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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

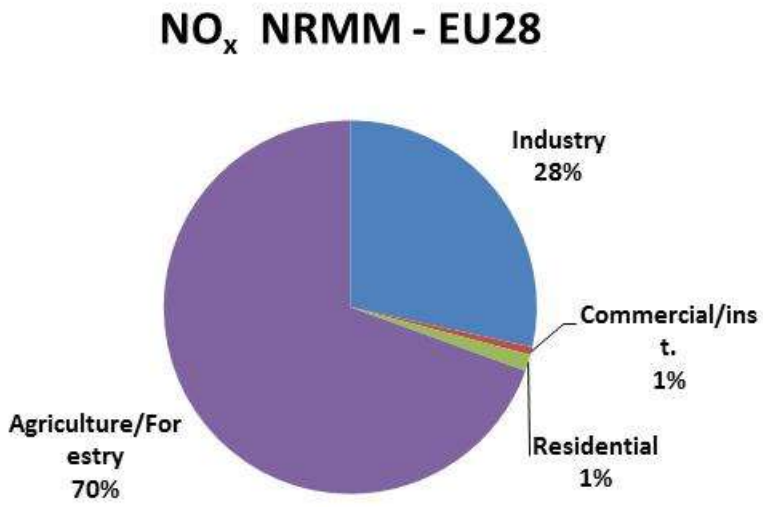
Introduction

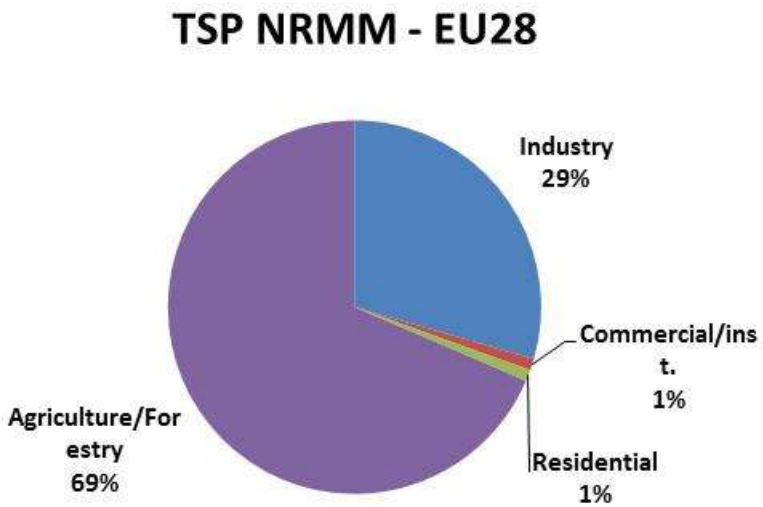
- Commercial/institutional & residential NRMM (1.A.4.a & b.ii)
  - Small gasoline gardening equipment
  - Types like: Lawn movers, riders, cultivators, chain saws, shrub clearers/trimmers, hedge cutters

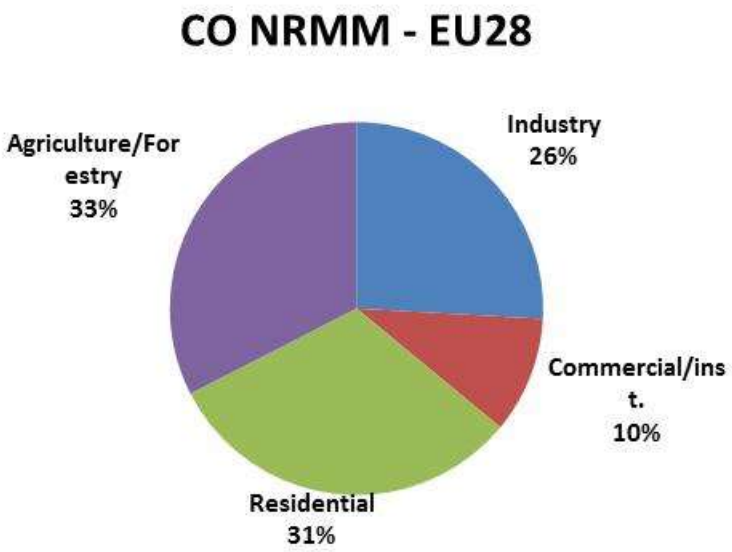
Introduction

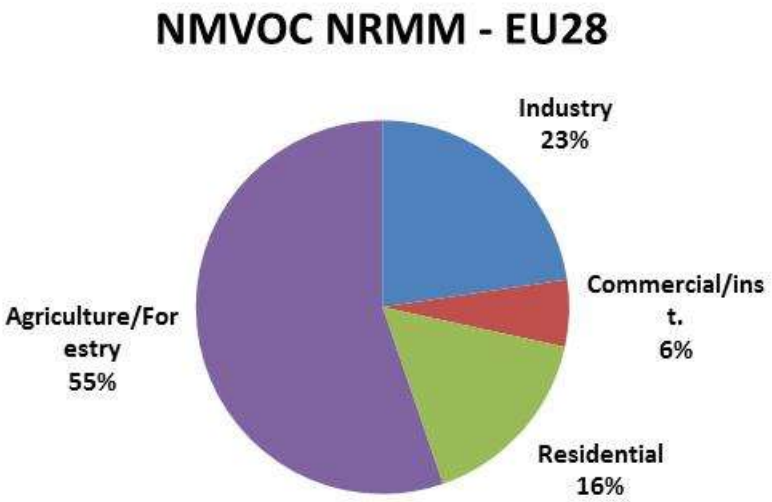
- Agriculture/forestry NRMM (1.A.4.c.ii)
  - Agricultural tractors, harvesters, ATV's
  - Forest tractors/cultivators, tree processors, haulers
  - Small types: e.g. Chippers, chain saws

Introduction – NRMM emission distribution – EU28









NRMM shares of EU 28 totals: NOx: 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 x 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

Tier 2 Emission Factors									
				Technology					
Fuel	NFR Sector	Pollutant	Units	<1981	1981-1990	1991-Stage I	Stage I	Stage II	Stage IIIA
Diesel	1A4cii: Agriculture	CH4	g/tonnes fuel	116	96	67	25	19	13
		CO	g/tonnes fuel	17995	16103	13080	6035	5956	5964
		CO2	kg/tonnes fuel	3160	3160	3160	3160	3160	3160
		N2O	g/tonnes fuel	122	129	137	137	138	139
		NH3	g/tonnes fuel	7	7	8	8	8	8
		NMVOC	g/tonnes fuel	7111	5917	4113	1561	1170	786
		NOx	g/tonnes fuel	29900	37351	48674	30999	20610	13594
		PM10	g/tonnes fuel	5137	3755	1644	832	627	581
		PM2.5	g/tonnes fuel	5137	3755	1644	832	627	581
		TSP	g/tonnes fuel	5137	3755	1644	832	627	581

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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Engine age	1A4cii Agriculture
0	8.00
1	7.60
2	7.20
3	6.79
4	6.39
5	5.99
6	5.59
7	5.18
8	4.78
9	4.38
10	3.98
11	3.57
12	3.17
Etc.	Etc.
	100.00

⇓

Age	Emission Level	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0	1981-1990	0	0	0	0	0	0	0	0	0	0	0	0
0	1991-Stage I	99	99	80	0	0	0	0	0	0	0	0	0
0	Stage I	1	1	20	64	8	0	0	0	0	0	0	0
0	Stage II	0	0	0	36	92	100	100	48	8	0	0	0
0	Stage IIIA	0	0	0	0	0	0	0	52	92	100	100	100
1	<1981	0	0	0	0	0	0	0	0	0	0	0	0
1	1981-1990	0	0	0	0	0	0	0	0	0	0	0	0
1	1991-Stage I	100	99	99	80	0	0	0	0	0	0	0	0
1	Stage I	0	1	1	20	64	8	0	0	0	0	0	0
1	Stage II	0	0	0	0	36	92	100	100	49	8	0	0
1	Stage IIIA	0	0	0	0	0	0	0	0	51	92	100	100
Etc.	Etc												

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 resourses, 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.

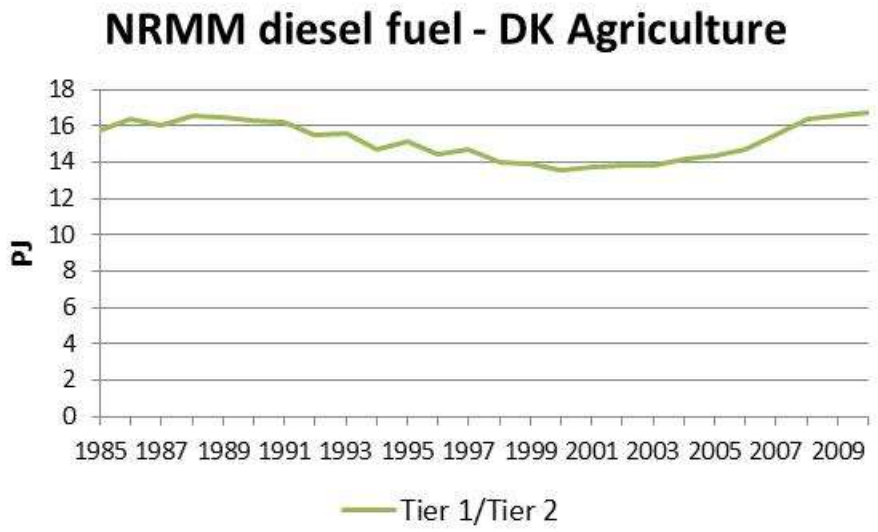
Tier 3: Emission factors - diesel

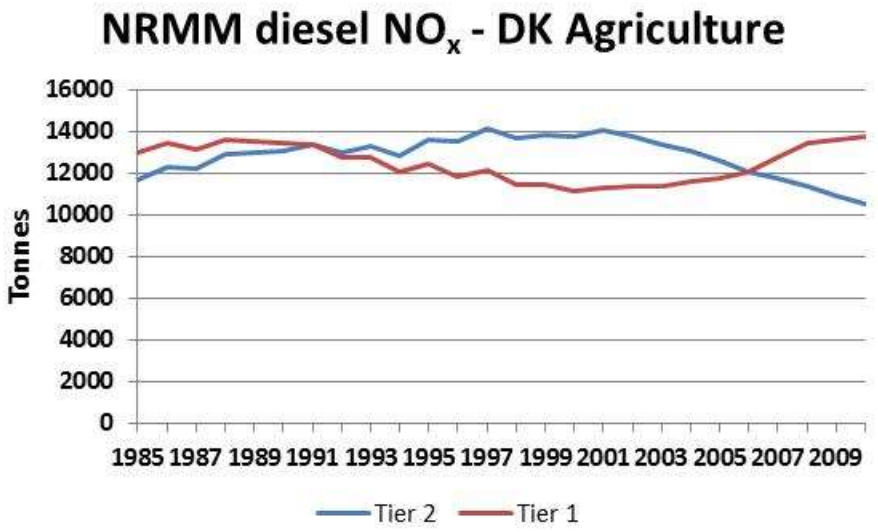
- Diesel machinery cont.:
- Stage III EF's in the present Tier 3 must be replaced by today's Stage IIIA and Stage IIIB EF's
- Stage IV (2014-2015) EF's needs to be added

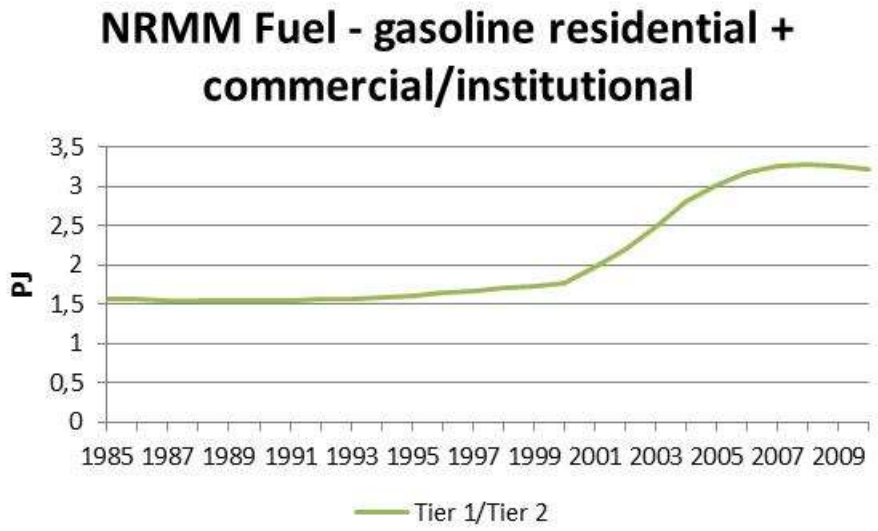
Tier 3: Emission factors - gasoline

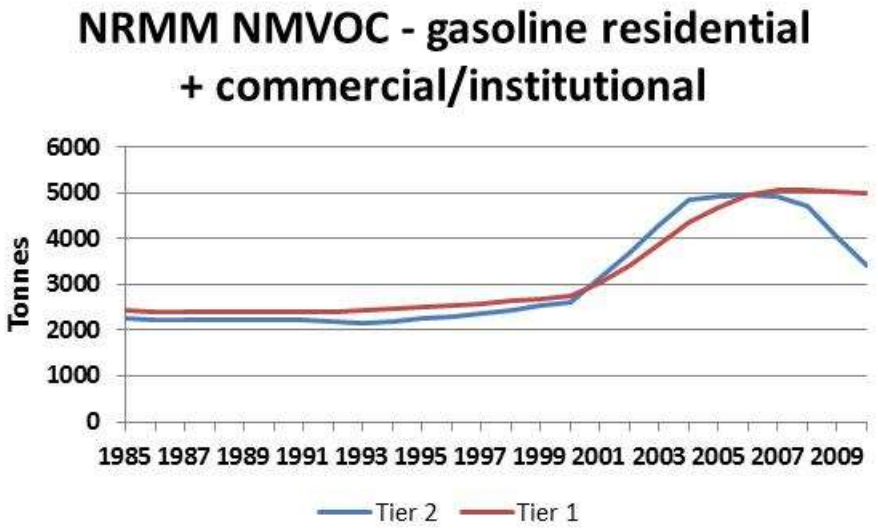
- Gasoline machinery
- Currently only uncontrolled EF's are available in GB. However, EF's needs to reflect today's EU emission stages.
- Measured EF's – those behind Tier 1-2 aggregates - exist for 3 pre EU and the EU Stage I-II emission classes

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!