Non road mobile machinery
-Challenges and methods in the EMEP/EEA Guidebook

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Disposition

- Introduction
  - Sector description
  - Emission importance
- Tier 1, 2, 3
  - Activity data
  - Emission factors
  - Problems/challenges
- Conclusions
Introduction

- Non road mobile machinery (NRMM) sectors in GB
  - 1.A.2.f.ii (industry NRMM)
  - 1.A.4.a.ii (commercial/institutional NRMM)
  - 1.A.4.b.ii (residential NRMM)
  - 1.A.4.c.ii (agriculture/forestry NRMM)
  - 1.A.5.b (military NRMM)
Introduction

- Industry NRMM (1.A.2.f.ii)
  - Building/construction machinery: Excavators, loaders, dumpers, dozers
  - Fork lifts
  - Small types: e.g. generators, pumps, compressors
Introduction

- Commercial/institutional & residential NRMM (1.A.4.a & b.ii)
  - Small gasoline gardening equipment
  - Types like: Lawn movers, riders, cultivators, chain saws, shrub clearers/trimmers, hedge cutters
Introduction

– Agriculture/forestry NRMM (1.A.4.c.ii)
  ▪ Agricultural tractors, harvesters, ATV’s
  ▪ Forest tractors/cultivators, tree processors, haulers
  ▪ Small types: e.g. Chippers, chain saws
Introduction – NRMM emission distribution – EU28

**NO\textsubscript{x} NRMM - EU28**
- Industry: 28%
- Commercial/ins t.: 1%
- Agriculture/Forestry: 70%
- Residential: 1%

**TSP NRMM - EU28**
- Industry: 29%
- Commercial/ins t.: 1%
- Agriculture/Forestry: 69%
- Residential: 1%

**CO NRMM - EU28**
- Industry: 26%
- Commercial/ins t.: 10%
- Agriculture/Forestry: 33%
- Residential: 31%

**NMVOC NRMM - EU28**
- Industry: 23%
- Commercial/ins t.: 6%
- Agriculture/Forestry: 55%
- Residential: 16%

NRMM shares of EU 28 totals: NO\textsubscript{x}: 8%; CO: 5%; NMVOC: 3%; TSP: 2%
Tier 1: Fuel x EF (constant) approach

- Fuel activity data from relevant national statistical sectors
- With no explicit non road fuel statistics; GB recommends to use sample, survey or industry data in order make stationary-mobile split (or use key expert judgment)
- If this cannot be done, GB recommends to regard the stationary + mobile sum as mobile
Tier 1: Fuel $\times$ EF (constant) approach

- GB provides constant emission factors per sector and fuel type

- The real challenge for Tier 1 is to obtain reliable fuel data for each non road sector in your country
Tier 2: Fuel x EF (technology) approach

- Emission factors:
- GB provides EF’s per sector, fuel type and engine year/EU emission stage

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## Tier 2: Fuel x EF (technology) approach

- Total fuel activity data: Same approach as for Tier 1
- Fuel split into Sector x fuel type x engine age: Use FC age share key (normalised ~ all inv. years)
- Further fuel split into emission level: Use FC age-emission level share per inventory year

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Tier 2: Fuel x EF (technology) approach

- Challenge: As for Tier 1, to obtain reliable NRMM fuel activity data for your country

- Problem for GB: Methodology needs to include years after 2010. An update is needed.

- This introduces the Stage IIIB and IV technologies (2011-2013 & 2014/2015 imp. years).
Tier 3: Equipment/technology specific approach

\[ E_{f,j,k} = N_{f,j,k} \cdot P_{f,j,k} \cdot LF \cdot HRS_{f,j,k} \cdot EF_{f,y,z} \]

- \( E \) = Emission/Fuel consumption
- \( N \) = No. of engines
- \( P \) = Engine Power
- \( HRS \) = Annual working hours
- \( LF \) = Load factor
- \( EF \) = Emission factor
- \( f \) = fuel type, \( j \) = engine size, \( k \) = engine year, \( y \) = size class, \( z \) = emission level
Tier 3: Stock and activity data

- Obtaining stock data is the most critical task - in view of the large amount of different non road machinery types
- Stock number (N) and engine size (P), some possible sources
  - National statistical bureaus
  - Trade organisations
  - Large machinery dealers
- Depending on equipment type, data can be available as total stock figures or as annual sales data

\[ E_{f,j,k} = N_{f,j,k} \cdot P_{f,j,k} \cdot LF \cdot HRS_{f,j,k} \cdot EF_{f,y,z} \]
Tier 3: Stock and activity data

- Building the stock/size matrix for each equipment type, include engine life time assumptions and further processing of the initial stock data

- Engine load factors (LF), annual working hours (HRS) and life time:
  - Trade organisations
  - Sectoral research (previous research studies)
  - Other key experts

\[ E_{f,j,k} = N_{f,j,k} \cdot P_{f,j,k} \cdot LF \cdot HRS_{f,j,k} \cdot EF_{f,y,z} \]
Tier 3: Emission factors

– Problems in GB:

– Due to lack of resources, the Tier 3 method was not updated during the GB revision in 2008.

– This gives a lack of consistency with results obtained using the Tier 1 and Tier 2 methods, which were updated at that time.
Tier 3: Emission factors - diesel

– Diesel machinery:

– Emission factors – which are largely based on EU directive legislation limits - needs to be updated with real measurements

– Measured EF’s – those behind Tier 1-2 aggregates - exist for 3 pre EU and Stage I-II emission classes.
Tier 3: Emission factors - diesel

– Diesel machinery cont.:

– Stage III EF’s in the present Tier 3 must be replaced by today’s Stage IIIA and Stage IIIB EF’s

– Stage IV (2014-2015) EF’s needs to be added
Gasoline machinery

Currently only uncontrolled EF’s are available in GB. However, EF’s needs to reflect today’s EU emission stages.

Measured EF’s – those behind Tier 1-2 aggregates - exist for 3 pre EU and the EU Stage I-II emission classes
Comparison: Tier 1 vs. Tier 2 results for Denmark

- 2006 is baseline year for Tier 1 aggregated EF’s
- Tier 1 is fuel proportional and do not capture technology turn over. The Tier 1 inaccuracy gets bigger and bigger after 2006
Conclusions

- The challenge for Tier 1 and 2 is to obtain reliable non road inventory fuel data

- For Tier 3, obtaining equipment and size specific stock data is the most critical task
Conclusions

- GB Tier 2 data needs to be updated with years after 2010 (EF’s and fuel split information)

- For Tier 3, EF’s need to be updated with measured values, and new technologies added
Thank you for your attention!