TT3: Emissions, Air Quality, Fuel and Ash Logistic
Webinar, 02/12/2020

Introduction emissions and air quality

ENTRAIN |AEE INTEC| Joachim Kelz

EMISSIONS AND AIR QUALITY

Main Impacts

Emission reduction

Operation of heating plants

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EMISSIONS AND AIR QUALITY

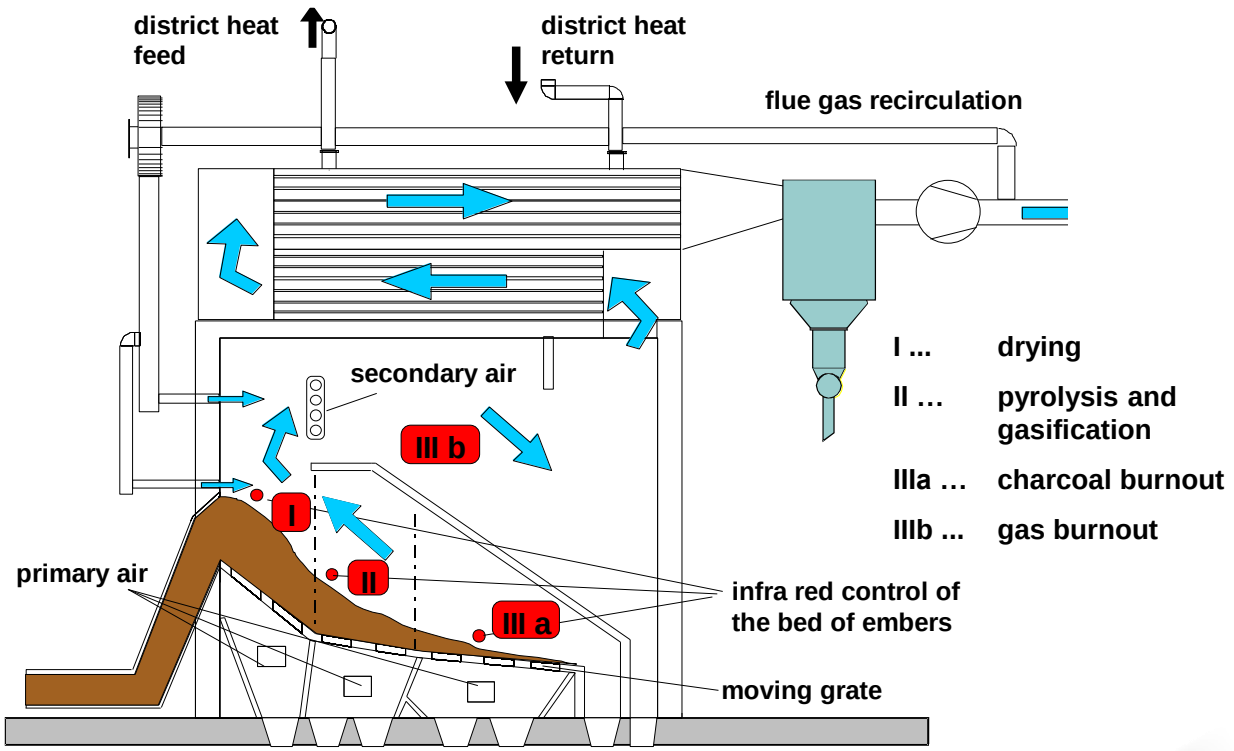
Main parameters influencing emissions and air quality

- Fuel properties
- Combustion temperature
- Mixing of the flue gases in the furnace
- Residence time of the flue gases in the furnace
- Process control

Remember the 3 T‘s: Time, Temperature and Turbulence

Stages of the biomass combustion process

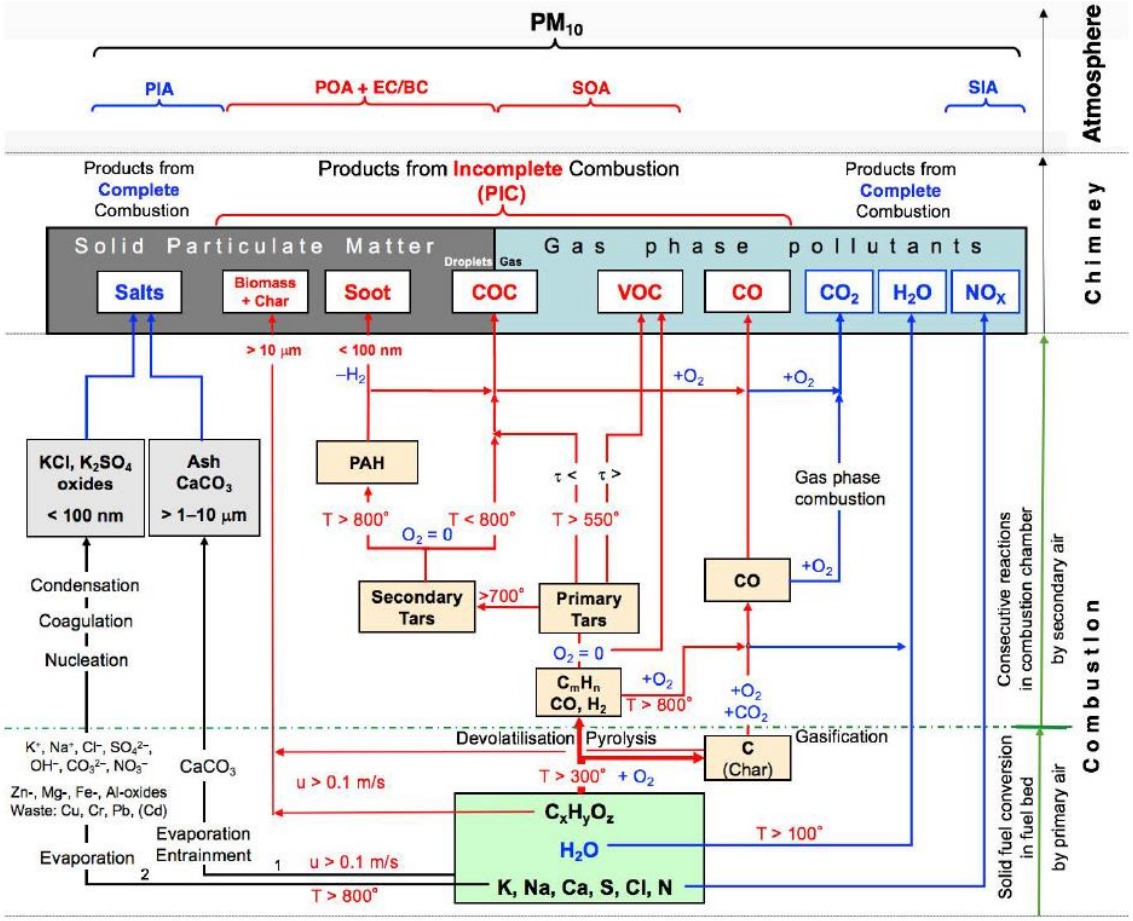
- Drying
- Pyrolysis
- Gasification
- Combustion



Overview on combustion technologies

- Fixed bed combustion
  - Under stoker boiler
  - Moving grate furnace
- Fluidised bed combustion
  - Bubbling fluidised bed combustion
  - Circulating fluidised bed combustion
- Pulverised fuel combustion

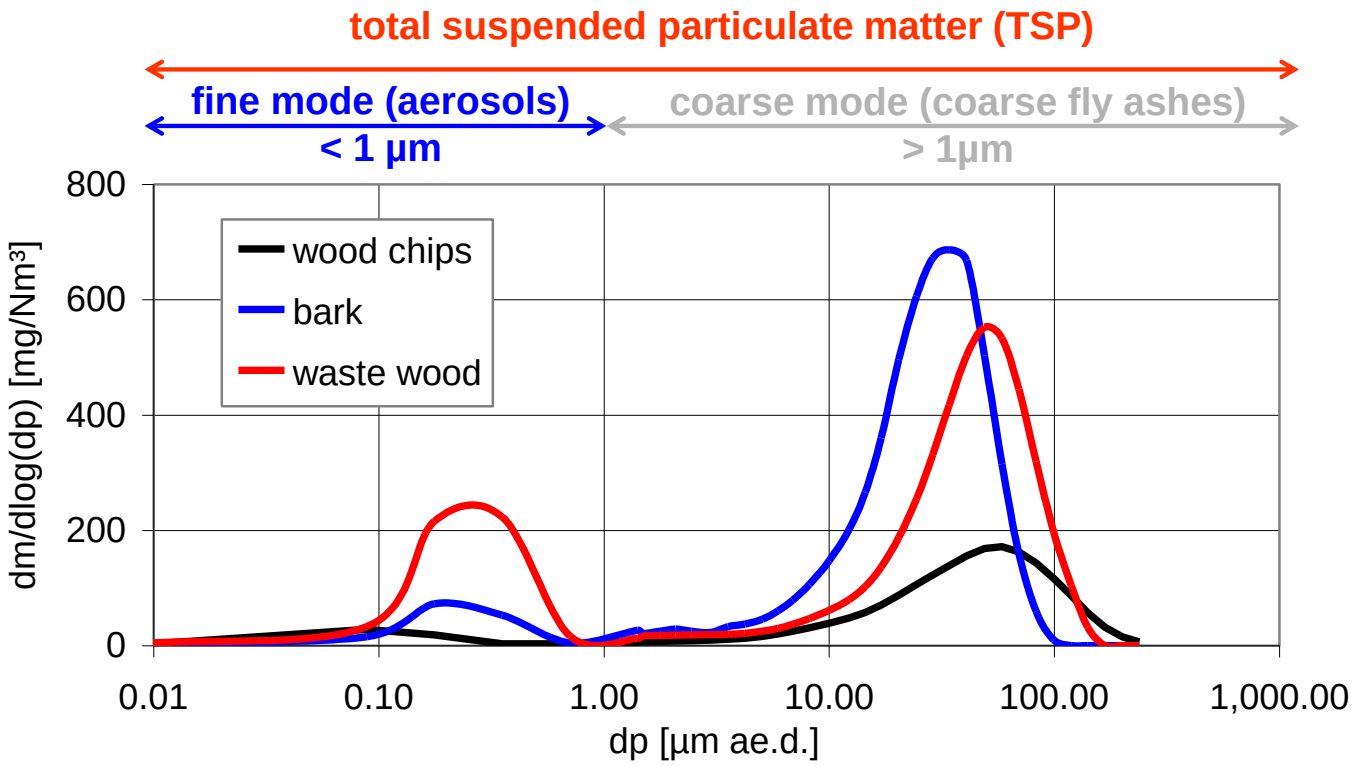
Types of emissions during biomass combustion processes

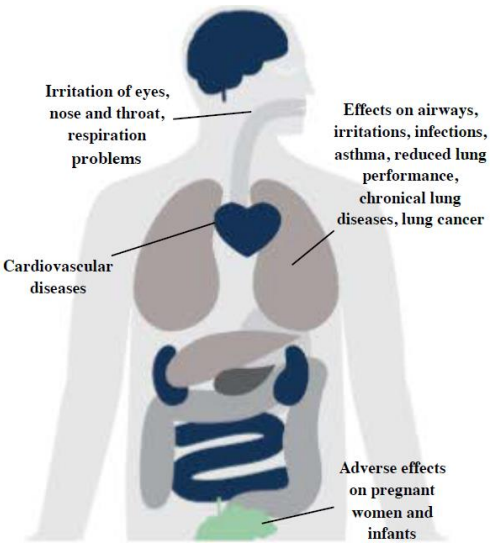


Imission = Air Quality

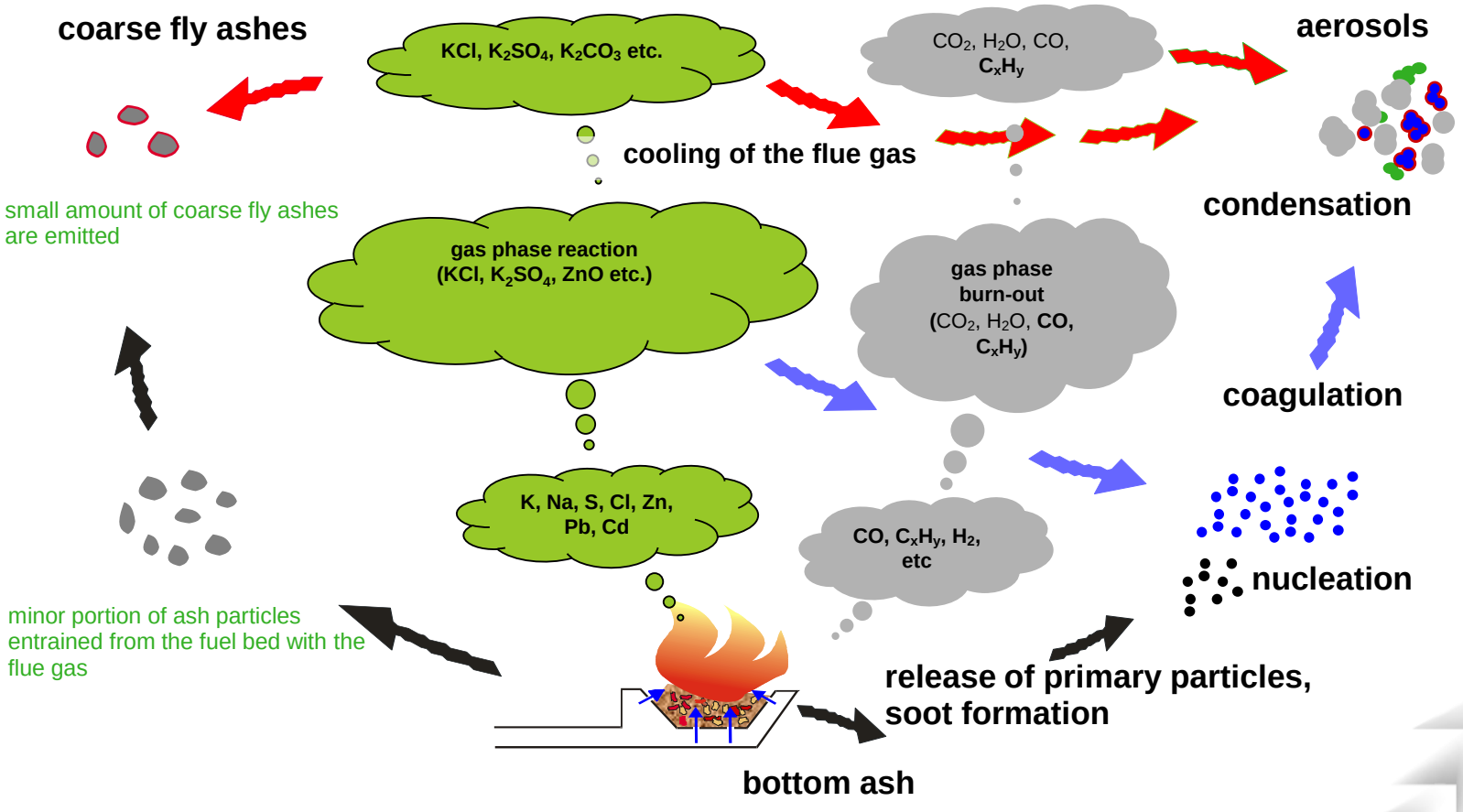
Emission

Categorisation of PM emissions from biomass combustion





Particle formation during biomass combustion



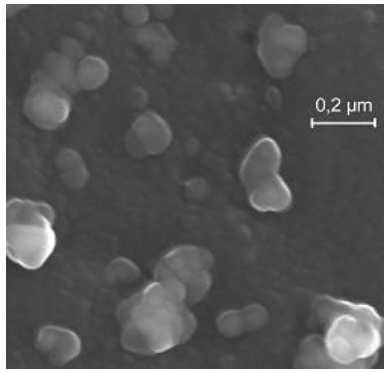
Aerosol formation during biomass combustion

complete combustion

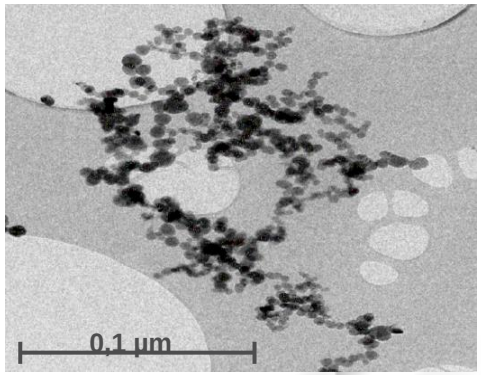
incomplete combustion

inorganic aerosols
alkali sulfates,
alkali chlorides,
alkali carbonates,
heavy metal oxides

carbonaceous aerosols
soot (EC),
organic aerosols



Source: Graz University of Technology



Source: University of Eastern Finland

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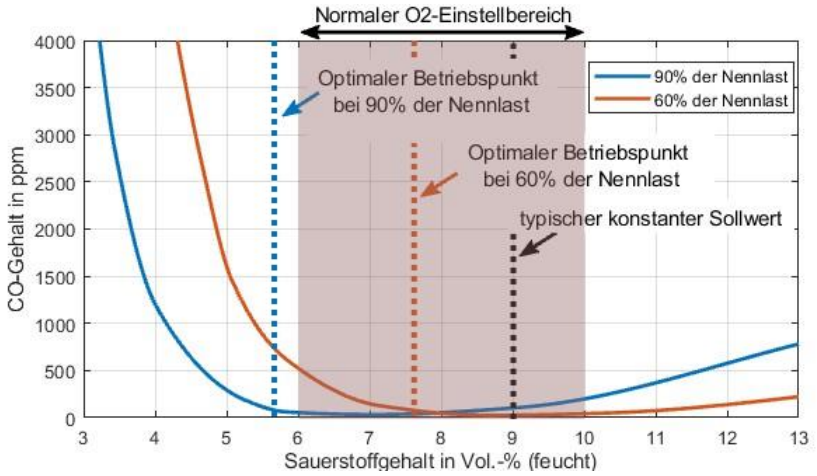
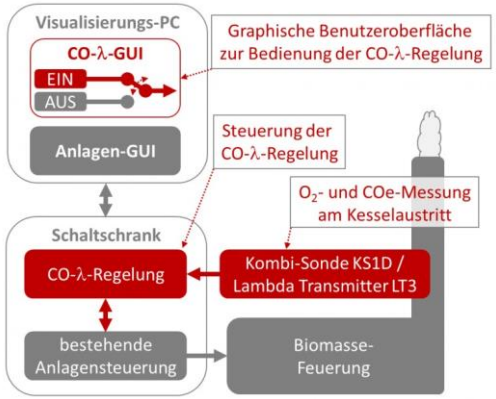
Primary measures for emission reduction – air staging

- A staged injection of primary and secondary combustion air in separated zones (combustion chambers)
- Excess air ratio (λ) in the primary combustion chamber between 0.6 and 0.8
- Residence time of the flue gas in the primary combustion chamber approx. 0.3 - 0.5 s
- Low λ in the secondary combustion chamber

Primary measures for emission reduction – process control

- PCS have to meet the requirements of the combustion system in all operation phases
- Application of advanced PCS (e.g. model based control, CO-λ-control, temperature control, etc.)





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Primary measures for coarse fly ash reduction

- Minimising the entrainment of particles
- Optimised grate and primary combustion zone
  - undisturbed fuel bed with low combustion air velocities in the fuel bed
  - low flue gas velocities at bed and primary combustion zone outlet
- Separation zones
  - low flue gas velocities
  - sharp turns of the flue gas flow direction

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Primary measures for carbon containing aerosol reduction

- Optimisation of the burnout quality
- Implementing of an appropriate air staging concept forms the basis for achieving an improved gas phase burnout
- Air staging leads to a significant reduction of soot (elemental carbon) and organic aerosols as well as gaseous emissions (CO, TOC, NOx)

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Primary measures for inorganic aerosol reduction

- Inhibitation of the release of ash forming elements leads to a further reduction of inorganic aerosols
- Potassium release is of major interest in biomass combustion systems
- Fuel bed temperature has to be kept as low as possible
  - Low flue gas velocities
  - Sharp turns of the flue gas flow direction

EMISSIONS AND AIR QUALITY

Main Impacts

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Operation of heating plants

- The combustion technology has to be appropriately adapted to the fuel quality (fuel type, moisture content, fuel composition, ash content, etc.)
- Combustion temperature
  - Too low combustion temperature →
    High CO and OGC emissions, poor char burnout
  - Too high combustion temperature →
    Problems with slagging and deposit formation
  - Control by flue gas recirculation and/or cooled surfaces

Operation of heating plants

- Mixing and residence time
  - Homogeneous fuel distribution over the fuel bed
  - Air staging and air distribution to reduce emissions
  - Mixing of flue gases
    - Relevant for a complete burnout of the gases
    - Achieved by an appropriate design of the geometry, number and position of the secondary air inlet nozzles as well as of the furnace geometry
  - Residence time of the flue gases in the hot furnace should be long enough to achieve a complete burnout of the gases

Operation of heating plants

- Process control system
  - Load control: smooth operation, avoid “stop and go”
  - Combustion control for appropriate excess air ratios λ
    - Too low λ → high CO and TOC emissions
    - Too high combustion λ → higher CO, increased flue gas flows, decreased thermal efficiency, increased particle entrainment from the fuel bed, higher PM emissions
  - Temperature control
    - to avoid slagging and deposit formation
    - to guarantee a complete combustion
  - Pressure control

Operation of heating plants

- Correct dimensioning of the whole DH system
  - combustion system
  - hydraulic system
  - buffer management
  - DH network (system temperatures, superordinate control, integration of other energy sources)

Operation of heating plants

- Miscellaneous
  - Minimisation of false air
  - Service & cleaning → minimize corrosion risks
  - Sensor placement and sensor aging
  - CFD simulations → time and cost saving design tool
  - Increase flexibility through different measures

Interreg CENTRAL EUROPE European Union European Regional Development Fund
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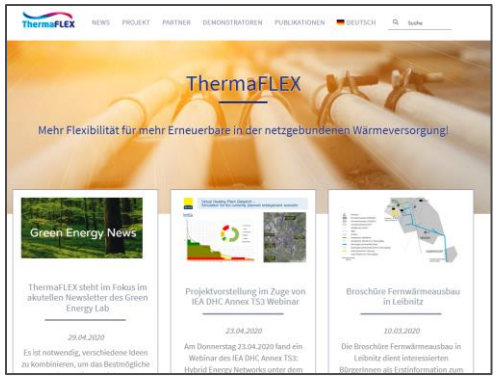
ThermaFLEX - approach for more flexibility and renewables

01.11.2018 30.10.2022 Duration

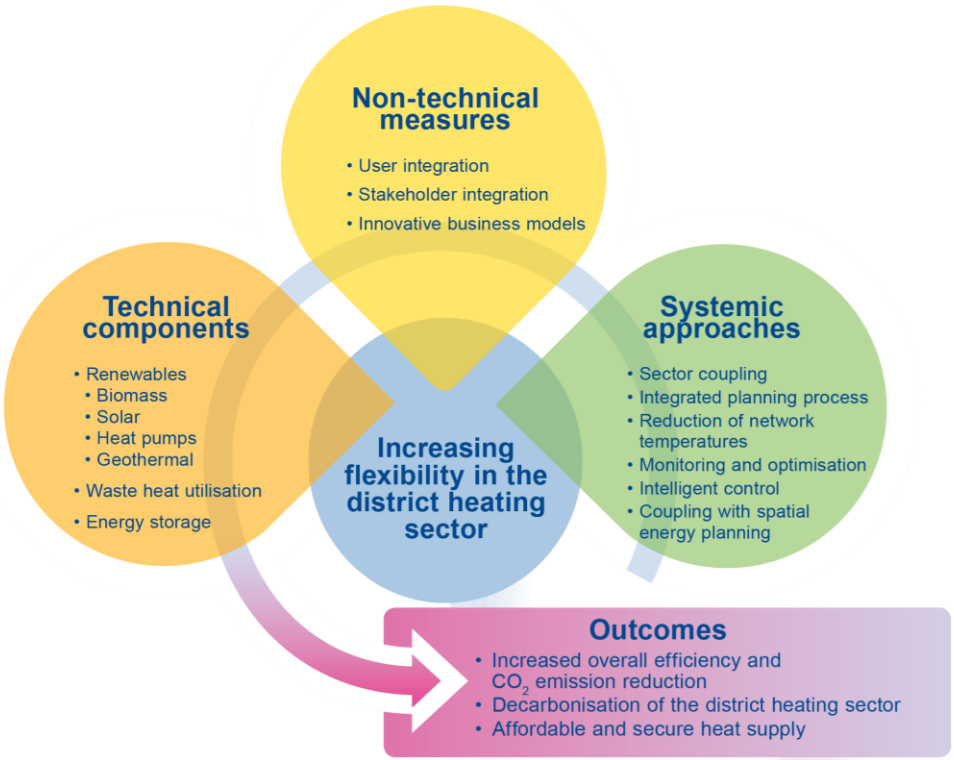
27 Partner

4,6 Mio Euro Budget

5-10 Demonstrators



https://thermaflex.greenenergylab.at/



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ThermaFLEX - value chain and USPs

ThermaFLEX

research requirements

expertise methods

demonstrator

problem identification

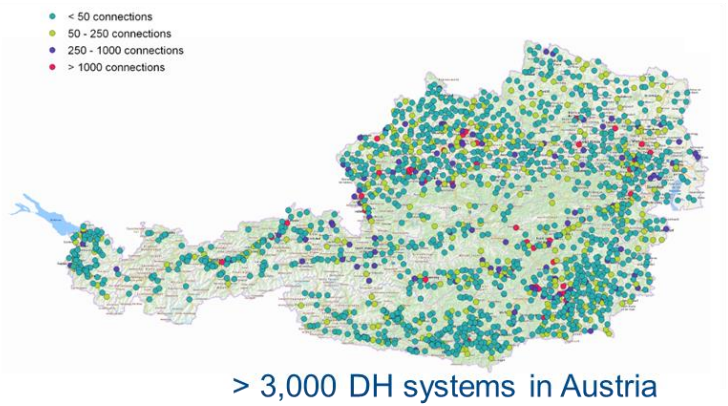
idea & concept development

planing, evaluation & realisation

implementation & monitoring

evaluation & optimisation

best practice scenarios,
know-how transfer,
scalability and transferability,
roll-outs etc.
for whole DH sector



> 3,000 DH systems in Austria

THANK YOU!

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