

## The Use of Biofuels in Urban Mobility



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## Outline

- Buses in the public transport system
- Technology options
- The need for advanced biofuels
- The OPTIBIO project
- Research methods for emissions
- Effects on emissions
- Current status of field test
- Summary



## Buses in the public transport system

- Buses are the backbone of many public transport systems
- Although buses in general are good for the environment (with adequate load rate), buses can have a significant impact on local pollution
- Running of buses or alternatively procurement of bus services is normally handled by the public sector
- Often targets for reduced emissions are set, regulated emissions as well as CO<sub>2</sub> emissions, or targets for the use of renewable fuels
- The best alternative fuel options can reduce local as well as global (CO<sub>2</sub>) emissions



# Alternative technologies

Biogas



Biodiesel



Hybrid technology, EVs and fuel cells



Ethanol

## Applicability

- Buses are normally operated for 15...20 years
- The oldest buses are normally put in service during peak hours
  - dirty old vehicles add to local pollution
- Only biodiesel in various forms can be implemented in new as well as existing diesel vehicles
  - limitations apply to conventional FAME-type biodiesel
  - gaseous fuels and ethanol require dedicated vehicles (vehicle renewal)
- High quality biofuels or synthetic fuels are in practise the only viable way to reduce emissions from old vehicles

## Why do we need advanced biofuels?



## Definitions

- "Drop-in" fuel
  - a fuel that is compatible with the existing refuelling structure and existing vehicles without any need for modifications
- "Blending wall"
  - technical limitations for component concentrations
  - the Fuel Quality Directive 2009/30/EC:
    - maximum 10 % (vol.) of ethanol in petrol (E10)
    - maximum 7 % (vol.) of FAME biodiesel in diesel fuel (B7)
    - both these options render only 6.5 % of renewable energy
    - how to achieve 10 % or even higher energy substitution?
- Limits are not required for high-quality biofuel components such as pure diesel-like hydrocarbons made from biomass using the Fischer-Tropsch process or hydro-treated vegetable oil (HVO).



**CEN****CWA 15940****WORKSHOP**

February 2009

**AGREEMENT**

ICS 75.160.20

English version

Automotive fuels - Paraffinic diesel from synthesis or  
hydrotreatment - Requirements and test methods



Photo:  
Alliance for Synthetic Fuels in Europe

- A specification for diesel fuel on the basis of synthesis gas (from natural gas, coal or biomass) or of hydro-treated vegetable or animal oils.
- Its main use is as diesel fuel in dedicated diesel vehicle fleets.
- From an environmental perspective, paraffinic diesel is a high quality, clean burning fuel with virtually no sulphur and aromatics.
- Paraffinic diesel fuel can be used in existing diesel engines substantially reducing regulated emissions.

## Fuel comparison

	Traditional	GTL CTL	FAME	HVO	BTL
In	Crude oil	Natural gas Coal	Some veg. oils Waste fats	Various veg. oils Waste fats	Biomass
Technology	Refining	Gasification Fischer-Tropsch	Esterification	Hydrotreating	Gasification Fischer-Tropsch
Out	Diesel Gasoline Jet	Diesel Gasoline Jet	FAME = Biodiesel	Renewable: Diesel Jet Gasoline	Renewable: Diesel Jet Gasoline
Chemistry	$C_nH_{2n+2}$ $C_nH_{2n}$ Paraffins Aromatics Polyaromatics	$C_nH_{2n+2}$ Paraffins	$H_3C-O-C(=O)-R$ Esters	$C_nH_{2n+2}$ Paraffins	$C_nH_{2n+2}$ Paraffins
Phase	Commercial	Commercial	Commercial	Commercial	Development phase



Source: Seppo Mikkonen, Neste Oil 2010

## Press release 11.10.2010

### Neste Oil and Stora Enso launch environmental impact assessment for a new renewable diesel plant

11.10.2010

Neste Oil Corporation  
Press release  
11 October 2010 at 9 am (EET)

#### **Neste Oil and Stora Enso launch environmental impact assessment for a new renewable diesel plant**

Neste Oil's and Stora Enso's joint venture, NSE Biofuels Oy, is to commence environmental impact assessments for a commercial-scale biorefinery at Porvoo and at Imatra in Finland. The two locations are seen as potential alternative sites for a unit capable of producing approximately 200 000 tonnes of premium-quality renewable diesel per year from wood biomass.

200 000 t/a ~ 10 % of the Finnish diesel fuel consumption

## The OPTIBIO-project 2007 - 2010

- **OPTIBIO "Optimized usage of paraffinic renewable diesel fuel"** has been endorsed by the European Commission's Sustainable Energy Europe Campaign as an Official Partner.'



## The OPTIBIO project...

- The objective is to demonstrate the use of high quality renewable diesel fuel in buses in metropolitan Helsinki for:
  - reduced toxic emissions
  - increased share of renewable fuels
- The first project in the world involving use of high quality renewable diesel in high concentration
  - 30 % and 100 % renewable paraffinic diesel (HVO) made through hydrotreatment of vegetable oils and animal fats
  - original initiative from the municipal organisations responsible for procurement of bus services
  - example of a public-private partnership

(NExBTL is the trade mark of Neste Oil's HVO)



## ..The OBTIBIO project

- Testing within a research project spanning more than three years
  - a comprehensive test programme is in place to verify performance as well as actual reductions in emissions levels over time
- Paraffinic HVO also depicts the end-use performance of future BTL qualities
- The project is part of the BioRefine technology programme by TEKES, – the Finnish Funding Agency for Technology and Innovation, and the initiative for development of 2<sup>nd</sup> generation biofuels by the Ministry of Employment and the Economy

## Partners

### Actual partners:

- Helsinki City Transport
- Helsinki Metropolitan Area Council
  - now merged into Helsinki Region Transport
- Neste Oil
- Proventia Emission Control

### Bus operators:

- Veolia Transport Oy
- Pohjolan Liikenne Oy
- Helsingin Bussiliikenne Oy
- Koiviston Auto -yhtymä

### Vehicle manufacturer:

- Scania

### Subcontractors:

- VTT Technical Research Centre of Finland
- Helsinki University of Technology
- TEC TransEnergy Consulting Ltd



Approximately 300 buses participate in the field test

## Emission research with HVO renewable diesel

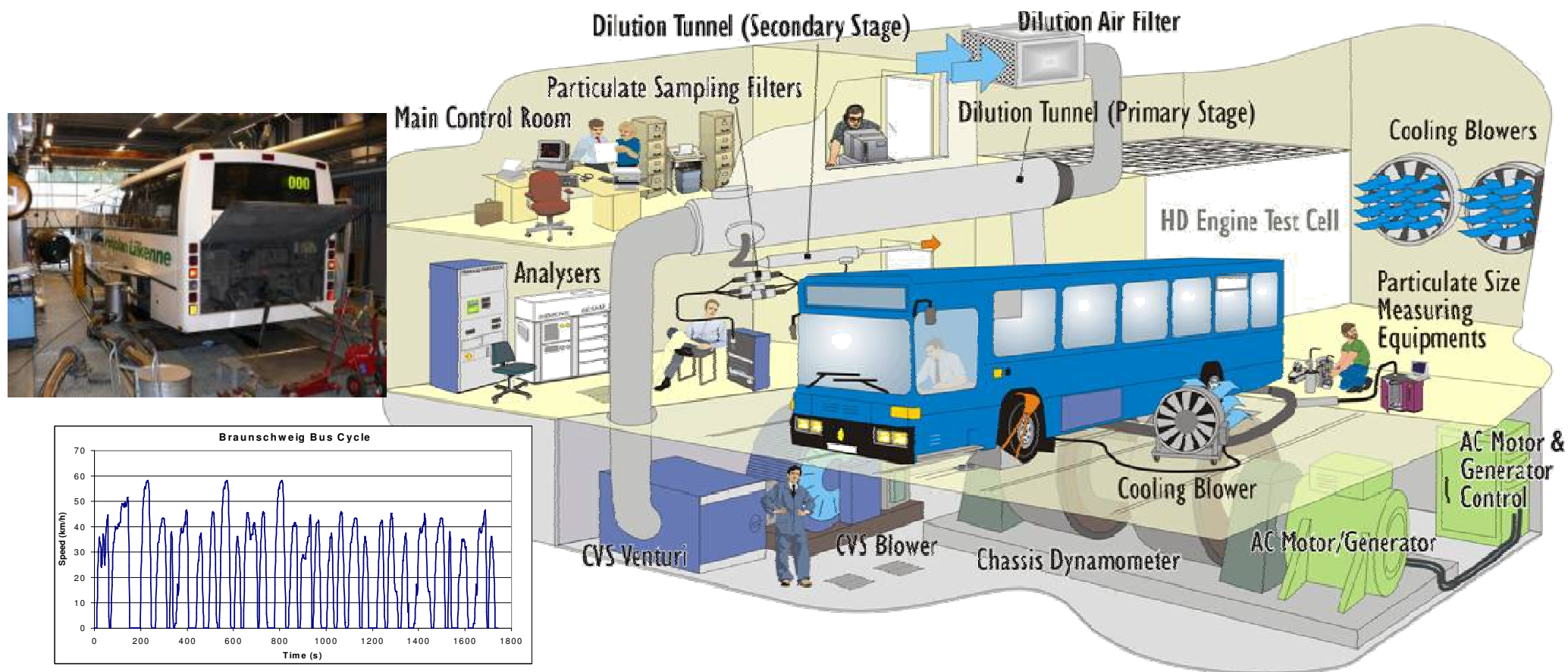
- Laboratory screening:
  - the effect of HVO diesel on emissions and fuel consumption in buses representing emission classes Euro II to EEV
  
- Follow-up on vehicles in service:
  - actual operational performance of the new fuel in long-term service
  - emission stability of vehicles participating in the project
  
- Catalyst tests:
  - the combined effect of particulate catalysts (p-DPF) and diesel particulate filters (DPF) and different HVO/diesel blends
  
- Non-regulated emissions tests:
  - the effect of HVO diesel on non-regulated emissions

## Measurement programme

- Screening
  - 13 vehicle types (11 buses, 2 refuse trucks)
  - Euro II – EEV
  - summer and winter grade diesel fuel
  - 0, 30, 50 and 100 % HVO
- Follow-up emission testing
  - 22 vehicles
  - Euro II – EEV emission classification
  - annual measurements
- Catalyst testing
  - 4 vehicle types
  - 3 fuel blends
  - wide range of catalytic converters and filters
- Non-regulated emissions testing
  - 3 vehicle types
  - 2 fuel types



## Research methodology – Chassis dynamometer testing

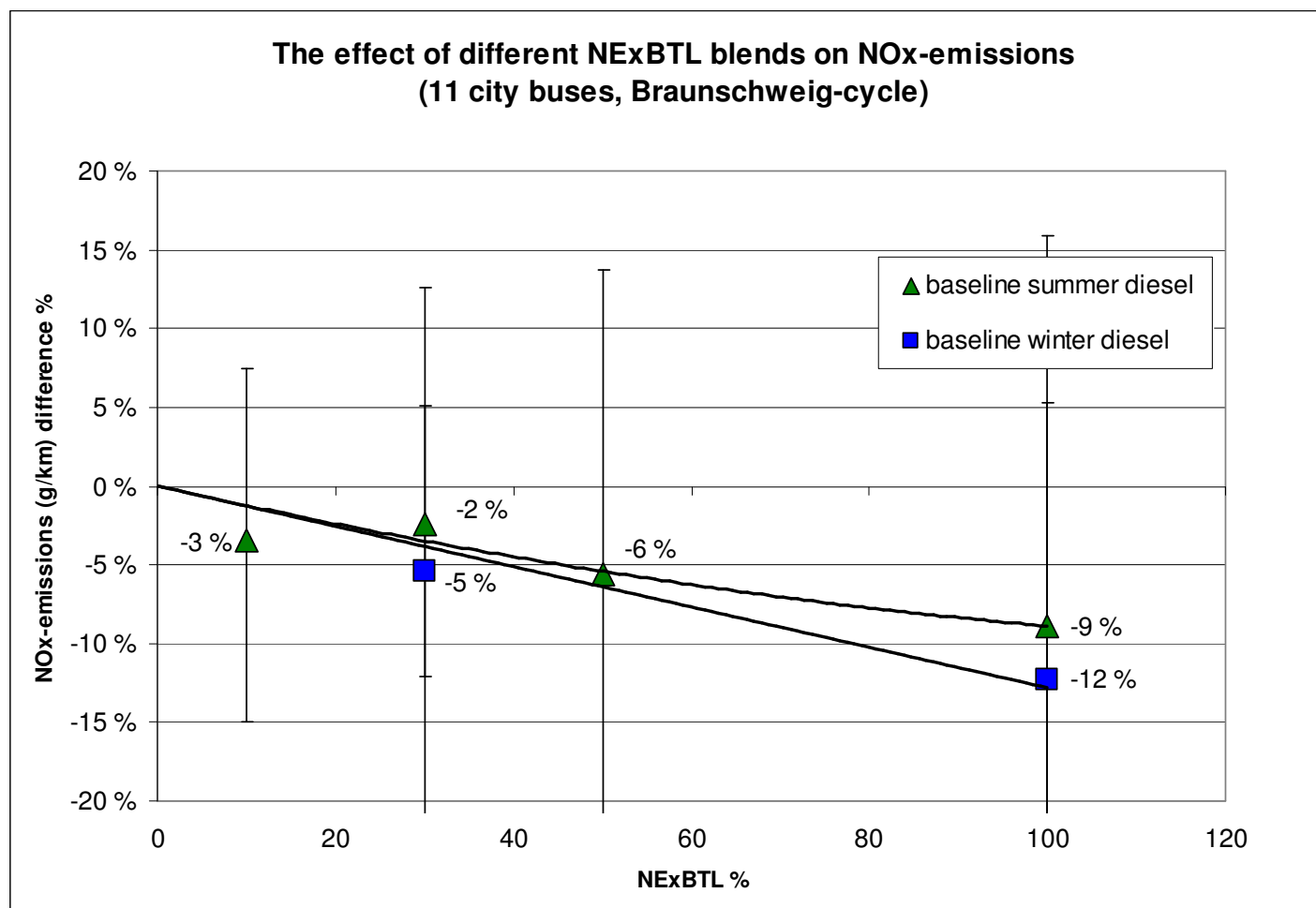


More than 100 buses and some 100 trucks have been tracked by VTT

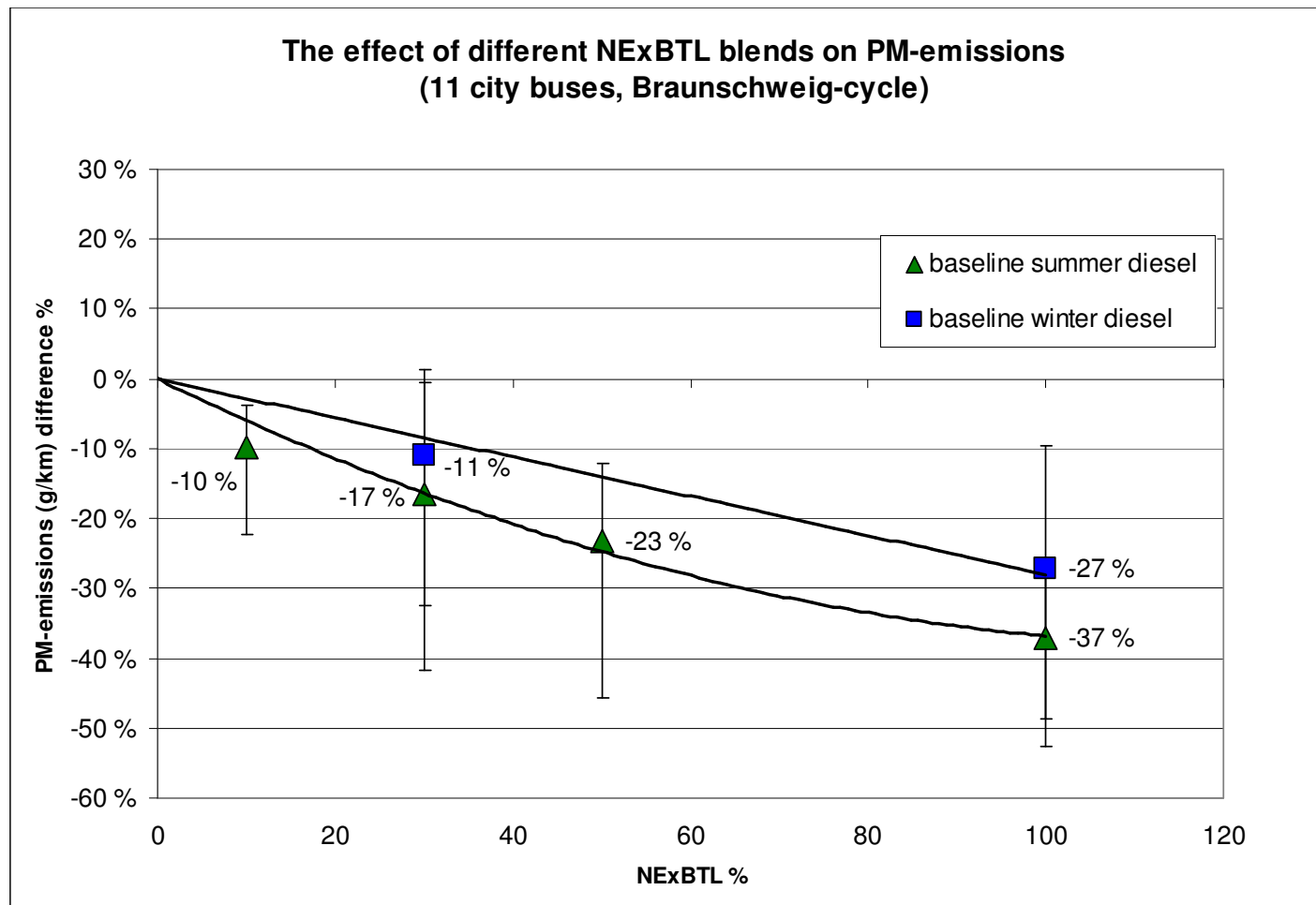
Accuracy:

- Fuel consumption  $\pm 1\%$
- Emissions  $\pm 15\%$

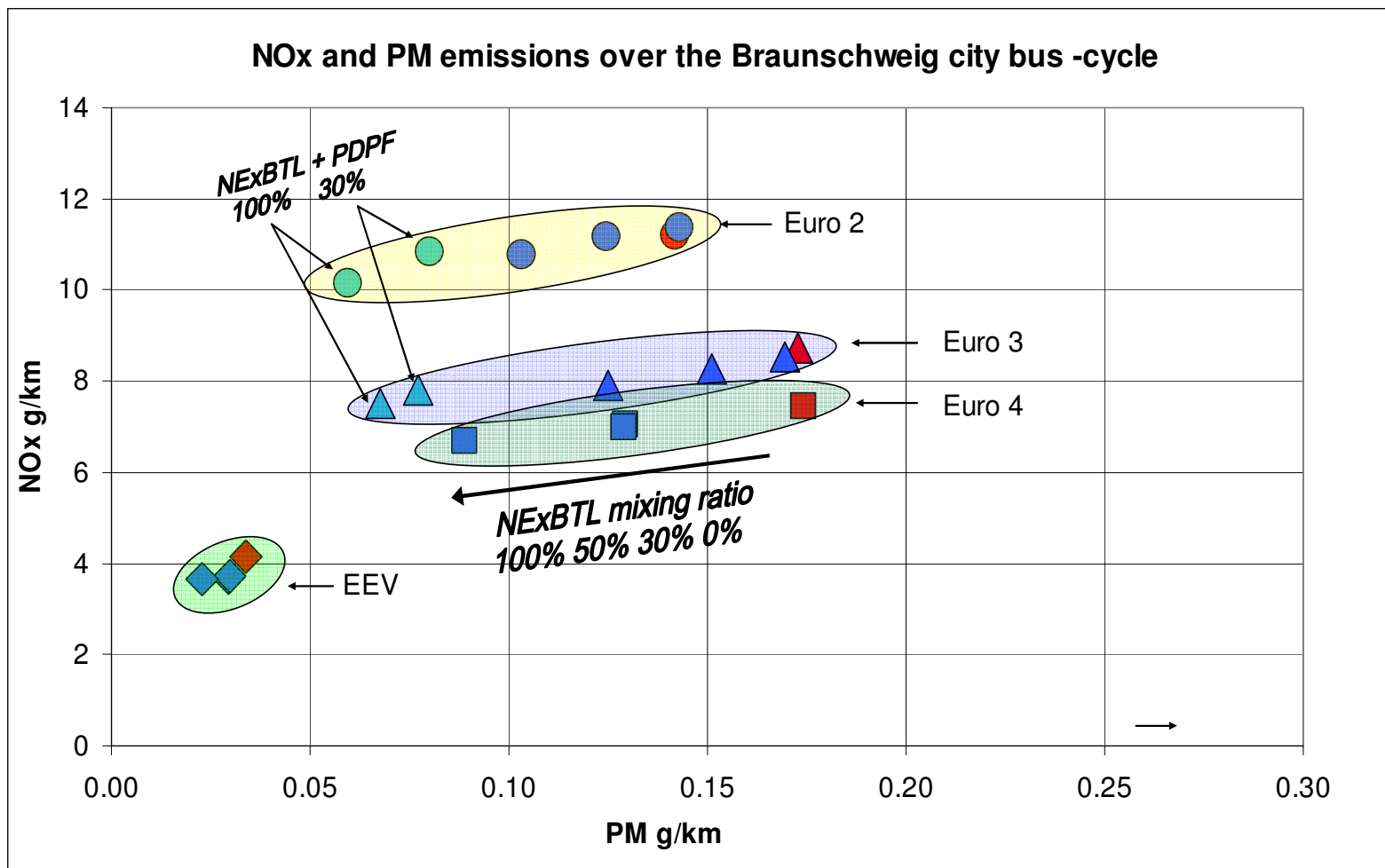
## Screening results - NOx



## Screening results - PM



## Screening results - Summary



## Non-regulated emissions

### Vehicle types:

- Euro III
- Euro IV
- EEV

### Fuels:

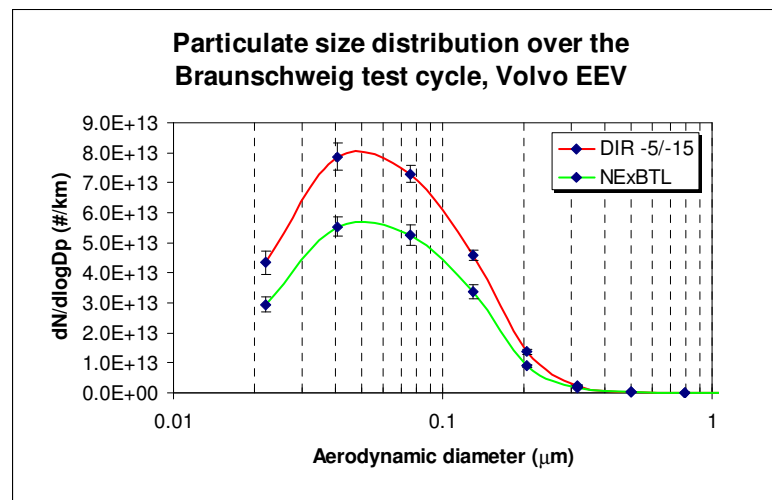
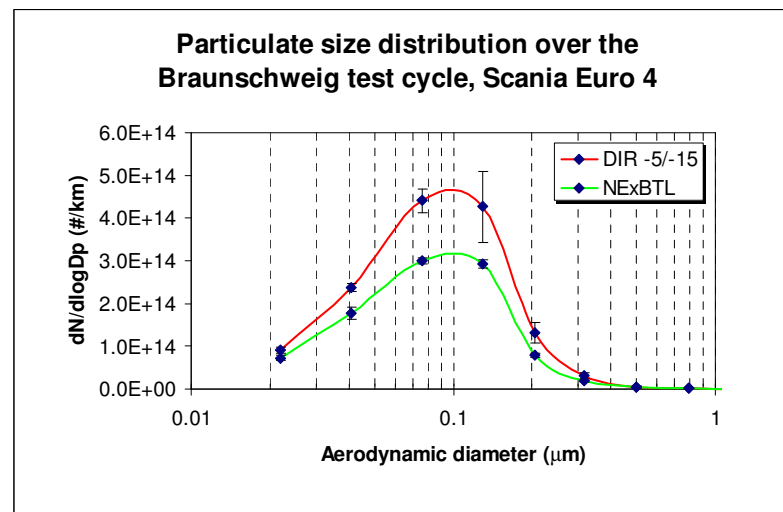
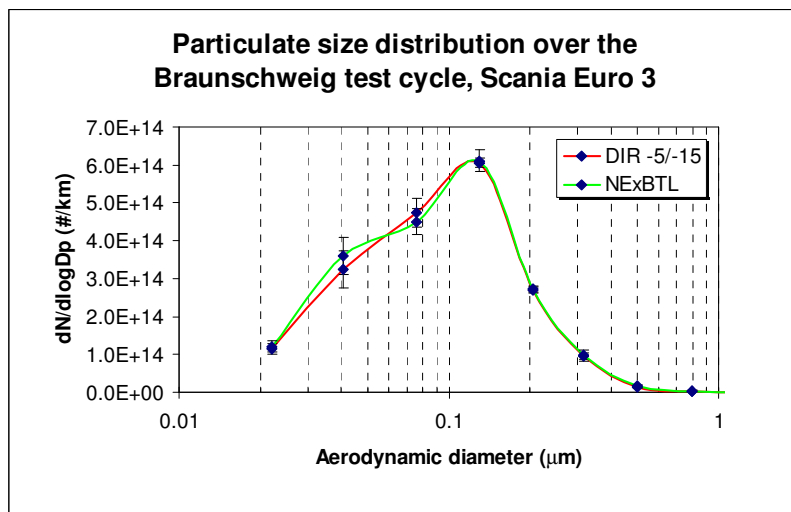
- summer grade diesel
- 100% HVO

### Emissions components:

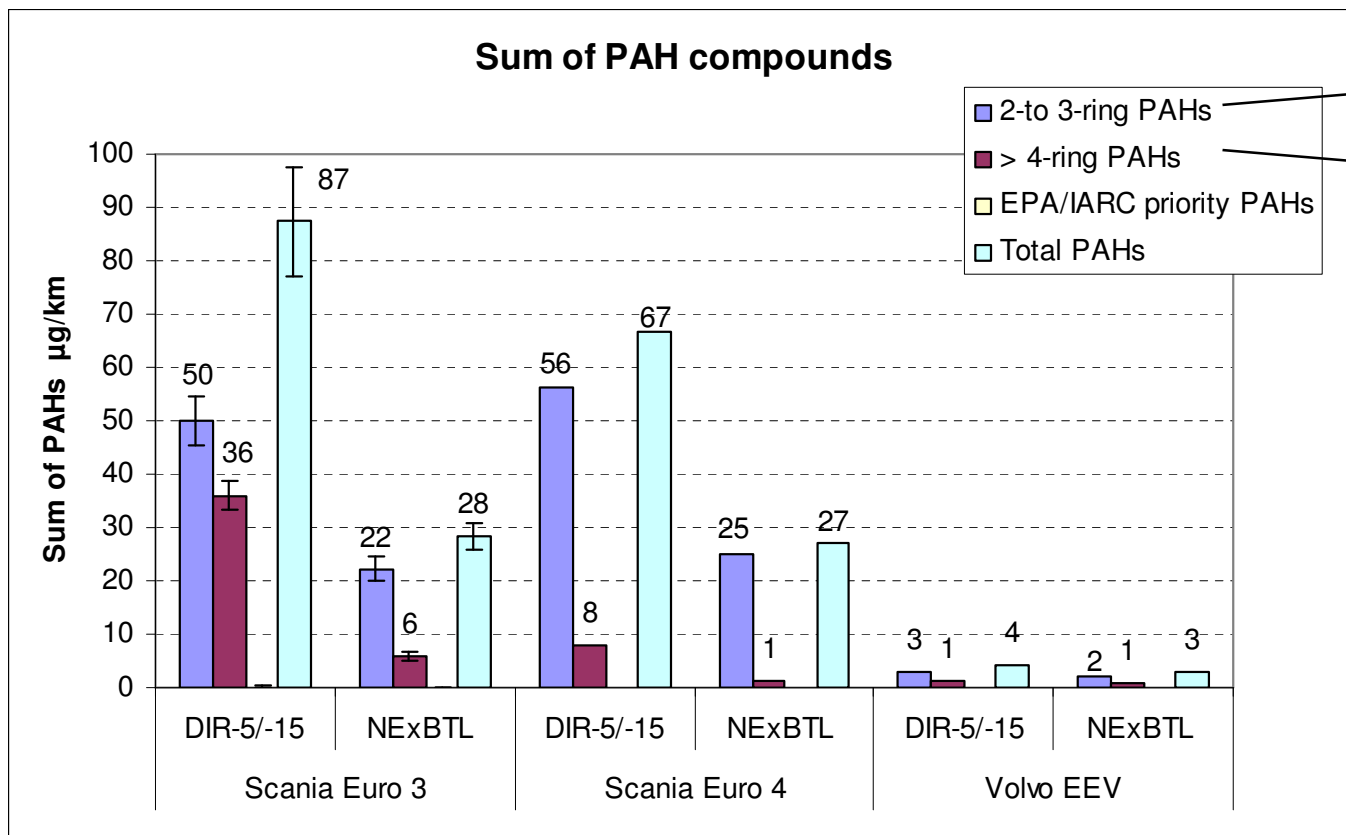
- Particle number count (ELPI)
- PAH (GC)
- Mutagenicity (Ames)
- Aldehydes (HPLC)
- Ammonia (FTIR)
- NO/NO<sub>2</sub> -ratio (CLD)



# Particulate numbers



# PAH compounds



approximately -55%

approximately -85%

## Field test..

- Commenced with some 50 buses on a 30 % HVO blend in September 2007
- 4 new Scania EEV vehicles on 100 % HVO entered the test in March 2008 (in addition 2 new reference vehicles on conventional diesel)
- Expansion to full scale (300 buses) in the autumn of 2008, most of them on a 30 % blend fulfilling the EN590 specifications
- Will run until the end of 2010

## ..Field test

- 3 older Euro III level Scania vehicles started operation on 100 % HVO in April 2009
- The Scania EEV test was completed in December 2009 after 240,000 km of operation on 100 % HVO
- 3 EEV level Irisbus vehicles started operation on 100 % HVO in February 2010
- No problems whatsoever in the field, not even during the extremely cold 2009/2010 winter

## Summary...

- The OPTIBIO project is a good example of public-private partnership
- Focus of the OPTIBIO project is on the end-use and emission performance of renewable paraffinic diesel fuel
- Approximately 300 buses currently participate in the HVO diesel field testing, test fuels being 30 % and 100 % HVO
- HVO is made through hydro-treatment of vegetable oils and animal fats, but the fuel also depicts the performance of future syngas-based BTL fuels
- No problems whatsoever in the field, field testing started in the autumn of 2007 and will continue until the end of 2010

## ...Summary

- A large number of chassis dynamometer measurements were carried out to determine the effects of HVO blend on emissions
- 100% HVO diesel reduced the most problematic emission components significantly: PM by some 30 % and NOx by some 10 % on average
- The combination of a simple particulate catalysts and 100% HVO diesel reduces PM emissions by over 50%
- HVO diesel reduces the number of particles in all size classes
- PAH compounds were also reduced significantly
- More than 20 vehicles are regularly monitored for emission stability
- The test has demonstrated that HVO (NExBTL) actually works as a "drop-in" fuel also in winter conditions, and that it delivers significant emission reductions