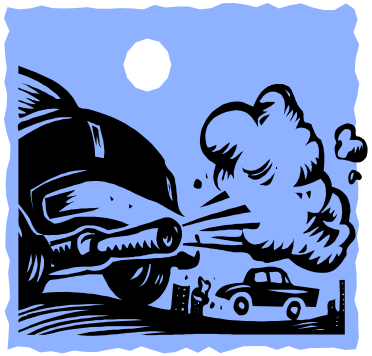
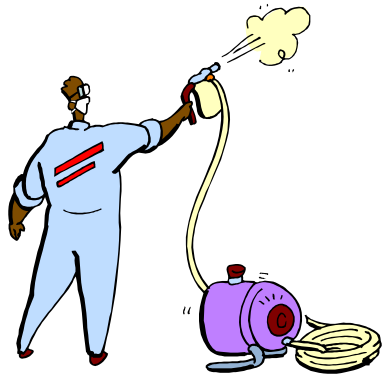
Development of an improved product based approach for the calculation of NMVOC emissions from solvent use in Germany and uncertainty analysis

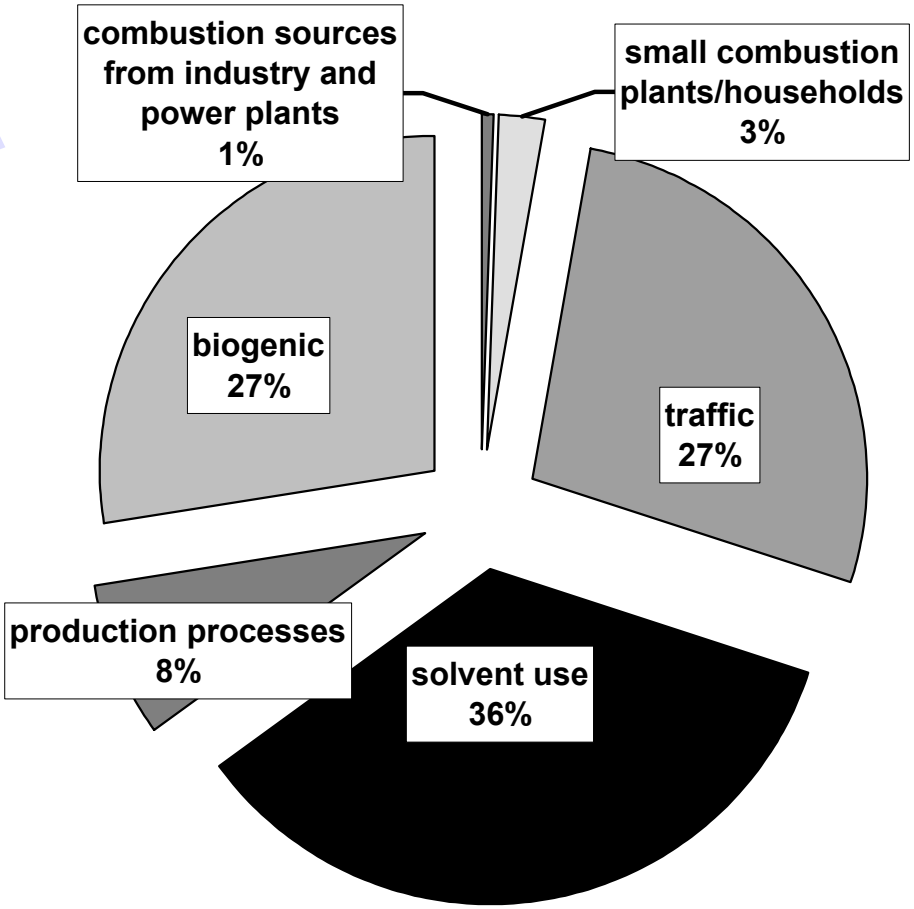
Jochen Theloke
University of Stuttgart

Contents

Solvent use was the largest NMVOC emission source group in Germany in 1998







Sum: 2 436 kt

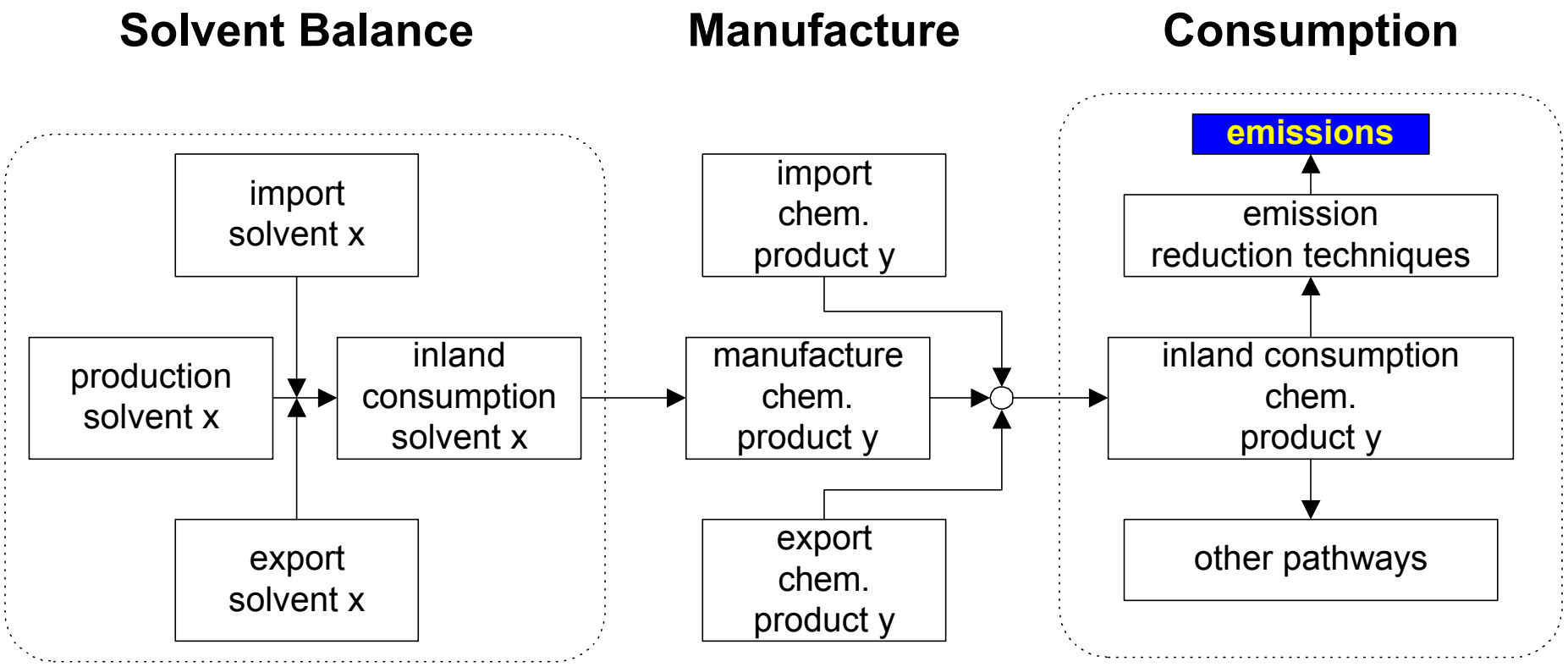
VOC - Volatile Organic Compound

"Volatile organic compound shall mean any organic compound having at 293,15 K a vapour pressure of 0,01 kPa or more, or having a corresponding volatility under the particular condition of use."

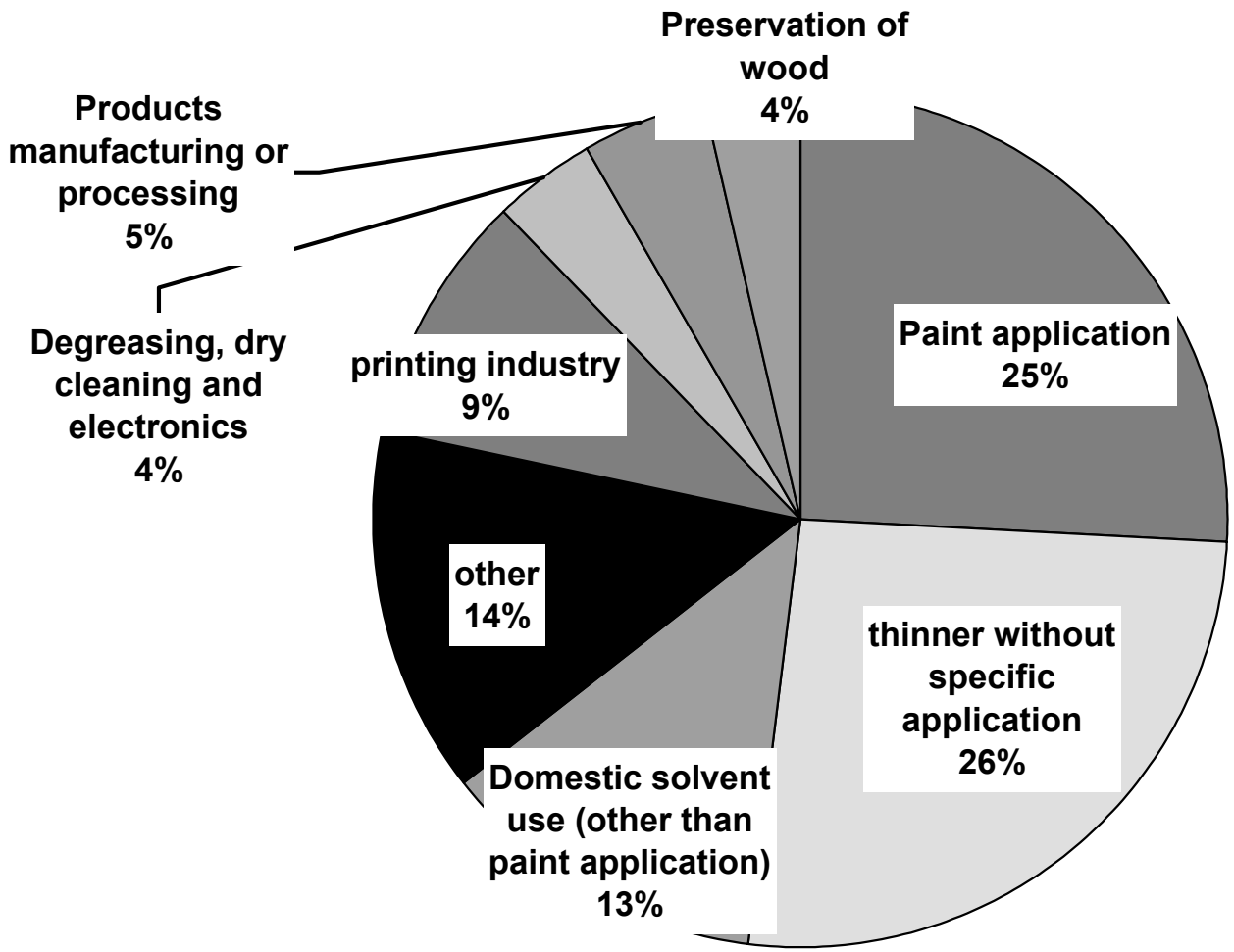
Solvent Use

- Application of solvents
- Application of solvent containing products
- Production of solvent containing products
- Propellants (Propane/Butane)
- Extraction of fat, edible and non edible oil (n-hexane)
- Cooling agents (HFHC`s, HFCHC`s, alcohols)
- Softening agents (Phtalates)
- Concrete additives
- Application of thinners

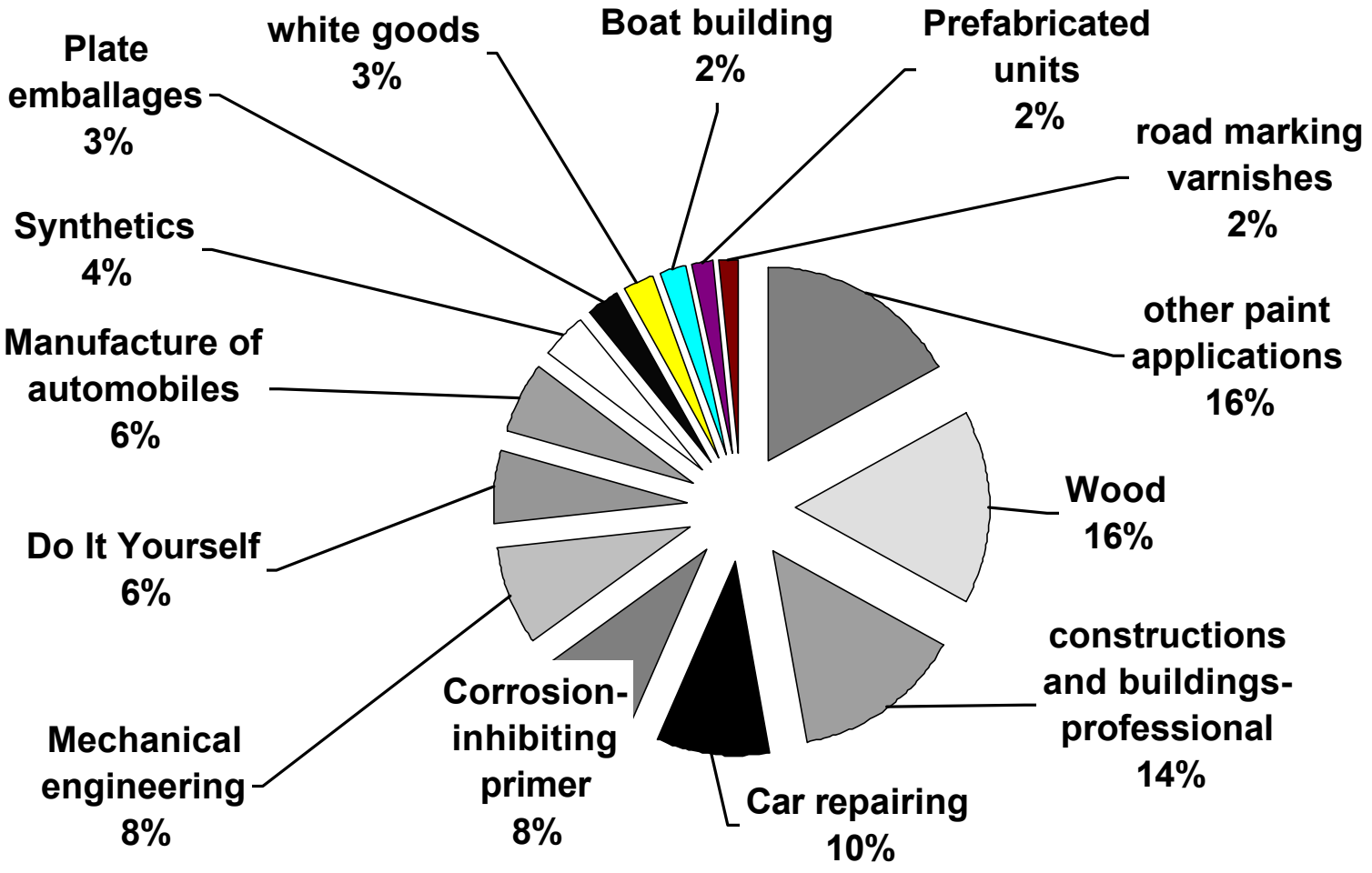
Method for the calculation of emissions from solvent use



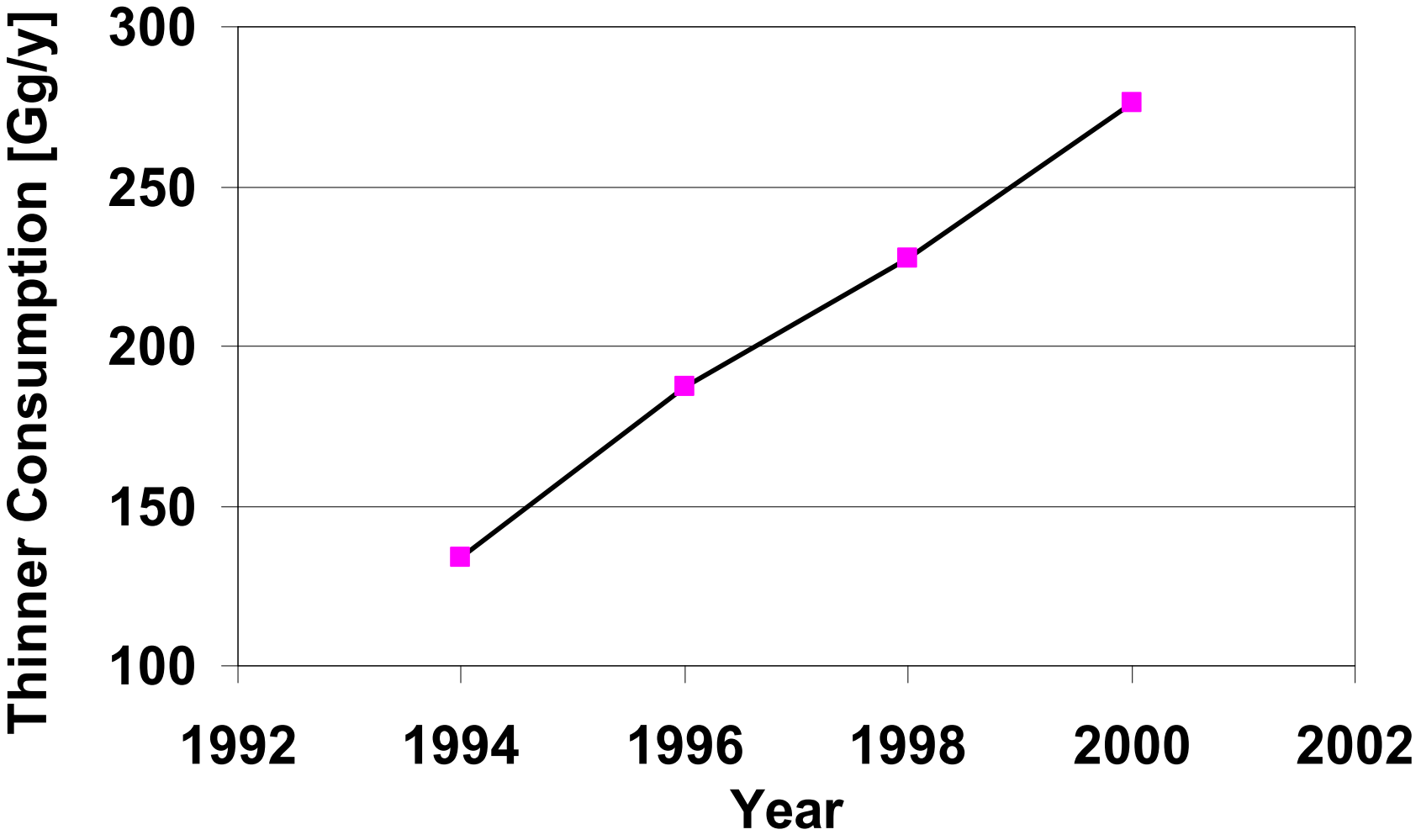
870 Gg NMVOC emitted from solvent use in Germany 2000



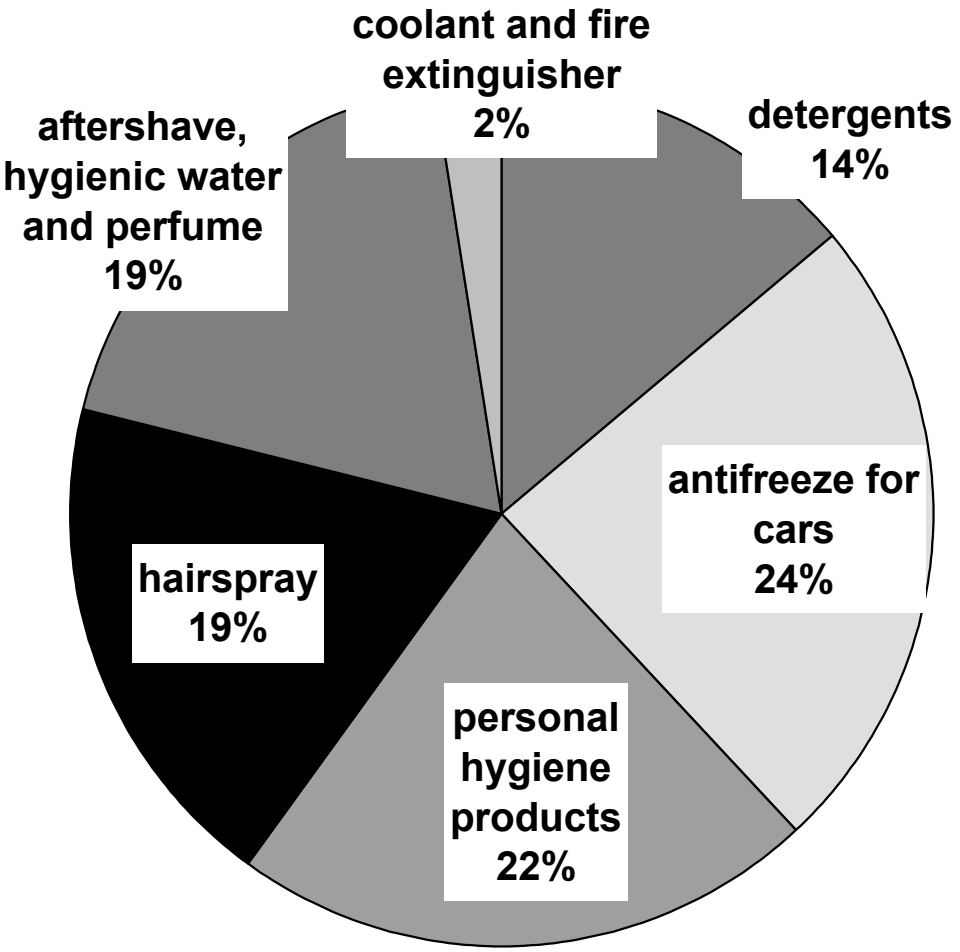
Paint application (sum 223 Gg)



The domestic consumption of thinners increased continously in the last years



NMVOC emissions from domestic solvent use (sum 105 Gg)

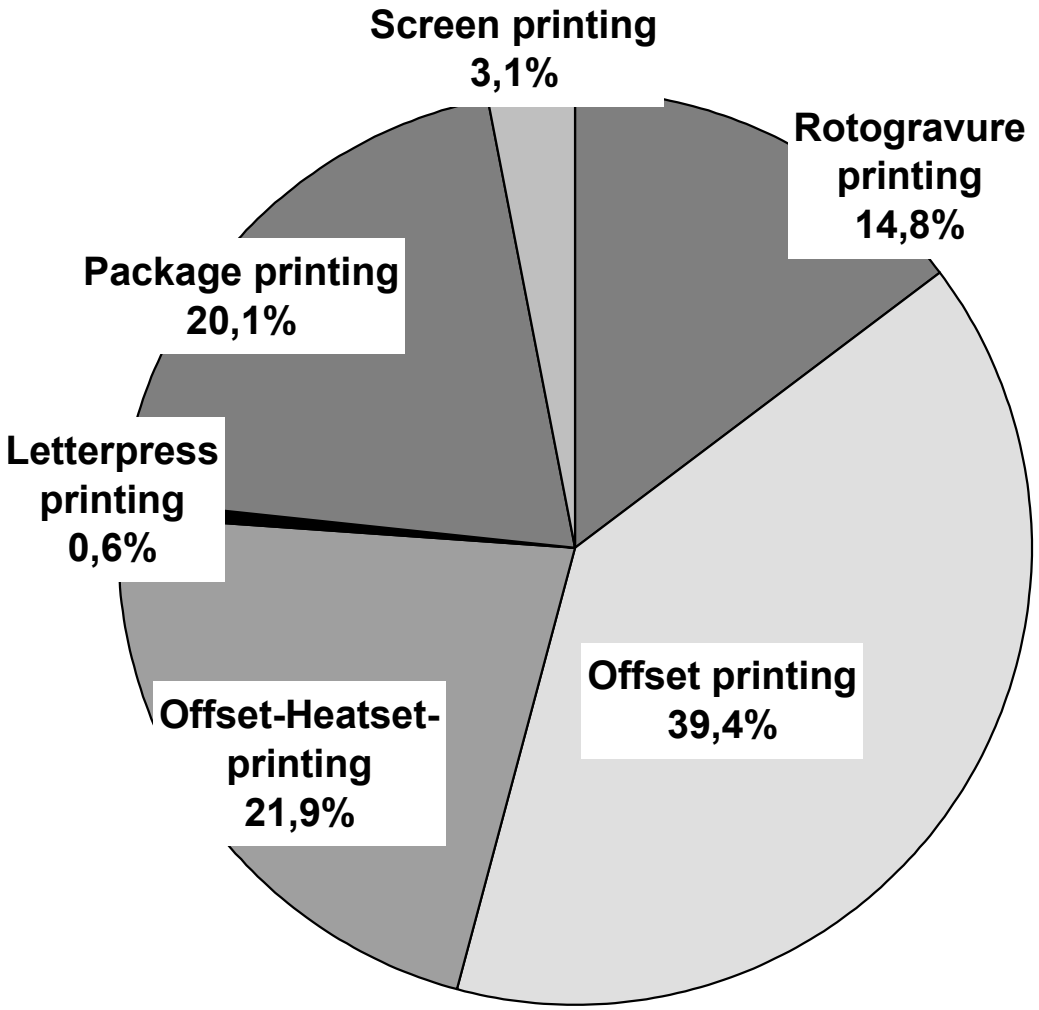


NMVOC emissions from domestic solvent use

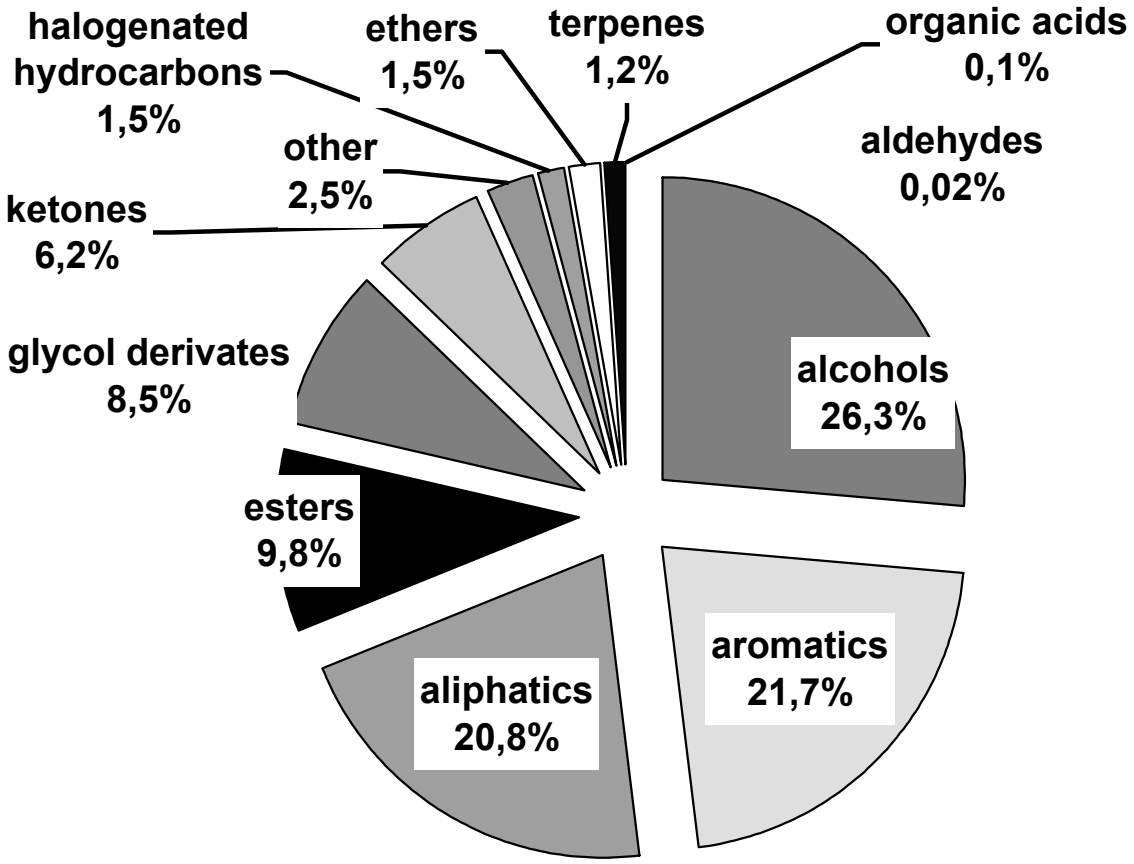
	Solvent consumption Mg/y	Emission factor %	NMVOC emissions Mg/y
Antifreeze for cars	51 100	50	25 550
Detergent for dishwasher	9 900	3	300
Detergent for car washing	10 900	3	330
Detergent for washing-machine	12 660	3	380
Alcohol consumption	750 000*	1	7 500
Hairsprays	19 350	95	18 400
Personal hygiene products	24 400	95	23 150
Toilet water	6 100	95	5 800
Aftershave	5 600	95	5 300
Perfume	2 500	95	2 400
Deodorants	1 180	95	1 120

*) pure Ethanol

NMVOC emissions from printing processes (sum 80 Gg)



Speciation of the NMVOC emissions from solvent use to substance classes



Verification - Plausibility check

Substance classes	Domestic consumption [t] (solvent industry)	Domestic consumption [t] (own estimation)	Deviation [%]
Aliphatics	**300 000**	**280 000**	**- 6,7**
Aromatics	**250 000**	**286 000**	**+14,4**
Terpenes		10 000	
Halogenic hydrocarbons	**35 000**	**35 000**	
Alcohols	**360 000**	**316 000**	**-12,2**
-Ethanol	50 000	85 000	
-Isopropanol	250 000	144 000	
-n-Propanol	40 000	200	
-n/i-Butanol	10 000	56 000	
Glycolderivates	**75 000**	**78 000**	**+4,0**
Esters	**75 000**	**76 000**	**+1,3**
Ketones	**60 000**	**61 000**	**+1,7**
Ethers	**30 000**	**29 000**	**-3,3**
Aldehydes		200	
Organic Acids		800	
Softening agents		225 000	
Other VOC`s		65 000	
Sum (Sum of bold faced substance classes)	**1 185 000**	**1 161 000**	**-2,0**

Assessment and calculation of uncertainties of NMVOC emissions from solvent use - Methods

Uncertainty analysis

- Qualitative assessment
- Semiquantitative methods

Quantitative methods

- Error propagation
- Monte-Carlo simulation

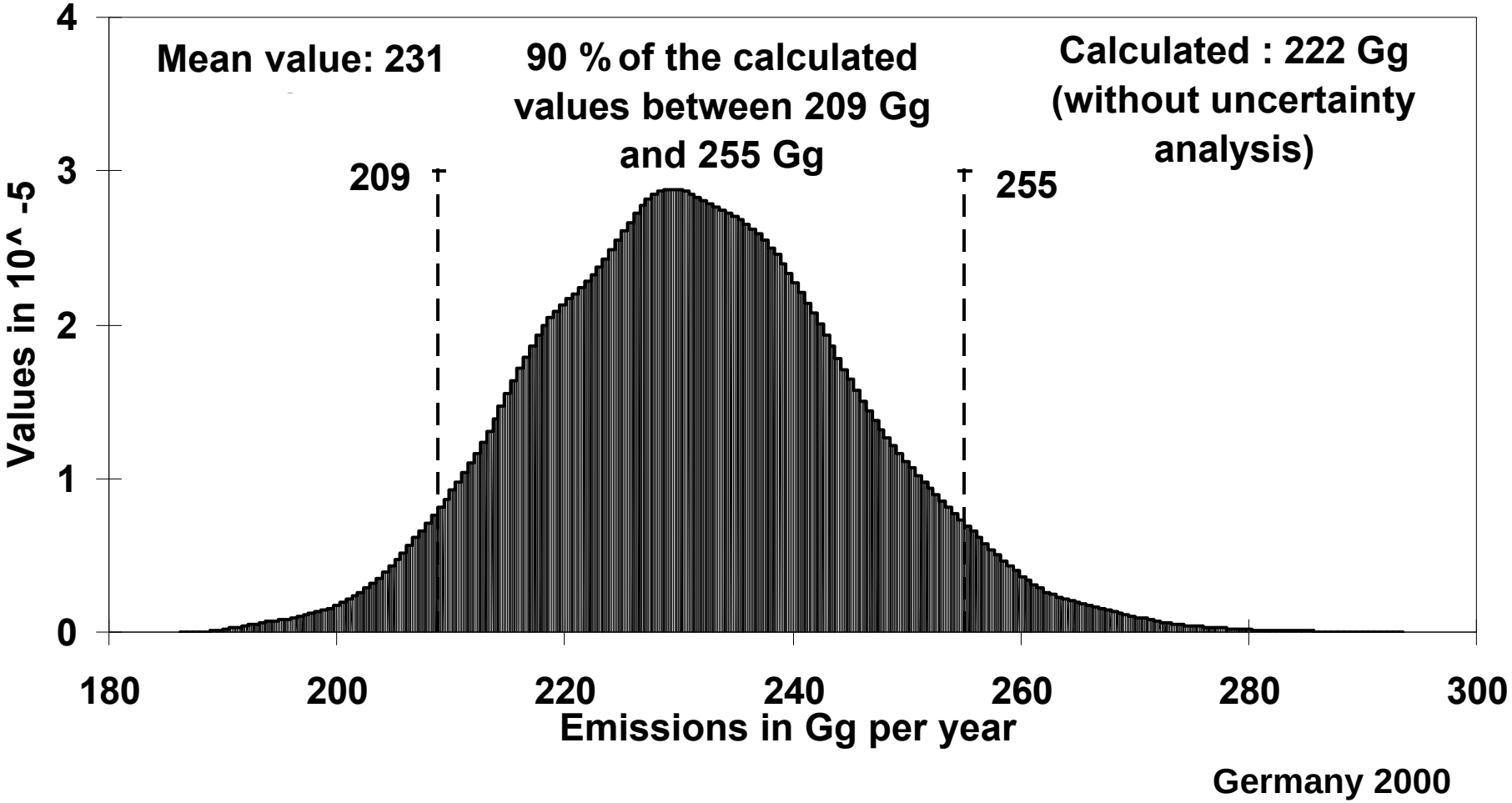
Verification

- Plausibility checks
- Evaluation experiments

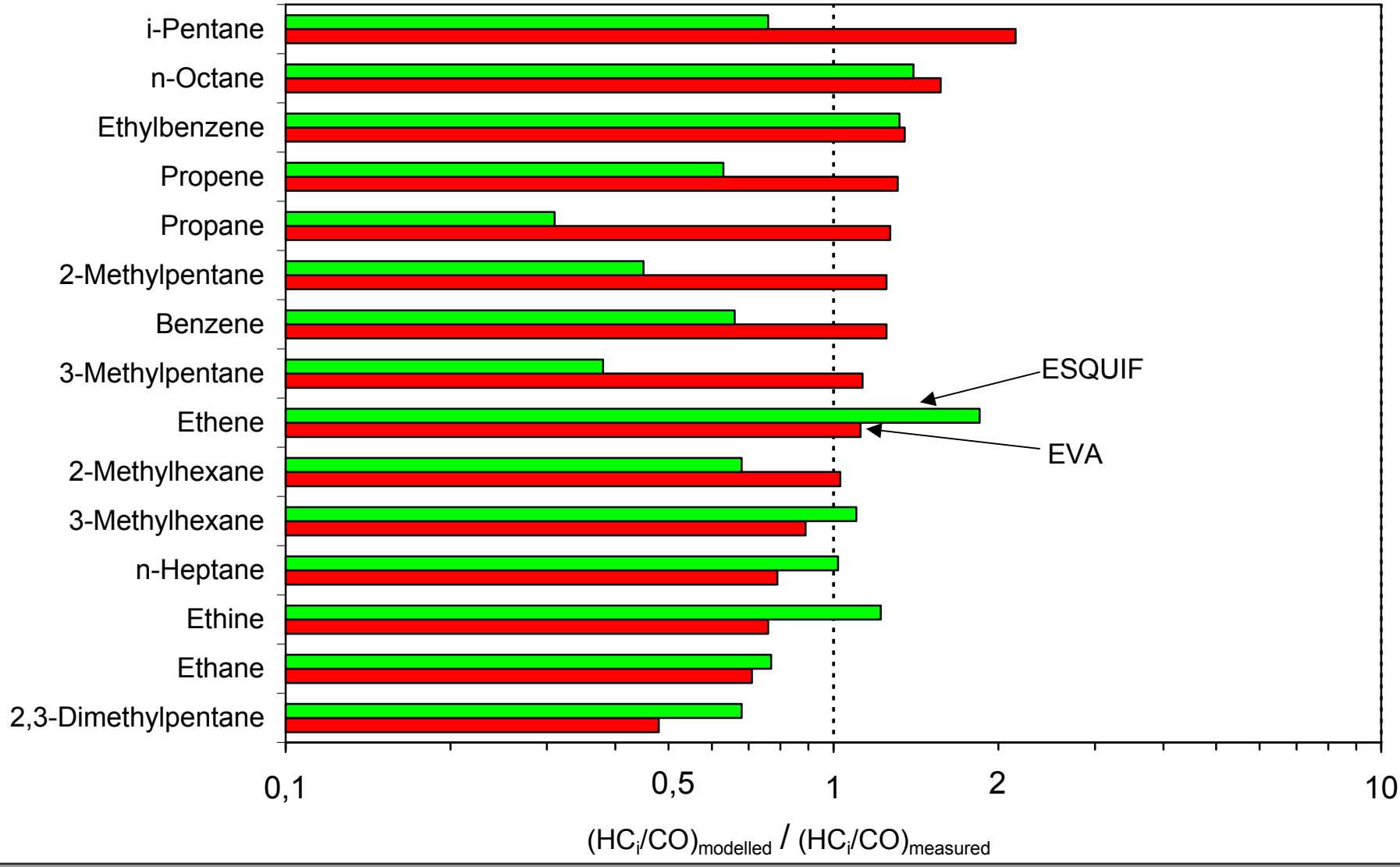
Semi-quantitative methods

Source groups	Uncertainty bandwith			
	Yearly emissions	Spatial resolution	Temporal resolution	VOC speciation
Paint application	2-3	3	3-4	3
Domestic solvent use	3	2	5	2
Printing processes	2	2	3	2
Synthetics processing	4	4	4	3
Metal degreasing	4	4	4	4
Other source groups	3	3	3-4	4
Solvent use Complete assessment	3	3	4	3

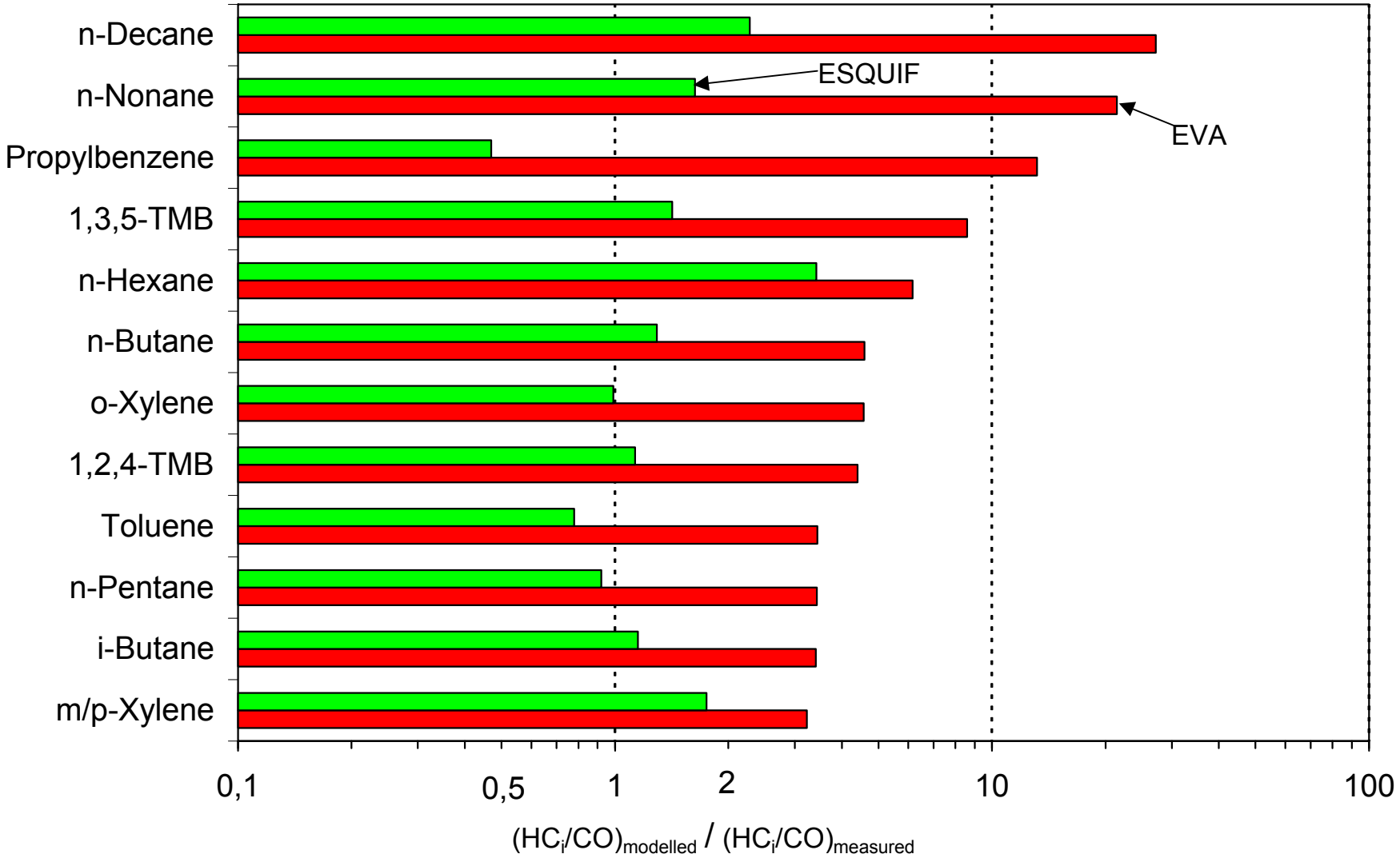
Monte-Carlo simulations for emissions from paint application - Preliminary results



Verification - Results of city experiments



Verification - Results of city experiments



Conclusion

- Emissions from solvent use was the largest NMVOC emission source group in Germany in 1998
- The developed improved product based approach for the calculation of NMVOC emissions from solvent use in Germany was further developed and applied for 2000
- The method can in principle also be used for other OECD countries
- Nearly 75% of emissions from solvent use are caused by paint application, application of thinners, domestic solvent use and printing processes
- Nearly 50% of emitted solvents are oxygen containing NMVOC`s
- A plausibility check between a solvent based approach and a product based approach yielded a good agreement
- The results of city experiments in Augsburg and Paris indicates that further experiments especially with measurements of OVOC are required
- Monte-Carlo simulation appears to be a promising approach for the quantification of uncertainties from solvent use emissions