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Emissions biomass use in stationary applications

Highlights BOLK Phase 2

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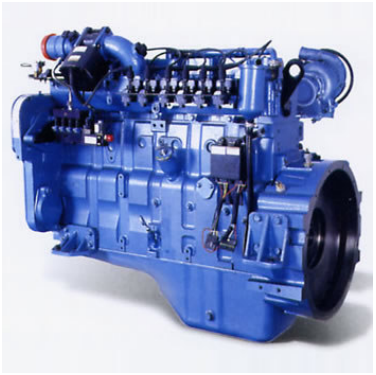

Objectives

•Provide:

- Estimations on populations/activities of biomass use in stationary applications and medium-scale fossil-fired installations (now and 2020) in the Netherlands
- Estimations NEC emission factors biofuel production, medium-scale fossil/biomass fired installations, small-scale wood stoves and biomass transshipment/storage activities in the Netherlands
- Estimation of costs/performance of flue gas cleaning for medium- and small-scale biomass installations
- Estimation of total NEC emissions of the combustion of biomass in stationary applications in the Netherlands

All as input for the BOLK integration phase to reduce bandwidths/ uncertainties

Approach

- Literature search (literature, internet, permits)
- Limited contacts with relevant companies/authorities
- No extensive market consulation/modelling/ statistical research
- ‘What-if’ scenario’s used for estimation future populations

Results

- A large amount of data has been gathered/generated in this study: reference is made to the report for all results. Only a small fraction is presented here.

Results populations

- Based on ‘What-if’ scenarios

PJ/a	2007 (CBS)	Updated Reference Projections 2020	Scenario Low 2020	Scenario High 2020
Co-firing gas/coal fired power plants	15	0	89	89
Waste incineration (only biogenic part)	28	48	41	41
Small-scale biomass combustion/stoves	12	8	8	16
Medium-scale biomass combustion	7	11	49	51
Large-scale biomass combusiton	0	0	0	0
Biogas engines from waste tips	*2*	*0*		
Biogas enginess from AWZI/RWZI	*2*	*8*		
Agricultural biogas plants	*2*	*2*		
Other biogas plants	*1.5*	*2*		
Total anaerobic digestion	7	13	37	50
Bio-oil/fat-fired engines	0.5	0	6	6
Cement industry	-	0	0	0
Total	**71**	**80**	**224**	**252**

Results emission factors

- Medium-scale biomassa and natural gas fired installations (< 50 MW_{th}):
  - Introduction of BEMS in 2010 will have nivillating and reducing effect on emissions of NO_x, SO_x and dust
  - Estimates based on available literature, own estimations, legislation
  - Higher emission factors found for biomass compared to (clean) gas fired installations
  - NH_3 emissions originate from De-NOX (ammonia slib). If NO_x is lowered by De-Nox, NH_3 is expected to rise

Results emission factors

	Nox		Sox		dust		NMVOC		NH3	
	Now	2020	Now	2020	Now	2020	Now	2020	Now	2020
Medium-scale biomass										
Solid biomass-fired boilers	x	x	x	x	x	x	x	x	x	x
Biogas-fired gas engines	x	x	x	x	x	x	x	x	x	x
Bio-oil fired dieselengines	x	x	x	x	x	x	x	x	x	x
Woodstoves (small scale biomass)	x	x	x	x	x	x	x	x	x	x
Medium-scale fossil-fired CHP										
NG gas engine	x	x	x	x	x	x	x	x	x	x
NG gas turbine	x	x	x	x	x	x	x	x	x	x
NG gas boiler	x	x	x	x	x	x	x	x	x	x
Biomass transshipment and storage					x					
Biofuel production										
Biodiesel	x		x		x		x		x	
Bioethanol	x		x		x		x		x	
Fischer-Tropsch	x		x		x		x		x	
Biomethanol	x		x		x		x		x	

= To much to discuss in detail here . . .

Results emission factors 2020

Category/NEC component	NO_x		SO_x		NH_3		Dust		NMVOC	
	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2
Co-firing	40	40	11	11	5	5	0.9	0.9	0	**2**[a)]
Waste Incineration (only biogenic)	35	35	1.3	1.3	1.3	1.3	0.5	0.5	1.3	1.3
Small-scale biomass combustion/stoves	150	**130**	30	**13**	9.0	**0**	108	**136/ 137**[b)]	43	**588/ 620**[b)]
Medium-scale biomass combustion	1020	**40**	0	**10**	0	**1.7**	29	**1.7**	4	**60**
Large-scale biomass combustion	1020	**n.d.**	0	**n.d.**	-	**n.d.**	29	**n.d.**	4	**n.d.**
Biogas from waste tips	250	**30**	27	**2**	0.0	**0.15**	1.2	**0.5**	0	**14**
Biogas from AWZI/RWZI	35	**30**	2	**2**	2.5	**0.15**	1.4	**0.5**	0	**14**
Agricultural biogas plants	250	**30**	108	**2**	5.0	**0.15**	10	**0.5**	0	**14**
Other biogas plants	**-**	**30**	-	**2**	**-**	**0.15**	**-**	**0.5**	**-**	**14**
Bio-oil/fat-fired engines	1020	**130**	0	**9**	0	**4.4**	29	**17**	4	**31**

- Woodstoves: CBS/Emission Registration are updating their data in 2010

Results emission factors

- Biomass transshipment and storage:
  - NeR dusting classes. Wettable/non wettable.
  - Wood pellets have often closed transportation systems.
  - Estimated emission 2020 around 0.02 tonne/a (@20 Mtonne/a)= 2% of total emissions of bulk activitities in 2008
- Biofuel (bio-EtOH, bio-MeOH, FT, bio-diesel) production process emissions:
  - Are estimated from permits
  - Are very location specific: depends on feedstock, process layout, integration with other plants. Number of plants is currently very limited.
  - NO_x and SO_x emissions arise from CHP:
    - SO_x: 0.2-1.9 g/GJ fuel
    - NO_x: 0.5-2.3 g/GJ fuel
  - NMVOC: 0.3-1.4 g/GJ fuel
  - Dust emissions are neglible, no NH_3 limits mentioned and expected negliable
  - No data found available on Fischer Tropsch fuels

Results costs and performance

- Flue gas cleaning medium-scale biomass installations:
  - For all NEC pollutants cleaning measures are available
  - Very wide cost ranges are found = function (fuel type and composition, combustion process, combustion conditions, type of reduction technology, size/throughput, pollutant inlet/outlet concentration, retrofit or green field, time of purchase/ordering, supplier, etc.) and often made to measure. Costs can therefore be very case specific.
- Flue gas cleaning for woodstoves:
  - Cost effectiveness replacing unapproved by approved stoves: 30-50 Euro/ton dust
  - Cost effectiveness using ESP: >210 Euro/ton

Results impact analysis biomass stationary applications 2020

Scenario		Biomass use	NO_x	SO_x	NH_3	Dust	NMVOC
		[PJ/a]	[kton/a]	[kton/a]	[kton/a]	[kton/a]	[kton/a]
Estimated emission level for 2007		*71*	*5.3*	*0.5*	*0.1*	*2.2*	*10*
BOLK Phase 1	Reference Projections 2007	215	18	1.7	0.7	1.2	0.5
BOLK Phase 2	Updated Reference Projections 2009	80	3.5	0.3	0.1	1.2	6
	Scenario 'Low'	224	10	1.8	0.6	1.4	9
	Scenario 'High'	252	11	1.9	0.6	2.5	13

- The degree of co-firing can significant impact on NO_x and SO_x emissions
- NO_x emissions are significantly lower due to lower estimate EF medium-scale installations
- NMVOC is higher due to significant higher estimate EF medium- and small-scale installations
- Small-scale installations contribute more than proportional for the components NMVOC and dust
- Substitution effect (coal, oil, gas) should be taken into consideration for 'net' effect!

Conclusions

- General observations:
  - Basic statistical data correlating relevant data (NEC emissions coupled with type of installation, size, fuel (composition), flue gas cleaning measures, efficiency) with the population is lacking (no detailed, correlated available data CBS/Emission Registration)
  - Actual emission factors can be very site specific ⇒ often a bandwidth can be expected.
  - Future populations are very uncertain as they are 1) often (currently) not economic feasible and therefore realisation is strongly dependent of subsidies/obligations 2) strongly dependent on future technological and market developments

  - **Results of this study should be used with care due to the high uncertainties, but can give a first indication of expected effects**

Recommendations

- Still large uncertainties present (although they are reduced…)
- However… further improvement of (current) emission data will require substantial effort to obtain (and maintain!) them. Some suggestions:
  - Improve population characteristics and emission data and coupling thereof
  - Improve the data on NMVOC by measuring at specific representative installations
  - Improve the data on biofuel production by extending the studied permits and/or obtain actual emission data
  - Improve the data on gas cleaning costs by performing an extensive survey
  - Improve the data on biomass transshipment and storage (measurements)
- Detailed information on fossil fuel substitution is required to assess the net effect of biomass use.

Any questions?

Results

Type of installation	Period	NO_x [g/GJ]	SO_x [g/GJ]	Dust/ PM10 [g/GJ]	PM2.5 estimate [fraction of PM 10]	NMVOC [g/GJ]	NH_3 [g/GJ]
Solid biomass boiler	2008/2009	67 [a)] 100[k)] max 70-130 [d)]	10 (range 6-40) [g)] 5[j)] 0-2 (installation Cuijk)[j)]	5 [a)]	0.79 [f)]	3.3-48 [g)] 60 [g)] 100 [i)] (for Belgium, GAINS data)	-without deNOx: 0 -with deNOx: 1,7 g/GJ [d)] (Installation Cuijk)
	2020	max **35** [b)] or 40 [k)]	**10** (range 6-40) [a)] max 68 [b)]	max **1,7** [b)]	0.79 [f)]	**60**, assumed to be the same as in 2009	**1,7** (SCR assumtion)
Bio-oil/fat in dieselengine	2008/2009	30-150[n)] max 130[e)] max 400-1200 (diesel)[d)]	0[a)], 1-22 [n)] max 9 [e)]	25[a)] 2-4[n)] max 13-17 [e)]	N/A	100 [h)] 31 (CxHy) [e)]	max 4.4 [e)]
	2020	max **130** [b)]	**9** [e)] max 69-70 [c)]	max **17** [c)]	N/A	**31**, assumed to be the same as in 2009, worst case	max **4.4** [c)], SCR assumption
Biogas in gas engines	2008/2009	max 140 (new)-800 (old)[a)] 175-195[p)]	0,5[a)] 2 [l)] 10 [m)]	0,5[a)] 2 [l)]	*1 (estimate based on natural gas) [f)]	4-14 [g)] 14 [j)]	-without De-NOx: 0 -with SCR 0.10-0.15 g/GJ (natural gas) [o)]
	2020	max. **30** (intention VROM for three years after introduction BEMS, until then: 100 [c]	**2** [l)] max approx 70 [b)] .	No limit, **0.5** assumed	*1 (estimate based on natural gas) [f)]	**14**, assumed to be the same as in 2009	All SCR assumed: **0.15**

References: a) Daniels, 2008; b) VROM, 2008; c) VROM, 2009; d) Kroon, 2008; e) BIOX, 2007; f) Visschedijk, 2007; g) EMEP, 2009; h) NERI, 2007; i) De Groot, 2008; j) De Wilde, 2006; k) Kroon, 2009a; l) Guis, 2006; m) Gijssen, 2001; n) Toom, 2009; o) Olthuis, 2007; p) Engelen

Results

Type of installation	Period	NO_x [g/GJ]	SO_x [g/GJ]	Dust/PM10 [g/GJ]	PM2.5 estimate [fraction of PM 10]	NMVOC [g/GJ]	NH_3 [g/GJ]
Gas engine	2008/2009	Average 16 (greenhouses, with SCR on)[k)] 166-333 (greenhouses with SCR off)[k)] 174 greenhouses [e)] 200 other [e)]	0.22 [a)]	0.15 [a)] 0.19 [g)]	*1 [e)]	117 [b)] (no oxycat) +/- 0 (with oxycat) 46 (incl 5% gas oil) [c)]	approx. 0.10-15 with SCR[j)] 0 without SCR [j)] Average: 0.05-0.07
	2020	>2,5 MW_{th}: max 30 [f)] <2,5 MW_{th}: max 30 (intention VROM after three years, until then: 80. [f)]	0.22 [a)] max 67 [f)]	No limit, 0.15 assumed	*1 [e)]	117 (no oxycat > worst case)	0.15 assuming SCR
Gas turbine	2008/2009	58 [h)]	0.22 [a)]	0.15 [a)]	*1 [e)]	1.4 [b)]	0 (assumed no SCR needed)
	2020	max 40 [f)]	max 67 [f)] 0.22 [a)]	No limit, 0.15 assumed	*1 [e)]	1.4, assumed to be the same as in 2009	0 (assumed no SCR needed)
Gas fired boiler	2009	40 [h)]	0.22 [a)]	0.15 [a)]	*1 [e)]	1-4 [b)] 1-3 [c)]	0 (assumed no SCR needed)
	2020	max 20 [f)]	max 67 [f)] 0.22 [a)]	No limit, 0,15 assumed [a)]	*1 [e)]	4, assumed to be the same as in 2009	0 (assumed no SCR needed)