

# Experiences of South Korea on Diesel Particulate Retrofit Program

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**Korea Automobile  
Environmental Association**

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## Purpose of establishment

To contribute to the improvement of the citizens' health and environmental conservation by reducing the pollutants from automotive exhaust gases as well as to promote the mutual benefits of members of the association.

- A legal basis : Article NO. 78, 80 of the "Clean Air Conservation Act"

## History

- **2007.11.** Held the inaugural assembly of the Korea Automobile Environmental Association  
Obtained permission of incorporation  
(Ministry of Environment NO.321)  
**Founded**  
(Seoul Central District Court)
- **2007.12.** Performed a follow-up management service for a reduction program
- **2009.01.** Performed a device return management service on commission
- **2010.03.** Performed the service to determine cars subjected to accelerated retirement
- **2011.02.** Performed a follow-up management service for Idle stop and go system
- **2011.03.** Implemented a Korean auto-oil program
- **2012.07.** Propagated an Eco-drive Campaign on commission
- **2015.03** EV public quick charging infrastructure operation management consignment work

## Main business

- 1. Diesel vehicle retrofit program**
  - Diesel Particulate Filter(DPF)
  - PM-NOx reduction device(DPF/SCR)
  - Urea voucher system management(153 station)
  - Low-emission engine remodeling/replacement
  - Emission retrofit program call center
  - Selection and confirmation testing of early scrapped subject
- 2. Eco driving culture spread program**
  - Eco driving nationwide campaign (eco-drive.or.kr)
  - Eco driving contest
- 3. EV charging infrastructure management**
  - Public quick charging infrastructure management(333 station)
  - Slow charger installation service
- 4. Research for Environmental transportation field**
  - Support Vehicles Emission In-use Compliance Test (NIER)
  - Support Heavy-duty Vehicles Real Driving Emission Test(NIER)
  - Support Hydrogen fuel cell bus pilot project(monitring)
  - Auto-Oil program management(MOE)
  - LEZ(Low Emission Zone) Research & Consultation
  - Pilot Project : New retrofit device supply
  - Other environmental transportation field research business

# Members

## DPF



## LPG Conversion

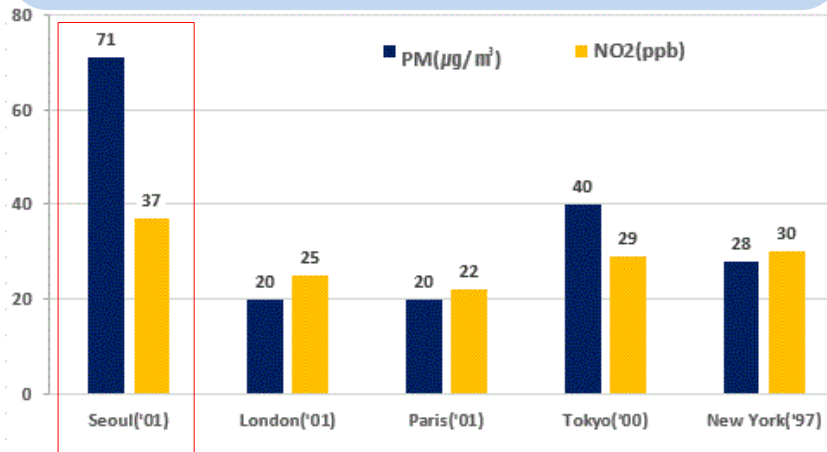


# I . Background

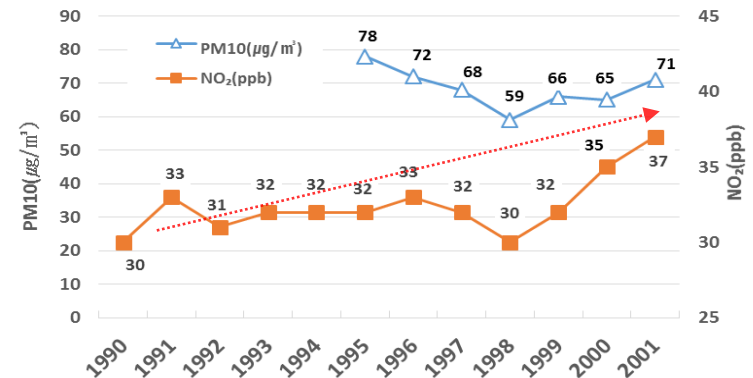
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# Severe Air Pollution in Seoul Metropolitan Area

## High PM level among OECD countries



## Air pollution level worsens in Seoul



## Limits of air pollution policy

- High concentration of pollutants in Seoul Metropolitan Area(SMA)
- Difficulties managing several metropolitan areas air pollution

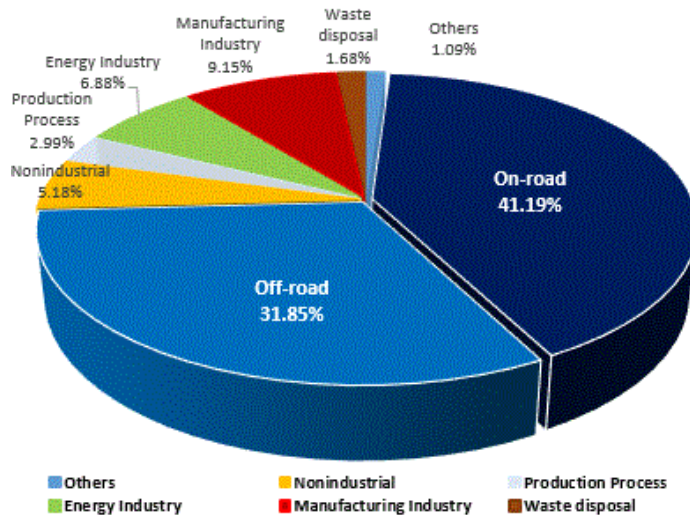
## Increase of social costs

- Annual environmental costs over KRW10 trillion
- 10,000 premature deaths are caused by PM<sub>10</sub> yearly, three times higher than the number of car accident deaths

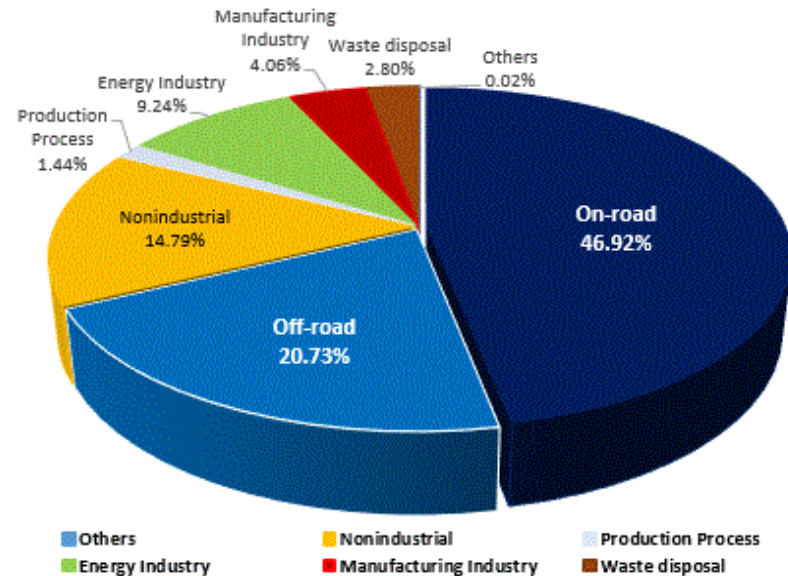
# Needs of Managing Old Diesel Vehicles

## Inventory of pollutants(2012)

### PM<sub>10</sub> Emissions



### NOx Emissions



[CAPPS (Clean Air Policy Support System),  
2012, NIER]

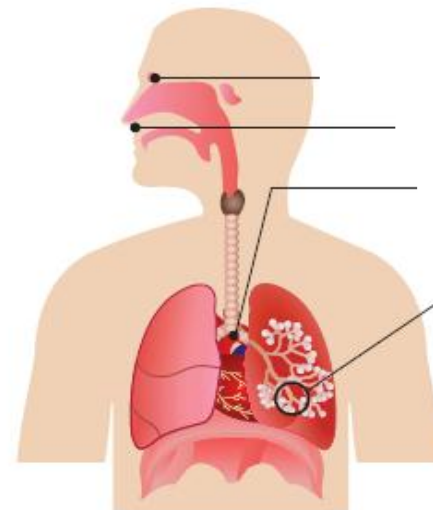
**70%** of air pollutants(PM<sub>10</sub> · NOx) in metropolitan area  
Emitted by **vehicles**(On-road · Non-road)

# Health Effects of Particulate Matter

- ❖ Particulates permeate into lung and vascular system affecting all kinds of diseases and premature deaths
  - (WHO) As first class of Carcinogen air pollution, excess mortality was 24 out of one hundred thousand in 2008, second highest in the world
  - (Seoul Research Institute)  $10\mu\text{g}/\text{m}^3$  increase of  $\text{PM}_{2.5}$  in Seoul influenced 0.8% of mortality and 13% increase of cardiovascular system disease during 2005~2007



미세먼지  $\text{PM}_{10}$     미세먼지  $\text{PM}_{2.5}$   
**10μm**                      **2.5μm**  
※ μm(마이크로미터) :  $\frac{1}{10^6}\text{m}$



Eye  
Nose  
Bronchus  
  
Alveolus

〈Size comparison of Hair and PM〉

〈Influence of Particulate matter〉



## II. Diesel Vehicle Retrofit Program

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1

1st Phase Special Measures on  
Metropolitan Air Quality Improvement

2

Retrofit of Old Diesel Vehicles

3

Accomplishment of the 1<sup>st</sup> Phase Execution

# 1. 1st Special Measures on Metropolitan Air Quality Improvement

## Improvement Targets and Management Area

### Target

### Reduction of PM and NO<sub>2</sub>

**2014 Goal PM 40 $\mu\text{g}/\text{m}^3$ , NO<sub>2</sub> 22ppb** (since 2005)



- Seoul (Entire Area)
- Incheon (excluding Ongjin-gun, including Yeongheung-myeon)
- Gyeonggi-do (Gwangju, Anseong, Yeosu, and Pocheon will be included, Gapyeong, Yangpyeong, and Yeoncheon are excluded)

(December, 2014)

**Secure a visible distance  
from Nam Mountain to the coast of Incheon on a sunny day**



# 1. 1st Special Measures on Metropolitan Air Quality Improvement

## Retrofit of Old Diesel Vehicles

Implemented **emission reduction program** since 2005 subsidizing installation of **aftertreatment devices**, conversion to **LPG**, and **early scrapping**



### Aftertreatment Devices

- Type: DPF, p-DPF, DOC
- Reduction: PM10(80%, DPF)
- Vehicles older than 5 years



### Conversion to LPG

- Diesel Engine → LPG Engine
- Reduction: PM(99%), CO, HC(30%), NOx(70%)
- Convert piston, injector, fuel pump, LPG tank etc.



### Early Scrapping

- Old diesel vehicles
- Reduction: All air pollutants 100%
- Vehicles older than 7 years



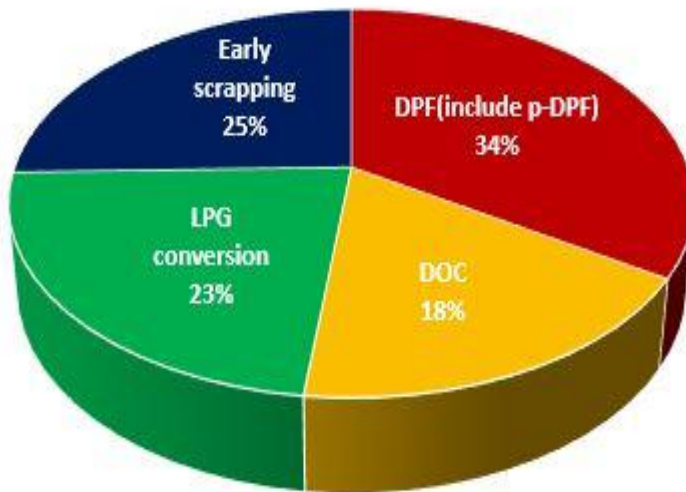
## 2. Retrofit of Old Diesel Vehicles

### Results

Retrofit of total 869,000 vehicles '05~'14  
funded by KRW 2.5 trillion

❖ Aftertreatment devices(DPFs) 456,666, Conversion to LPG 201,084, Early scrapping 211,416

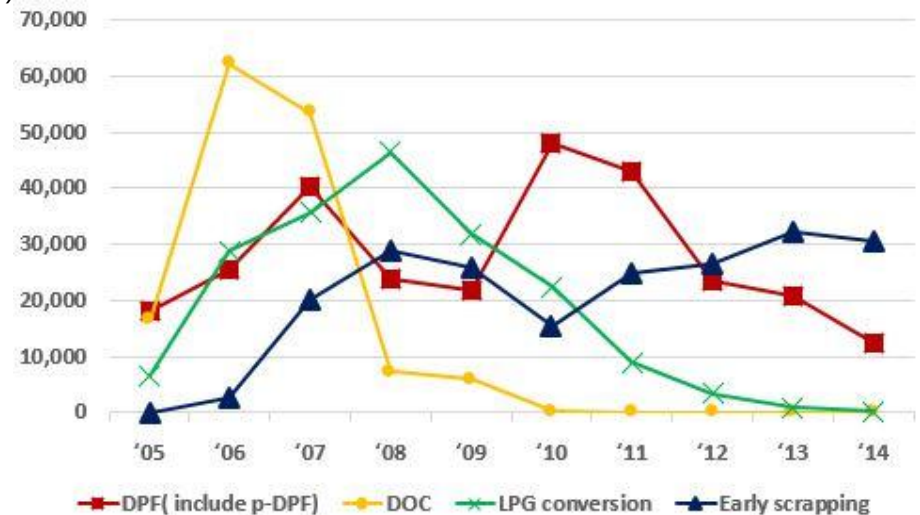
Ratio of retrofit with different means



Status of retrofit

('05~'14)

(Unit : ea)



### 3. Accomplishment of the 1st Phase Execution

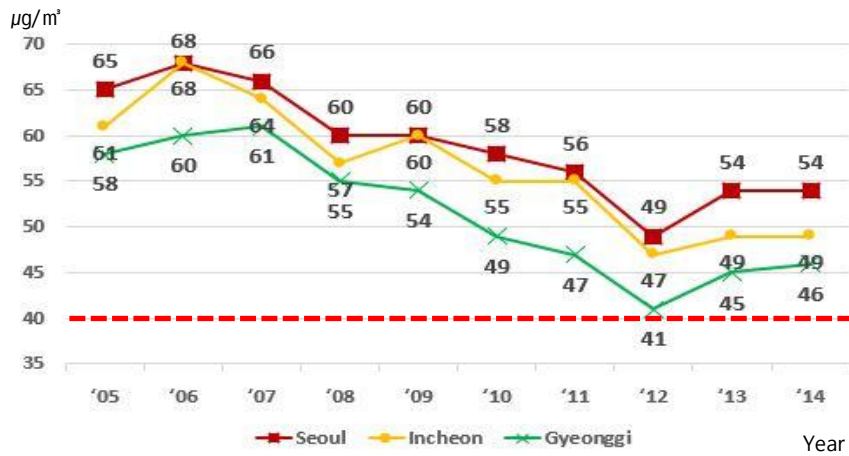
PM<sub>10</sub>

60  $\mu\text{g}/\text{m}^3 \rightarrow 46 \mu\text{g}/\text{m}^3$

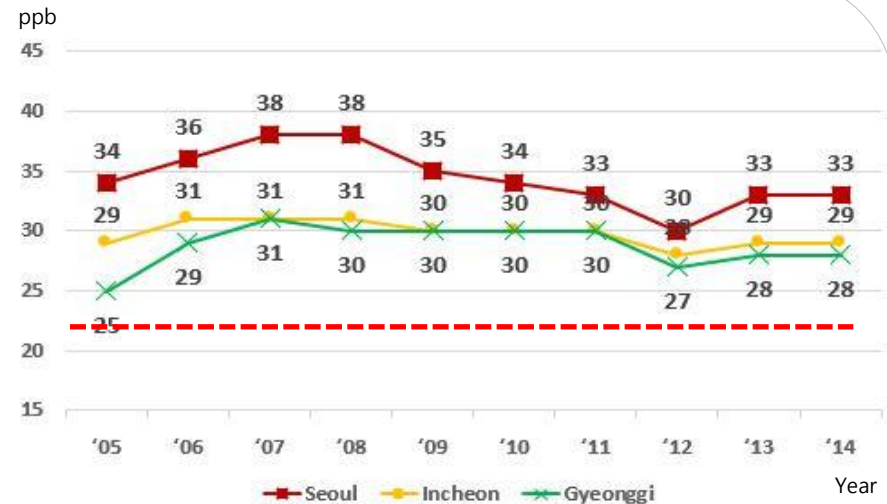
NO<sub>2</sub>

36 ppb  $\rightarrow$  33 ppb

#### Air Quality in Metropolitan Area



PM<sub>10</sub>



NO<sub>2</sub>

# III. Status of Retrofit Device Technology

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1

Retrofit Devices

2

DPF Certification

3

Maintenance (DPF Cleaning & Monitoring)



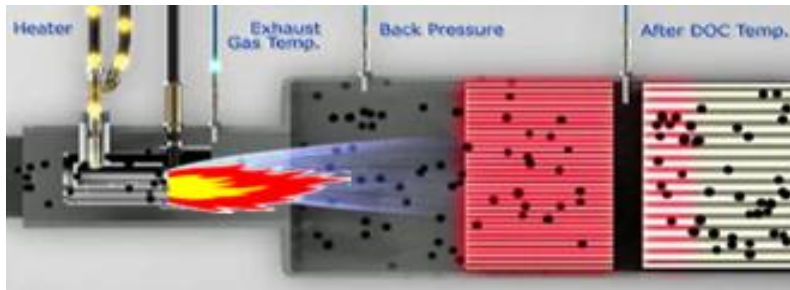
# 1. Retrofit Devices

## Aftertreatment Device(hybrid DPF System)

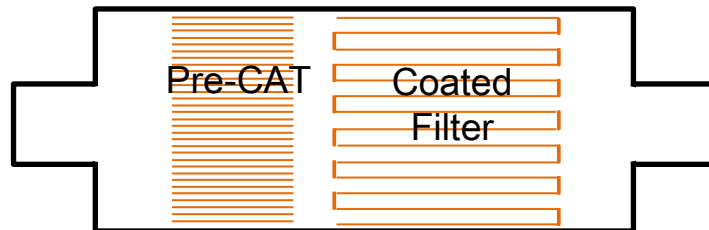
- Applicable to various kinds of vehicles(Low speed vehicles)
- Less affected by vehicle driving pattern and exhaust temperature

### Fuel Burner

#### ■ Active(Fuel burning)

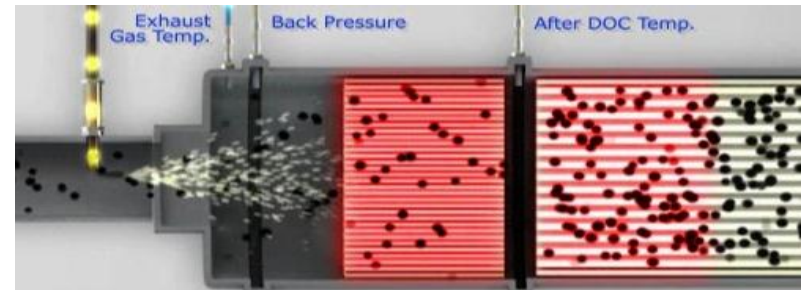


#### ■ Passive(CCRT)

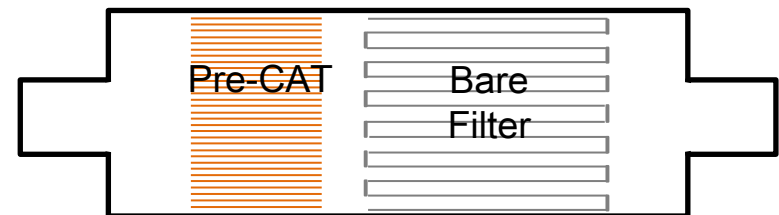


### Catalytic combustion with FBC

#### ■ FBC



#### ■ Passive(FBC+CRT)



## 2. DPF Certification

### Certification

Total 42 DPF systems  
(p-DPF included) got certified

### Certificate Procedure

- National Institute of Environmental Research(NIER) and Korea Automotive Technology Institute(KATECH) conducts the certificate test under the supervision of *Ministry of Environment(MOE)*,
- Tests are composed of emission tests, durability test, applicability test, and physical test

#### Agency in charge

DPF Maker

N.I.E.R (National Institute of Environmental Research)

DPF Maker, KATECH  
(Korea Automotive Technology Institute)

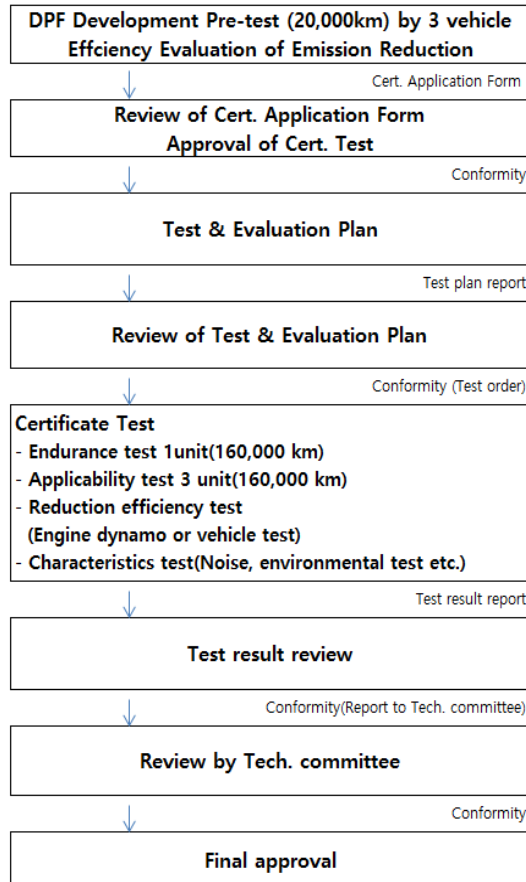
N.I.E.R (National Institute of Environmental Research)

KATECH (Korea Automotive Technology Institute)

N.I.E.R (National Institute of Environmental Research)

N.I.E.R (National Institute of Environmental Research)

#### Certificate Procedure by KMOE



Non-conformity  
(Improvement)

Non-conformity  
(Improvement)

Non-conformity  
(Improvement)


Non-conformity  
(Cert. failure or cancellation)



## 2. DPF Technology Certification by MOE

### Hybrid DPF System Certificate

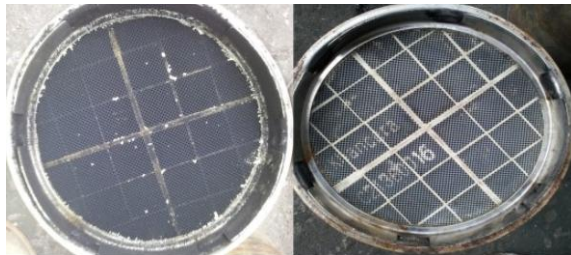
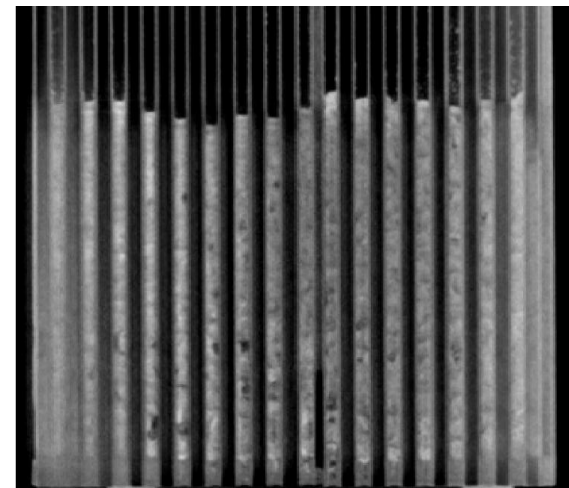
(주)이엔드디 복합방식 DPF의 인증내용  
The Certification Details of E&D DPF

장치명(형식) Type and Name of DPF		복합재생방식 DPF Assisted Passive Type DPF
		ACT-B
인증번호 Certification No.		6F1-MB-03
인증기관 및 일시(최초인증) Certification Authority & Date of Issue		대한민국, 환경부 Ministry of Environment, Republic of Korea 2006.06.07
장치사양 System Specification	DOC	9" X 4.5" " (Cordierite)
	DPF	9" X 12" (Sic)
	재생방식 Regeneration Type	복합(자연+강제)재생방식 Passive + Active(Diesel Injection to Exhaust)
장치적용대상 Application Condition		<ul style="list-style-type: none"> <li>배기량 : 3,000~11,000cc</li> <li>Engine Displacement : 3,000~11,000cc</li> <li>출력 : ~235ps</li> <li>Engine Power : ~235ps</li> <li>배기가스 온도조건 없음</li> <li>No Exhaust Temperature Condition</li> <li>사용연료: 초저유황 경유</li> <li>Fuel: ULSD (Ultra Low Sulphur Diesel)</li> </ul>
<p>PH.D J. H. Hong / Director of TPRC</p> <p>National Institute of Environmental Research Ministry of Environment, Republic of KOREA</p> 		

### 3. Maintenance (DPF Cleaning)

#### Importance

Improve fuel economy, prevent low output, reduce number of regeneration and maintain filter efficiency



- Management of nationwide 36 Cleaning Center
- Support Cleaning expense
- Call Monitoring Manage and supply used DPF

### 3. Maintenance (Monitoring)

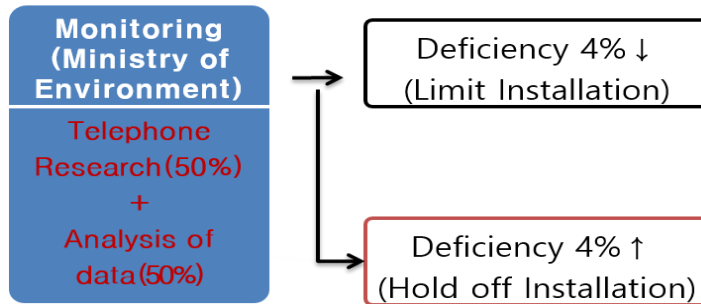
#### DPF system operation monitoring system

- Detect the defects of devices and improve its function
- Manage the maintenance and reduction rate by monitoring and inspection of the devices installed on vehicles

#### Monitoring

- Inspect vehicles in 2 phase  
(1st) 30% of devices installed after certification  
(2nd) 5% of total installed devices
- Analyze the temperature, back pressure, regeneration cycle, etc.

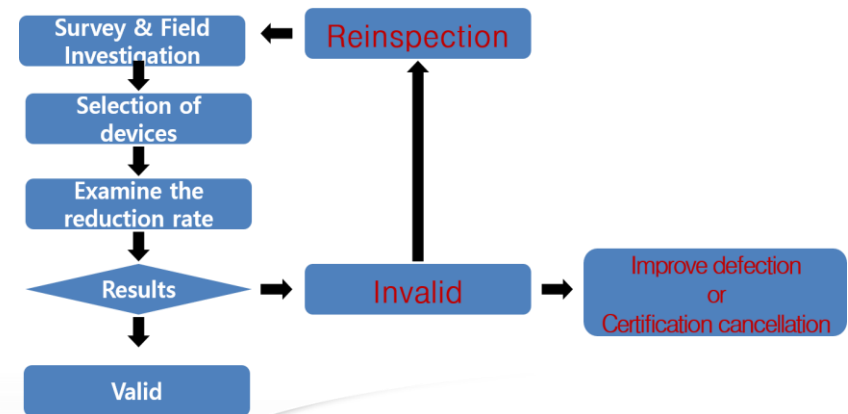
##### 〈Monitoring Procedure〉



#### In-use vehicle compliance test

- Vehicles retrofitted more than 1 year
- Examine the vehicles and cancel the certification if results are inconsistent

##### 〈Test Procedure〉



Guarantee proper working of DPF system in-use

## IV. Future Plan

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# Future Plan

## 2nd phase for further air quality Improvement

Goal  
2024

$PM_{10}$   $30\mu g/m^3$ ,  $PM_{2.5}$   $20\mu g/m^3$ ,  $NO_2$  21ppb

Decrease excess deaths(20,000), Bronchitis patients(800,000)

### 1st Retrofit Program

- Retrofitting with DPF
- LPG Conversion
- Early Scrapping
- Euro-3 ↓



### NOx Reduction (2nd Retrofit Program)

- PM · NOx After treatment, Euro-3 ↓
- Installation of SCR, Euro-4 ↑ ('17~'24 : 202,000 vehicles)
- Monitor the status of Urea use and manage supply system



### Construction Machinery

- Engine conversion(Excavator)  
Tier1 ↓ → Tier 3
- Retrofitting with DPF



Continued (~2019)

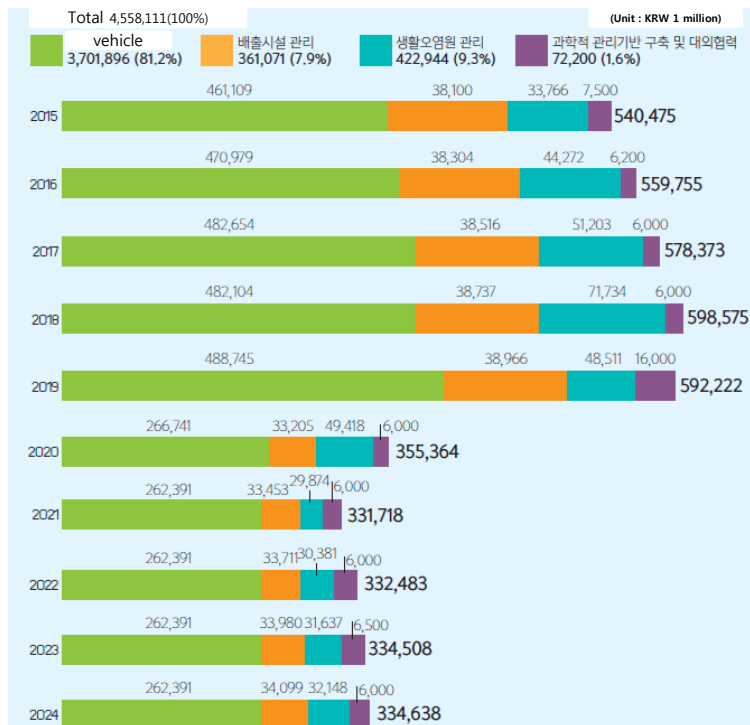
On-road, Non-road vehicles emissions restriction(~2024)

# Future Plan

## 2nd Measures Investment Plan

- Total fund is KRW 4.5 trillion(~2024)
- Retrofit Program Fund total KRW 3.5 trillion(1,440,000 vehicles)

## Total Investment for 2nd Air Quality Improvement Plan



## 2016 Retrofit Program

- Budget: 2015(KRW 112 billion), 2016(KRW 121 billion)

(Unit : ea)

Category		2015 Results	2016 Plan
Total		47,611	52,564
DPF (include p-DPF)		16,212	16,209
LPG Conversion		780	210
Early Scrapping		30,337	35,486
PM·NOx After treatment		60	242
Construction Equipment	DPF	10	27
	Engine conversion	212	390

# Conclusion

1

Air quality in Seoul has been improved since 2005 and 2<sup>nd</sup> phase program is running for further improvement.

	2005	2014	2024(target)
PM <sub>10</sub>	60μg/m <sup>3</sup>	46μg/m <sup>3</sup>	30μg/m <sup>3</sup>
PM <sub>2.5</sub>	-	-	20μg/m <sup>3</sup>
NO <sub>2</sub>	36ppb	33ppb	21ppb

2

The DPF system should pass strict certification process set by MOE and its **running** performance is monitored by KAEA .

3

456,666 DPF systems, which are mainly hybrid type(burner or FBC), are installed and running for the 1<sup>st</sup> phase.

4

The members of KAEA have accumulated sufficient technologies and experience on DPF system.

5

We hope to contribute to improve air quality in Iran with our proven DPF systems.



# Thank you



Korea Automobile  
Environmental Association



Ministry of  
Environment

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[sysung@aea.or.kr](mailto:sysung@aea.or.kr)