



DEPARTMENT OF ENVIRONMENTAL SCIENCE

AARHUS UNIVERSITY

Improved Nordic emission inventories of short-lived climate pollutants

Workshop on Improving Black Carbon Emissions Estimates and Abatement

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Ole-Kenneth Nielsen
Department of Environmental Science
Danish Centre for Environment and Energy
Aarhus University



Outline

- › **The Nordic project**
- › **The measurement programme**
 - › **Appliances**
 - › **Pollutants**
 - › **Fuel types**
 - › **Other variables**



The Nordic project

- › **Focus on Black Carbon**
- › **2013-2014: Background analysis and identification of knowledge gaps, design of measurement program**
- › **2014-2015: Emission measurements, development of emission factors, inventory methodology**
- › **2015: Identify relevant actions/measures for reduced emissions of SLCP in the Nordic countries**
- › **Provide support to the Arctic Council "Task Force for action on Black Carbon and Methane(TFBCM)"**
- › **Coordinate/cooperate with other relevant international activities, e.g. emission inventory work within TFEIP**



The Nordic project

- > **First stage: Background analysis:**
 - > Sources of SLCP in the Nordic countries, identification of knowledge gaps
 - > Available emission inventories
 - > Available emission measurements
 - > Emission factors
 - > Methods for estimating emissions of PM_{2.5} and BC
 - > International shipping emissions of SLCP in the Nordic countries
 - > The background analysis provided the basis for designing the measurement program
 - > **Report available at <http://dx.doi.org/10.6027/TN2015-523>**
- > **Second stage: Designing the measurement programme**
 - > Balancing the wishes of experts with the budget available!



The measurement programme

- › **Tendering process ended April 30th – a pre-study was made to explore possibilities**
- › **The measurement program will be divided into three parts**
 - › **Exploratory tests for quality assurance**
 - › **Basic test programme**
 - › **Extended test programme**



The measurement programme

- › **The aim of the exploratory measurements is to**
 - › produce samples which can be analyzed
 - › provide some insight of the repeatability of the results
 - › evaluate if it is possible to simplify the sampling in terms of number of filter holders
 - › safeguard that the sampling of filter material for analysis is relevant
- › **These measurements will be carried out on two types of appliances, i.e. a manually fired log-wood boiler and a manually fired room heater**
- › **Provided it has been possible to analyze all filters, the same nozzle sizes, suction rates and measurement periods will be used going forward**

Types of heating devices - boilers

Notation	Type of boiler	Priority
P1	Log wood boiler with inverse combustion and λ -probe	1
P2	Log wood boiler I with inverse combustion and flue gas fan *	1
P3	Log wood boiler II with inverse combustion and flue gas fan*	2
P4	Log wood boiler with inverse combustion and natural draught	1
P5	Log wood boiler, "simple" boiler	1
P6	Old combination boiler (oil + wood)	2
P7	Traditional pellet burner in an oil or combination boiler	1
P8	Advanced pellet burner in boiler designed for pellet firing	2
P9	Pellet boiler with integrated grate burner	1
P10	Wood chip boiler	2

* Boiler I and boiler II are two different products from either the same manufacturer or from two different manufacturers.

- **Priority 1 covers the basic test programme, while priority 2 is part of the extended test programme, i.e. 6 different boilers will be included in the basic programme**

Types of heating devices - stoves

Notation	Type of appliance	Priority
A1	Traditional simple stove, (“building market product”)	1
A2	Average modern room heater	1
A3	State-of-the-art room heater	1
A4	Cast iron stove	1
A5	“Brick stove”	2
A6	Slow heat release appliance (tiled stove or soap stone stove)	1
A7	Pellet stove, Swedish type	1
A8	Pellet stove, continental type	2
A9	Sauna stove	1

- › **7 different stoves will be part of the basic test programme**
- › **All appliances will be documented in detail in the reporting of the measurement results**

The measurement programme

- > **Pollutants measured will cover: PM_{2.5}, BC, EC/OC, NMVOC, CH₄, CO**
- > **Sampling will take part both at full load and part load, i.e.:**

Boiler type	Boilers no	Test at nominal heat load	Test at 30 % part load
Log wood boiler for accumulator operation	P1, P2, P3, P4	Yes	No
Log wood boiler not necessarily for accumulator operation	P5, P6	Yes	Yes
Pellet boiler	P7, P8, P9	Yes	Yes
Wood chip boiler	P10	Yes	Yes

Appliance type	Appliance no	Test at nominal heat load	Test at part load	Test at high load	Test acc. to NS 3058
Log-wood non-accumulating Appliance	A1, A2	Yes	Yes	Yes	Yes
Log-wood non-accumulating Appliance	A3, A4, A5	Yes	Yes	No	No
Slow heat release appliance	A6	Yes	No	No	No
Pellet stove	A7, A8	Yes	Yes	-	-
Sauna stove	A9	Yes	No	No	No

The measurement programme

- › A range of test fuels will be used, albeit not all fuels will be tested for all appliances

Fuel type	Water content, %	Ash content, %	Net calorific value, dry basis, MJ/kg
Standard log wood (SLW)	16 - 20	$\leq 1,0$	>17
Moist log wood (MLW)	25 - 30	$\leq 1,0$	>17
Dry log wood (DLW)	10-14	$\leq 1,0$	>17
Wood pellets (WP)	≤ 12	$\leq 0,5$	>17
Standard wood chips (SWC)	20 - 30	$\leq 1,5$	>17
Moist wood chips (MWC)	40 - 50	$\leq 1,5$	>17

- › Batch size and ignition method (top-down vs. bottom-up) will also be investigated as part of the test programme
- › Fortunately, all suggested measurements (both basic and extended) in the tender offer could be carried out within the allocated budget 😊



Thank you for your attention

For the next TFEIP meeting the results can be presented

Project group

Karin Kindbom, Erik Fridell, Tina Skårman, IVL, Sweden

Ole-Kenneth Nielsen, Morten Winther, AU, Denmark

Kristina Saarinen, SYKE, Maija Lappi, VTT, Heikki Lamberg, UEF, Finland

Páll Valdimar Kolka Jónsson, Umhverfisstofnun, Iceland

Kristin Aasestad, SSB, Norway