



Catalytic Systems

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## Vehicle Emissions Control as an Air Quality Management Tool: A Review of European Experience

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Catalytic Systems

## Background

- **Presentation is delivered from the perspective of a solution provider**
  - Johnson Matthey has 30 years experience developing and supplying emissions control systems for cars, and more recently for trucks and buses
  - Products include the autocatalyst, diesel particulate filters and fuel cell components
- **This presentation focuses on the interaction between technology and policy**

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## Scope of Presentation

- **Policy context**
  - California had problem and opted for a techno-fix
- **European policy approaches**
  - commenced with US style legislative pathway
  - outlook broadened to accommodate other policy approaches
  - Sweden plays a critical role in defining the push to “clean diesels”
  - UK highlights new trend toward voluntarism
- **Review**
- **Conclusions**



## California Defines Air Quality Problem



Pollution Standard Index

500	Everyone advised to remain indoors
400	Everyone should avoid outdoor exercise
300	Susceptible people stay indoors
200	Susceptible people avoid outdoor activity
100	

...and sets out to solve this problem with a 90% cut in Tailpipe emissions

$$\text{Pollution burden} \approx \text{Number of cars} \times \text{Car use miles travelled} \times \text{Tailpipe emissions per car (grams/mile)}$$

↓

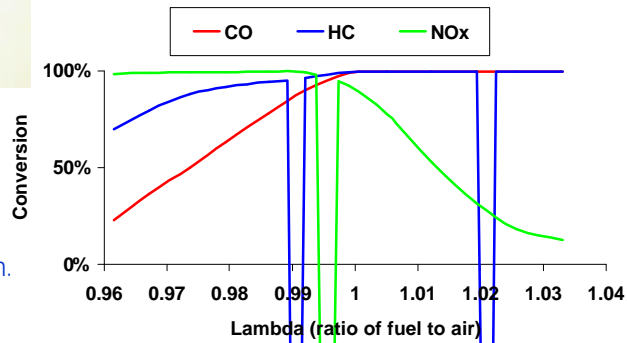
## The Autocatalyst Provides a Techno-fix



H<sub>2</sub>O  
CO<sub>2</sub> N<sub>2</sub>

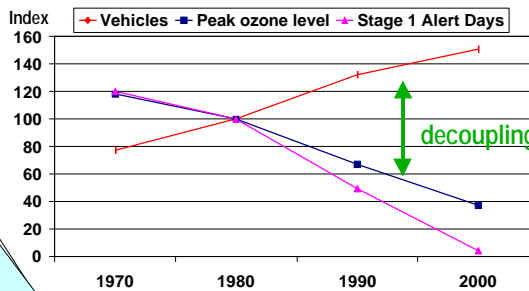
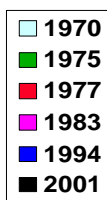
Autocatalysts promote both oxidation and reduction of pollutants. Operation at lambda = 1 offers control of all three gaseous pollutants.

Emissions control depends on the integration of autocatalyst technology within the engine management system.



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## Emissions Legislation Tightens; Los Angeles Air Quality Improves



Prompted by California, the US sets increasingly stringent exhaust emissions limits. Over time these help improve air quality, as shown by improvements in Los Angeles air quality.

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## Should Europe Follow the US Approach?

The debate of the 1980s

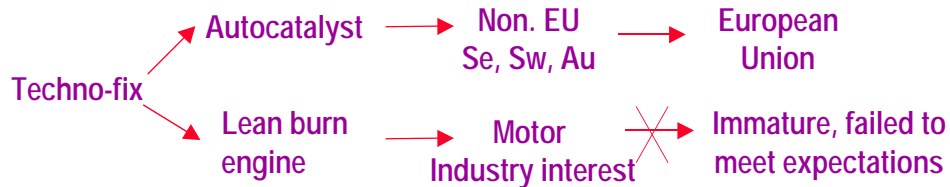
Does Europe have the same air quality problems? **Yes**



and smog in European cities

Ozone damage to forests in Germany

Is the US techno-fix the right one for Europe? **Yes**



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## Non-technical Policy Options Explored

- **Integrated Transport\Modal Shift**
  - Stop road expansion and invest in public transport to alter behavioural patterns of car use
- **Economic Instruments**
  - Tax on ownership - Swedish & German tax schemes favouring clean vehicles (Inc. catalyst retrofit)
  - Incentives to upgrade - accelerated scrappage
  - Tax on use - UK fuel duty escalator and congestion charging
- **Local Regulations**
  - Athens alternate number plate scheme, Paris car-free days, Swedish E-Zones

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## Sweden - the “Second California”

Environmental protection becomes a major political issue at both a national and local level. Local Government ownership or control over public transport turns bus operations into environmental battle ground.



Health debate develops over PAHs and PM10 present in diesel exhaust. Eastern Sweden opts for biofuels, Western Sweden considers natural gas and clean diesel.

Clean diesel lobby leads to national introduction of MK1 zero sulphur (< 10ppm) diesel.

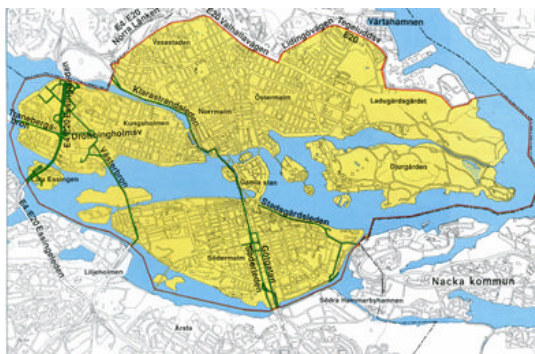


MK1 aids catalyst and trap fitment.



## Sweden defines the E-Zone

Restricts access - prevents entry of older vehicles unless the environmental performance is upgraded through filter fitment or use of alternative fuels

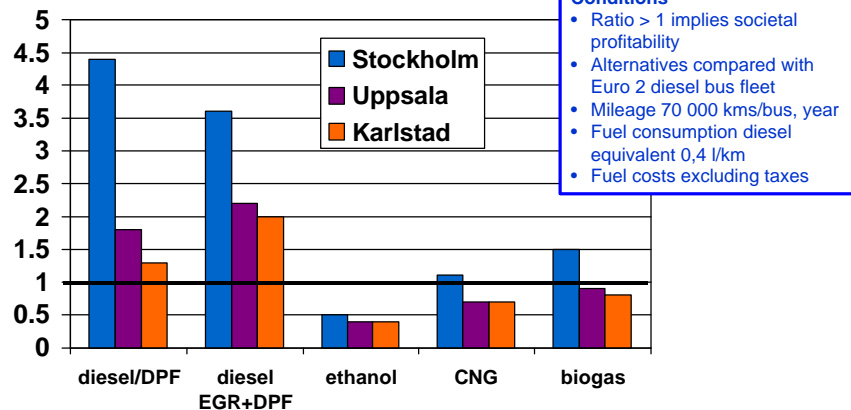


Policy emphasis now on heavier commercial and public service vehicles, e.g. trucks and buses

Stockholm E-Zone

## Cost Benefit Extends to Societal Costs

Does society benefit from financing vehicle upgrade?



Swedish Analysis by SLTF (Trade Association for Public Transport Associations)  
Environmental costs by Swedish State Institute of Transport Analysis (SIKA)

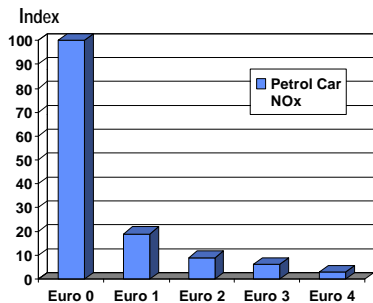
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## UK Policy Review 1998-2000

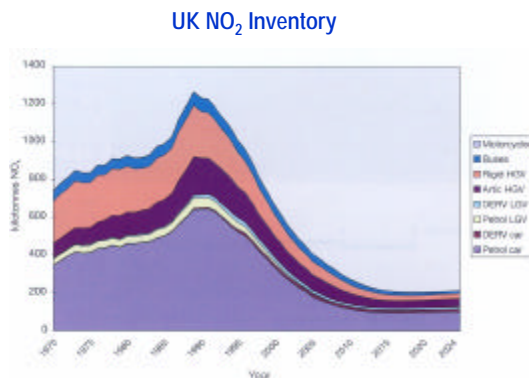
- **New Labour Government initiates extensive review of 'transport and environment' policy**
- **Covers all policy options**
  - Integrated Transport White Paper
  - Cleaner Vehicles Task Force (CVTF) investigated technology options
- **Consensus develops on key points**
  - Need for local policy initiatives
  - Health concerns make PM10 a prime target
  - Benefits of diesel particulate filters
  - Cost-effective solutions can be supported by incentive route

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## Emissions Legislation will Deliver Reductions in Pollutant Inventories



Modelling clearly shows Euro standards delivering a cut in pollutant emissions



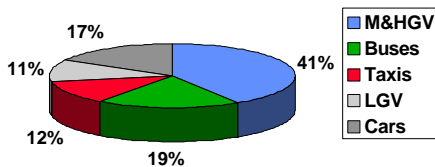
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## But Local Air Quality Remains a Problem



Air quality modelling shows that PM10 and NO<sub>2</sub> air quality standards will be exceeded in London and other city centres

Westminster Study, city centre PM10

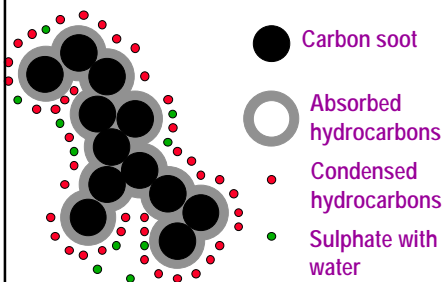


Studies highlight the significance of HGV and Buses for city centre PM10

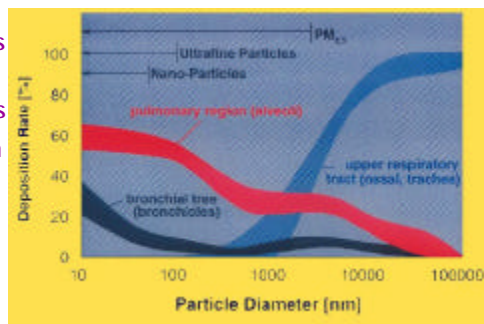
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## Diesel Particulate Identified as a Major Health Concern

Emphasis on PM10 turns attention to diesel exhaust

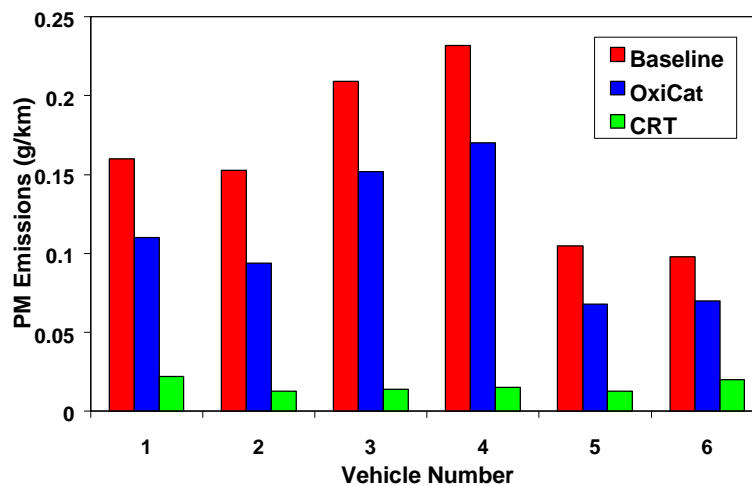


Epidemiological studies highlight risks from PM10. Medical experts believe that diesel particulate matter bypasses the lungs defence mechanisms, aggravating lung and heart conditions. Hydrocarbons are a cancer risk.



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## Catalysts and Filter Systems offer PM10 Reduction



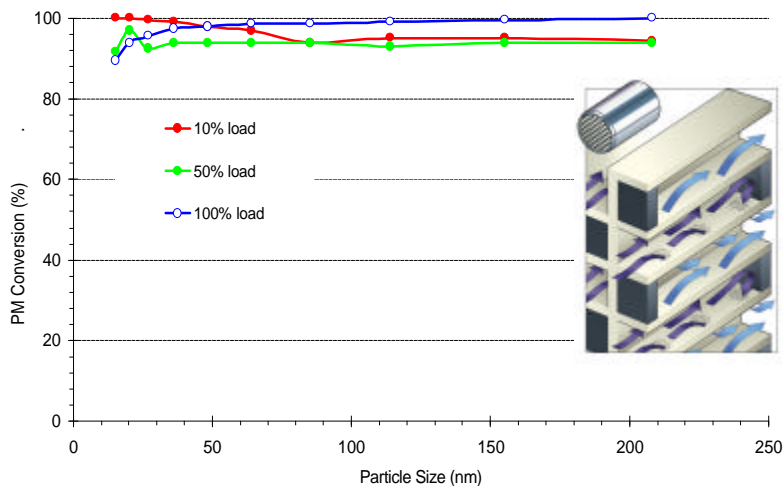
Testing at Millbrook Proving Ground on the London Bus Cycle

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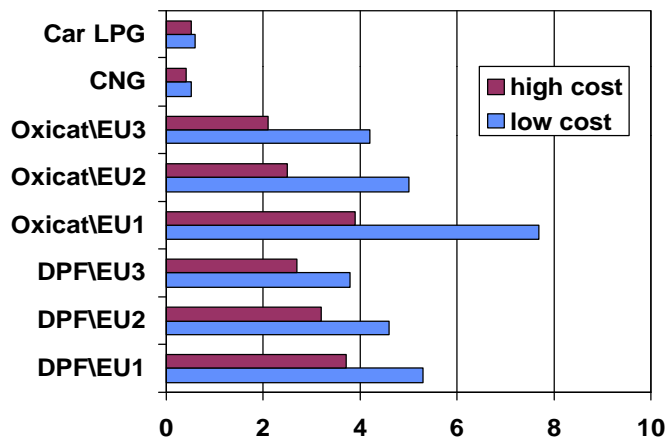


## Diesel Particulate Filters (DPF) help control particle number, inc.. ultrafines



## CVTF Cost Effectiveness Analysis

Urban PM10, Cost effectiveness ratio (PM10 g per £)



With options showing cost-effectiveness, the case exists for financial incentives from Government



## UK Incentives for Voluntary Retrofit

Environmental Cost for Upgrading a 31 Tonne Truck	
Cost of a CRT	£3,000
less	
Incentive to purchase	
Energy Saving Trust 75% capital grant	£2,250
= Net cost for purchase	£750
Cost of use for 6 year ownership	
Maintenance cost of £120 pa	£600
less	
Incentive for use =	
Rebate of road tax (VED)	£2,220
Net cost of	-£870
Payback in 3 years	

Uptake by bus companies following local Government policy requirements.

Uptake by truck operators following Corporate Social Responsibility (CSR) initiatives of their owners or customers (e.g.. supermarkets).

Policy approach now being copied across Europe and in Asia (Hong Kong and Tokyo)



## Incentives Influencing NOx Control

Technical developments being driven by incentive-based retrofit as well as by upcoming legislation

- Re-engine
- Operate on emulsion fuels
- Retrofit EGR & CRT
- Selective Catalytic Reduction (SCR) & SCRT
- NOx Traps

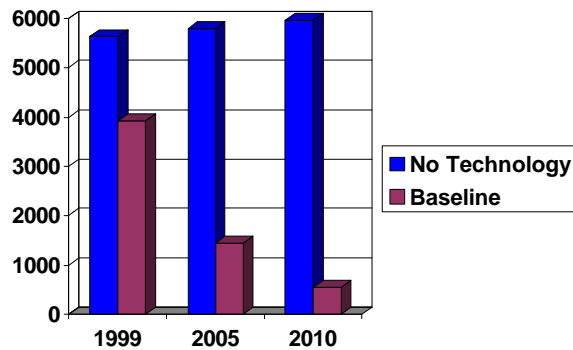
Retrofit

Original equipment

## Review (1)

- **Legislation is working (at low cost to Government) slowly but surely**

Reduction in UK road links with annual average NO<sub>2</sub> concentrations exceeding the Air Quality Standard



Source: AEA Technology

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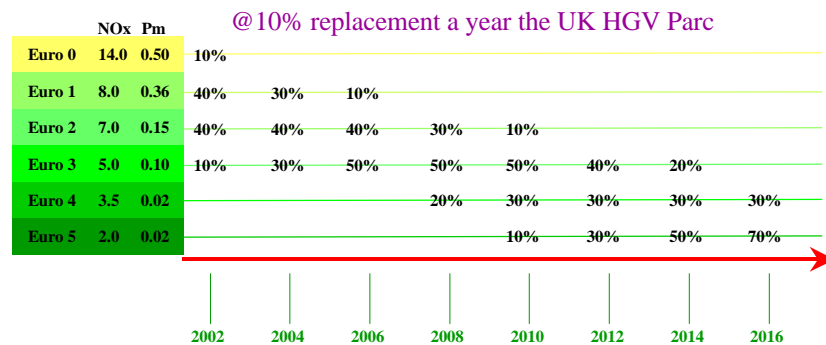
## Review (2)

- **However, devolving air quality management to a local level requires additional policy approaches**
  - technical & non-technical, action orientated, deliver in politicians time-frames
- **Impact of health concerns over PM<sub>10</sub> significant**
  - trucks and buses a legitimate target
- **Swedish approach now seen as a way forward**
  - fuel quality a key enabler
  - reduce public services' environmental impact
  - E-Zones provide local policy approach
- **UK uses incentives to support voluntarism**
  - CSR means private sector can mimic public sector

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## Review (3)

- But can voluntarism extend beyond early adopters?
- Costs and long life of commercial diesel a problem



- Therefore UK retains an interest in the more prescriptive E-Zone approach

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## Conclusions

- Technology providers respond well to legislative drivers
- The legislative techno-fix is logical first policy step
- However, local problems need local measures based on a mix of policy approaches
- Technology can play a role including:
  - Public sector environmental purchasing criteria
  - E-Zones
- Incentives for vehicle upgrade can draw in private sector
  - Providing right political and economic environment
  - Cost effective, particularly when costs shared
  - Technology providers will respond

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