The impact of Low Emission Zones and some conclusions for particulate matter research

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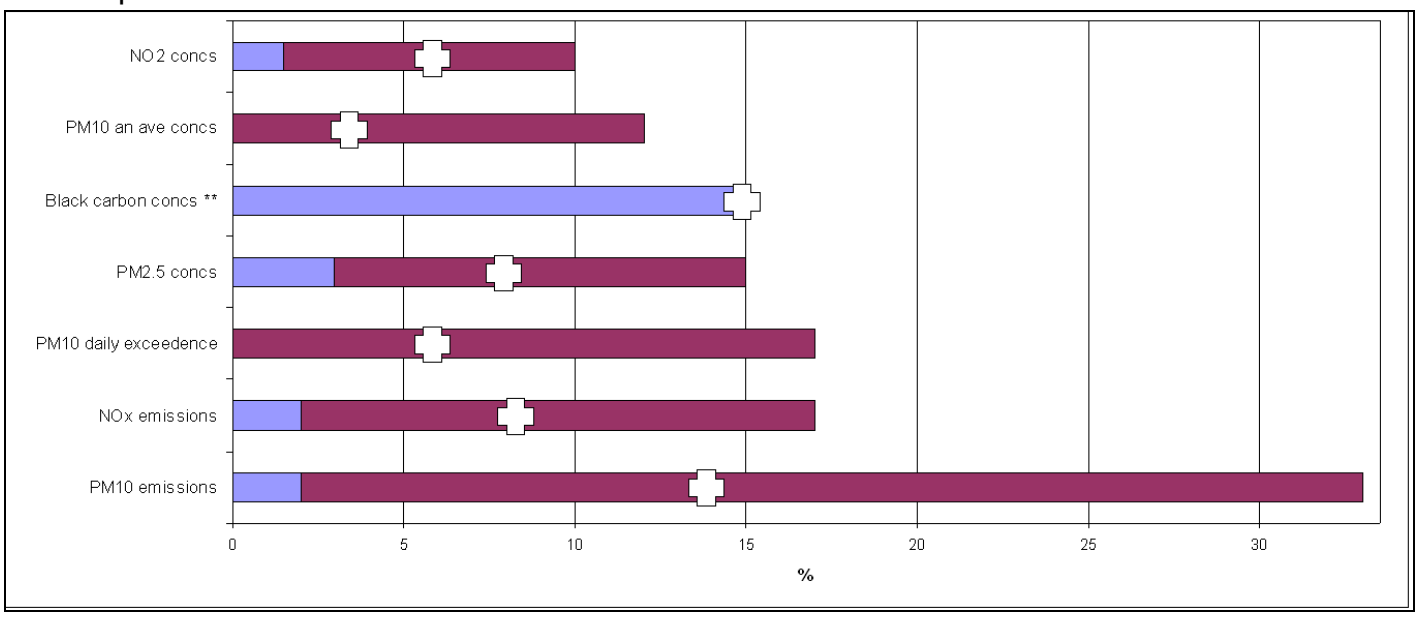
Low Emission Zones (LEZs) are areas that limited entry for the more polluting vehicles. There are around 200 in operation, or concrete planning, in 11 European countries. LEZs have been found to be one of the most effective measures towards meeting the health-based EU PM_{10} and NO_2 EU Limit Values.

Many LEZs have been in operation for over a year, and their impact can start to be assessed. This paper collates the air quality impacts of LEZs around Europe from published assessments. All have reported a positive impact on air quality, emissions and cleaner vehicles, and there is a climate change gain through black carbon reductions.

The magnitude of the air quality impact of the LEZ is dependent on the emissions standard set. Most LEZs have two phases, phase 1 with a less stringent standard to enable start-up, phase 2 expecting to have more impact. Most of the LEZs monitored so far were still on phase 1.

Assessments have tried to account for the impact of weather, however as with any assessments there are uncertainties. Assessments have used two methods, monitoring and modelling - both have advantages and disadvantages. However, the overall magnitude of impacts from different cities using the two methods is generally in a similar range, providing more confidence than in either method alone.

The range of impacts is given below. All the figures below represent reductions in concentrations or emissions, i.e. improvements. The impacts are presented in the table below.



Key: ✚ average, ** 2 assessments.

Concentrations reduced by less than emissions, due to the impact of PM_{10} from outside the LEZ and the reactions between emitted NO and NO_2 and ozone. Particulate filters have increased the PM impact, NOx abatement may start to enable that for NO_2. PM_{10} daily exceedences increase by more than the annual average, due to the impact of the threashold.

The smaller, diesel-related particulates, are more affected by the LEZs than more general PM_{10}, and these are also the particles that have greatest health effect. NO_2 is also reduced by LEZs, due to the fleet renewal required by LEZs, however primary NO_2 emissions from DPFs and cycle-beating of Euro 5 lorries in urban areas are both of concern. LEZs are often the most effective measure at a local level to improve air quality and health. However, in many parts of the EU, LEZs alone are not enough to meet the limit value, and further measures are also needed.

The smaller and black carbon particles are the particles with greater health and climate impact. This gives an issue in terms of meeting the EU limit values and it asks the question of whether measures should be taken solely to meet limit values, or to also maximise health impact. In many countries cost benefit analysis is used to help ensure that the most health (and therefore cost-) effective measures are taken. On the EU level, emissions standards for Euro 6 heavy duty vehicles and Euro 5 light duty vehicles will now include particle number to try to ensure that the emissions standards reflect current knowledge on health effects, and enable accurate measurements of particulates in vehicle exhausts.

The EU limit values reflect the health impact, and are based on proven science, including epidemiological studies, and are by definition behind current understanding. This has caused a ‘chicken and egg’ issue. Until it is known that a pollutant is dangerous, it is not widely monitored, and therefore cannot be used in epidemiological studies, be proved to be of health concern and therefore set as a limit value. However, we now know that particulate metrics other than PM_{10} and $PM_{2.5}$ are also dangerous. The World Health Organisation’s (WHO’s) last particulate report in 2005 recommended $PM_{2.5}$ in addition to PM_{10}, but that this was not the last word, and perhaps black smoke might be a useful metric. We now need to monitor other particlate metrics more widely in ambient air; include them in epidemiological studies as well as other health research. There then needs to be a review of particlulate by the WHO, and then a review of the particulate limit values by the EU to enable the measures that give most health impact to also meet limit values.

Low emission zones are an important tool but will not solve the problem alone. LEZs are part of a package of measures implemented, and in many parts of europe, however, in many cases yet further measures are needed to improve air quality. To help this in particular for road vehicles, the tools we have available also need improving. An EU-wide DPF certification could enable usage of full DPFs that do not increase primary NO_2, and an EU-wide NOx certification implemented early enough may enable a single rather than multiple certifications, and appropriate test cycles to be used to ensure good operation in urban areas. The Euro standards need to be tightened and *ensure* that they require the fitting of a diesel particulate filter (DPF), the Euro standard test cycle needs not to be cycle beaten.

The impact of LEZs & thoughts for PM research

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14th ETH Nanoparticles Conference 2010

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Specialists in air quality policy

~ 1700 LEZs planned / in operation in Europe

LEZs are:

Geographical areas where entry is only allowed or free for less polluting vehicles

www.lowemissionzones.eu

View it, Use it, link to it, recommend it

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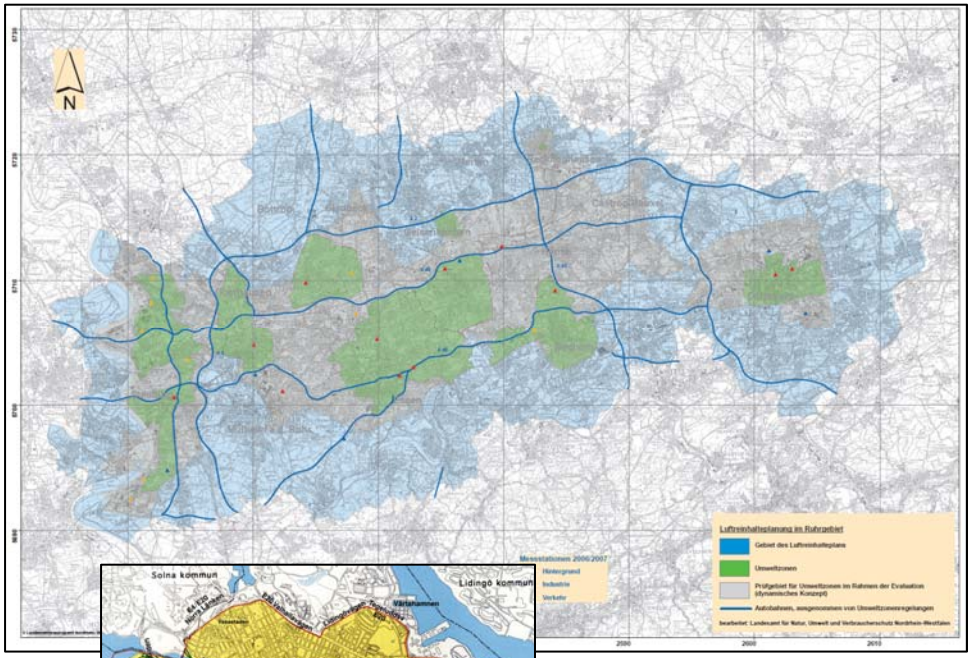
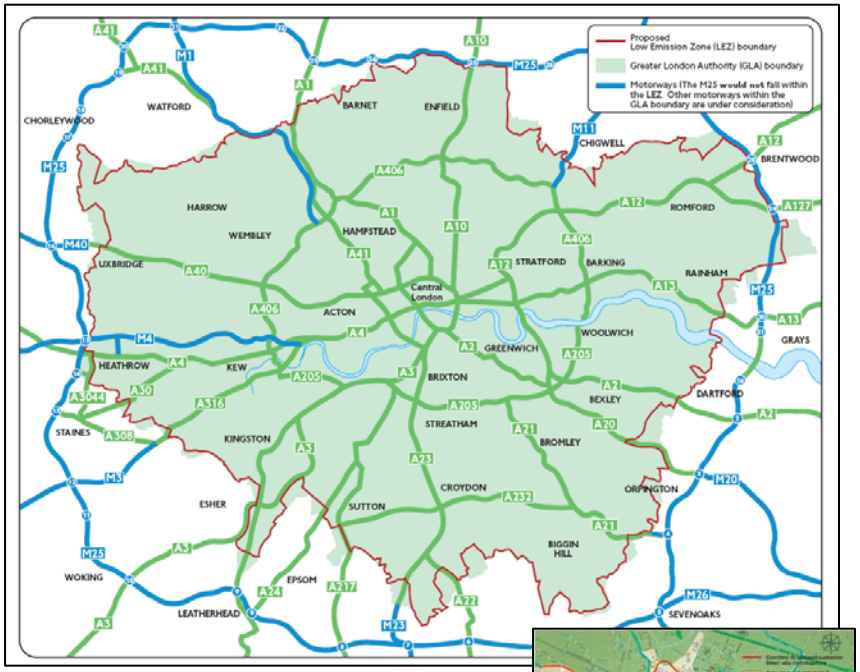
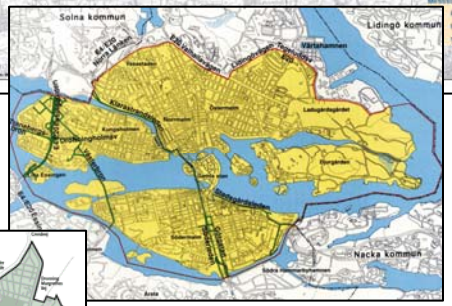
Different zones







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Current LEZ models

Netherlands
Lorries >3.5T
Euro 4(PM)

Germany
All 4-wheelers
Euro 2-4(PM)/E1petrol

Austria
Lorries >7.5T
Euro 2 / 3

Italy
All vehicles
Euro 1-3/no 2-stroke

Prague
>3.5T
Euro 2

Norwich
local buses
Euro 3(NOx)

Sweden
>3.5T
8 years old

Denmark
>3.5T
Fit filter if < Euro 4

London
>3.5T
Euro 3 (PM)

AQ assessment methods

2 main methods, both have pros & cons

At individual locations

Assessing with & without LEZ needs care

'Real' data, assessing relevant concentrations directly

Are estimates

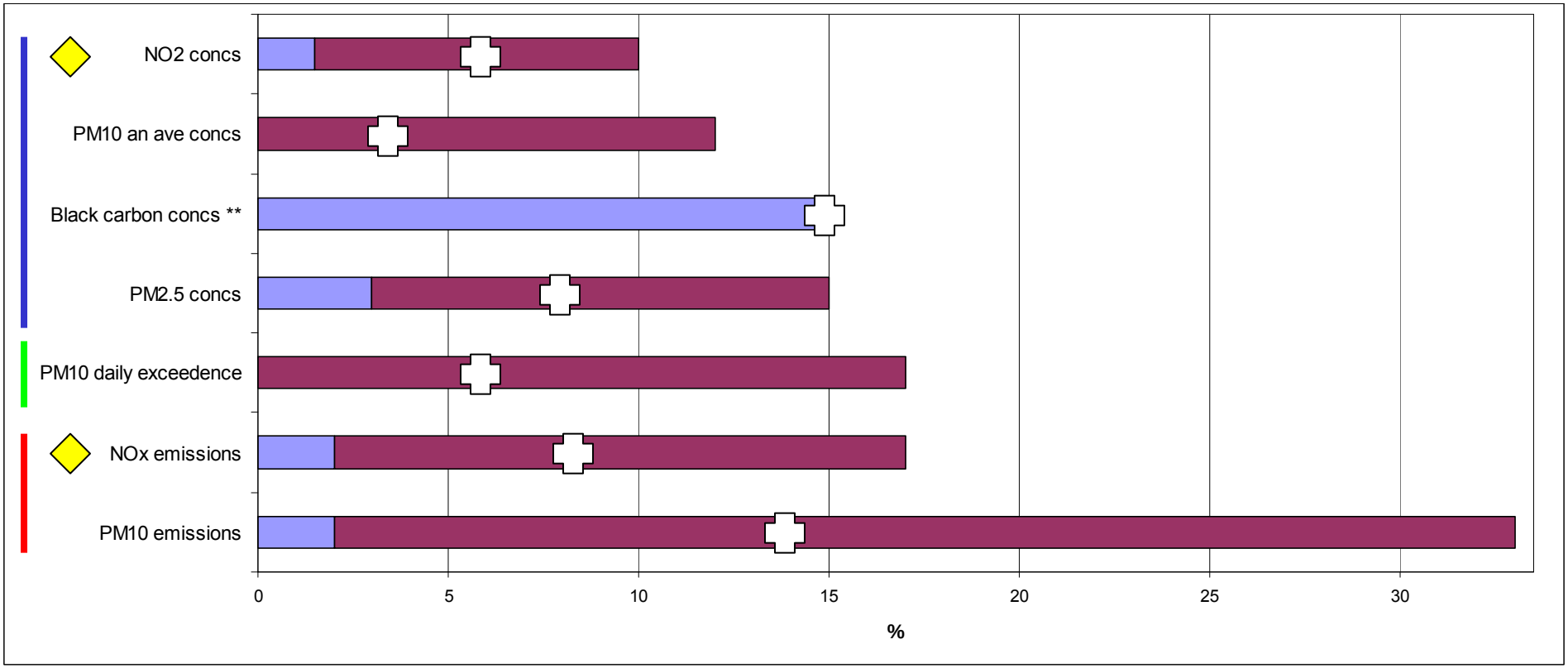
Dependent on emissions factors, drive cycle/speed, imported estimates, complete emissions inventories, good validation...

With & without LEZ easier to assess

Can assess the whole area

For LEZs, both methods in general give similar results - gives some 'sensitivity testing' & reassurance

LEZ air quality impacts



For recent LEZs, from published studies

average

** 2 assessments

Impact discussion

- Impact dependent on LEZ standards, vehicles affected, fleet age, city specifics, imported background…..
- Concentration reductions limited by

  NO_2 & PM_{10}
  - imported aspects (more for PM_{10})
  - other sources
  - NO_2
  - 1º NO_2 from some DPFs/aftertreatment
  - cycle-beating for heavy duty Euro 5
  - NO:NO_2 conversion

  PM_{10}
  - secondary
- Diesel PM
  - ⇓ ⇓ by LEZs (health impact ⇑ ⇑)
  - less affected by long range pollution

LEZ environmental impacts

AQ emissions

- Smaller, more harmful PM metrics
- PM_{10}
- NOx

AQ concentrations

- Smaller, more harmful PM metrics
- $PM_{2.5}$
- NO_2
- PM_{10}

Climate Change

- Black Carbon
- CO_2

noise

- Yet larger change
- Larger change
- Small change
- No measureable change

Reminder: Why are we doing this?

Because Air Pollution Kills

Especially our children, our grandparents and our infirm

London: $PM_{2.5} \Rightarrow$ 4267 deaths (2008)

EU: $PM_{2.5} \Rightarrow$ >492 000 premature deaths annually, ~4.9m years of life

World: 3 million deaths from outdoor air pollution annually

every 10µg/m^3 $\Uparrow$ $PM_{2.5} \Rightarrow$ 6% $\Uparrow$ all-cause death rates

LEZ environmental impacts

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- PM_{10}

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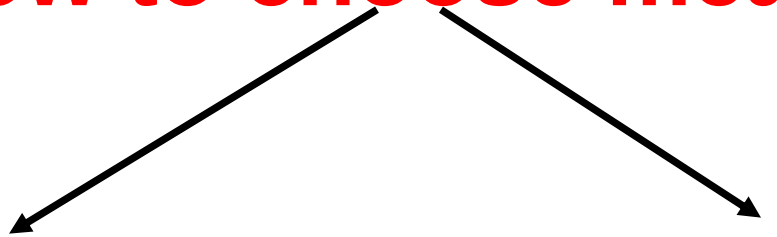
How to choose measures?



To meet the standards? To have most health impact?

Ideally both!

Standards & Tools are by definition behind science

$\Rightarrow$ need to be regularly reviewed/augmented

Process of review

Health research

⇓

Proof of impact on health

⇓

WHO Recommendations

⇓

EU Limit Values

⇓

Cost-benefit analysis

&

emissions standards

Actions to improve air quality

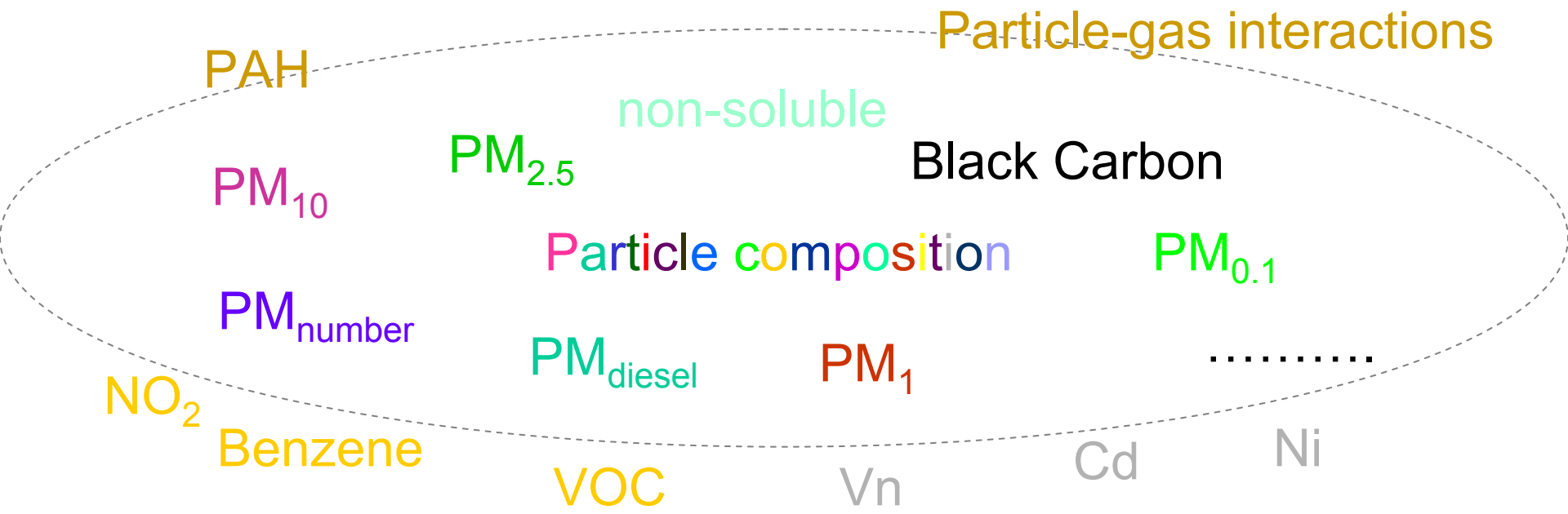
⇓

Improved air quality (hopefully)

⇓

Fewer deaths

Health metrics



- More (Standards relevant) health research needed
  - get appropriate instruments in wider use in studies
  - if we think they might be dangerous monitor them now, we need the time series for studies

Better tools

Standards need to be set in terms of what is needed

- Euro standards need to *manage to* force DPFs
- Euro test cycle needs not to be (cycle-)beaten

- Allowing full DPFs with no ⇑1º NO_2 would be great
  - EU Standard
- NOx abatement starting to come into play
  - Single EU standard please!

…..the hopefully...

- New emissions sources & knowledge, imported background, climate change…….
- The Weather
- Even with LEZs, many cities not meet EU LVs
  $\Rightarrow$ other further measures needed
  - public procurement
  - financial incentives (cost neutral)
  - planning conditions
  - regulation of ('new') sources
  - construction schemes
  - energy efficiency
  - international agreements/national incentives for ships & aircraft……..

Key Partners

- Health researchers
- Instrumentation manufacturers

- Policy makers
  - International, EU, national, local

- Equipment manufacturers
- Fuel providers

- Politicians
- The public

Hopefully we'll get there one day

Clean air for our children and our grandparents - for all

Thank you for your attention

Thank you for your participation in the work we have before us

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