Air Quality Governance in the ENPI East Countries

RPP3 – Training workshop

Stationary combustion and industry

14-16 July, 2014, Chișinău, Moldova

MWH CENN FORCE TECHNOLOGY GOPA WORLDWIDE CONSULTANTS NERI AARHUS UNIVERSITY

Outline

- Scope of the model
- Stationary combustion and industry
  - Point sources
  - Area sources
- Input data
  - Large point sources
  - Area sources
- Calorific values
- Emission factors
- Emission output

Scope of the model

- Pollutants:
  - NO_x, SO_x, NMVOC, CO and PM (TSP, PM_{10} and $PM_{2.5}$)
- Sectors:
  - Public electricity and heat production, refineries, large industrial plants → point sources
  - Residential plants, small combustion in manufacturing industry, commercial and institutional plants → area sources
- Geographical coverage:
  - The cities as chosen by the participating countries

Emission calculation

$$E = AR \times EF \times (1 - \eta_{abatement})$$

E = Emission

AR = Activity Rate (fuel consumption, produced amount)

EF = Emission factor

$\eta_{abatement}$ = abatement efficiency

Calculation may be used for verification of measured emission

Large point sources (LPS)

- LPS is generally defined as e.g. power plants with a thermal capacity > 300 MW
- For a city inventory LPS should include all large plants within the defined boundaries of the city area
- Important to identify all plants with significant emissions in order to achieve the most accurate emission inventory and hence the most accurate air quality modelling

Stationary combustion plants

- Stationary combustion plants are a key category for emissions of NO_x and SO_x and can also be an important source of particulate emissions
- Key elements to assess the emission level are the fuel type(s) used and if there is abatement equipment installed
- Important elements for the air quality modelling are the location of the plant and the stack height

Industrial plants

- Many industrial plants can have significant emissions
- The emissions can both stem from fuel combustion and from the industrial process
- The plants can be divided into five main categories:
  - Mineral industry
  - Petrochemical industry
  - Chemical industry
  - Metal industry
  - Other industry

Mineral industry

- Cement production
  - Large emission source of most air pollutants
  - Emissions related to both fuel consumption, raw material handling and the calcination process
- Lime production
  - Emissions related to both fuel consumption, raw material handling and the calcination process
- Glass production
  - Process emissions mostly limited to PM and heavy metals
- Ceramics, bricks and tiles
  - Potential large emissions of SO_x related to the process (raw material)

Petrochemical industry

- Emissions from refineries cover a range of sources
  - Fuel combustion
  - Fugitive emissions from refining and storage of crude oil
  - Flaring
- Large source of emissions for especially SO_x and NO_x (fuel combustion) and NMVOC (fugitive emissions)

Chemical industry

- A large numbers of plants could in addition to fuel combustion emissions have process related emissions, these include:
  - Ammonia production
  - Nitric acid production
  - Adipic acid production
  - Sulphuric acid production
  - Fertiliser production
  - Carbon black production
  - Production of organic chemicals (ethylene, PVC, PE, etc.)
- Potentially large sources of SO_x, NO_x and NMVOC

Metal industry

- Iron and steel production
  - Pig iron production
  - Steel production
  - Sinter production
  - Coke production
- Aluminium production
- Other metal production (Copper, nickel, lead, zinc, etc.)
- Potential large emissions both fuel and process related

Other industry

- This can comprise many different industries most of which will have limited process emissions but where the fuel combustion emissions can be significant
- These plants include:
  - Pulp and paper production
  - Food and beverage production
  - Textile and leather
  - Wood and wood processing
- There can be process emissions of especially PM and NMVOC (food and drink)

Area sources

- Even though the largest fuel flow takes place in LPS there is still potentially significant fuel consumption in small combustion installations
- Combined with the high emission factors this means potential significant contribution to total emissions
- Also the low stack height will mean a higher contribution to urban air quality
- Important to assess the magnitude of the fuel consumption taking place in small combustion installations

Area sources

- Small combustion installations occur in multiple sectors:
  - Manufacturing industries (excluding LPS)
  - Commercial plants, e.g. wholesale and retail companies
  - Institutional plants, e.g. hospitals, schools, public buildings
  - Residential plants
- Especially, if there is a high share of residential plants using solid fuels or biomass, the emissions can be dominating for NMVOC and PM

Input data LPS

- In order to have an accurate estimate of the emission, it is necessary to gather some basic information
  - Sector, e.g. power plant, refinery
  - Technology, e.g. boiler, turbine, engine
  - Abatement, e.g. wet scrubber, DeNO$_x$, filterbag
  - Fuel consumption data divided by fuel types
  - Geographical information on the location of the plant
  - Stack height
  - Measured emission data, if available

Input data LPS

- Emission data (NO_x, SO_x, PM), if available
- Fuel consumption data
  - Coal
  - Brown coal/lignite
  - Residual fuel oil
  - Gas oil
  - Natural gas
  - Wood
  - Waste
- More fuels are possible but did not occur during this project and is therefore not included in the model

Input data LPS

- The model can use both fuel consumption in energy units (GJ) and physical units (m^3 or tonnes)
- Information on sulphur content of the fuels
- Abatement type
  - Sulphur abatement
  - NO_x abatement
  - Particulate matter abatement
- Information on the abatement efficiency
- Information on abatement types and efficiencies can be used to adjust the default emission factors

Input data
Small combustion plants

- Difficult sector to collect activity data for but potentially important
- Need for fuel consumption data divided into:
  - Residential plants
  - Other small scale combustion plants
- Important to assess the technology distribution for residential plants, i.e. stoves/fireplaces vs. boilers, since the emission factors are very technology dependent

Input data
Small combustion plants

- Industrial/commercial plants:
  - Boiler (Coal, brown coal, residual oil, gas oil, natural gas, wood)
  - Turbine (Residual oil, gas oil, natural gas)
  - Engine (Residual oil, gas oil, natural gas)
- Residential plants:
  - Boiler (Coal, brown coal, gas oil, natural gas, wood)
  - Stove (Coal, brown coal, gas oil, natural gas, wood)
- Fuel consumption can be entered as energy or in physical units (m^3 or tonnes)

Calorific values

- If fuel consumption data are not available directly in energy units (GJ) the data have to be converted
- The model uses default net calorific values from the 2006 IPCC Guidelines and the Energy Statistics Manual from the International Energy Agency
- However, especially for solid fuels and biomass, the calorific values can vary significantly → better estimate is country-specific or city specific value is available

Emission factors

- The emission factors from the EMEP/EEA Guidebook is used as default values
- For LPS the emission factors refer to the Tier 2 emission factors for energy industries
- For area sources the emission factors refer to Tier 1 and Tier 2 emission factors for small combustion
- If measured emission data are not available the fuel consumption data will be combined with emission factors

Emission factors

- Emission factors can vary a lot depending on technology, e.g. for natural gas combusted in power or CHP production

Technology	NO_x	SO_2	NMVOC	CO	TSP	Reference - EMEP/EEA Guidebook 2013
Boiler	89	0.281	2.6	39	0.89	Dry bottom boiler
Gas turbine	48	0.281	1.6	4.8	0.2	Gas turbines
Engine	135	0,5	89	56	2	Reciprocating engines

- If national emission factors are available they can replace the default emission factors in the model

Emission output

- An emission output sheet is generated for both the LPS and area sources based on the input data provided combined with the emission factors
- For LPS the output contains for each LPS:
  - The estimated emissions of NO_x, SO_x, NMVOC, CO and PM (TSP, PM_{10} and $PM_{2.5}$)
  - The sector code (SNAP) used in the spatial distribution and the air quality modelling
  - The geographical coordinates
  - The stack height

Emission output

- For area sources the output is divided in two parts covering industrial/commercial plants and residential plants respectively. For both sectors the output contains:
  - The estimated emissions of NO_x, SO_x, NMVOC, CO and PM (TSP, PM_{10} and $PM_{2.5}$)
  - The sector code (SNAP) used in the spatial distribution and the air quality modelling

Thank you for your attention