

Determination of sectoral emission factors for small combustion installations

in Germany

Results of a research project
carried out by
Universität Stuttgart



Dr. M. Struschka;
Institute for Process Engineering and Power
Plant Technology, University Stuttgart:

„Determination of average emission factors for
the current and future development of
emissions from combustion units in
households and the small consumer sector“



Aim of the Study

- n Improvement of data for several reporting obligations
- n Source category 1.A.4 (a, b, c)
 - n Small & medium combustion installations
 - n Residential (households, mobile sources)
 - n Small consumer sector
 - n Armed forces
- n Approx. 30,000,000 installations



Scope

- n Determination of appliance-specific emission factors taking into account the mode of operation and age structure
 - n Determination of the stock of boilers, burners and heating appliances in Germany
 - n Determination of average nominal heat output and of construction types installed in selected areas
 - n Determination of the appliance-specific energy consumption (framework: energy balance supplemented by other results)

Determination of Emission Factors

- n Differentiation
 - n design and type of construction
 - n operation mode
 - n range of nominal heat output (permitted and not permitted installations)
 - n year of manufacture (3 classes)

Determination of Emission Factors

- n Differentiation of energy sources
 - n Light fuel oil
 - n Heavy fuel oil
 - n Gaseous fuels
 - n Coke from hard coal, hard coal briquettes
 - n Brown coal briquettes from different areas
 - n Untreated wood, wood materials, pellets, wood scraps and straw

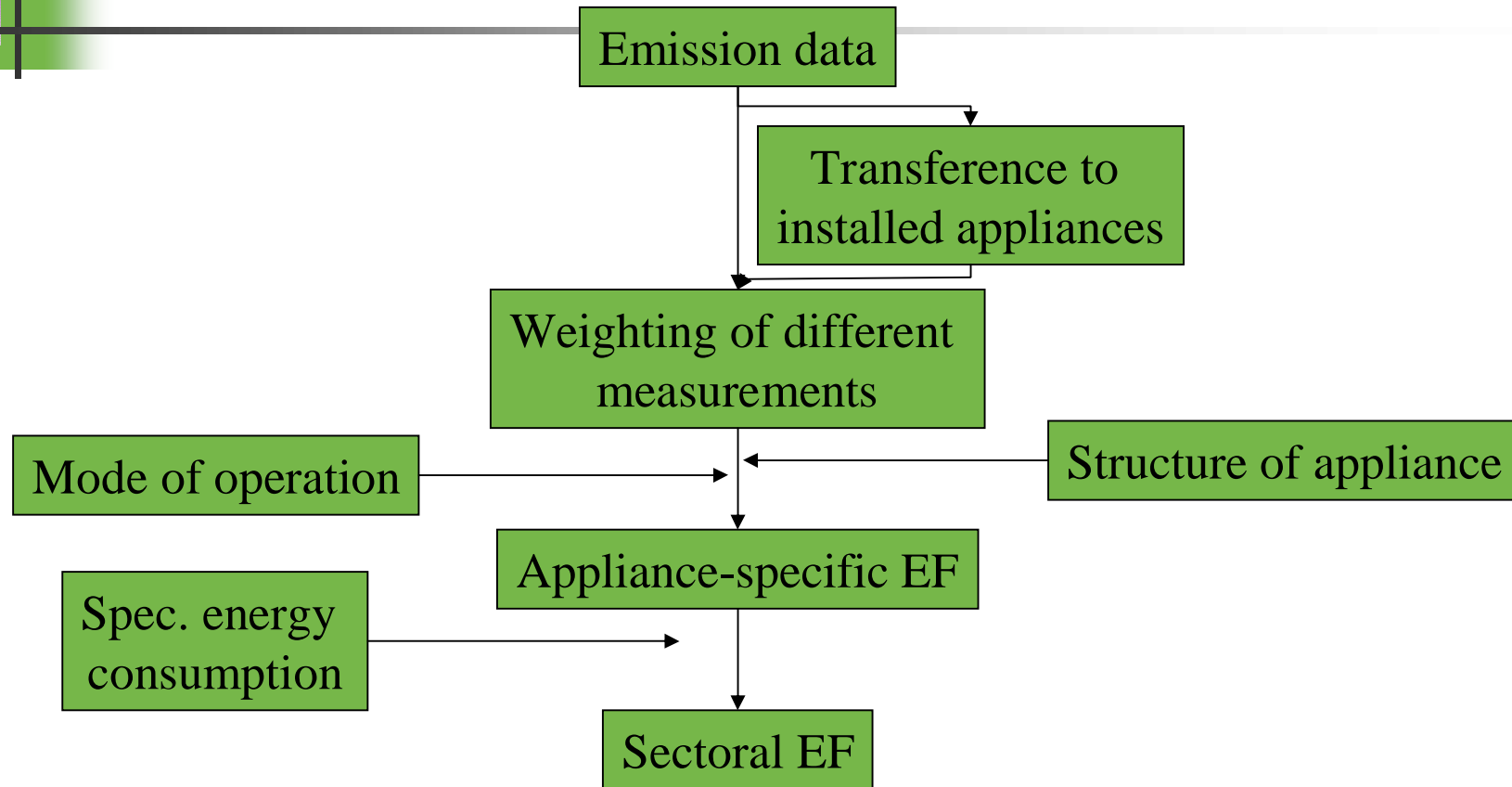
Data Sources

- n Determination of the structure
 - n data from chimney sweeps (survey in selected chimney sweep districts)
 - n extensive literature analysis
- n Determination of emission factors
 - n emission measurement from test stands
 - n field investigations

Flue Gas Components for Calculation of Sectoral Emission Factors

- n CO₂, CO, VOC, CH₄, NMVOC
- n Benzene
- n Particulate matter (PM 10, biggest share PM 2.5)
- n SO₂, NO_x (as NO₂), N₂O, HCl,
- n Heavy metals: As, Cd, Cr, Cu, Hg, Ni, Pb, V, Zn
- n Polychlorinated dioxines and furanes (PCDD/PCDF)
- n Polycyclic aromatic hydrocarbons

Calculation of sectoral emission factors with the proportionate energy consumption and the appliance-specific emission factors



Differentiation of Emission Factors (1)

Fuel	Type of boiler	Power class (kW)
Light oil	Furnaces with vaporizing boilers	≥ 4
	Atomizing oil burners	4 – 25
		25 – 50
		>50
Condensing boilers	4 – 25 25 – 50 >50	
Natural gas liquid gas	Fan assisted gas burners (boiler)	4 – 25
		25 – 50
		>50
	Natural draught burners	4 – 25 25 – 50 >50
	Combi-waterheaters, instantaneous water heaters	≥ 4
	Condensing boilers	4 – 25 25 – 50 >50

Differentiation of Emission Factors (2)

Fuel	Type of boiler	Power class (kW)
Solid fuels (coal and wood)	Boilers (central and floor heating)	4 – 25 25 – 50 >50
	Pellets fired boilers	4 - 50
	Wood chips fired boilers	>50
	Slow combustion stoves	< 15
	Masonry heaters and tiled-stove inserts	< 15
	Openfire stoves	< 15
	Fireplaces (open or closed inserts)	< 15
	Bathroom boilers	< 15
	Cookers	< 15
Wood scrap	4 different type of boilers	all >50

New Installations and Technologies

- n Pellet-fired boilers
- n Boilers fired with wood chips (small district heating networks up to 1 MW)
- n Condensing boilers (since 2001, oil with low sulphur content)
- n (Biogas not considered, mostly used for production of electricity, feed-in tariffs)

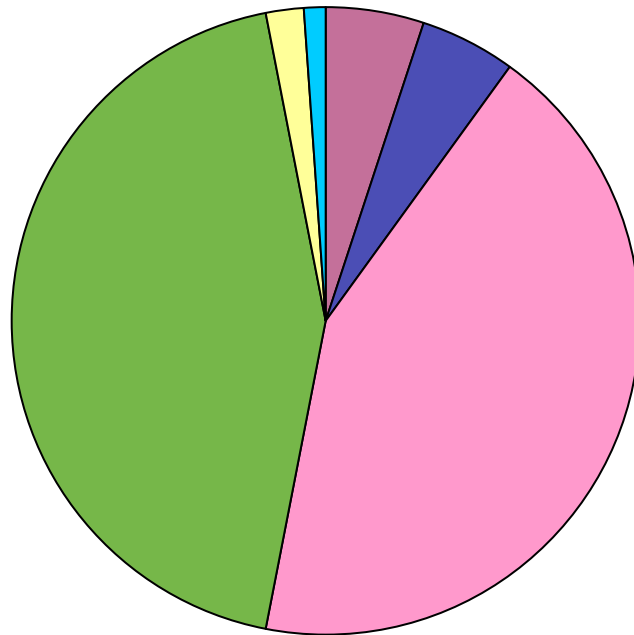
Age of Installations

- n 3 classes
- n before 1988/ 1989 to 2000/ from 2001
- n since 2001 open fireplace, pellet-fired boiler, condensing boiler
- n number of oil fired boilers declining, replaced by gas-fired or wood-fired
- n gas-fired boilers increasing

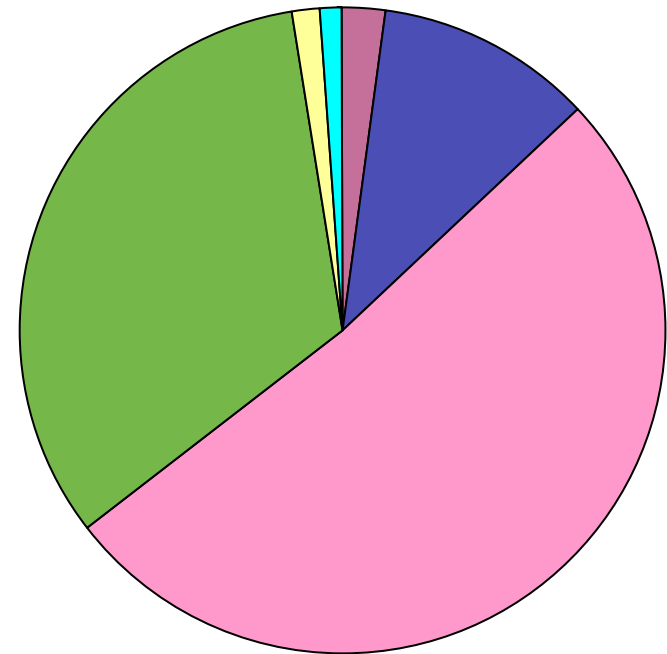
Trends of Emissions

- n Components dependent on combustion directly - improved
- n High share of dioxines from combustions in smaller consumer sector (wood scraps, flake boards with remainders of plastic?)
- n Increase of particulate emissions from open fire stoves (filter technically challenging and expensive)
- n 95% of benzo(a)pyrene from small combustion installations

Trends of Energy Sources

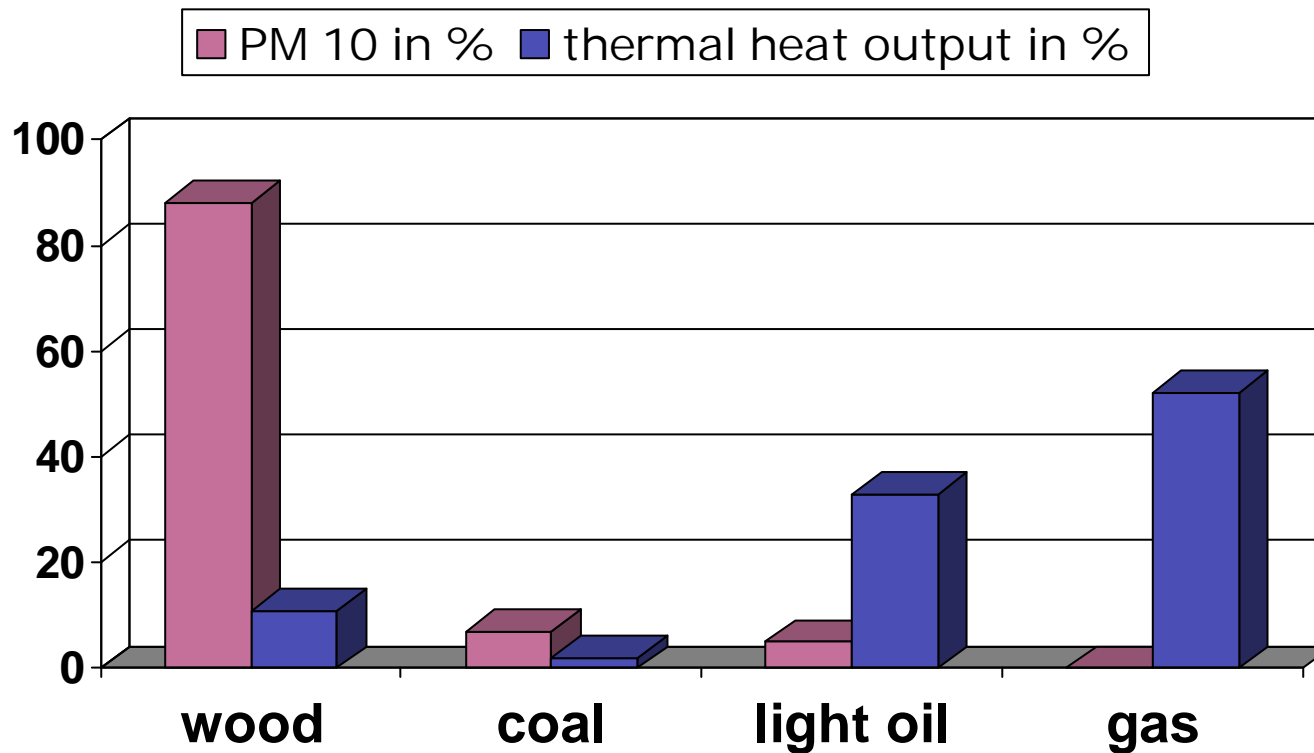


1995 (2,046 Mio TJ)

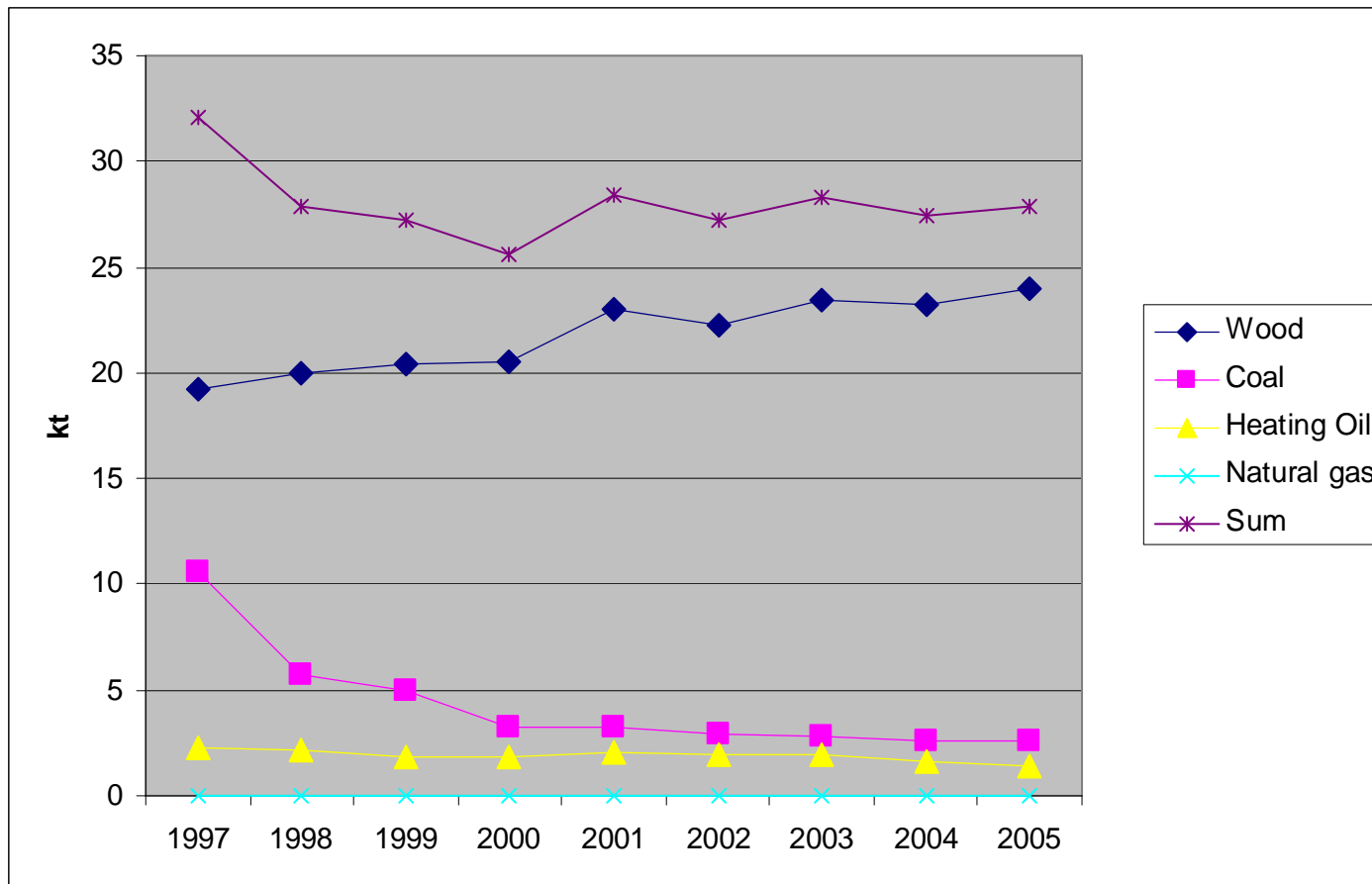


2005 (1,996 Mio TJ)

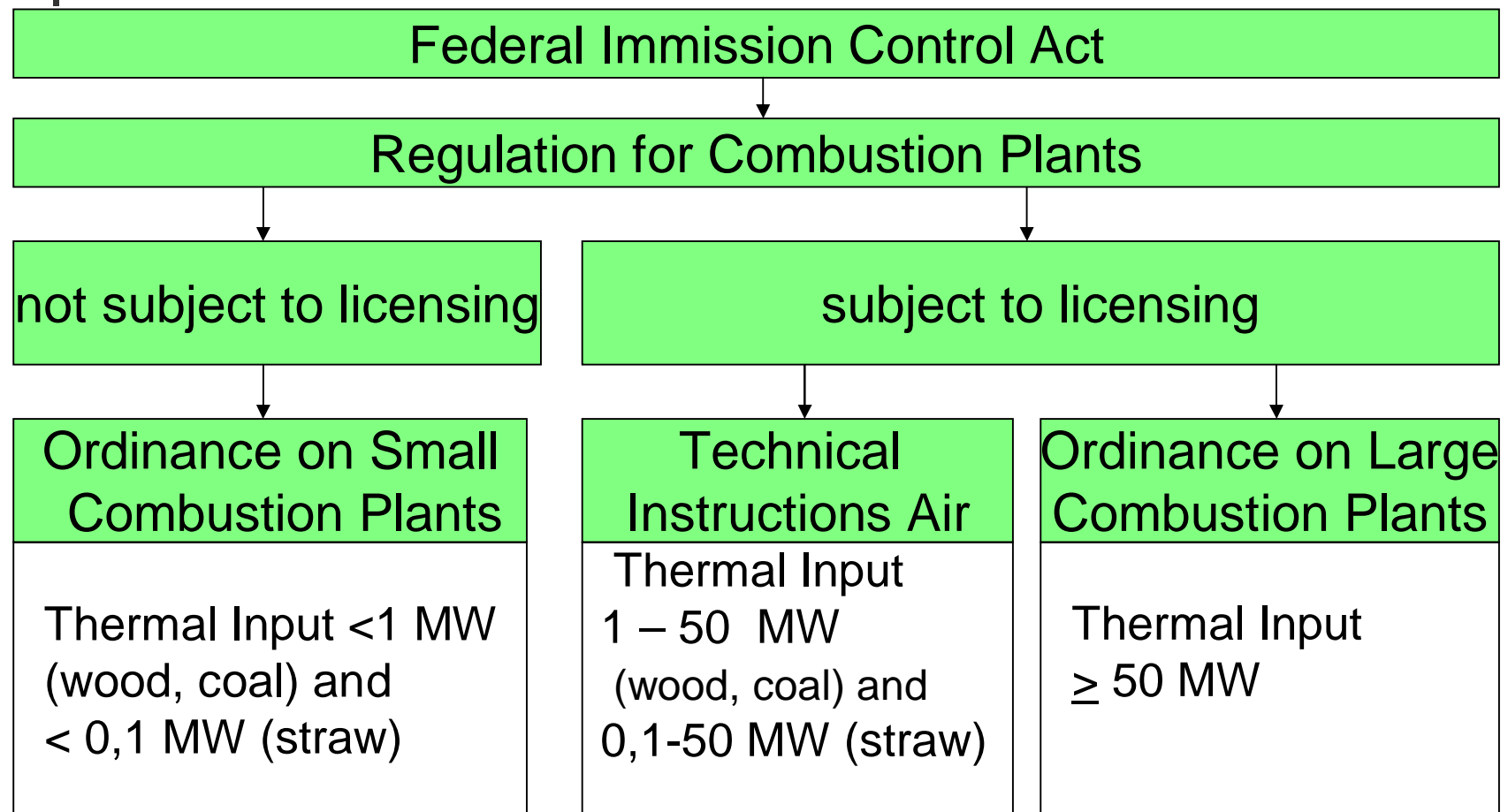
Heat and Particulates Relationship



Development of Dust Emissions



Legal Framework



Uncertainties

- n Estimation of uncertainties by expert judgement
- n Sources of error:
 - n Uncertainties in estimating transfer factors (systematic differences between test-bench and field measurements);
 - n Uncertainties resulting from having too little emissions data;
 - n Uncertainties resulting from use of different measuring procedures;
 - n Uncertainties in the plant data used (overall group structure in terms of type, age and performance and fuel consumption)
 - n Measuring errors in determination of pollutant concentrations;
- n Differentiation between systems with gaseous or liquid and systems with solid fuels

Thank you for your attention!

