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Conclusions of the project and After-LIFE Plan

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The contents are purely those of the beneficiaries of the REAL-LIFE EMISSIONS project and may not in any circumstances be regarded as stating an official position of the EUROPEAN COMMISSION.

Who need, and what kind of measurement data about small-scale combustion is needed?

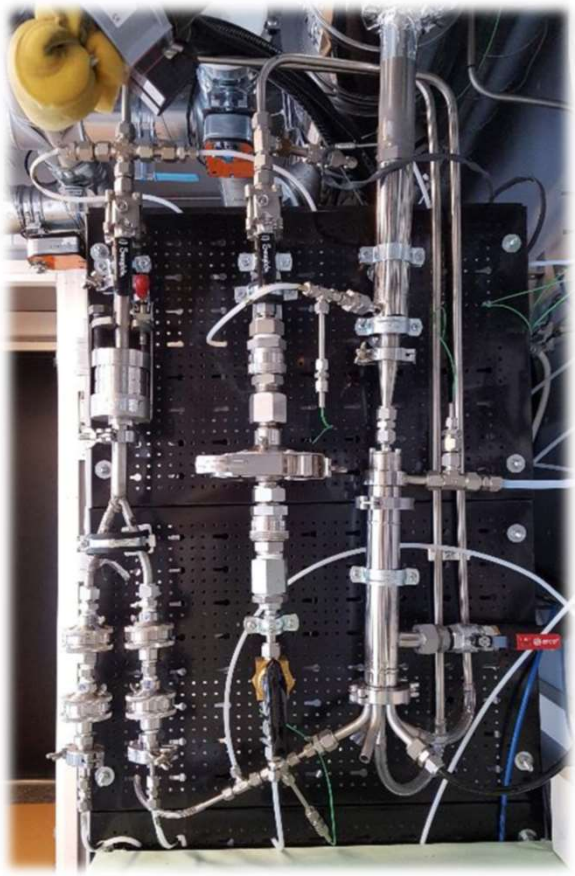
- **EU Legislation**
  - **NECD - The National Emission Ceilings Directive**
    - **National emission inventories:** Average emission factors of real-life combustion appliances, for scenarios also real life data from new appliances
      - several emission compounds such as PM, PAHs, BC …
  - **Ecodesign Regulation**
    - Ecodesign requirements are aimed at improving energy efficiency by integrating environmental issues and life-cycle thinking already in the product design phase.
    - PM, OGC, CO, NOx limits for the most common combustion appliance type in the EU
      - ”Best” possible values of emissions, new appliances, good operational practices
  - **CPR – Construction products regulation**
    - Safety of products (for stoves, including efficiency and emission measurements)
    - Only for appliance types with harmonized product standards (CEN)
    - Need: Comparable results – good operational practices – detailed standards for testing
  - **(+UNECE** Convention on Long-range Transboundary Air Pollution), EMEP database

Other needs

- **Manufacturers**
  - The most important is that regulations are met
  - **For product development**
    - Real-time particulate emissions during the whole combustion process.
    - How to decrease the real emissions…, **Real-time data**
- **Climate and health scientists** (modellers…)
  - Real and very specific emission factors of all kind of physicochemical parameters
- **Normal citizens**
  - Need knowledge about good operational practices
- …
- This project mainly concentrate to **Particulate Matter** - aim is to produce technical rekommendations to measure PM now and future
  - technically possible – during testing of new appliances (Ecodesign & CPR + supporting inventories)!

Main objective of the project

- To produce a plan on the development and execution of the testing procedures, which better reflects quality and quantity of the real-life emissions from solid fuel heating appliances, as well as the adverse effects to human health and environment.



- To support the work done in the working groups of e.g., CEN, Ecodesign and UNECE
- Fill in the gaps-of-knowledge
- Disseminate new and existing knowledge

Action A5:
Emission factors and limits

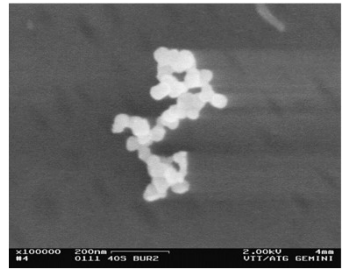
Action A2:
Emission components

Action A1:
Sampling and dilution methods

Action A3:
Testing protocols

Real-LIFE Emissions

Action A4:
Inter-comparison campaign



Actions B and C:

B1-Communication
B2-Networking
C1-Management
C2-Monitoring and indicators
C3-Sosioeconomic impacts
C4-After LIFE plan

Main conclusions A1-A5

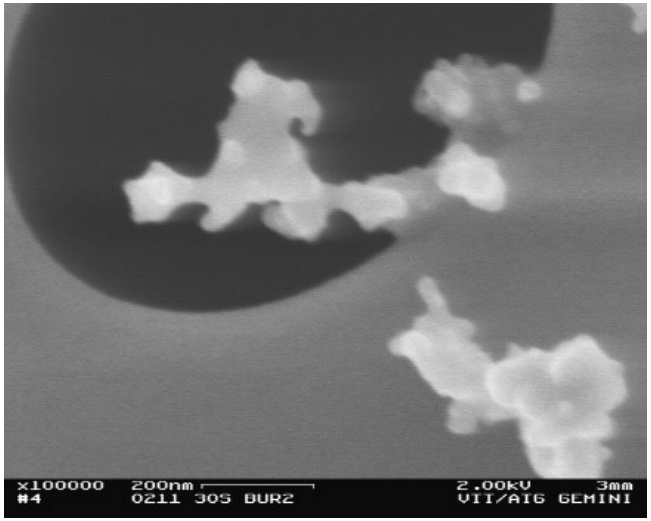
Action A1 - Sampling and dilution methods

- The outcome of this action is an evaluation of the methods, and suggestion for a long-term sampling and dilution methods.

Real-LIFE Emissions

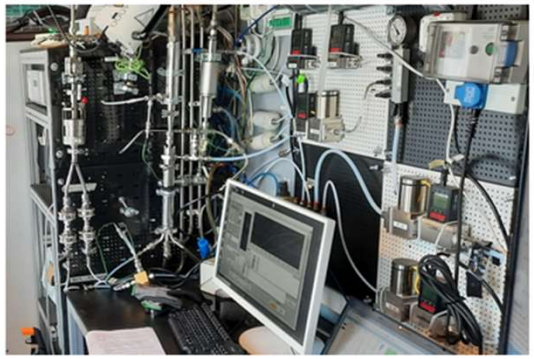
OVERVIEW OF PARTICULATE MATTER SAMPLING AND DILUTION METHODS FOR THE SMALL-SCALE SOLID FUEL COMBUSTION

Summary of Action A1 Report



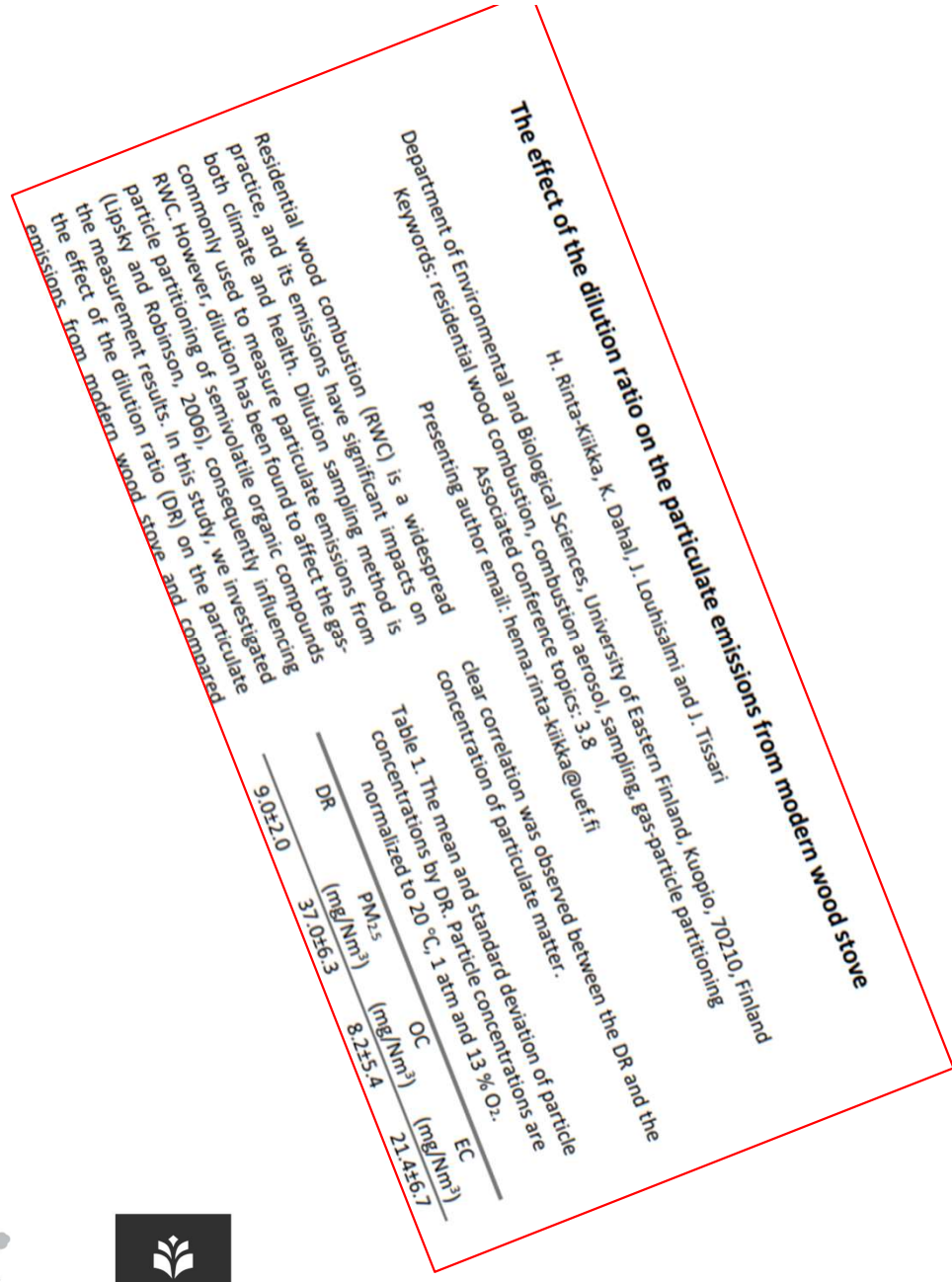
A1-conclusions (1)

- There are various sampling and dilution methods and dilutors, which are available to measure particulate emissions from RWC
  - some of these methods are established also as standards
  - all methods have own advantages and disadvantages
- **Four main methods is considered as the most useful methods.**
- Dilution is needed if organic matter is like to measure.



A1-conclusions (2)

- **Four options:**
  - 1) Porous tube diluter + the ejector and (PTD+ED) combination dilution system
    - with which all the most important chemical components and physical parameters of PM emissions can be measured.
  - 2) Dilution tunnel (DT) method which is used in many emission measurement standards at the moment – need extra dilution system, if more specific compounds need to be measure
  - 3) Dilution chamber (DC) method which can be more comfortable option than DT.
  - 4) Filter in hot flue gas and porous tube diluters
    - ENPME + PTD
      - Partial or total flow in PTD –different configuration possibilities.



The effect of the dilution ratio on the particulate emissions from modern wood stove

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Keywords: residential wood combustion, combustion aerosol, sampling, gas-particle partitioning

Residential wood combustion (RWC) is a widespread practice, and its emissions have significant impacts on both climate and health. Dilution sampling method is commonly used to measure particulate emissions from RWC. However, dilution has been found to affect the gas-particle partitioning of semivolatile organic compounds (Lipsky and Robinson, 2006), consequently influencing the measurement results. In this study, we investigated the effect of the dilution ratio (DR) on the particulate emissions from modern wood stove and compared clear correlation was observed between the DR and the concentration of particulate matter.

Table 1. The mean and standard deviation of particle concentrations by DR. Particle concentrations are normalized to 20 °C, 1 atm and 13 % O_2.

DR	$PM_{2.5}$ (mg/Nm³)	OC (mg/Nm³)	EC (mg/Nm³)
9.0±2.0	37.0±6.3	8.2±5.4	21.4±6.7

A1-conclusions

- Short term option
  - ENPME + PTD
    - Partial or total flow in PTD –different configuration possibilities.
- Long term option
  - Porous tube diluter +the ejector and (PTD+ED) combination dilution system

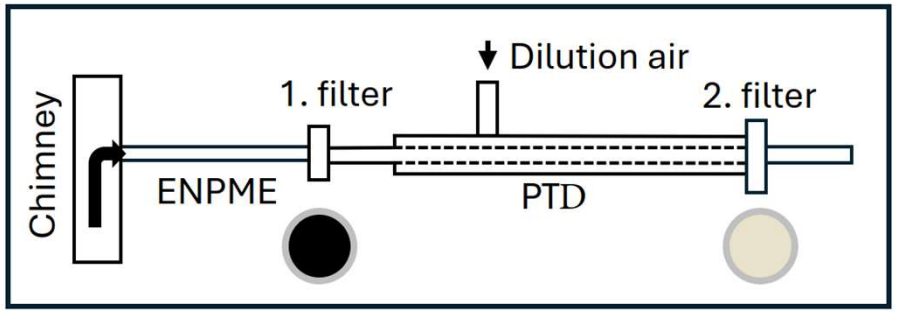
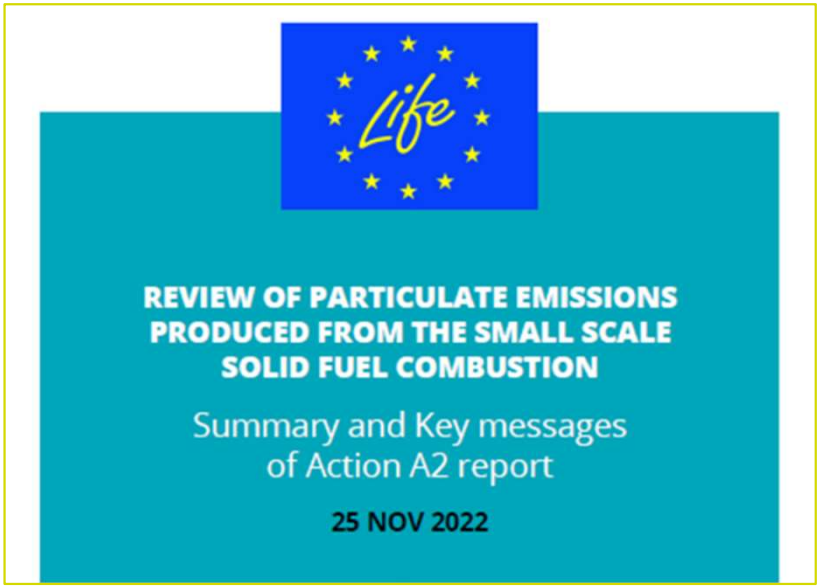


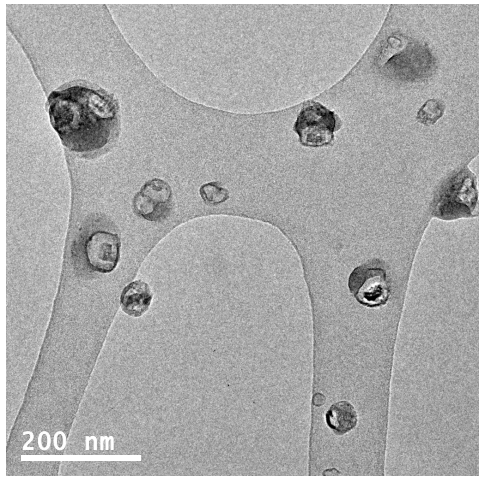
Figure 1. Extended ENPME method consists of an ENPME sond and a porous tube diluter (PTD). Solid and condensed particles are collected on successive filters.

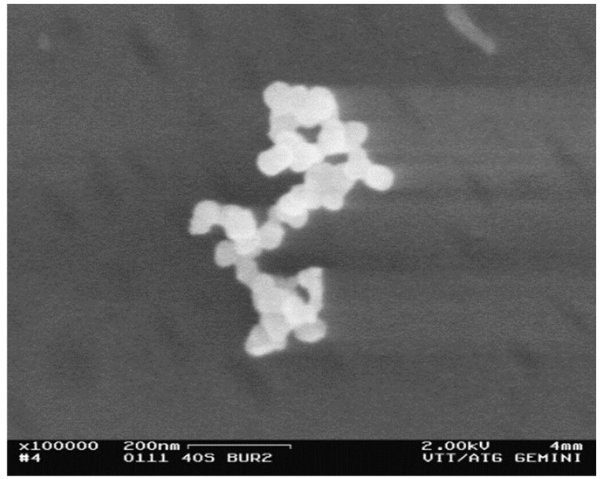
See Juho Louhisalmi's presentation

Action A2 – Emission components

- Results of emission testing should reflect the harmfulness of the emissions, for both environmental and human health perspective, and should be suitable to be used as input to emission modeling activities.
- The outcome will include suggestions for the new parameters that should be considered in future (long-term) testing procedures.

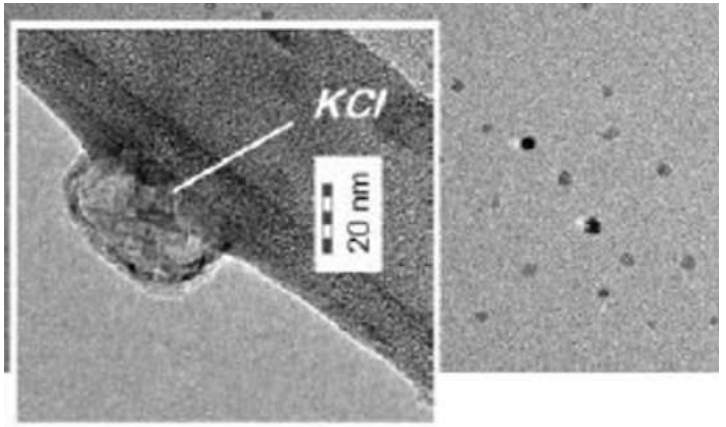






A2: Key Messages (1)

- The most important components
  - PM2.5, BC or EC, VOCs, PAHs, PN, UFP, PSD, LDSA, SOAs
    - PN is not correlated to other physical and chemical properties of emission compounds and cannot be used as predictors.
    - SOAs should be studied more extensively in research (SOA potential could be included in future emission inventories)
- Other compounds
  - PCDD/F, PCB, HCB (have already been included in the EMEP guidebook)
    - AAE, SSA…

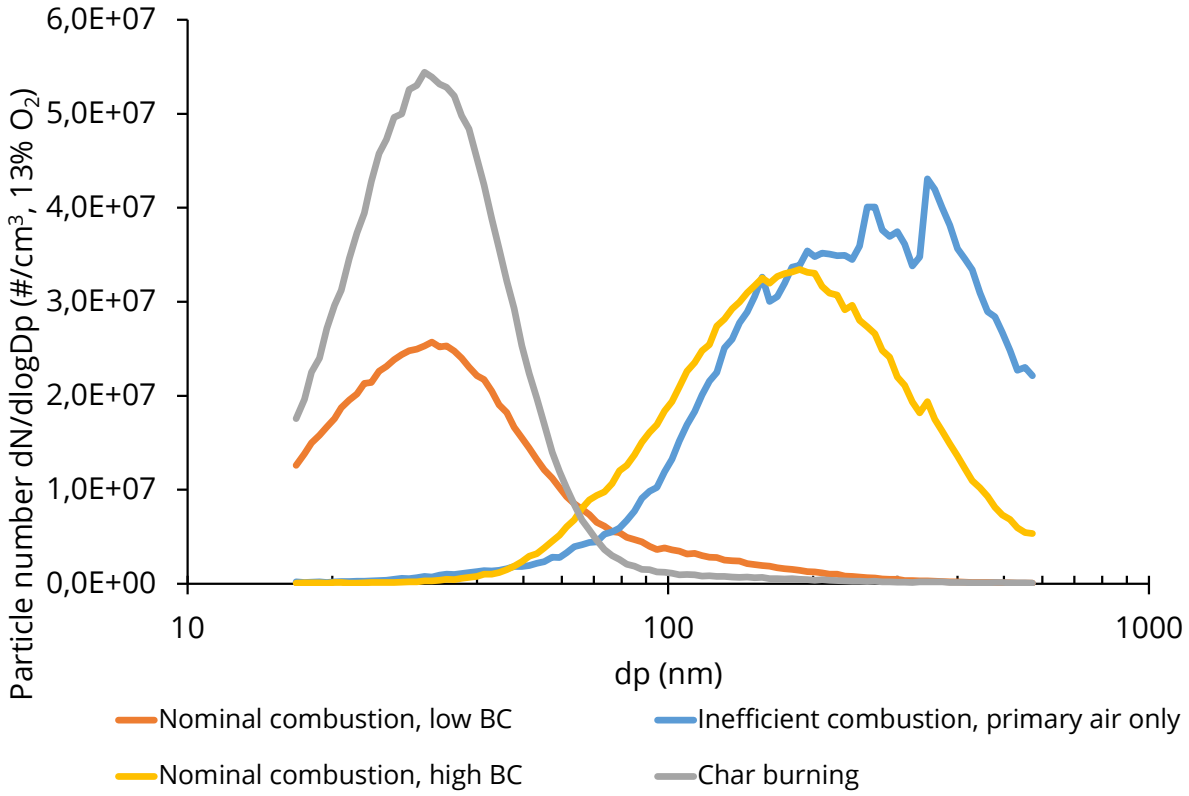


A2: Key Messages (2)

- All targeted emissions can be measured with various available instruments.
- For short term, measurement of only particulate matter (PM with condensables) including gaseous compounds THC, NO_X and CO is appropriate for legislation, but for long term, e.g. BC, PAHs and secondary aerosols or SOA formation potential could be included.
- However, for other needs (e.g. inventory, modelling),
  - the list of EMEP compounds,
  - particle number and particle size,
  - and the conversion factor for old appliances (i.e. portion of condensables of total PM) should be included for the measurement and reporting.
- Summary: Several compounds, instrumentation available, for short-term PM+condensables, for long-term many componds + SOA potential

Action A3 – Testing protocols

- There are several test protocols, which makes comparability of test results difficult and impossible, particularly when protocols aim at including unfavorable combustion phases for achieving real-life operational conditions.



e.g. Particle size, Number, Mass, Composition, Morphology, are depending on the combustion conditions

A3 - Literature review

- Various national and international test protocols for residential appliances burning solid fuels were reviewed.
- Different protocols in use
  - lead to variation in measured emissions causing difficulty in the comparison of emissions
  - currently used test protocols in existing test standards do not reflect the real life or near to real life emissions from RWC.
- Testing protocol for wood stoves was formed and tested in A5.

Real-LIFE Emissions

LIFE20 PRE/FI/000006
LIFE PREPARATORY PROJECT 2020
01/05/2021 - 30/04/2024

A4 – Intercomparison campaign

- Testing of suggested ENPME + PTD method
  - Different configurations (-> experiences)
  - Different emission levels

A4 – Conclusions

- Solid fraction results correlated well between configurations.
- Condensable fraction was found in all systems.

- Deviation was seen in the condensable fraction obtained between two configurations

  -> Needs a separate project where the new method is formulated precisely (modeling of nucleation of organic vapour in porous tube, when there is not seed particles)

- Summary report is coming soon

Action A5 - Emission factors and emission limits

- Several testing procedures exist worldwide making is necessary for different emission limits.
- Emission factors range widely depending on the operation during the combustion test.
- Mostly, the emission factors were determined during nominal load while neglecting other phases of combustion such as the ignition phase, partial load or overload.

- Summary report is coming soon

Real-LIFE emissions, Life preparatory project 2020

Project Number: LIFE20 PRE/FI/000006

Action A5: Emission factors and emission limits

Technical report on emission factors, emission limits, round robin with Real-LIFE test protocol - Draft

Main output and further use from A5

- Development, testing and establishment of extended ENPME method using ENPME and Porous Tube Diluter (Round-robin campaign and laboratory tests)
- Development, definition and successful validation of Real-LIFE test protocol for log wood stoves
- Application of Real-LIFE test protocol to 11 small scale appliances (9x log wood stove and 2x inset) and generation of new emission factors
- Round robin: Emission results were in good agreement for both stoves in each laboratory
- Emissions in different phases varied, which emphasizes the importance of wide (inc. different loads/phases) emission measurements in type testing

Main output and further use from A5

- Further application of Real-LIFE test protocol to more appliances after the end of the project (at least at TFZ)
- Provision of emission factors to authorities and stakeholders for further decissions on emission limits

ACTION C.4: **"After-LIFE" plan**

- As part of the final report
- an overview of the project and an assessment of the situation at the end of the project
- describe the continuation of the project topic after LIFE project has finished
- to make sure that the work carried out will continue in the future.

After-LIFE
What has been changed during the timespan of the project?

- Before the project
  - no harmonized testing standards or EU legislation in force for PM
- At the end of the project, CPR
  - EN 16510-1, and standards for roomheaters, inserts and cookers published in OJ (11/2023) -> will enter into force after a transition period of two years. (icl. PM)
    - Some standards under revision (e.g. heat storing heaters, sauna stoves)
    - Whole CPR Regulation under revision -> what kind of effects?
  - Ecodesign (incl. PM)
    - 1.1.2022 entered into force
    - 2026 evaluation

After-LIFE : The continuation of the project topic

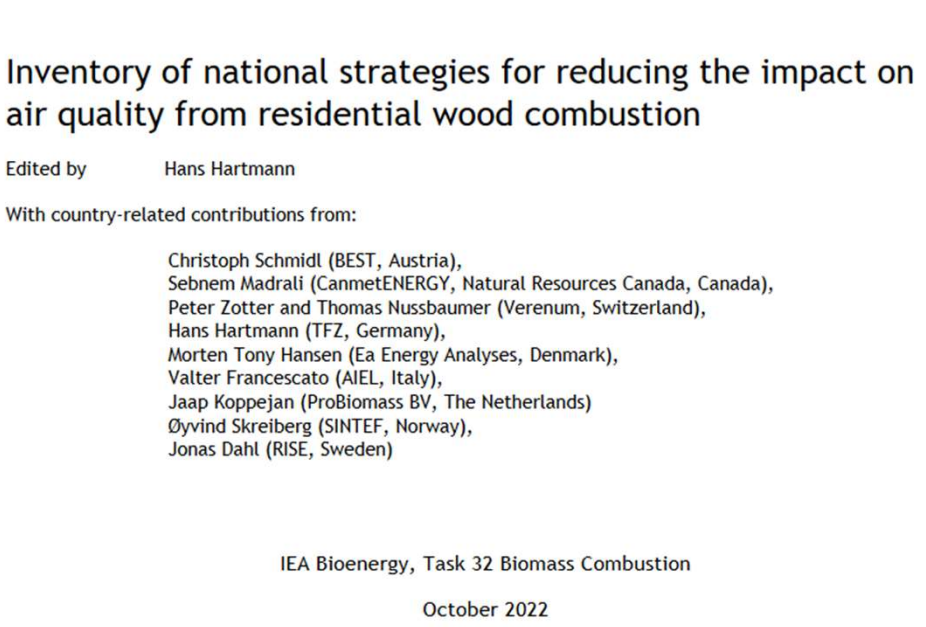
- Measurement data has still many different needs - the most important thing would be to improve air quality, i.e. lower end-use emissions
  - More data is needed e.g. for emission inventory needs, modeling and assesment of climate and health effects
  - Topics related to RWC emissions should to add to EU Research programs!
- Product development
  - Continues due to stricter regulations
- Experiments continues after the project – plan to publish results also in scientific journals

After-LIFE : The continuation of the project topic

- Testing procedures
  - Development work continue
    - Project beneficiaries will test new system also after the project
  - As the concentrations decrease, more precise methods should be used
    - ENPME+PTD first step
    - A project is needed where the specifications of the new method are determined precisely, modeling of nucleation is needed
- New project under planning (NGPEMM-consortium)
  - "Next generation particle emissions measurement method"
  - Funding still open.

Question is, how to decrease real emissions in practice

- Many measures has been taken!
- See IEA Report



Inventory of national strategies for reducing the impact on air quality from residential wood combustion

Edited by Hans Hartmann

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IEA Bioenergy, Task 32 Biomass Combustion

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https://task32.ieabioenergy.com/wp-content/uploads/sites/24/2022/10/NationalStrategies_Report-final.pdf

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Thank you!