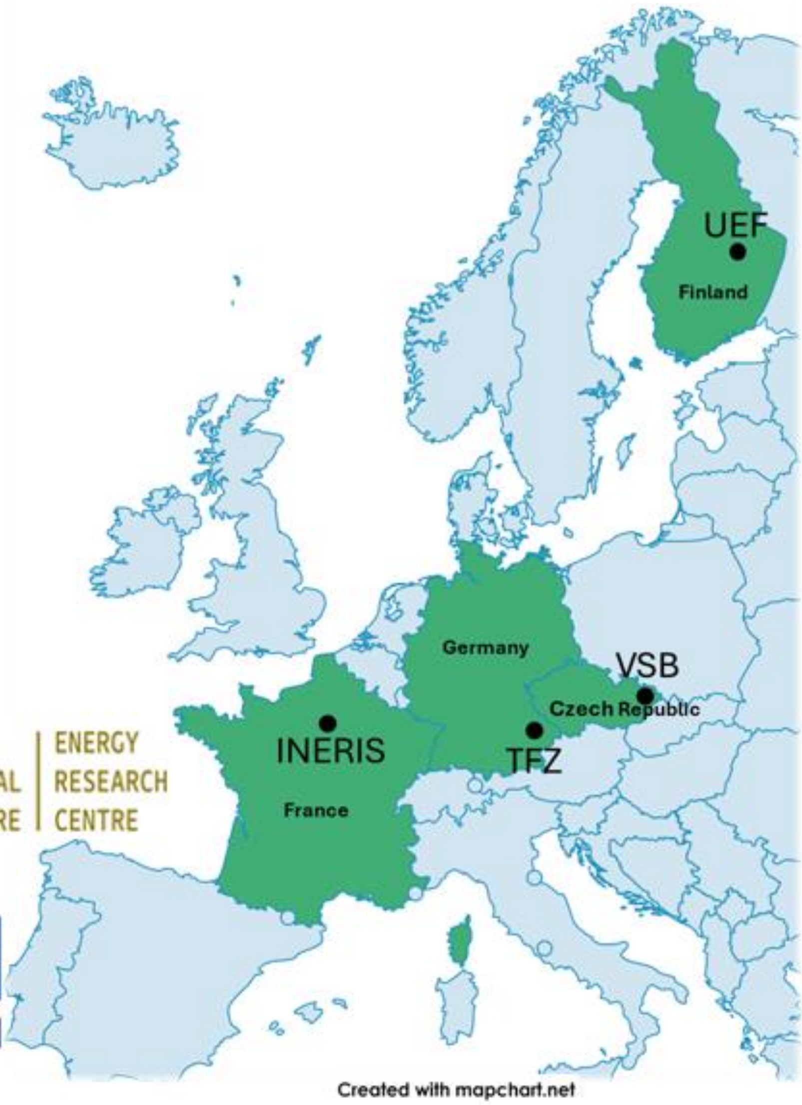
LAYMAN'S REPORT

12/2024

PROJECT: HARMONIZING RELIABLE TEST PROCEDURES REPRESENTING REAL-LIFE AIR POLLUTION FROM SOLID FUEL HEATING APPLIANCES

Real-LIFE emissions, Life preparatory project 2020

Project Number: LIFE20 PRE/FI/000006



Partners

University of Eastern Finland (UEF), Kuopio, Finland; Technical University of Ostrava (VSB), Czech Republic; The French National Institute for Industrial Environment and Risks (INERIS), Verneuil-en-Halatte, France; Technology and Support Centre in the Centre of Excellence for Renewable Resources (TFZ), Straubing, Germany

Project Background and Objectives: Emissions from small-scale solid fuel combustion are a major contributor to air pollution, impacting human health and the environment. Particulate matter (PM) is particularly harmful, and current emission measurement methods do not adequately address the different chemical compounds within PM. The project aims to improve emission testing methods and protocols to better reflect the real-life combustion conditions.

Main Objectives:

- Investigate testing methods and procedures that better reflect real-life emissions of small-scale solid fuel combustion.
- Evaluate the benefits of using more realistic emission factors in environmental impact studies.
- Support the work of relevant regulatory bodies and ensure that their visions are incorporated in projects implementation.
- Develop an improved PM measurement method
- Generate new knowledge on the differences in testing methods and protocols through carefully planned combustion experiments.
- Disseminate new and existing knowledge to stakeholders.

Main Actions and Findings:

A1 Sampling and Dilution Methods:

Currently, the PM measurement methods are mainly based on sample collection directly from the hot flue gas which means that some particles (so-called condensable particles) remain undetected. Dilution sampling is necessary to include condensable particles and improve the accuracy of emission measurements.

Four representative dilution methods were identified from literature, with the combination of porous tube and ejector diluters (PTD+ED) being the most effective.

In addition, a novel extended ENPME method was developed and tested with promising results.

A2 Emission Components:

Current standardized testing methods focus on solid particulate matter, but other components like condensable particles, black carbon or elemental carbon (BC or EC) and polycyclic aromatic hydrocarbons (PAHs) are also important regarding climate and human health.

Including condensable matter in emission testing is recommended. It is also recommended to measure atmospheric secondary organic aerosols (SOA) in the future, as some particulate compounds are only formed in the atmosphere.

Particulate number concentration (PN) is not a suitable parameter for the combustion emissions evaluation because PN does not reflect the combustion quality.

A3 Testing Protocols:

Standardized testing protocols have major differences, such as sampling time and burn rate, which affects the obtained emission results. A new Real-LIFE testing protocol was developed to include the ignition phase and three different load levels, better mimicking the real-life use of combustion appliances.

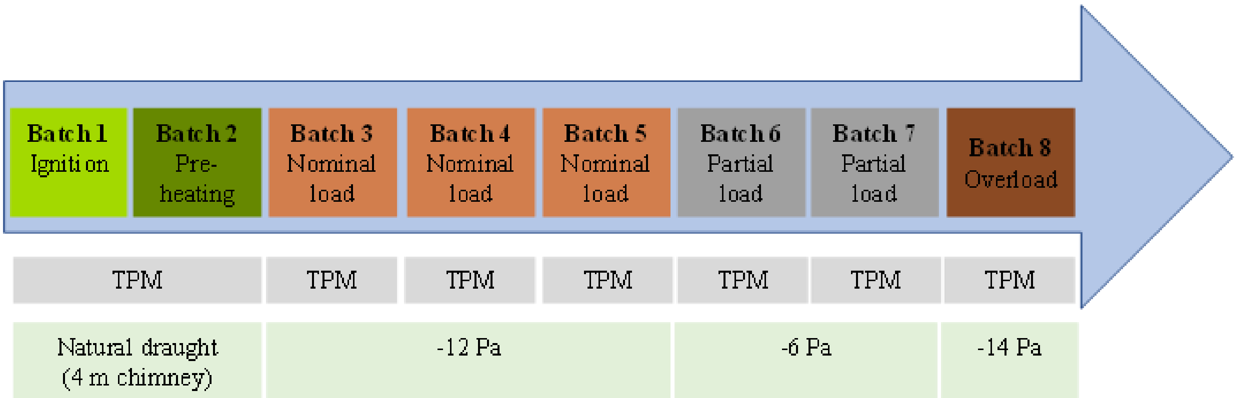


Figure 1. Procedure of a log wood stove test following the Real-LIFE test protocol. Emissions are measured from each phase

A4 Intercomparison Campaign of PM measurement methods:

In an intercomparison campaign, the extended ENPME method was tested with full and partial load configuration. Good correlation was found for solid fractions but more scatter between condensable particle fractions.

The extended ENPME method is a two-stage method which consists of an ENPME sampler described in EN 16510-1:2022 standard, and porous tube diluter (PTD), and filter collection for both stages.

Further research is needed to finalize the evaluation and validation of the extended ENPME method.

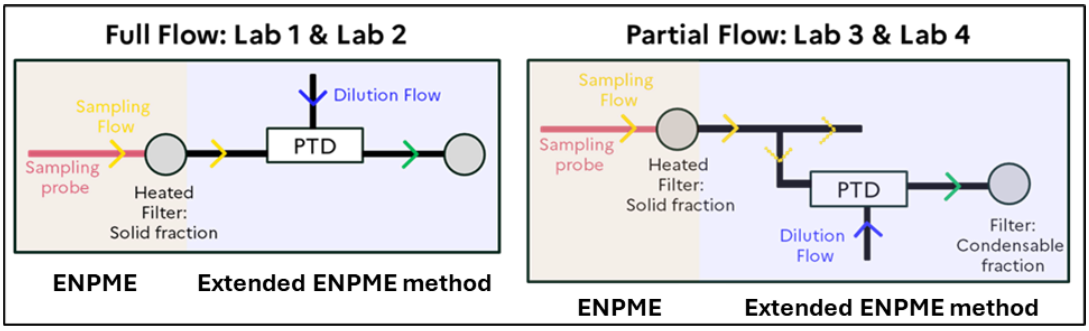


Figure 2. Different extended ENPME configurations used in the intercomparison campaign.

A5 Emission Factors and Limits:

Modifications to sampling and testing protocols will affect emission factors and limits.

Real-LIFE test protocol was validated within round robin campaign and applied on total of 11 appliances, showing the importance of including all combustion phases in emission measurements.

C3 Socio-Economic and Environmental Impacts:

Cost estimations for implementing the new Real-LIFE test protocols and the extended ENPME method ranged from €510 to €1564 per stove tested, depending on the scenario.
Using realistic emission factors, including condensable PM, improves the accuracy of air quality models and supports effective environmental policy.

Suggestion for near-term and long-term PM sampling methods

Suggestion for near-term method: Extended ENPME method (Figure 3)
Suggestion for long-term method: Two stage partial flow dilution system, PTD+ED method (Figure 4)

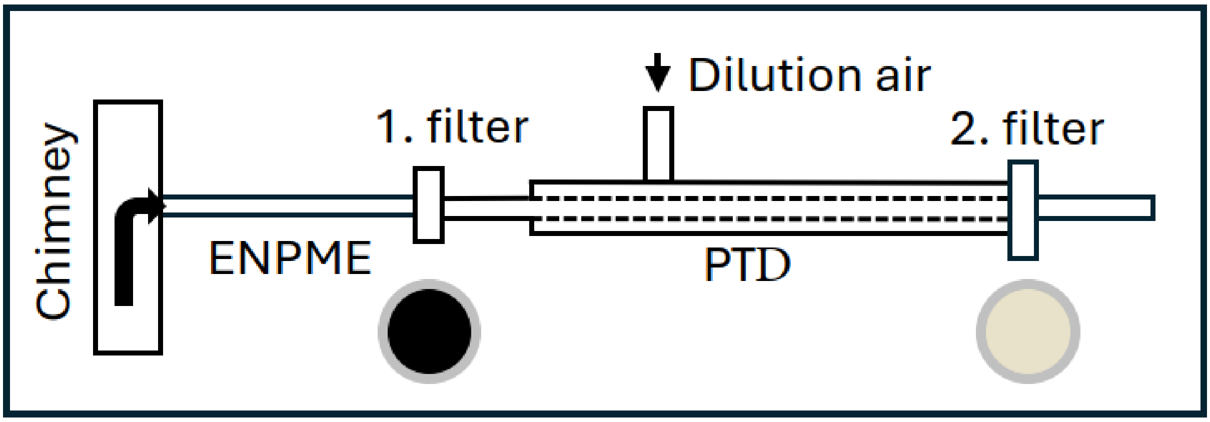


Figure 3. Schematic figure of the extended ENPME method comprising of the ENPME sampling and the porous tube diluter (PTD).

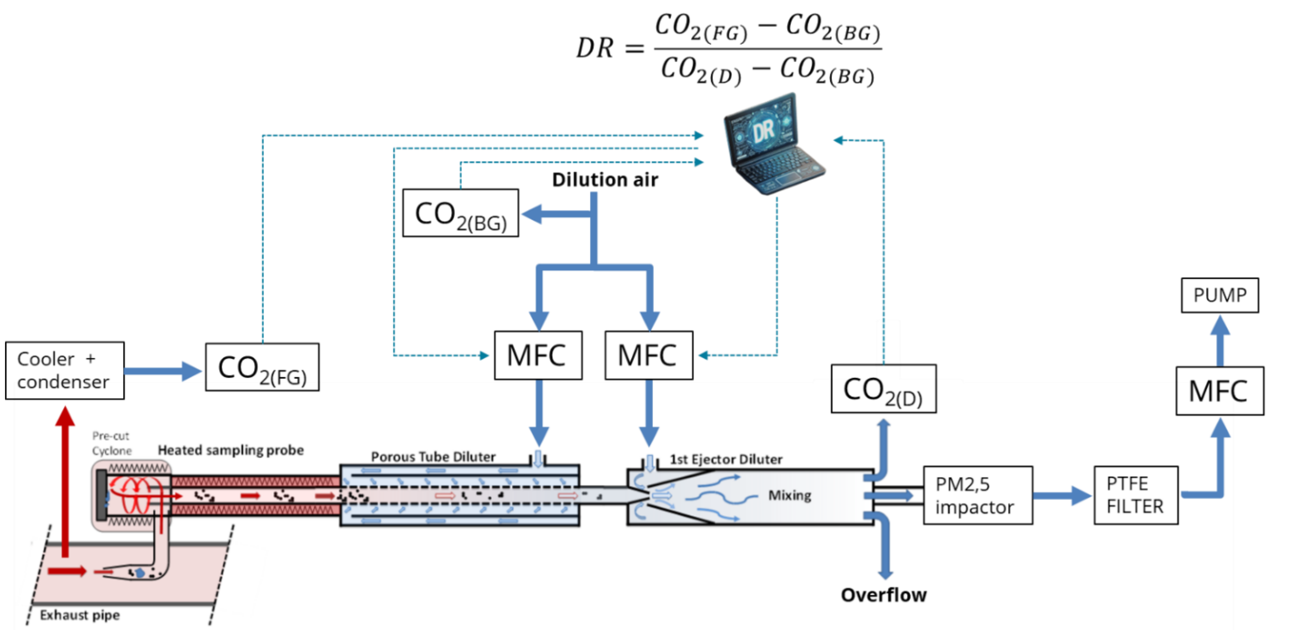


Figure 4. Schematic figure of porous tube diluter and ejector diluter combination method (PTD+ED) with dilution ratio control system.

Conclusion: The Real-LIFE emissions project developed improved testing protocols and sampling methods that better reflect real-life emissions from solid fuel heating appliances. These advancements are crucial for accurate air quality modeling and achieving emission reduction targets. Continuing research and validation are necessary to finalize these methods and incorporate them into European standards.

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UNIVERSITY OF EASTERN FINLAND

Harmonizing reliable test procedures representing real-LIFE air pollution from solid fuel heating appliances - **Real-LIFE Emissions** project.

Project Partners

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