



# Particulate Emissions from Mopeds: Effect of Lubricant and Fuel

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## Main objectives:

**The main objective was to contribute to the discussion on the possibility of introducing new limits for particulate emissions from mopeds**

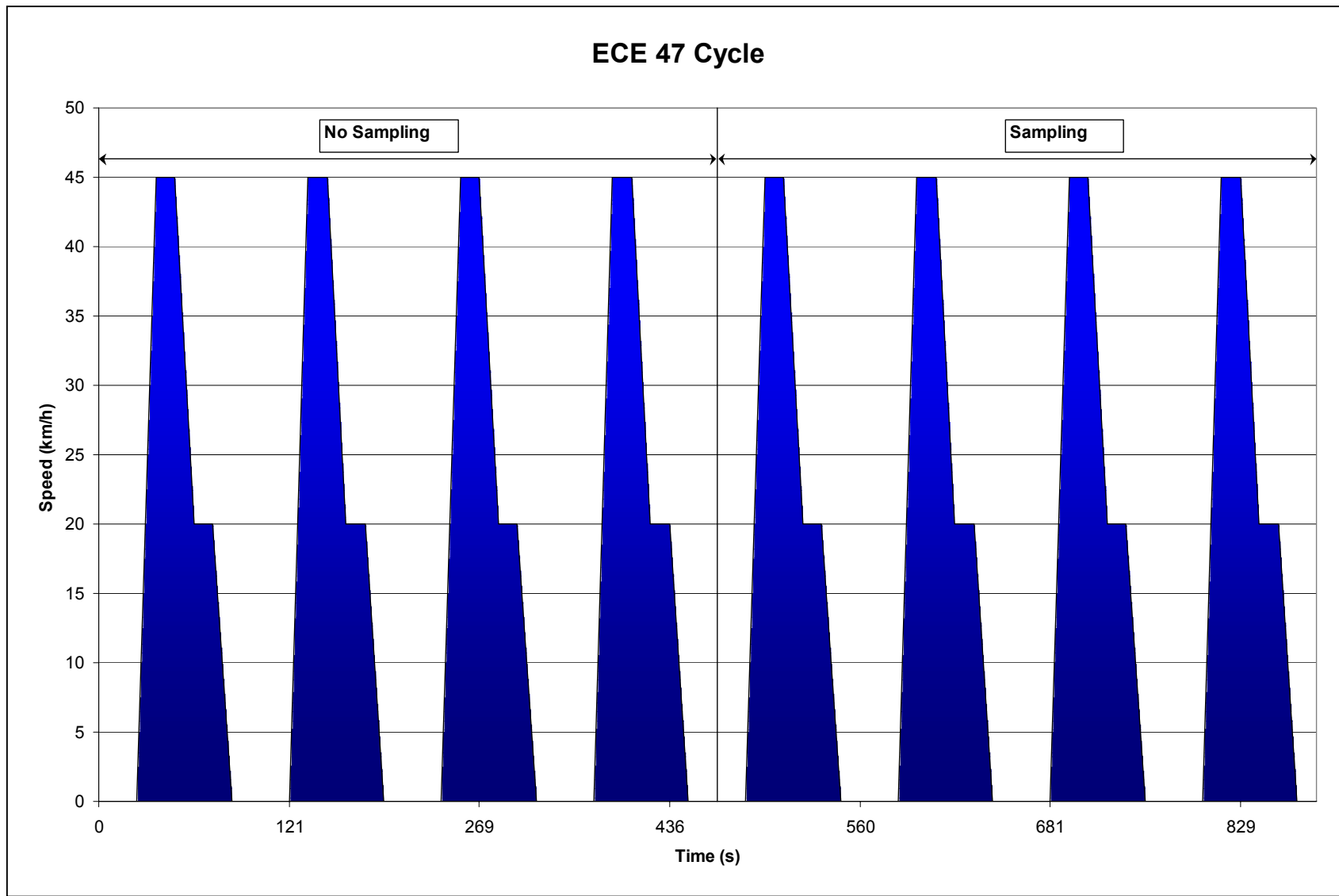
**The experimental programme was designed in order to have an understanding of:**

- physical properties of particulates emitted by mopeds
- the effect of engine technology on particulate emissions from mopeds
- the effect of the lubricating oil quality on particulates emissions
- the effect on pollutant emissions of a conversion kit to LPG for mopeds



## Experimental programme details:

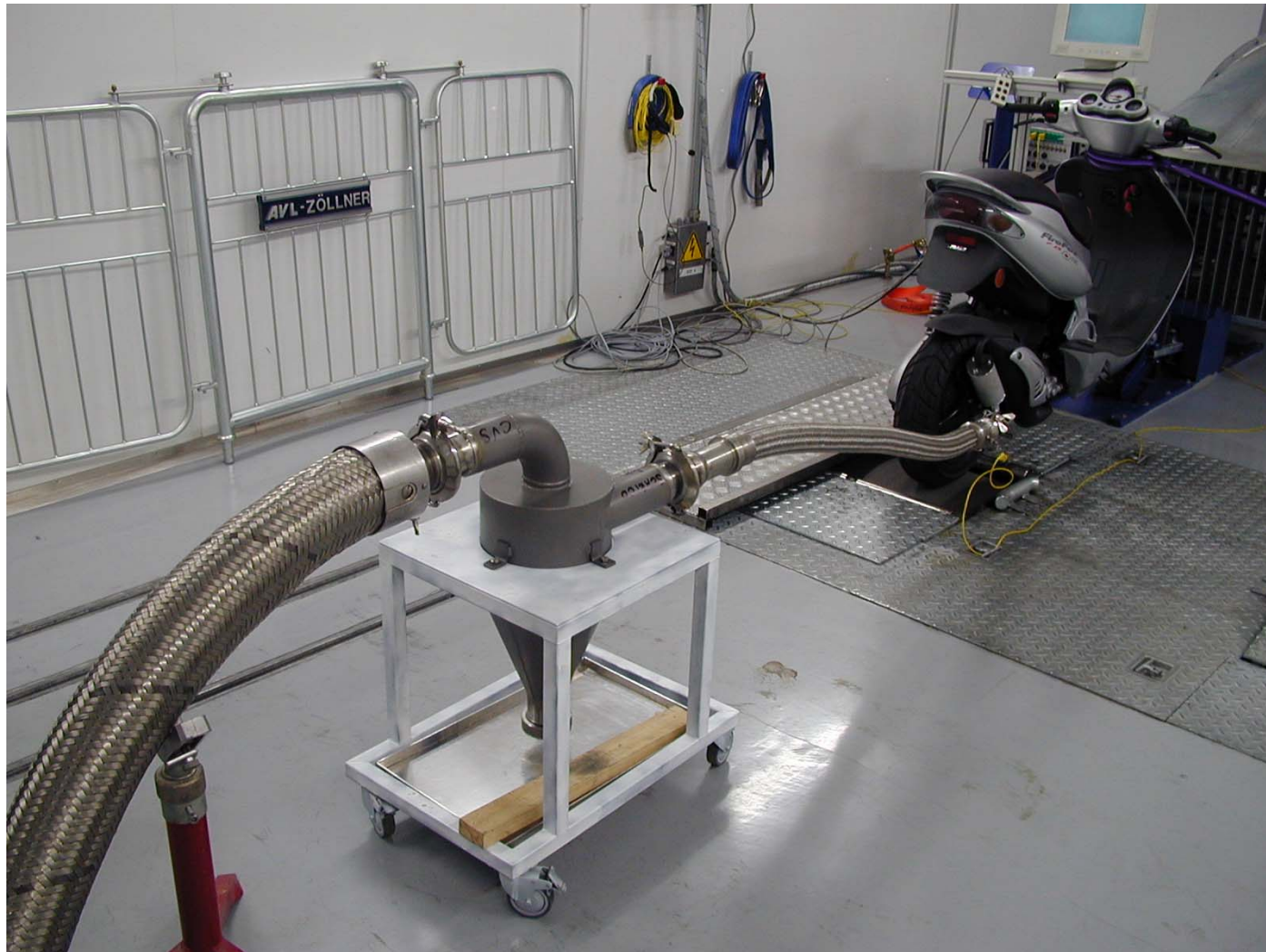
- **Emission tests:**
  - Carried out at the JRC emission test facility
  - Roller bench 48” suitable for testing small two wheelers
  - Conventional CVS system + dilution tunnel
  
- **Driving Cycle:**
  - ECE 47
  - Emissions were measured during both the “cold part” and the “hot part” of the cycle





# Particulate Emissions Characterisation:

- **Measurement of particulate total mass**
  - The legislative procedure prescribed for Diesel was used to measure particulate total mass
  - In addition, a cyclone was used to avoid contaminating the sampling system and the analysers with very large droplets of lubricant
- **Particulate physical properties:**
  - Number/size distribution (TSI – SMPS)
  - Mass/size distribution (LPI)





## Particulate physical properties:

- **Number/size distribution (TSI – SMPS)**
  - *Constant speed (40 km/h)*
  
- **Mass/size distribution (Low Pressure Impactor)**
  - *11+1 stages*
  - *Volume flow rate: 25 l/min*
  - *Measuring range: 0.0085 mm-16 mm*
  - *Constant speed (40 km/h) and ECE 47 cycle*





# Effect of Lubricant on Particulate Emissions

- **Test lubricants**
  - Low quality lubricant (mineral, low content of additives)  
API TC specifications
  - High quality lubricant (full synthetic, high content of additives)  
API TC, JASO FC and ISO-L-EGD specifications





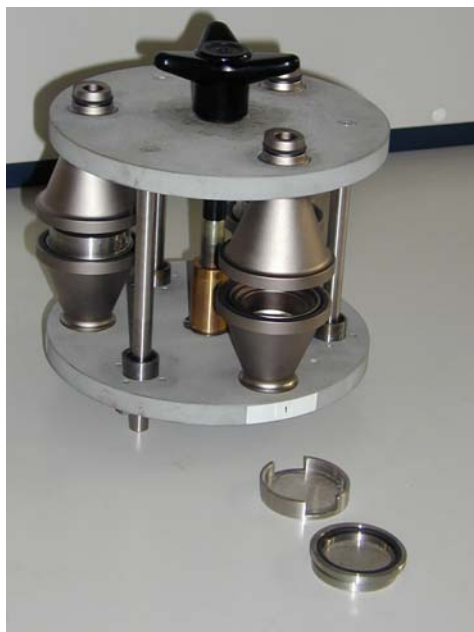
## Test Fleet

- **MT001-M-50**
  - *Pre-Euro 1 moped*
  - *Conventional two stroke engine; no after-treatment device*
- **MT002-M-50**
  - *Euro 1 moped*
  - *Direct injection engine; no after-treatment device*
- **MT003-M-50**
  - *Euro 1 moped*
  - *Conventional two stroke engine; oxidation catalyst*
- **MT004-M-50**
  - *Euro 1 moped equipped with a LPG conversion kit*
  - *Conventional two stroke engine; oxidation catalyst*



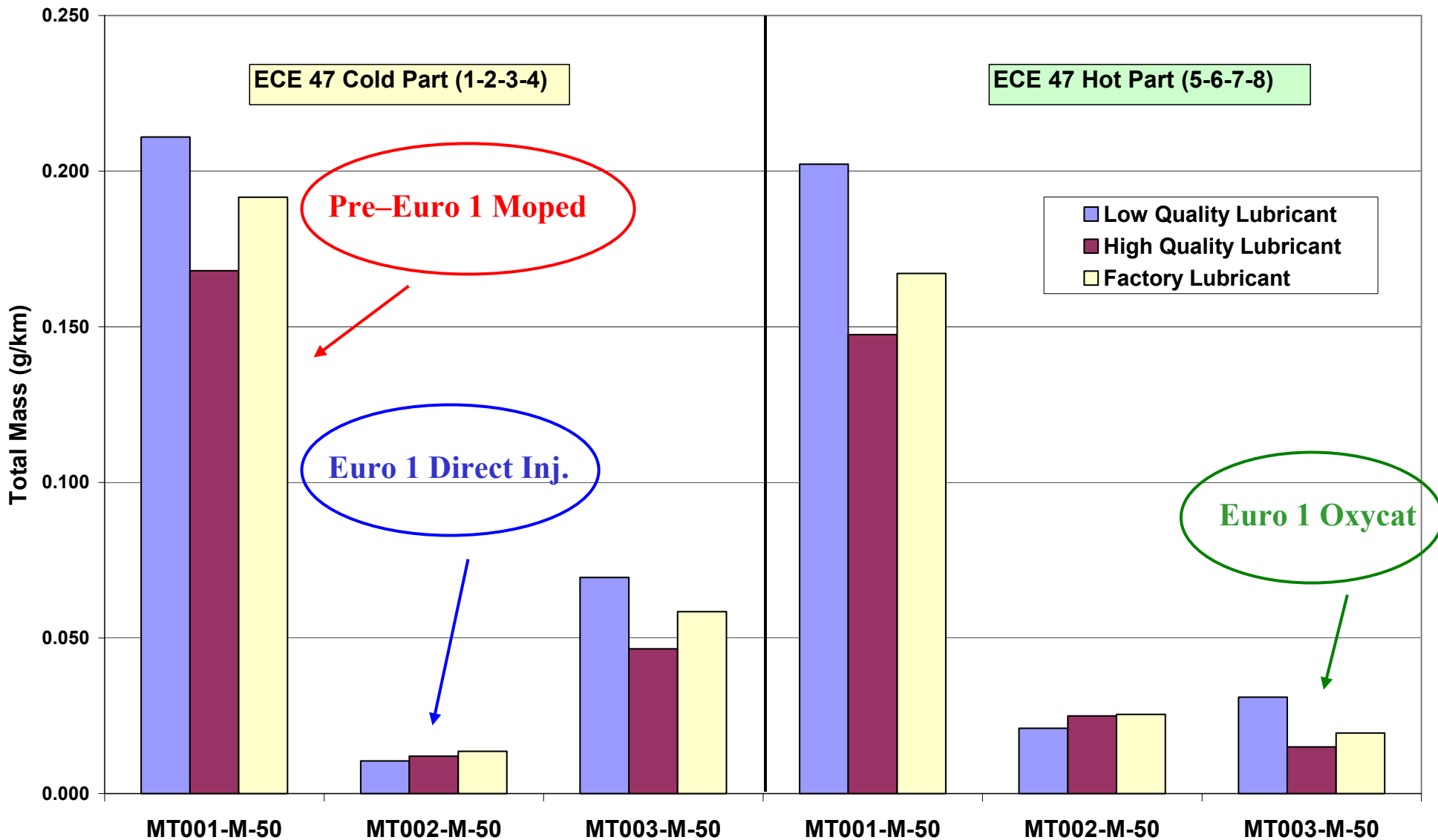
# Effect of Lubricant on PM Emissions

## Total Mass



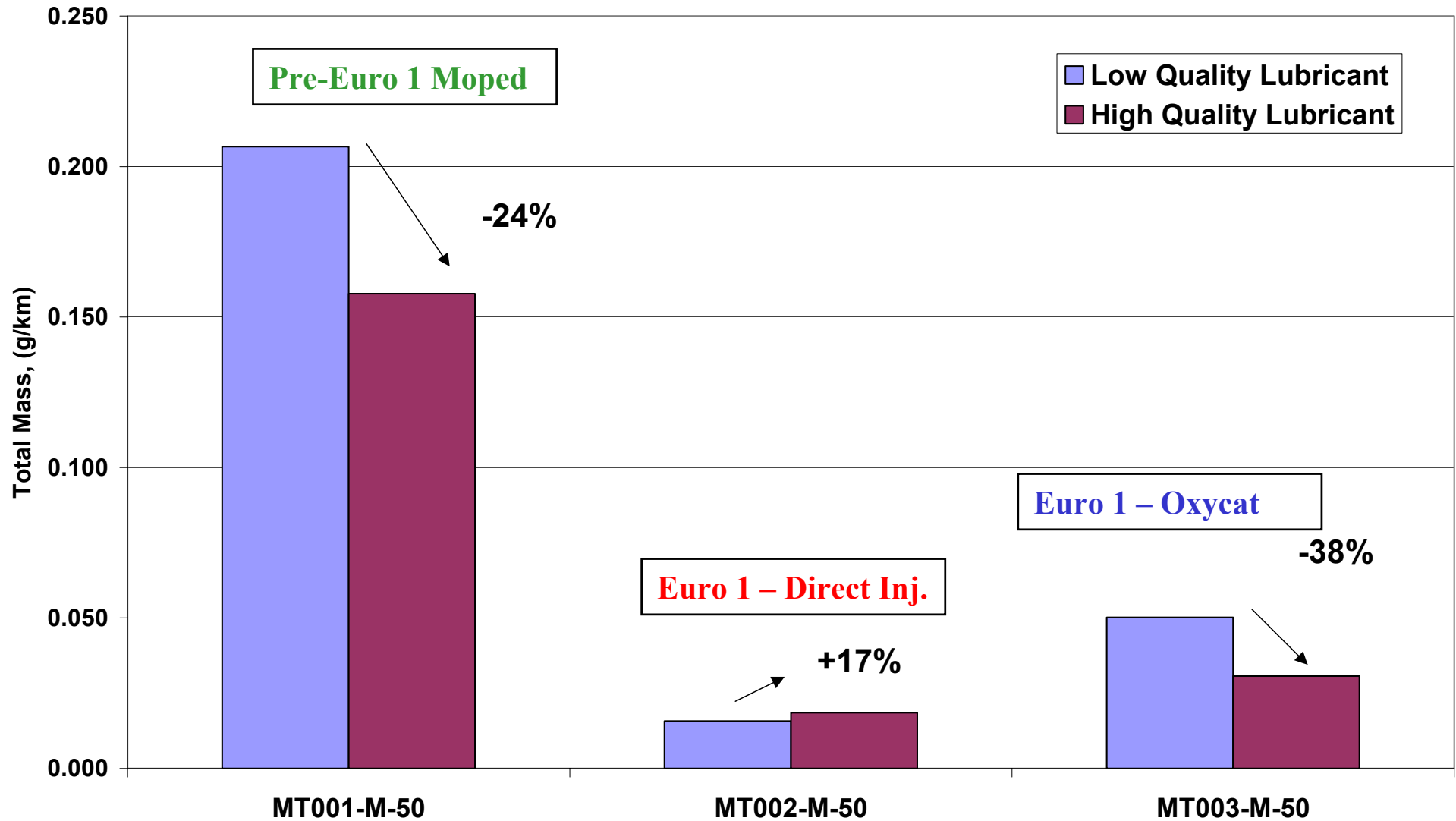


### Effect of Lubricating Oil Quality on Moped Emissions ECE 47 Cycle - Particulates Emissions



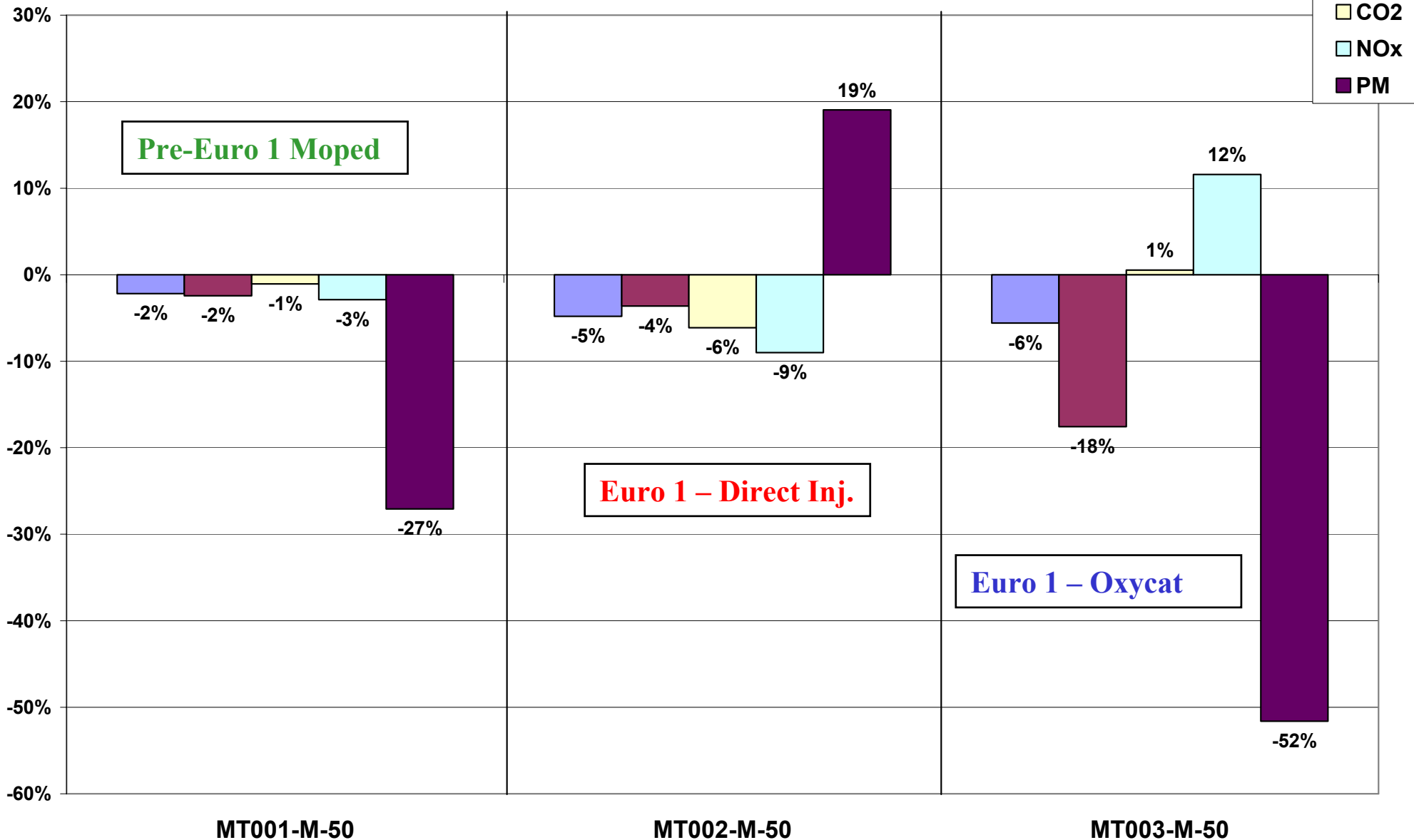


### Effect of Lubricating Oil Quality on Moped Emissions ECE 47 Cycle (Whole Cycle) - Particulates Emissions





### Effect of Lubricant Oil Quality on Moped Emissions ECE 47 Cycle (Hot Part) - Percentage Variations Change from Low Quality Oil to High Quality Oil



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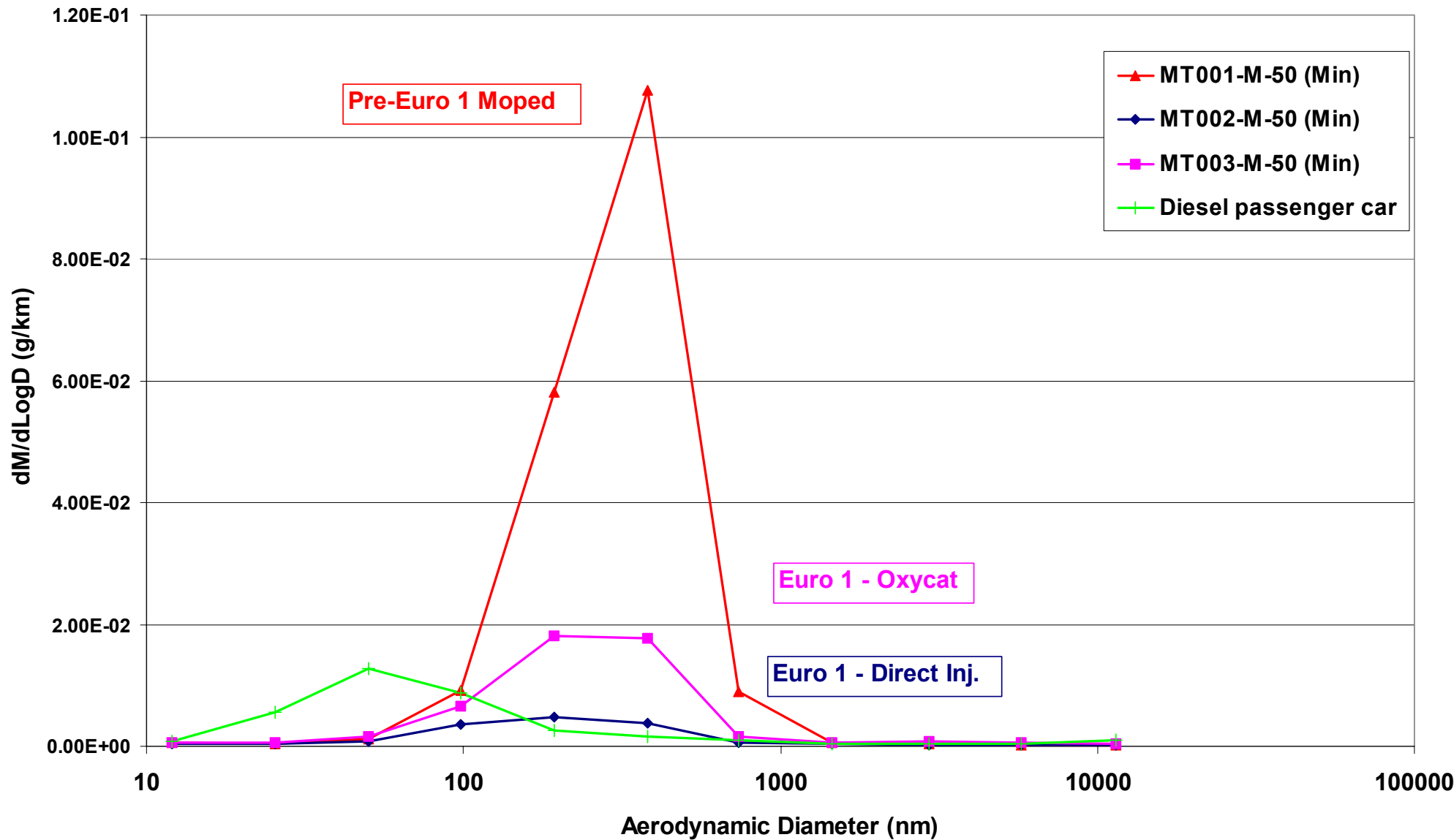
# Effect of Lubricant on PM Emissions

## Mass/Size Distribution



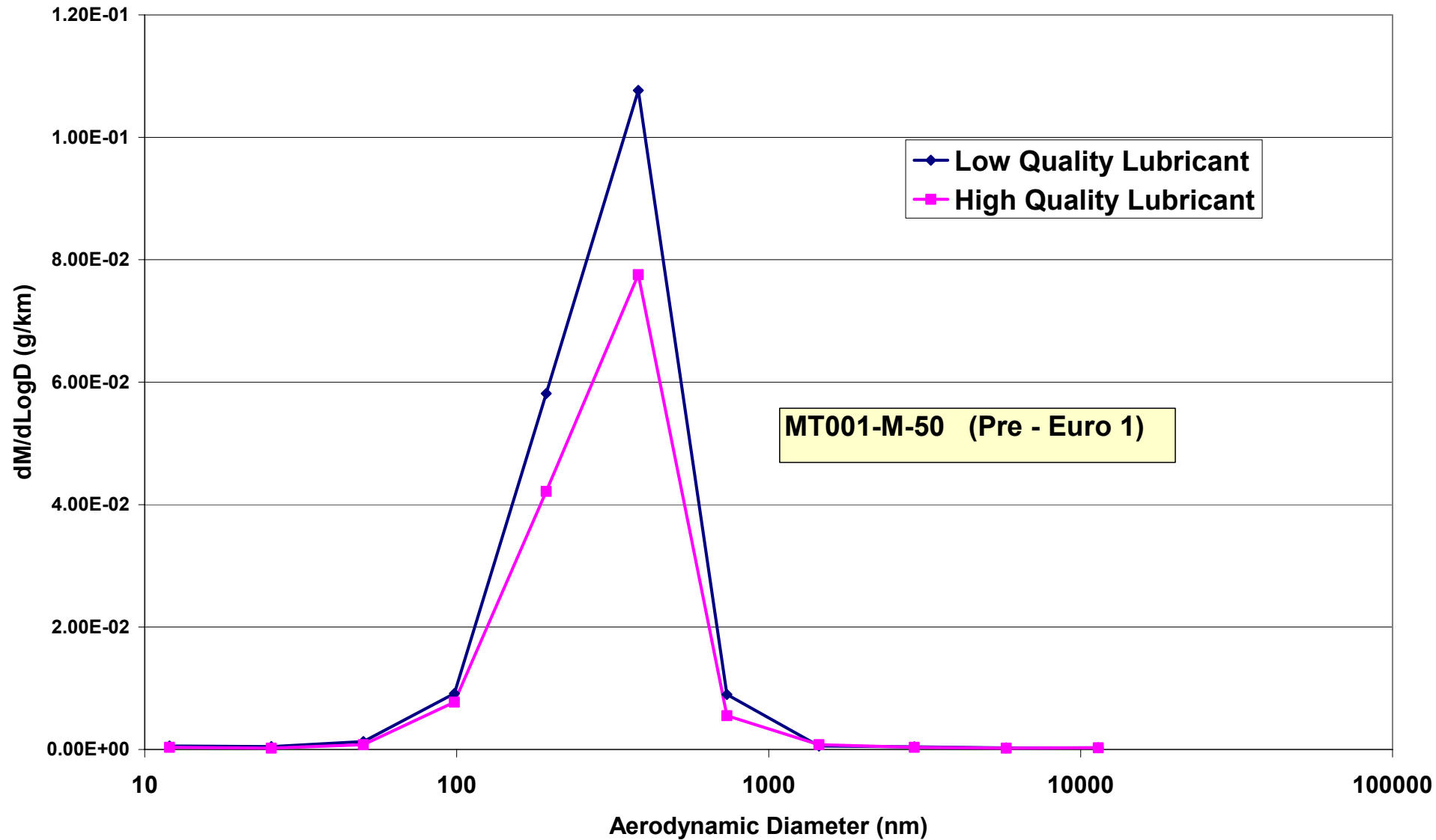


### Particulate Emissions from Mopeds ECE 47 Cycle - Mass/Size Distribution (LPI 11 stages)





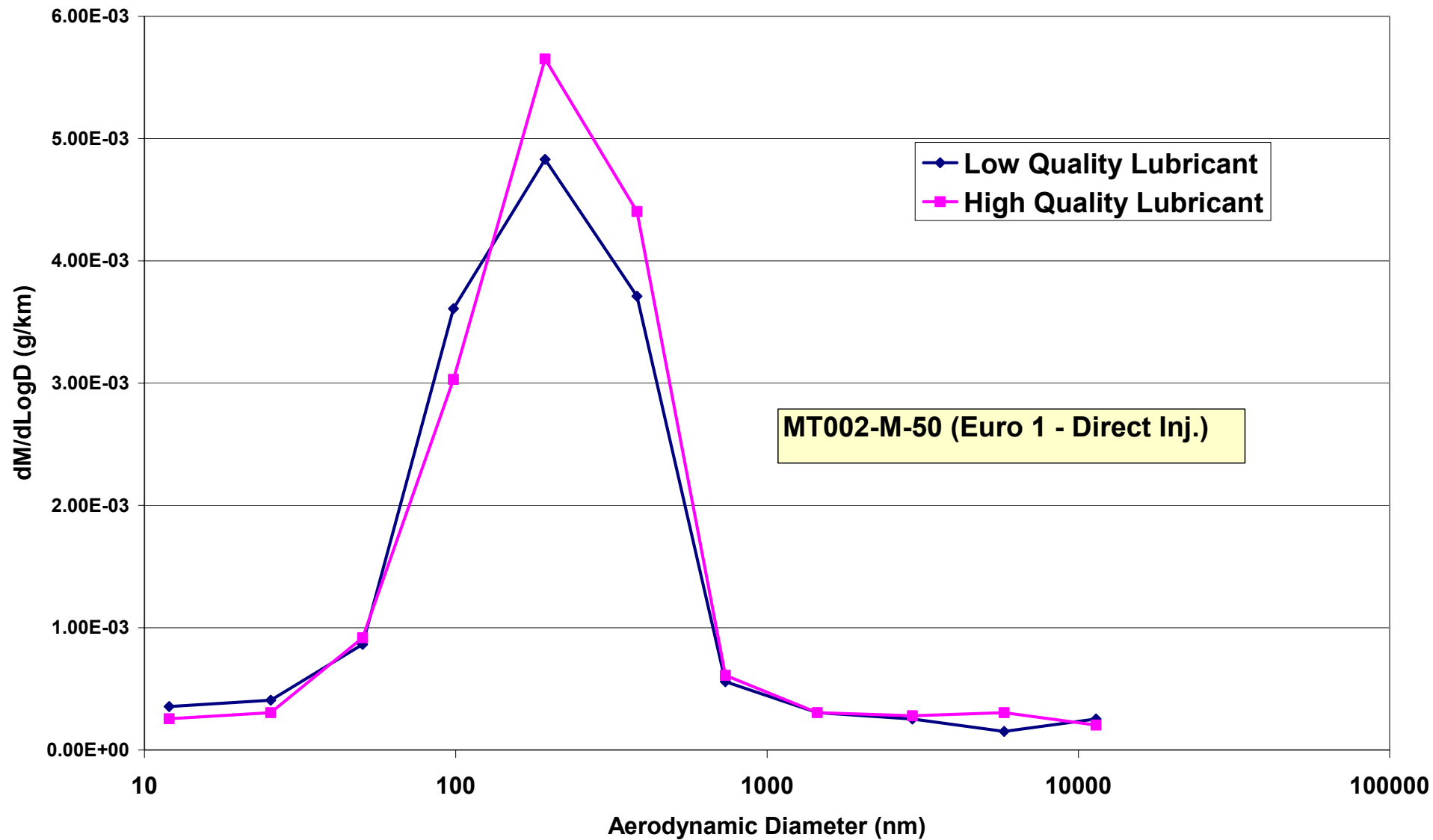
### Effect of Lubricating Oil on Particulate Emissions ECE 47 Cycle - Particulate Mass/Size Distribution (LPI 11 stages)





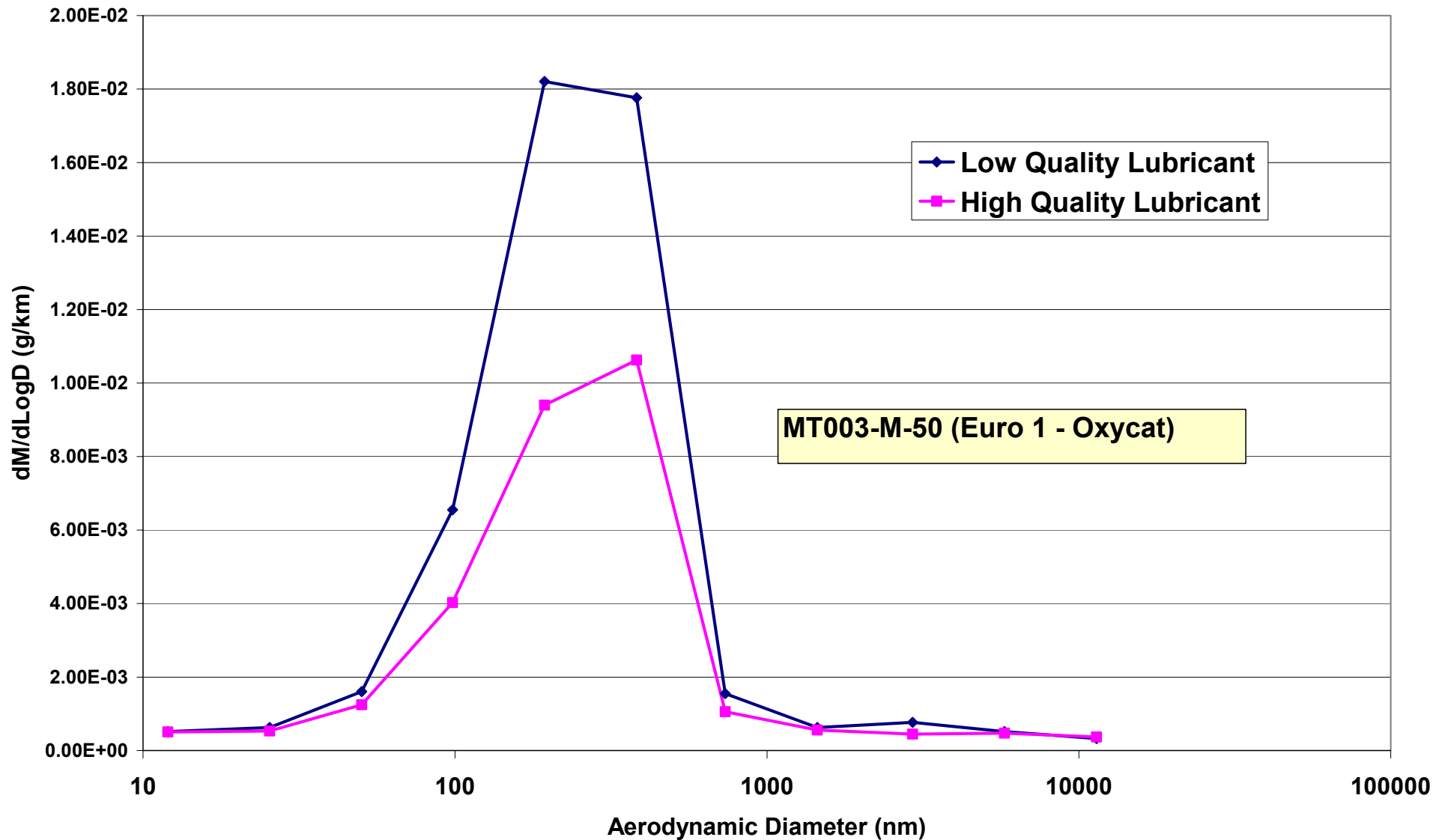


### Effect of Lubricating Oil on Particulate Emissions ECE 47 Cycle - Particulate Mass/Size Distribution (LPI 11 stages)



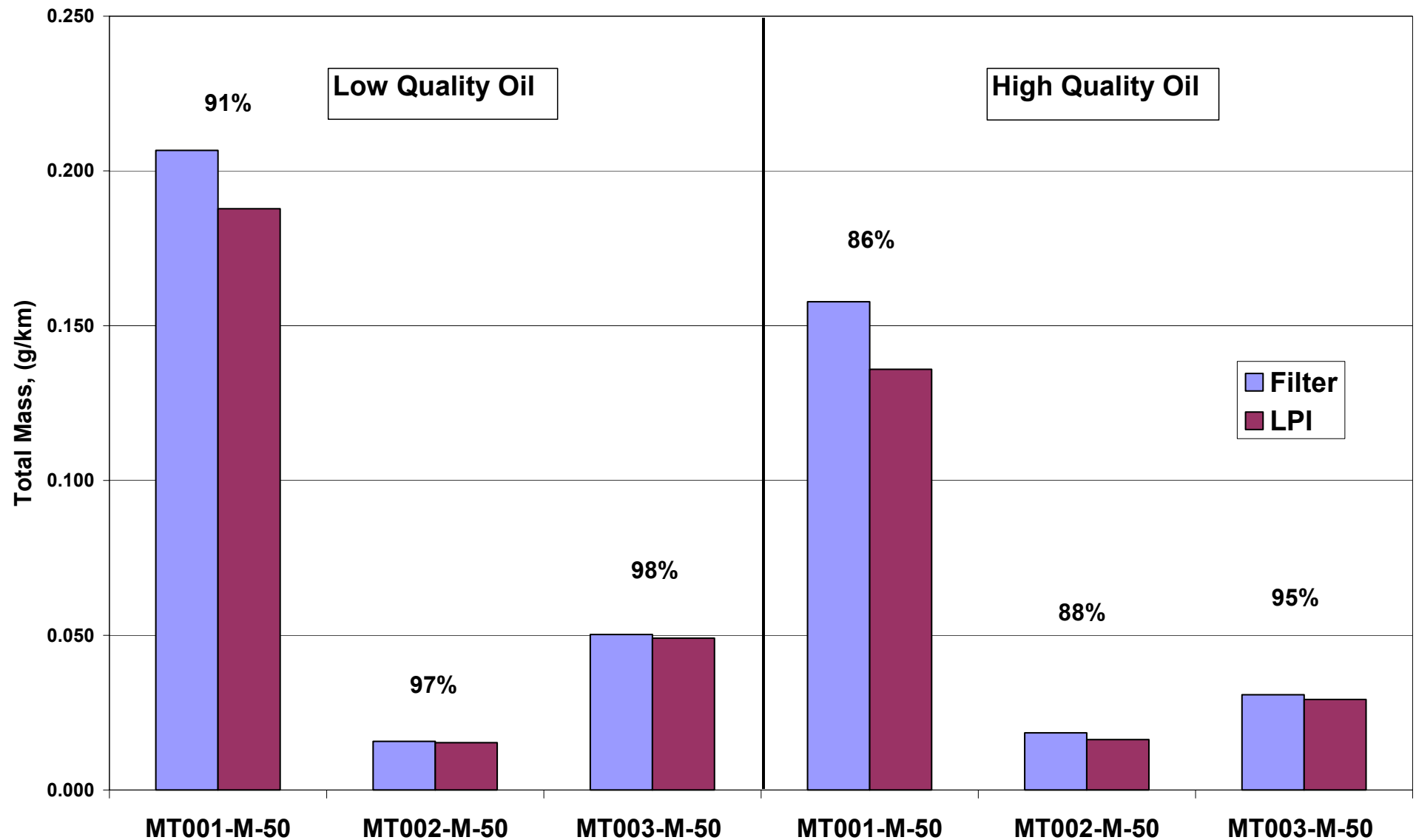


### Effect of Lubricating Oil on Particulate Emissions ECE 47 Cycle - Particulate Mass/Size Distribution (LPI 11 stages)





### Particulate Emissions from Mopeds Total Mass - Filter vs LPI





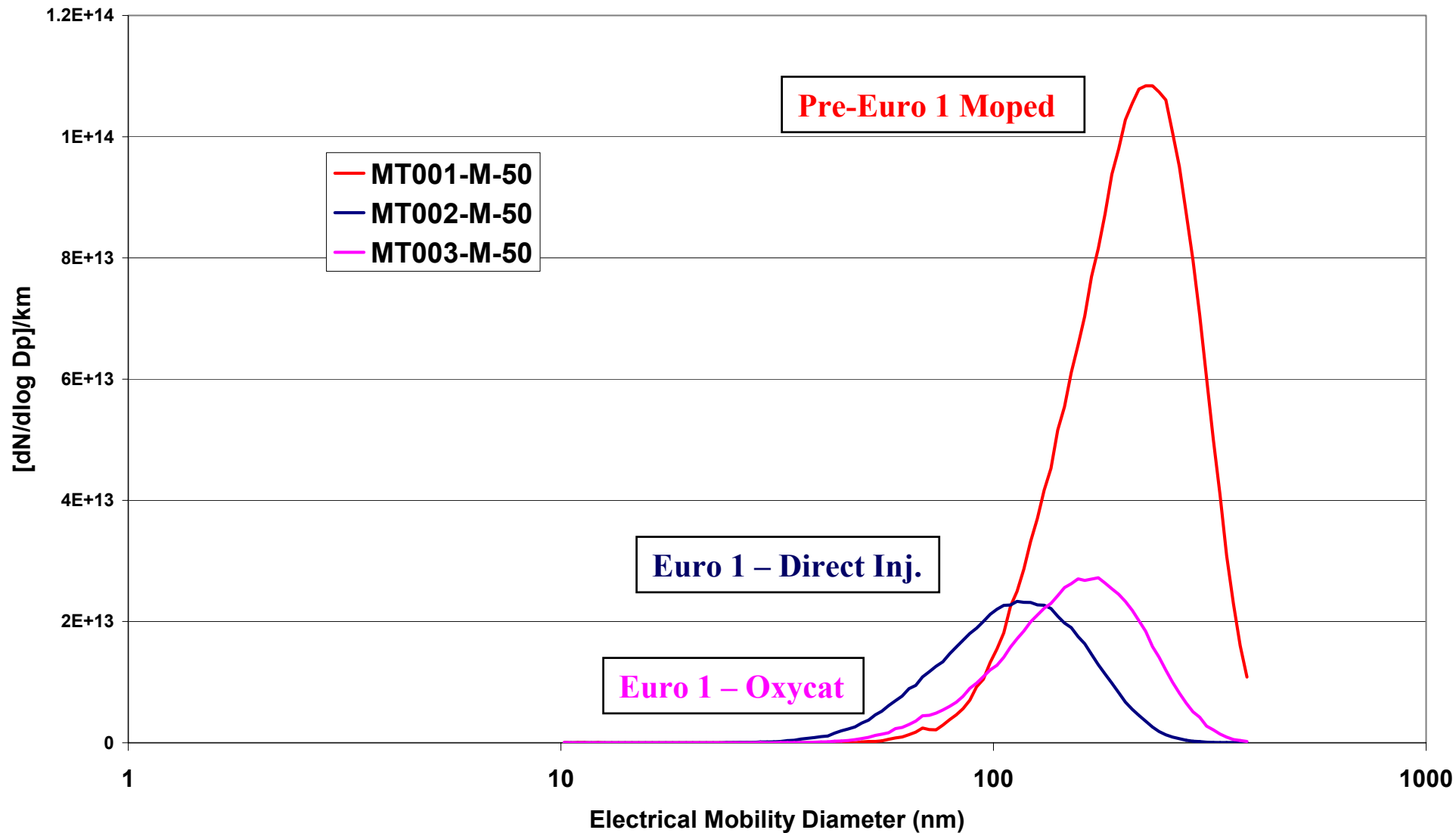
# Effect of Lubricant and Fuel on PM Emissions

## Number/Size Distribution



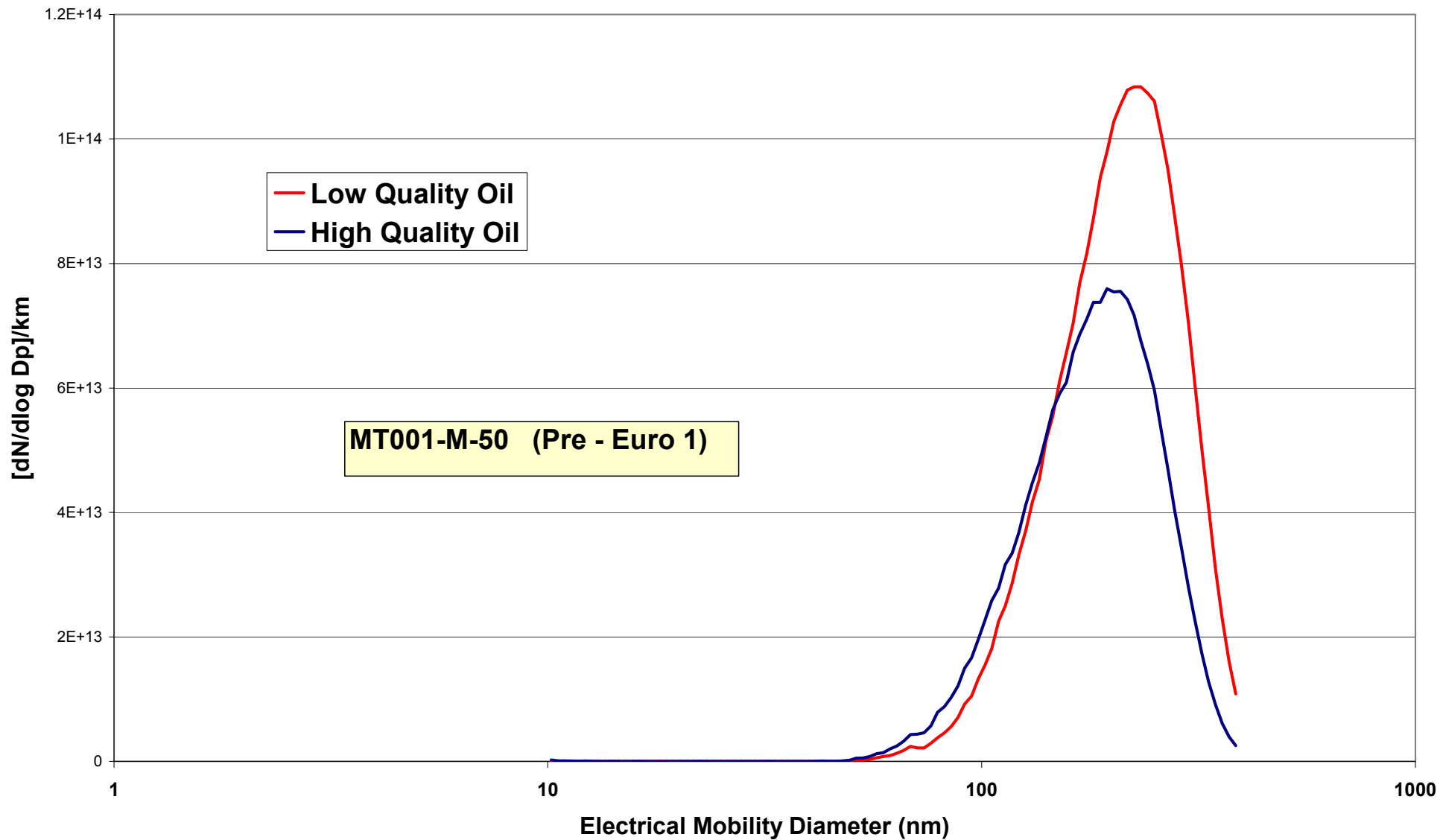


### Particulate Emissions from Mopeds Number/Size Distribution - Constant Speed: 40 km/h Low Quality Oil



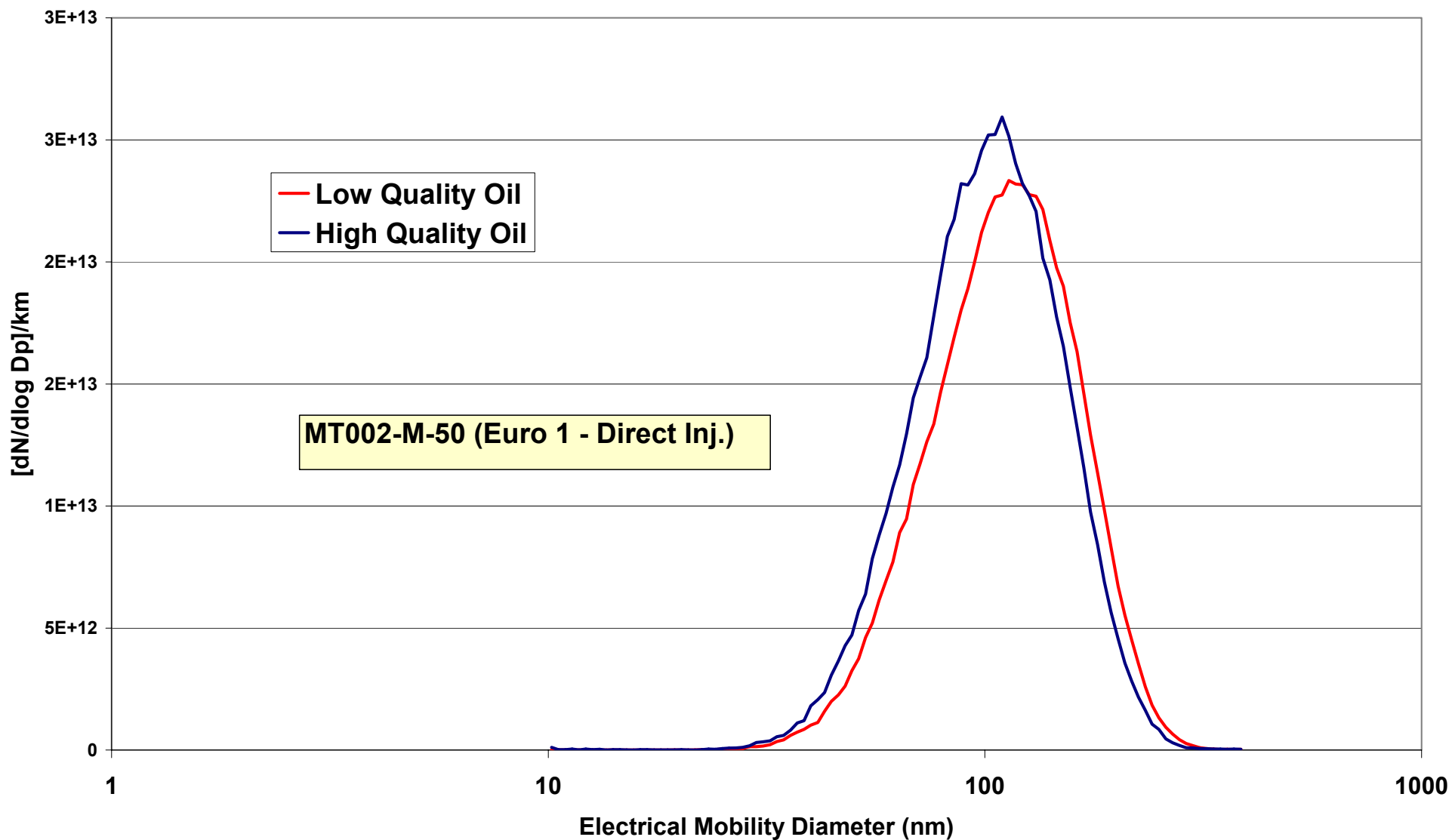


### Effect Of Lubricating Oil on Particulate Emissions Number/Size Distribution - Constant Speed: 40 km/h



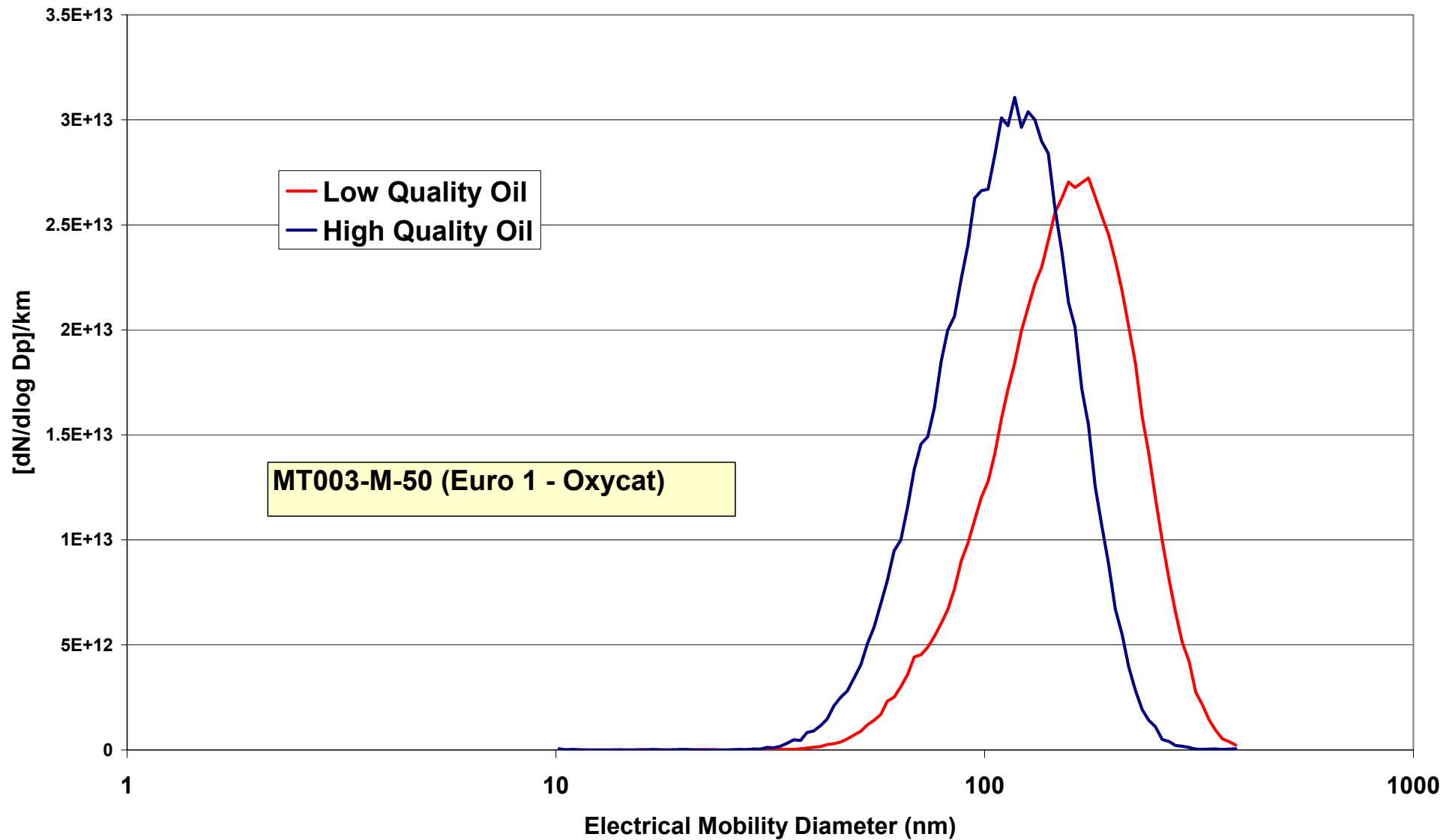


### Effect Of Lubricating Oil on Particulate Emissions Number/Size Distribution - Constant Speed: 40 km/h





### Effect Of Lubricating Oil on Particulate Emissions Number/Size Distribution - Constant Speed: 40 km/h





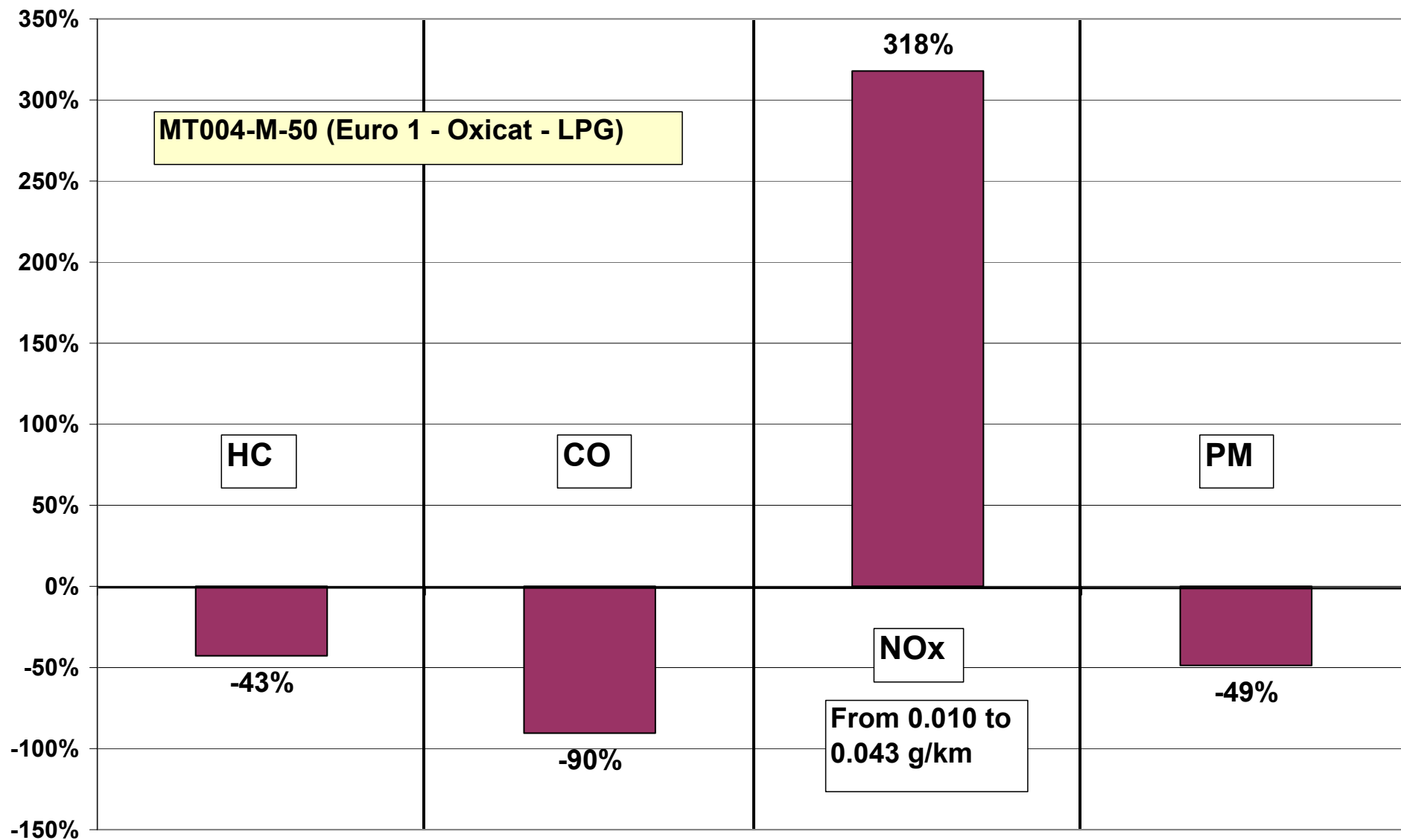


# Effect of Conversion to LPG on Emissions of Moped



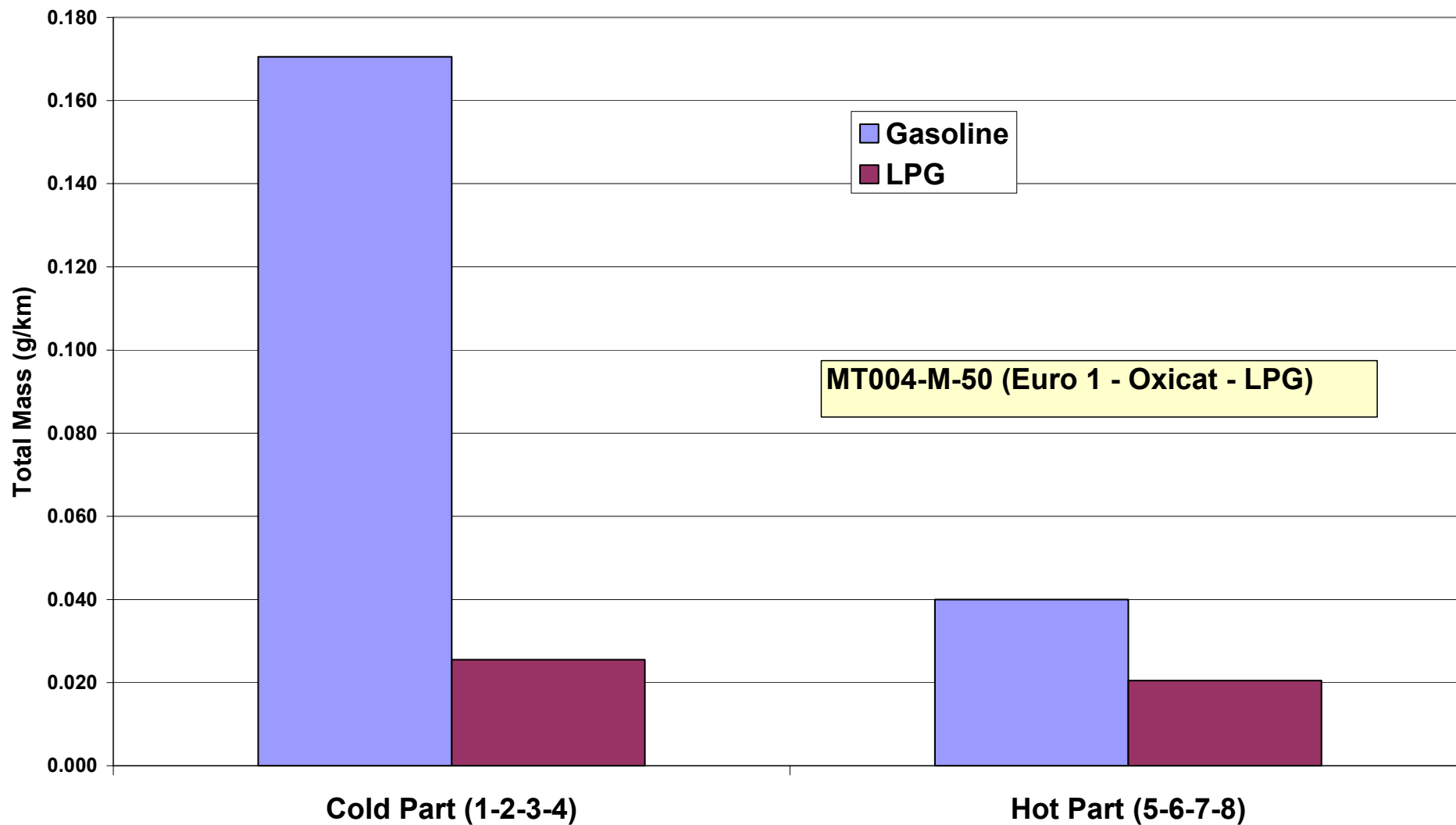


### Effect of LPG on Emissions ECE 47 Cycle (Hot Part) - Percentage Variations



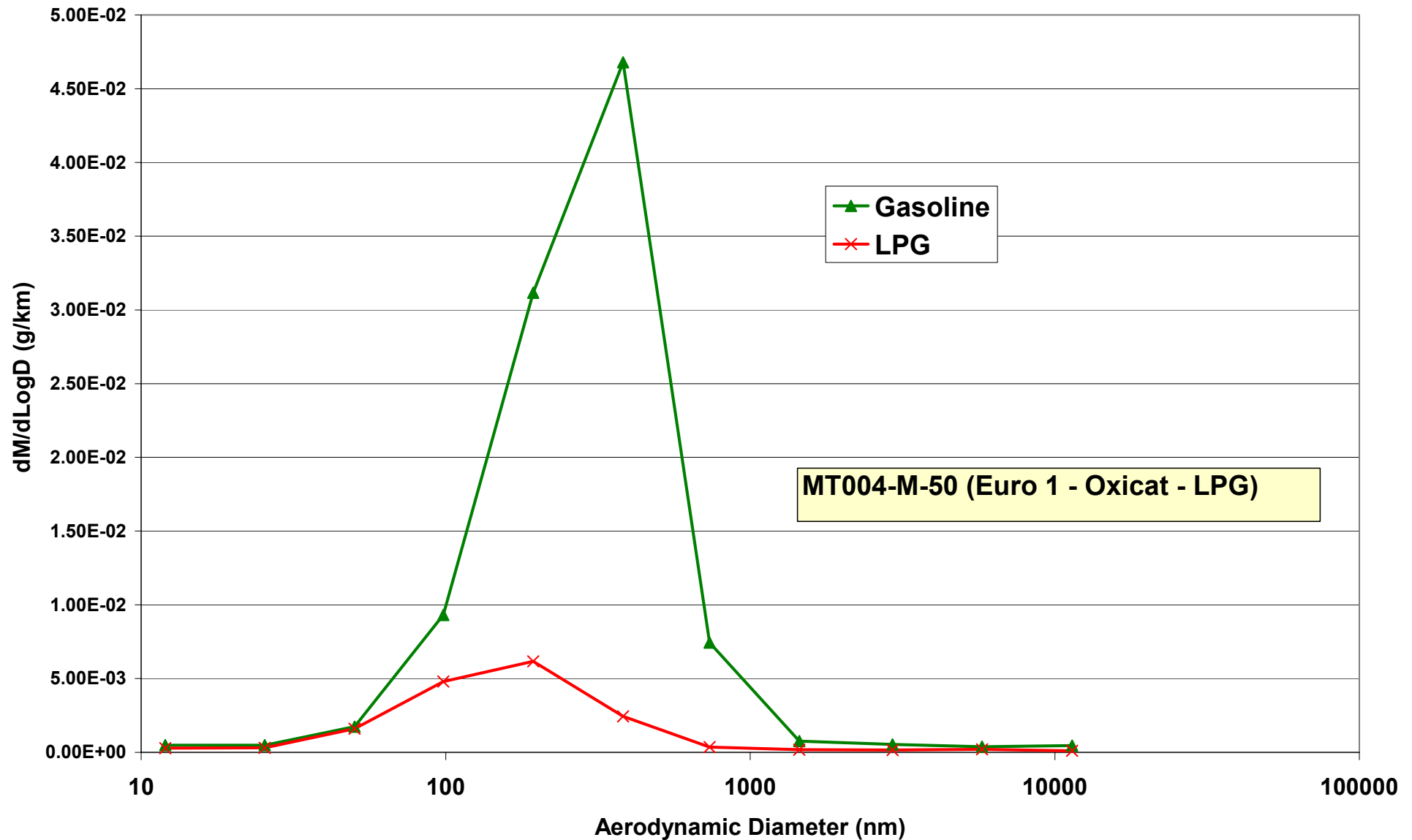


### Effect of LPG on Emissions ECE 47 Cycle - Particulate Emissions



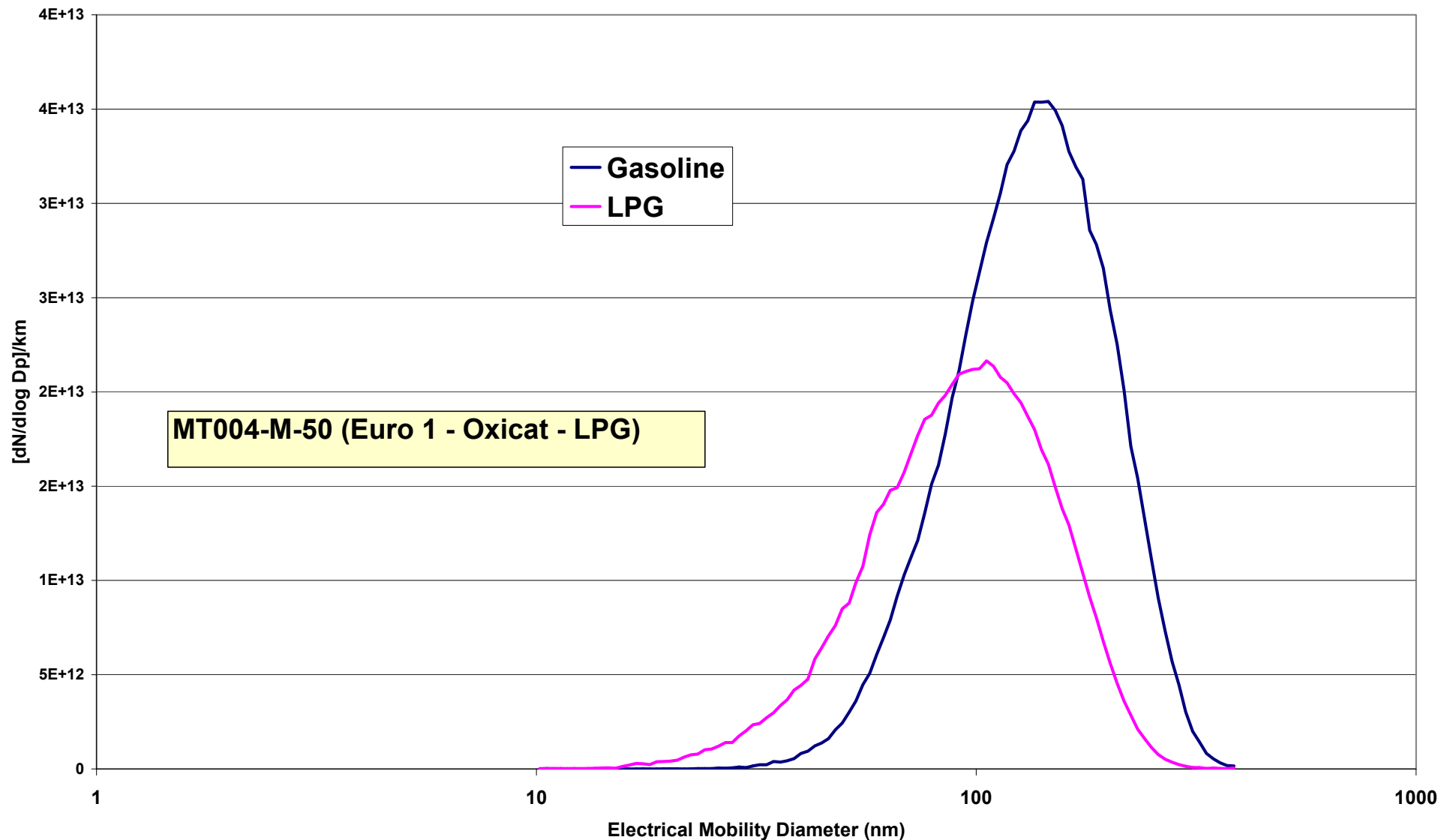


### Effect of LPG on Particulate Emissions ECE 47 Cycle (Whole Cycle) - Mass/Size Distribution (LPI 11 stages)





### Effect Of LPG on Particulate Emissions Number/Size Distribution - Constant Speed: 40 km/h





## Conclusions:

- The engine technology has a huge effect on particulate emissions from mopeds
- The Euro 1 mopeds tested at the JRC showed particulate emission values (g/km) close to those of Euro 3 diesel vehicles
- The lubricant quality has a significant impact on particulate mass, particle number and size
- The effect of lubricant quality depends on the engine technology
- The moped equipped with the direct injection engine exhibited a different behaviour compared to conventional two stroke engines
- The LPG conversion kit tested proved to be an effective way to reduce particulate emissions from mopeds