biosweet
Biomass for Swiss Energy Future
Swiss Competence Center for Energy Research

In cooperation with the CTI

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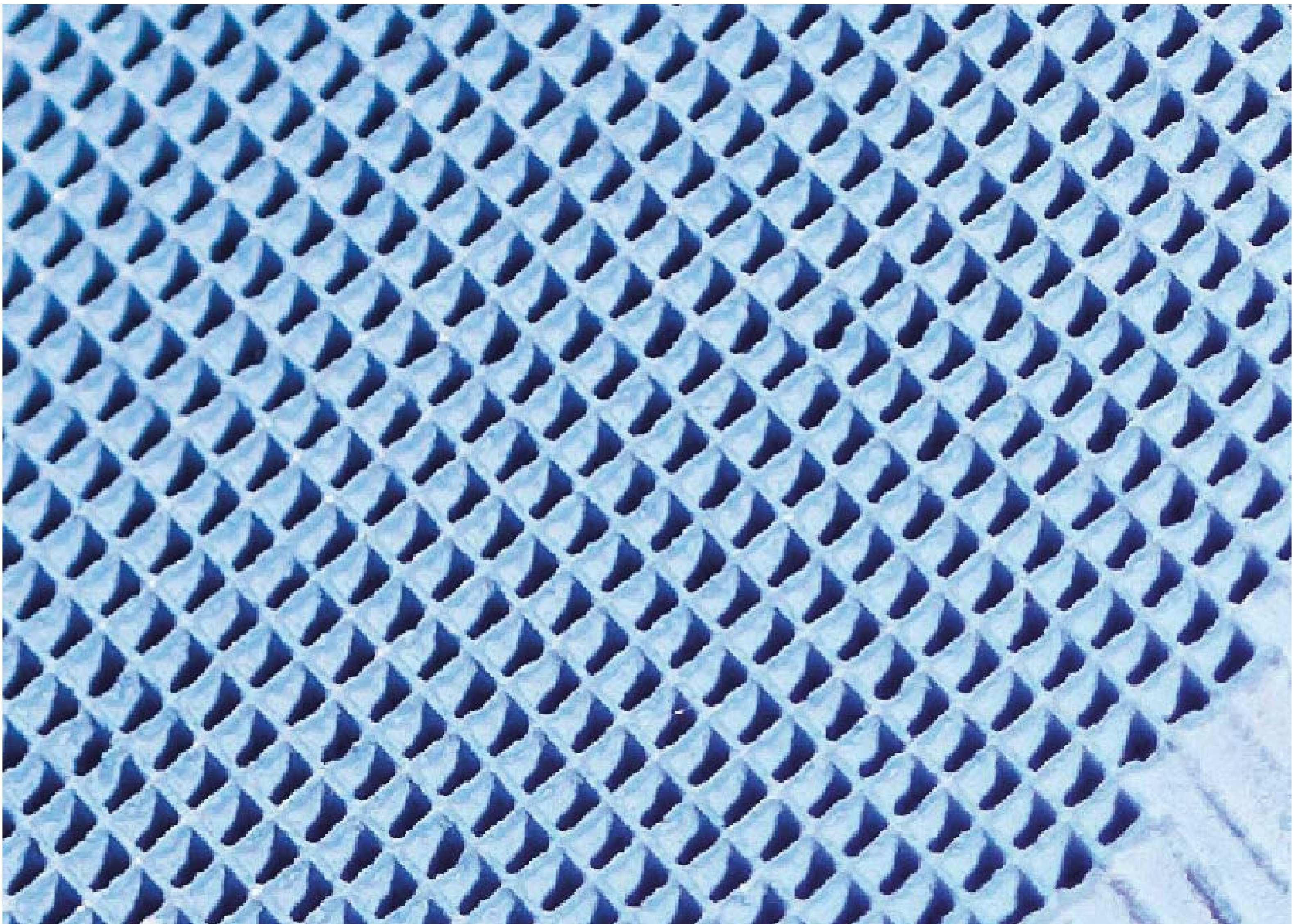
Flue Gas Treatment

Bioenergy with lowest emissions
Reduction of methane, particulate matter and NO_x



Emission Reduction in Biomass and Biofuel Combustion

The combustion of solid, liquid and gaseous biofuels is accompanied with the formation of undesired pollutant emissions. The most important emissions are particulate matter, nitrogen oxides and unburned hydrocarbons like methane. All of these emissions occur also in fossil fuel combustion. However, existing emission reduction technologies need to be modified and further developed to accommodate the specific needs and different operation conditions and economics of biofuel combustion.

Emission treatment systems contribute significantly to the total cost of combustion technologies. Cost reductions in this area improve the competitiveness of biofuel combustion. SCCER BIOSWEET pursues both the optimization of combustion concepts to avoid harmful emissions in the first place as well as the after-treatment of flue gas to eliminate such emissions before their release to the environment.

Methane Abatement in Stoichiometric and Lean-Burn Engines

Methane from renewable sources is one of the most promising fuels in stationary as well as mobile applications. However, due to its chemical inertness high concentrations of methane are generally found in the exhaust gas of both lean-burn and stoichiometric internal combustion engines.

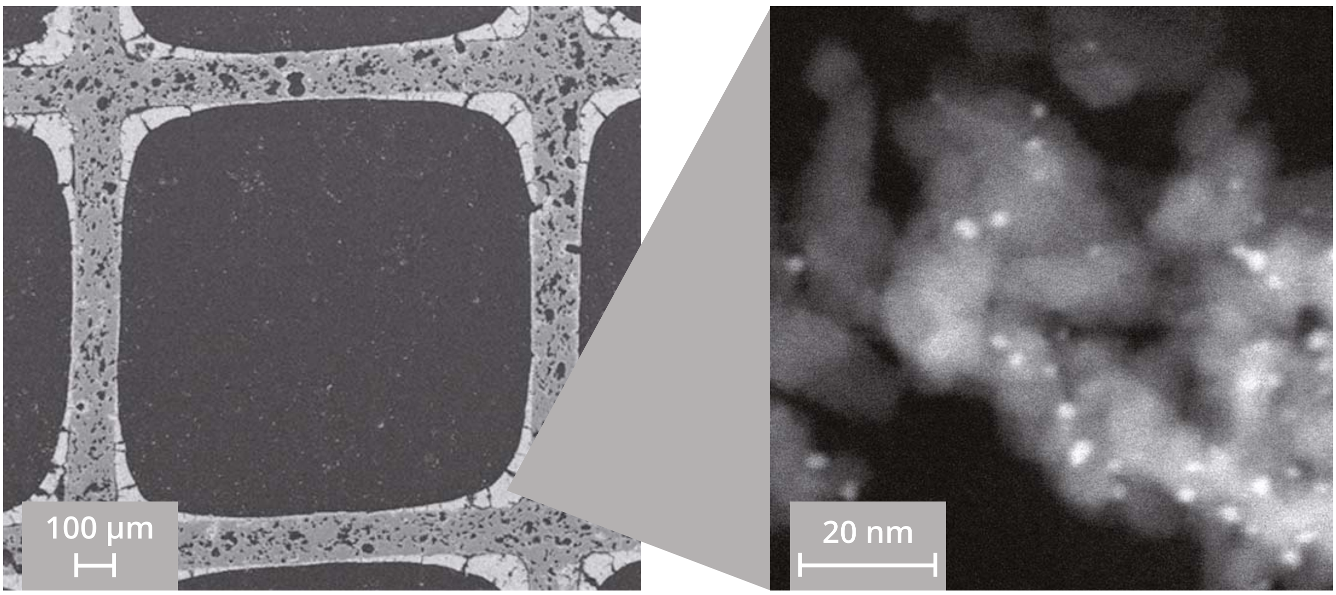
Research at the SCCER BIOSWEET has helped to better understand catalytic methane oxidation on Three-Way-Catalysts under stoichiometric conditions and to develop advanced control strategies for maximizing methane abatement under static as well as dynamic operation conditions. As a consequence, the flue gas after-treatment system can be designed smaller and costly precious group metals can be saved.

Under lean-burn conditions Three-Way-Catalysts cannot be applied for methane oxidation. For these operation conditions a new palladium-zeolite can be used, which proved to be more active and stable than the current technology.

Technology Readiness and Roadmap 2020

In 2015, the advanced control strategy for methane abatement in stoichiometric gas engines has been developed in the laboratory. An industrial partner is looked for, with which the technology can be tested at a real gas engine and introduced into the market.

In 2016, the active and stable palladium-zeolite catalyst has been developed for methane oxidation in lean exhaust gases. Discussion with a catalyst manufacturer has been started about the potential of the technology to be upscaled



Electrostatic Precipitator for Wood Burning Devices

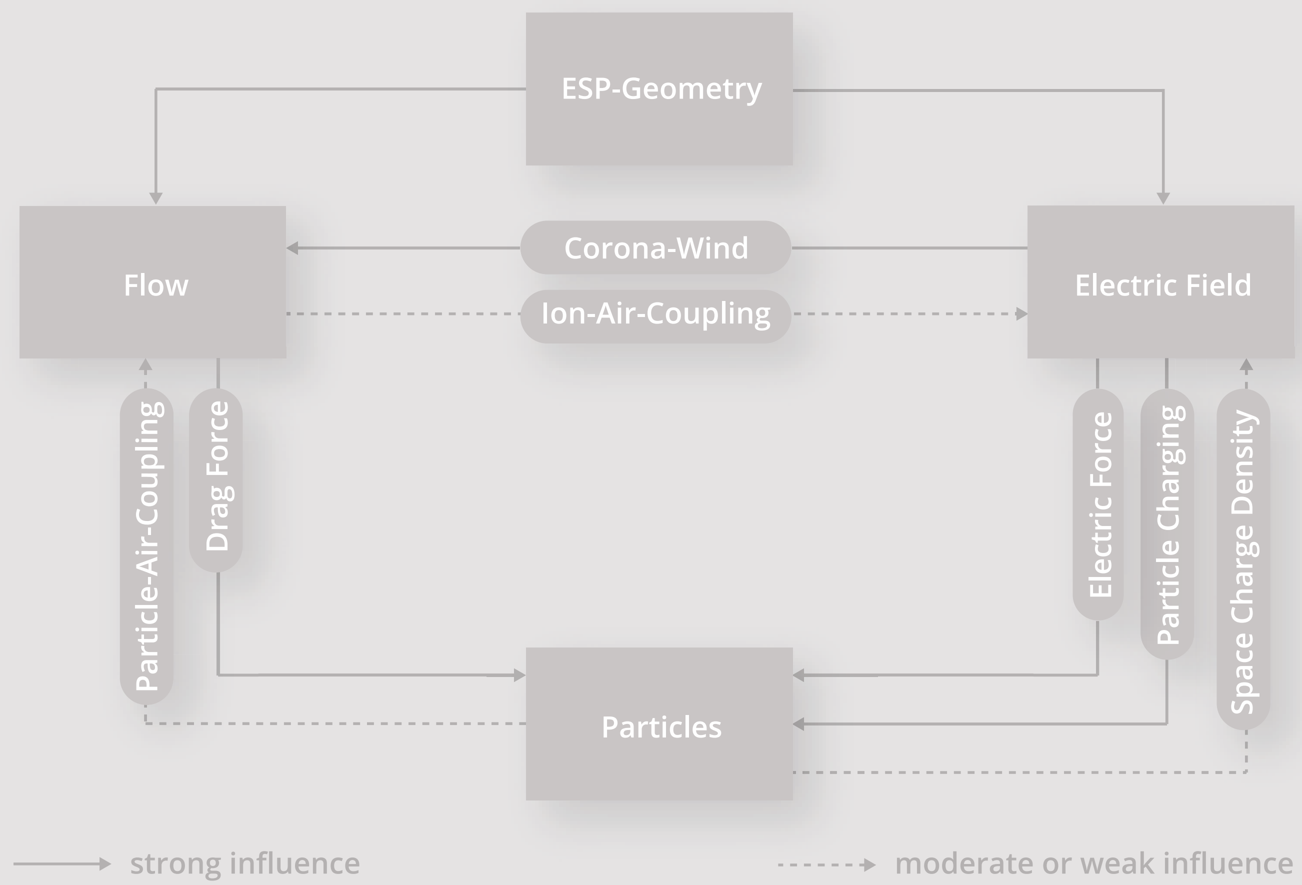
Within an electrostatic precipitator (ESP) an electrical field is generated by applying a high voltage across electrodes. The resulting high field strength leads to electron emissions and ionization processes of the surrounding molecules. The free electrons can then accumulate on the dust particles. Due to electrostatic forces, the loaded particles move to the grounded collecting electrode, where they finally are captured (precipitated). Periodical cleaning is carried out by mechanical abrasion, washing or other mechanisms that avoid re-entrainment of agglomerates into the flue gas.

The main parameters for an efficient precipitation are the geometry of the precipitator, the electrical field, the exhaust gas flow rates and the composition as well as size of the particles themselves.

Technology Readiness and Roadmap 2020

ESP's are well developed exhaust gas treatment systems that are however, expensive and space consuming, especially for small scale boilers. Thus, we are focusing our work on integrating the ESP into the appliance itself. This will hopefully significantly reduce cost and space requirements to further widespread implementation in wood combustion systems. In the best case the novel ESP could be retrofitted into nearly every furnace with acceptably low investment costs.

By the end of 2019, long-term testing of an internal ESP should be completed. Further improvement of ESP will focus on numerical modelling to optimize performance and development costs.



Selective Catalytic reduction (SCR) of NO_x with Ammonia

The combustion of biomass in stationary power plants as well as the combustion of biofuels in lean-burning internal combustion engines produces significant amounts of NO_x, which have to be reduced to meet strict emission limits. SCR is the most efficient process for the reduction of NOx in lean exhaust gases. In this process ammonia is used to reduce NO_x over a specialized catalyst. Ammonia is either injected directly into the hot exhaust gas or in form of an environmentally benign urea solution upstream of the SCR catalyst. Several SCR catalyst technologies have been developed at the Paul Scherrer Institute in recent years together with industrial partners to cover a broad range of different applications. This comprises VWT, metal-exchanged zeolites, rare earth metal oxides and metal vanadates.

Technology Readiness and Roadmap 2020

A SCR catalyst technology based on VWT for diesel engine applications has been developed at PSI for coating ceramic and metal substrates. This technology has already been transferred to two industrial partners as a non-exclusive license.

Significant know how in metal-exchanged zeolites, rare earth metal oxides and metal vanadates has been built up at the Paul Scherrer Institute and is now available for industrial partners interested in developing an optimum SCR system for their specific stationary or mobile application.

SCR catalyst at the Paul Scherrer Institute test facility

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