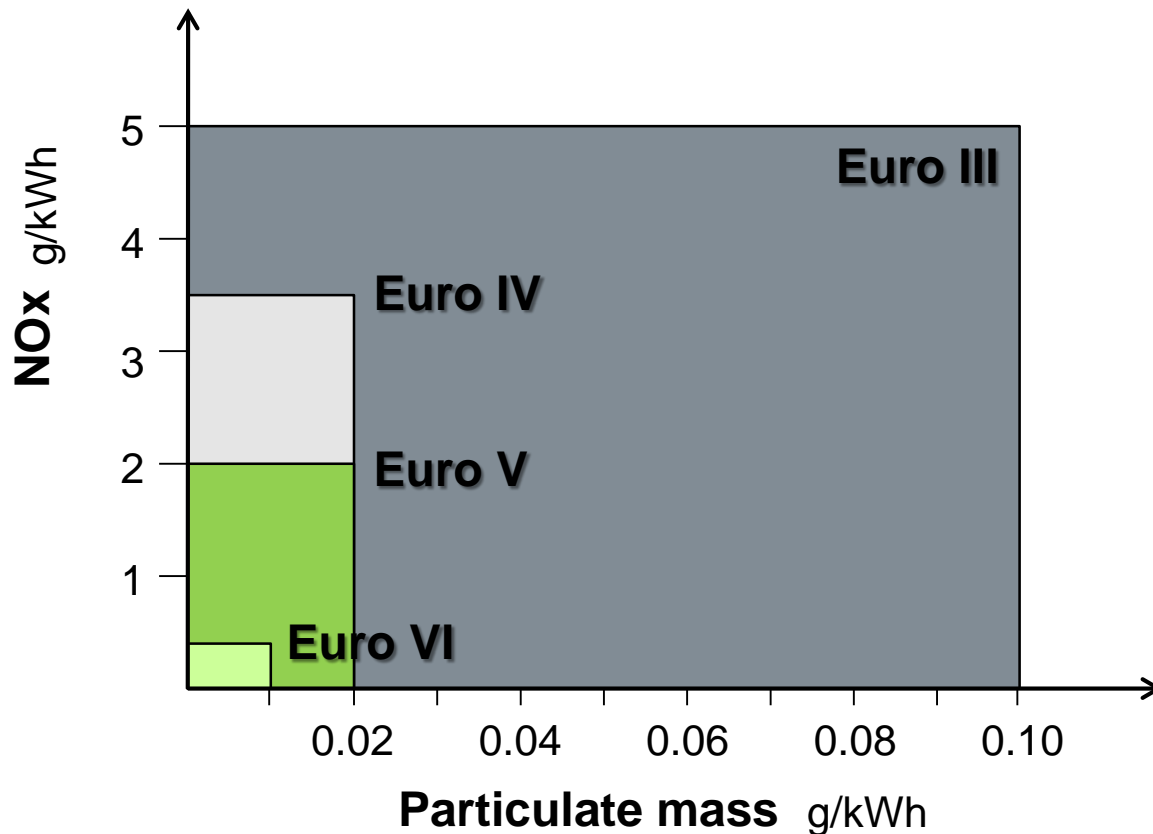
Round-the-clock assistance

Four main drivers for sustainable transport



EU Emissions Regulation

– successively lower emissions in European legislation



Particle number



Regulated Fuel quality

Euro III	300 ppm S
Euro IV	50 ppm S
Euro V	10 ppm S
Euro VI	

The council of ministers approved regulations regarding to vehicle emission standard, decided that regulation No. H51187T/10994 dated 22.04.2015 is the criteria for assessing of emission level

Islamic Republic of Iran
Cabinet of Ministries' Act

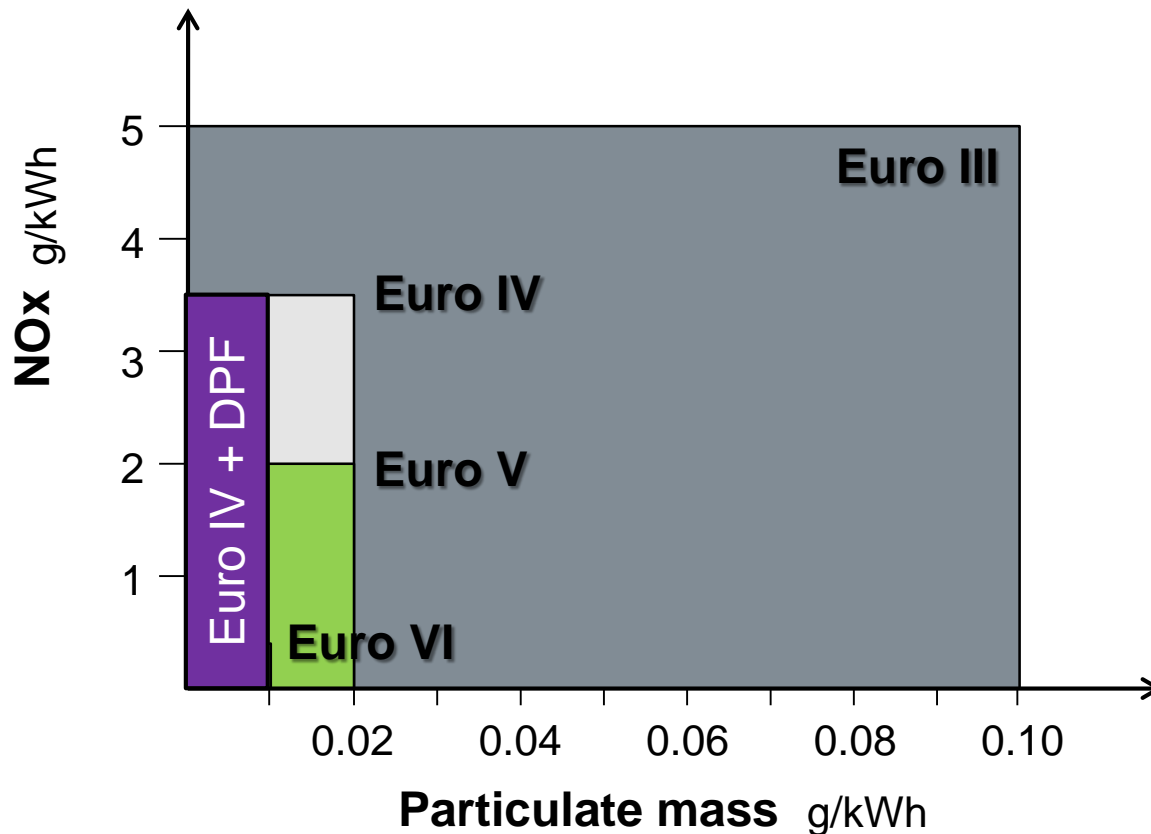
Following proposal No.60/159391, dated October 15, 2014 and referencing to constitutional law no.138, On April 19, 2015 Cabinet of ministries legislated:

1- Article (4-1) of row 4 in attached table of act no.49952ت/12782 dated April 30, 2014 is replaced by the following table.

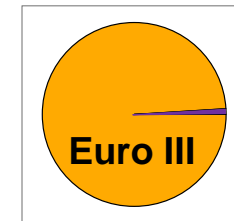
Row	Activity	Executer	Supervisor	Schedule
4	New Vehicles			
4-1	To register all heavy and medium weight diesel city vehicles, meeting Euro6 or Euro4 standards and DPF installation are required.	Traffic Police of Iran	Department of Environment	September 22, 2016
4-2	To register all heavy and medium weight diesel intercity vehicles, meeting Euro6 or Euro4 standards and DPF installation are required.	Traffic Police of Iran	Department of Environment	March 21, 2017

EU Emissions Regulation

– successively lower emissions in European legislation



Particle number



Euro VI
Euro IV+DPF

Regulated Fuel quality

Euro III	300 ppm S
Euro IV	50 ppm S
Euro V Euro VI	10 ppm S

EXHAUST EMISSIONS, EUROPE + Iran

Limit values for CI (Compression Ignition) engines.

Implementation date	Test cycle	Emission levels						Remarks
		CO g/kWh	HC g/kWh	NO _x g/kWh	NH ₃ ppm	PM mass g/kWh	PM Number #/kWh	
1.Oct. 2000 / 1. Oct. 2001	ESC	2.1	0.66	5.0	-	0.10	-	"EURO 3"
1.Oct. 2005 / 1. Oct. 2006	ESC	1.5	0.46	3.5	25	0.02	-	"EURO 4"
1. Oct 2008 / 1. Oct. 2009	ESC	1.5	0.46	2.0	25	0.02	-	"EURO 5"
1.Oct. 2000	ESC	1.5	0.25	2.0	25	0.02	-	EEV
22.Sep. 2016 21.Mar. 2017	ESC	1,5	0,46	3,5	25	0,02	1x10e12	"EURO 4" + DPF

Type Approval / All new types	Test cycle	CO mg/kWh	THC mg/kWh	NO _x mg/kWh	NH ₃ ppm	PM <u>mass</u> mg/kWh	PM <u>number</u> #/kWh	Remarks
31. Dec. 2012 / 31. Dec. 2013	WHSC	1500	130	400	10	10	8*10 ¹¹	"EURO 6"

ESC European Steady state Cycle,
means a test cycle consisting of steady state modes, (at 4 speeds)
WHSC World-wide Harmonized Steady state Cycle, (at 6 speeds)

Limit values for CI (Compression Ignition) engines.

Implementation date	Test cycle	Emission levels						Remarks
		CO g/kWh	NMHC g/kWh	NO _x g/kWh	NH ₃ (ppm)	PM mass g/kWh	PM Number #/kWh	
1. Oct. 2000 / 1. Oct. 2001	ETC	5.45	0.78	5.0	-	0.16	-	"EURO 3"
1. Oct. 2005 / 1. Oct. 2006	ETC	4.0	0.55	3.5	25	0.03	-	"EURO 4"
1. Oct. 2008 / 1. Oct. 2009	ETC	4.0	0.55	2.0	25	0.03	-	"EURO 5"
1. Oct. 2000	ETC	3.0	0.40	2.0	25	0.02	-	EEV
22.Sep. 2016 21.Mar. 2017	ETC	4,0	0,55	3,5	25	0,03	1x10e12	"EURO 4" + DPF

Type Approval / All new types	Test cycle	CO mg/kWh	THC mg/kWh	NO _x mg/kWh	NH ₃ ppm	PM <u>mass</u> mg/kWh	PM <u>number</u> #/kWh	Remarks
31. Dec. 2012 / 31. Dec. 2013	WHTC	4000	160	460	10	10	6*10 ¹¹	"EURO 6"

ETC European Transient Cycle, means a test cycle consisting of second-by-second transient modes.
WHTC World-wide Harmonized Transient Cycle

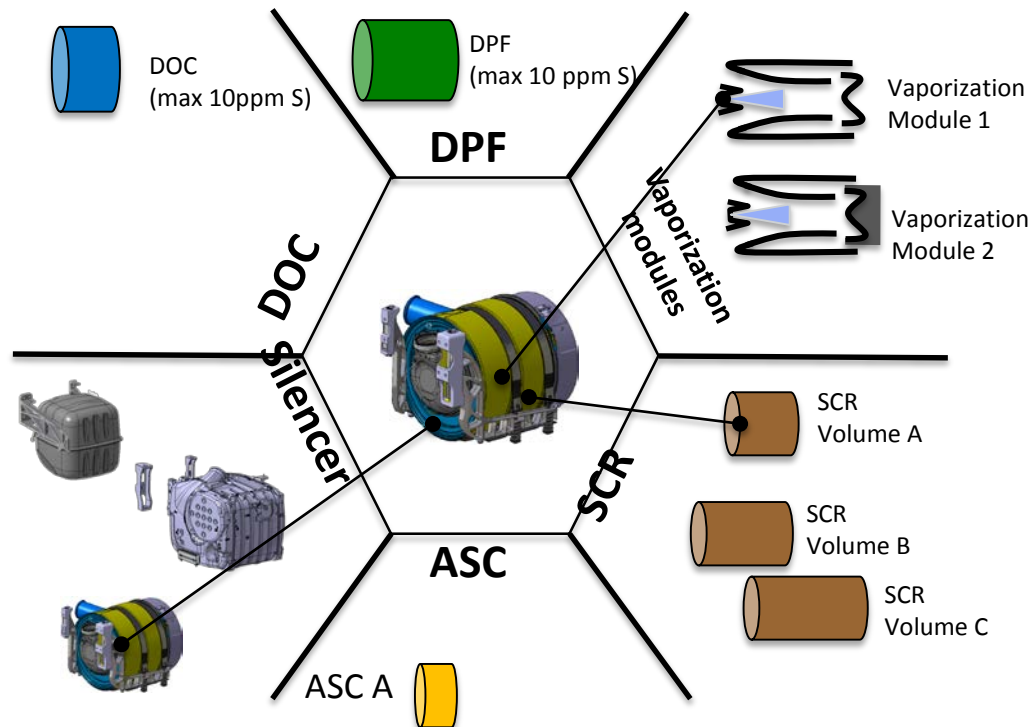
Exhaust treatment components

- **DOC – Diesel Oxidation Catalyst**
 - Oxidizes hydrocarbons and carbon monoxide to water and CO₂
- **DPF – Diesel Particulate Filter**
 - Removes particles from the exhaust. Breaks down PM to CO₂
- **UDS – Urea Dosing System**
 - Injects liquid Urea to exhaust
- **Vaporization module**
 - Turns liquid Urea to gaseous ammonia
- **SCR – Selective Catalytic Reduction**
 - Catalyst that breaks down NO_x using ammonia
- **ASC – Ammonia Slip Catalyst**
 - Removes excess ammonia from emissions

Scania Aftertreatment toolbox

Components with verified performance

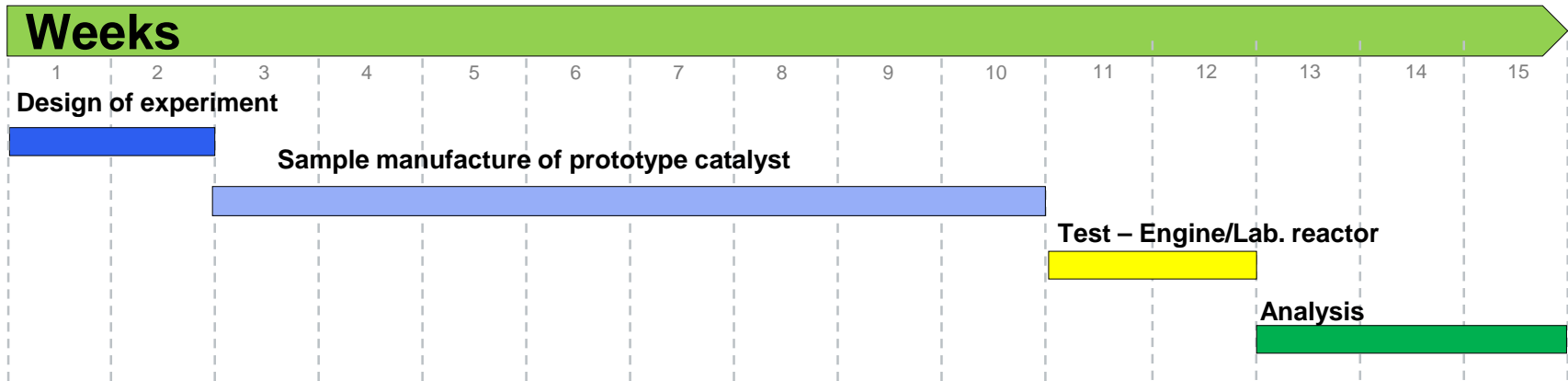
Euro IV



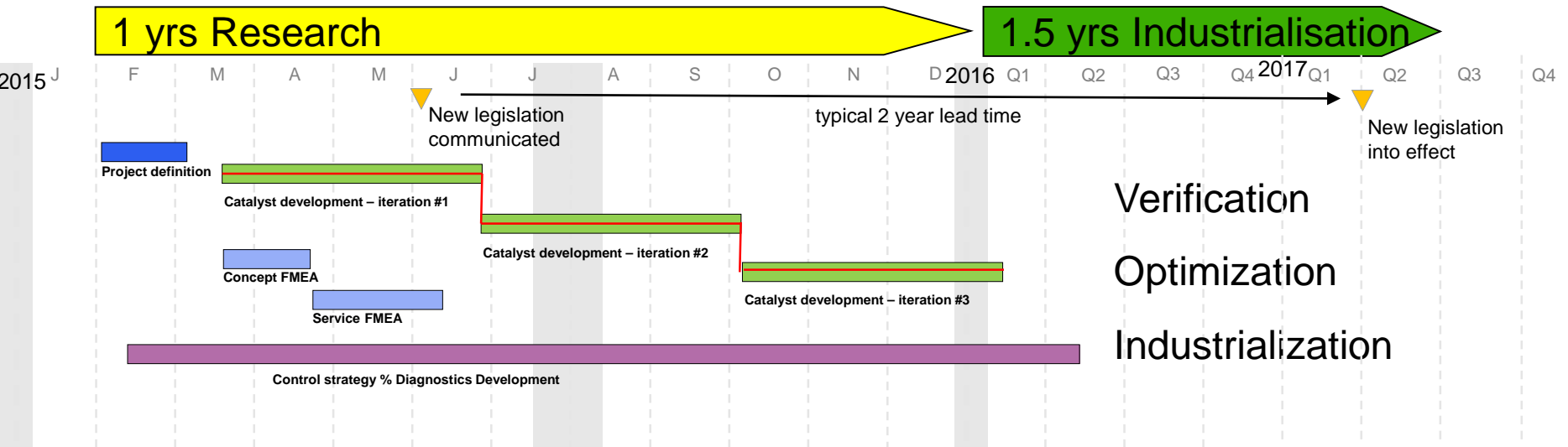
How the problem was solved?

- Continuous improvement is a core value at Scania
- Already in 2011 we started testing the concept and identifying improvements for Euro VI.
- So we improved the catalyst in both functionality and assembly to make it more Sulphur tolerant.
 - We use the same substrate as Euro VI.
 - The catalyst is different
- We have patented the integration of the technology

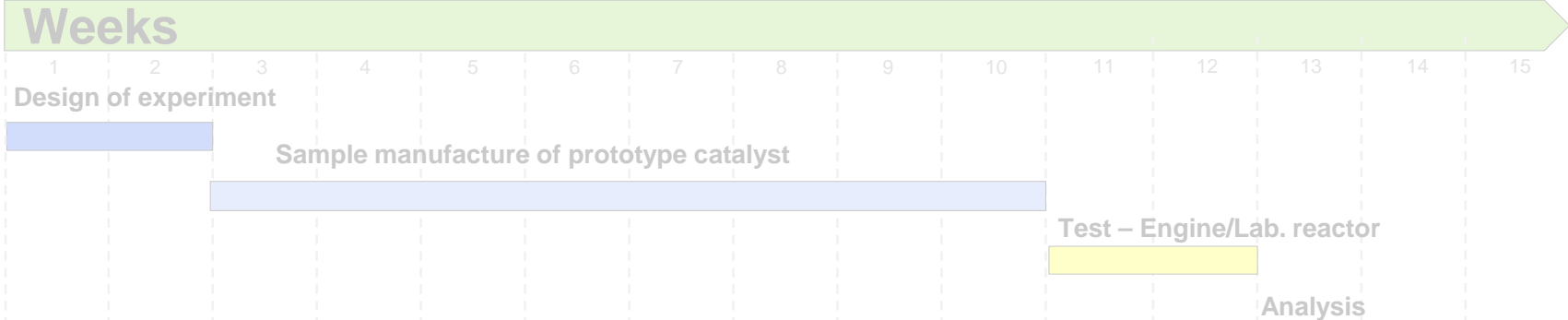
Development method for adding catalyst to Toolbox



Aftertreatment development

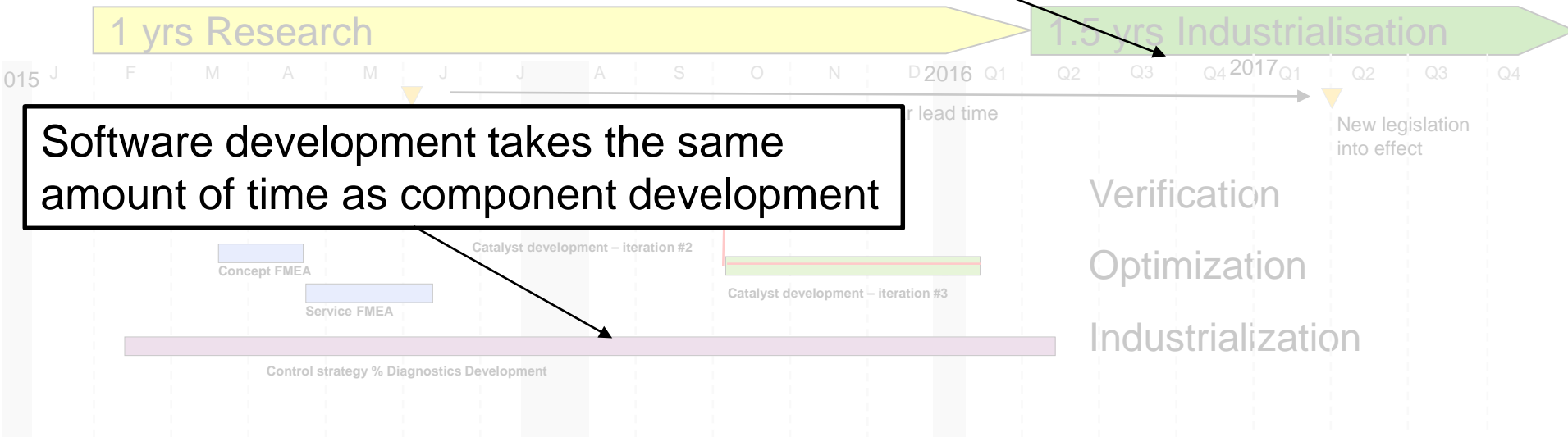


Development method for adding catalyst to Toolbox



The majority of the time is spent in industrialisation and verification

Aftertreatment development



Software development takes the same amount of time as component development

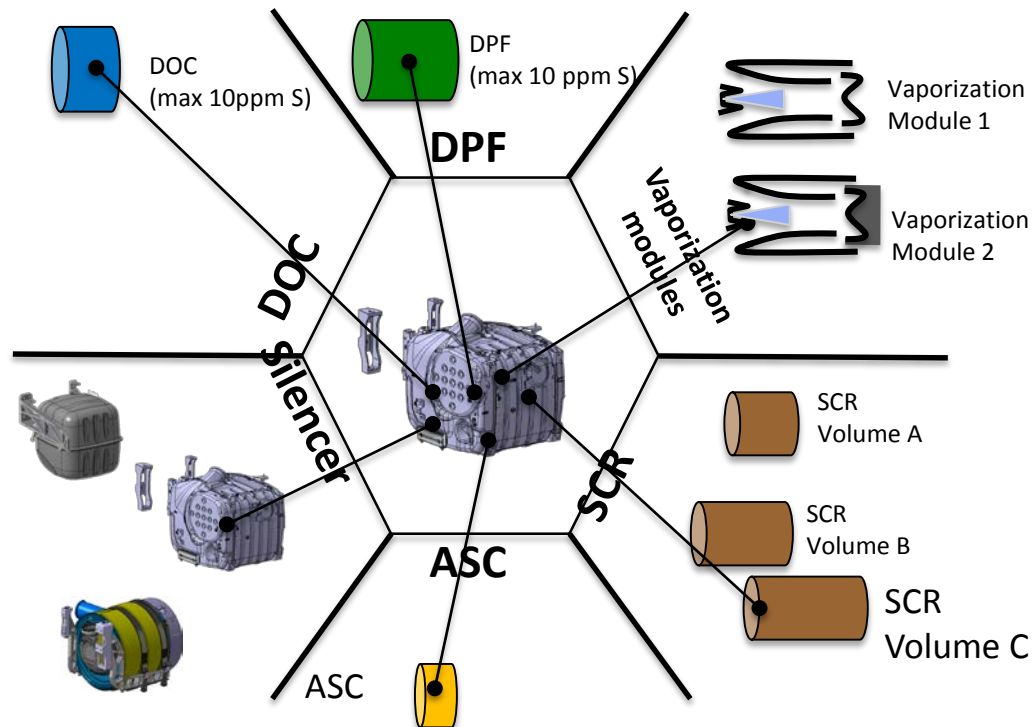
Verification
 Optimization
 Industrialization



Scania Aftertreatment toolbox

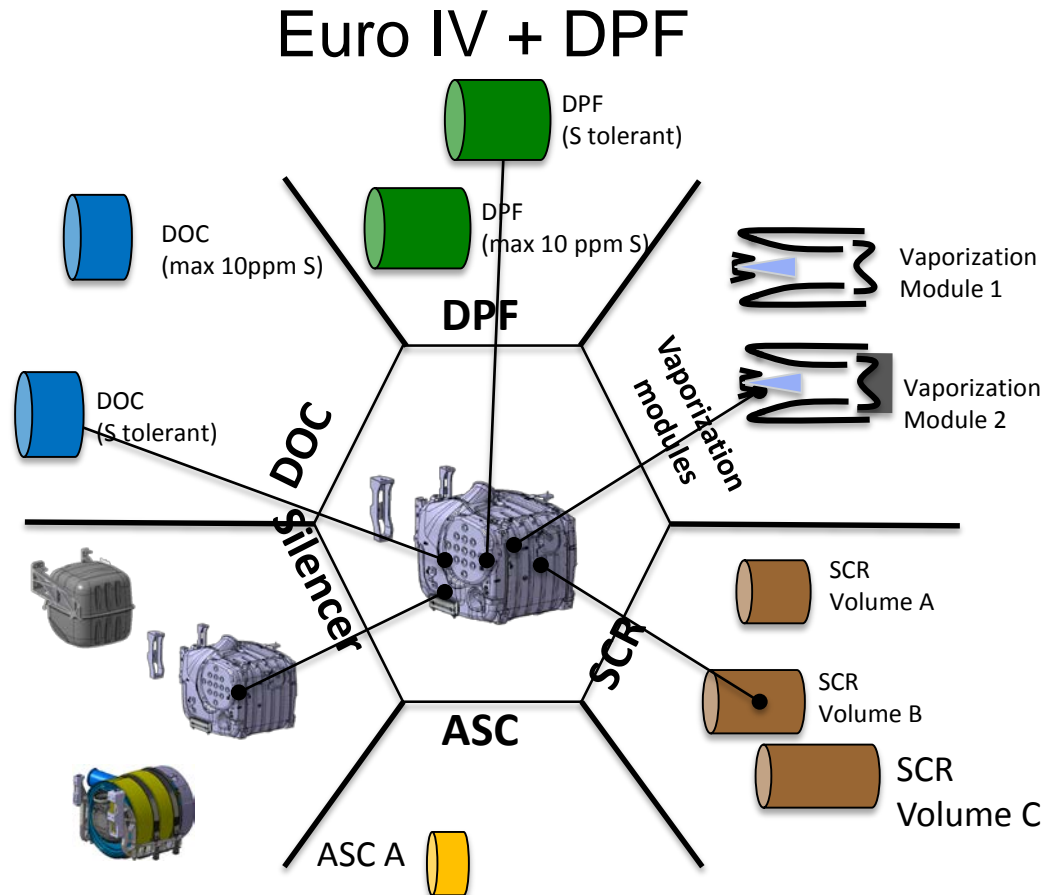
Components with verified performance

Euro VI



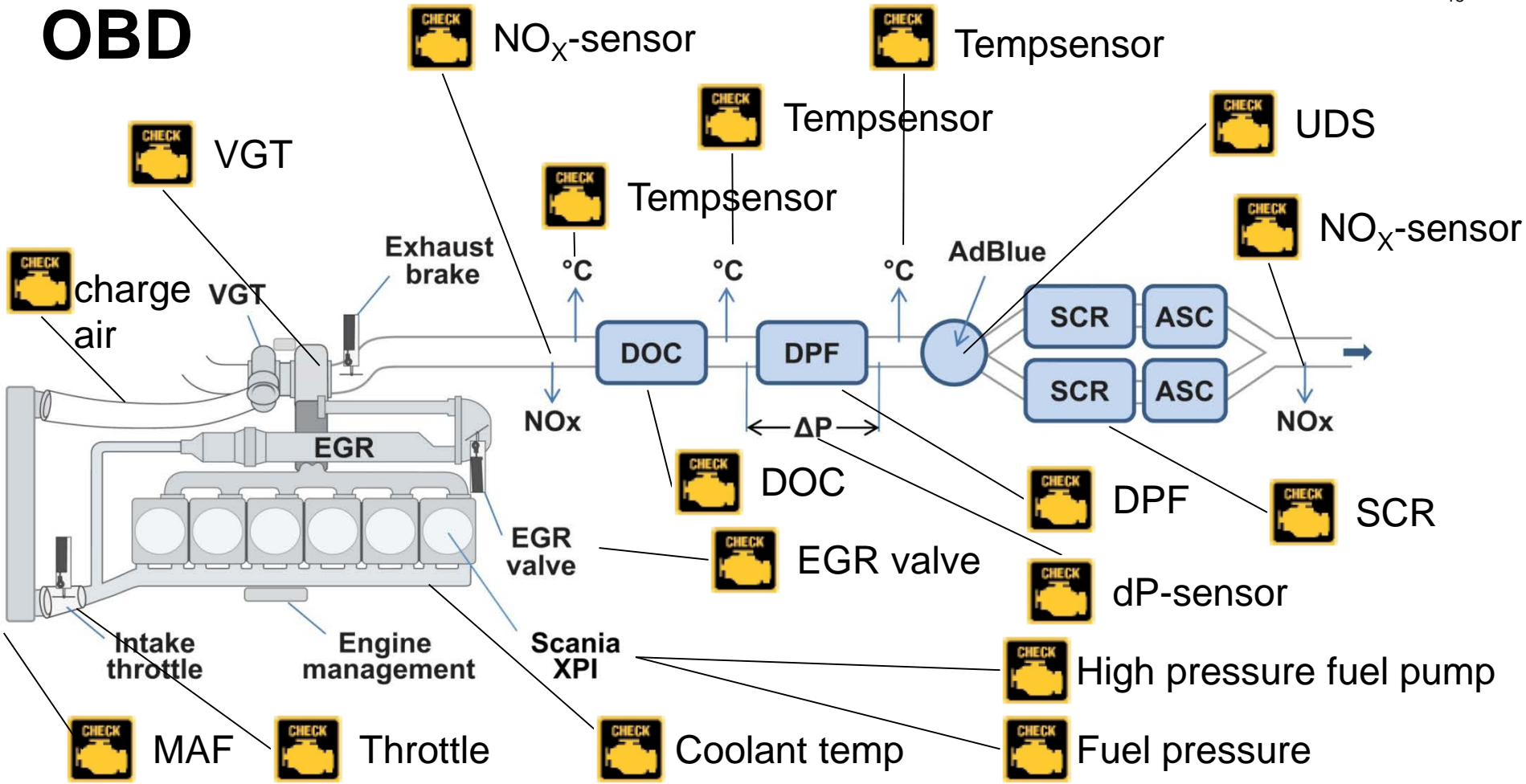
Scania Aftertreatment toolbox

Components with verified performance



New demands requires new additions to the toolbox

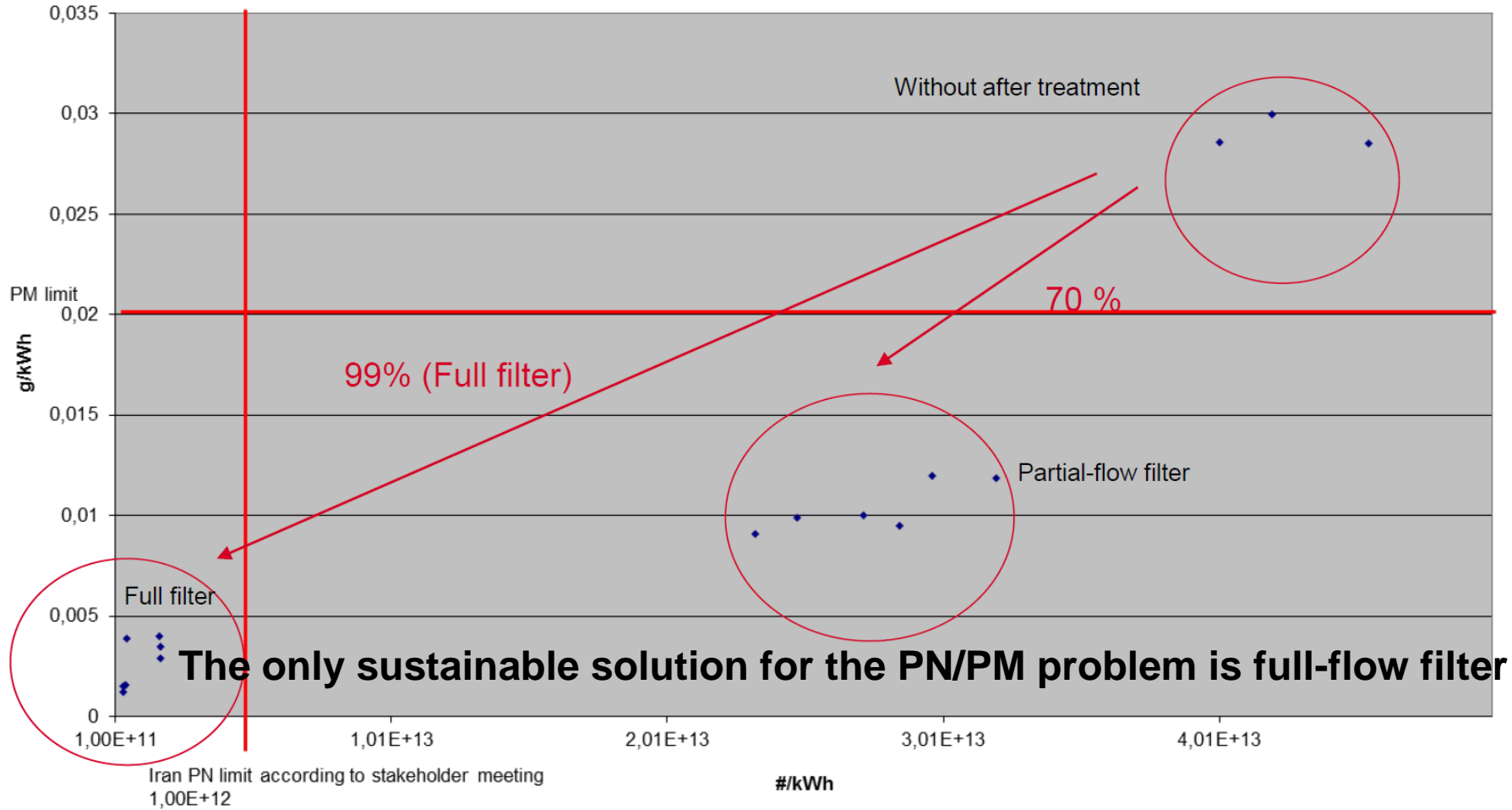
OBD



All components affecting emissions have to be monitored by OBD

Partial-flow filter (EEV) vs Full-flow filter (Euro IV + DPF)

Correlation PM (g/kWh) vs PN (#/kWh)
 9-liter engine with partial-flow filter, full filter and without after treatment



How its works?

- Regeneration of the full flow filter is catalytic
- If saturation occurs then the vehicle have to be parked and by pushing a button the process of burning the soot up will start converting the particles into gases by using engine heat.
- No additives, No burners
- It is fully integrated in our system making it better than a retrofit system.

How much it cost?

- The know how for achieving Euro VI technology level in our products is reached by many years of investments in both people and technology
- The project cost for developing a DPF that is Sulphur tolerant and integrated in our Euro VI system is approx. 3,4 MEUR
 - Man-hours, building prototypes, cell test, road test, manufacturing tools.
- The price of a retrofit system is between 3.000 EUR up to 15.000 EUR
- Our solution is integrated and more robust, it is a Scania product.

When starts the production?

- The legislation requires Euro IV + DPF from September 2016 for city buses.
- The production of the first bus chassis starts in September 2016.
- The legislation requires Euro IV + DPF from March 2017 for trucks and intercity buses.
- The production will start in February 2017

Type approval requirements

1. The type approval of Euro IV plus DPF and fuel quality shall comply with DIRECTIVE 2005/55/EC and DIRECTIVE 2005/78/EC latest amendments.
2. The PN measurement shall follow the test procedure described in ECE R49:
 - PN measurement test procedure according to ECE R49 rev 6 Annex 4 paragraph 10.
 - PN measurement equipment requirements according to ECE R49 rev 6 Annex 4 Appendix 8.
 - Test condition for engine with exhaust after treatment system according to ECE R49 Rev. 6 Annex 4 section 6.6.
 - Test cycles according to ECE R49 Rev 5 Annex 4A for Euro IV
3. OBD requirements according to ECE R49 Rev 5, Annex 9A or EU directives (2005/55/EC, 2005/78/EC)



Concerning⁽¹⁾:

- approval granted
- ~~approval extended~~
- ~~approval refused~~
- ~~approval withdrawn~~
- ~~production definitely discontinued~~

of a vehicle type with regard to the emission of pollutants by the engine pursuant to Regulation number 49.

Approval number: E4-49RC-050365

Extension number: 00

- 1. Trade name or mark of the engine : SCANIA
- 1.1. Make and type of the engine : SCANIA / DC09 137
- 1.2. Manufacturer's code as marked on the engine : DC09 137
- 2. Vehicle make and type : SCANIA / P-, G-, R-series and K-, N-series
- 3. Manufacturer's name and address : SCANIA CV AB
S-151 87 Södertälje
Sweden



9.2. ESC test (if applicable):

Deterioration factor (DF) : ~~calculated~~/fixed⁽¹⁾

Specify the DF values and the emissions on the ESC test in the table below:

ESC test					
DF	CO	THC	NO _x	PT	PN
	1.1	1.05	1.05	1.1	--
Emissions	CO (g/kWh)	THC (g/kWh)	NO _x (g/kWh)	PT (g/kWh)	PN #/kWh
Measured	0.0	0.00	2.6	0.00	1.58E+11
Calculated with DF	0.0	0.00	2.7	0.00	--

9.3. ELR test (if applicable):

Smoke value : 0.083 m⁻¹

9.4. ETC test:

Deterioration factor (DF) : ~~calculated~~/fixed⁽¹⁾

ETC test						
DF	CO	NMHC	CH ₄	NO _x	PT	PN
	1.1	1.05	N.A.	1.05	1.1	--
Emissions	CO (g/kWh)	NMHC (g/kWh) ⁽¹⁾	CH ₄ (g/kWh) ⁽¹⁾	NO _x (g/kWh)	PT (g/kWh) ⁽¹⁾	PN #/kWh
Measured with regeneration	g/kWh	g/kWh	N.A.	g/kWh	g/kWh	--
Measured without regeneration	g/kWh	g/kWh	N.A.	g/kWh	g/kWh	--
Measured/weighted	0.0	0.00	N.A.	2.6	0.00	1.04E +11
Calculated with DF	0.0	0.00	N.A.	2.8	0.00	--

10. Engine submitted for tests on : 15 March 2016
21 & 22 March 2016
27 June till 5 July 2016



Approval number: E4-49RC-050365

Extension number: 00

11. Technical service responsible for conducting the approval tests : RDW
P.O. Box 777
2700 AT Zoetermeer
The Netherlands
12. Date of test report issued by that service : 30 June 2016
05 July 2016
13. Number of test report issued by that service : RDW-49R-0045486
RDW-49R-0041888
14. Approval number of the engine/engine family, if approved as a separate technical unit : N.A.
15. Site of approval mark on the vehicle/engine⁽¹⁾ : In or close to main entrance door
16. Reason for extension : N.A.
17. Place : Zoetermeer
18. Date : 5 July 2016
19. Signature :



Jim van Pommere

Documentation 54 pages

⁽¹⁾ Strike out what does not apply.





OGHAB
Euro4
+ DPF

Torsion

We are riding on Green

Conclusions

The only way to reduce the Particle Numbers (PN) to the limits requested by the Iranian authorities ($1,01E12$ #/kWh) is with a full flow filter (DPF).

The Euro IV + DPF after treatment system has to be functional at high altitudes like the city of Tehran and therefore the engine is developed to comply with the emission limits up to 1600m.

The OBD system of the Euro IV + DPF will control that the after treatment system and the DPF works correctly.

The technology for regeneration of the full flow filter of the Euro IV + DPF engine is similar to the Euro VI regeneration technology.

Finally the Scania engine Euro IV + DPF developed for Iran is robust, Sulphur tolerant and applicable to reduce the particle number with 99% with a full-flow filter while using low fuel quality and complying with the emissions at up to one mile high altitude, all this by using Euro VI technology.

The only sustainable solution for the PN/PM problem is full flow filter

Scania is sustainable



