From empirical studies to bioenergy statistics: Bridging the gap of unrecorded wood-bioenergy in Germany

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Bridging the gap of unrecorded wood-bioenergy in Germany

Background

Energy statistics do not provide data on all energetic uses of wood and solid bioenergy.

Hence, there is a need to fully cover solid bioenergy

→ to report the development of bioenergy regards energy security or climate change mitigation

→ for market transparency

(Energy) Transformation Sector	Energy statistics
Industry Sector	Energy statistics
Transport Sector	Energy statistics
Other sectors:	
- Residential	? (Empirical studies)
- Agriculture, Forestry, Fishing	?
- Commercial & Public Services	?
- Industry sector < 20 Employees (specific DE)	?

Methodological approach
General approach

Background: "*Wood resources monitoring*" – Material & ener. use of wood raw mat.

Problem:

→ imprecise statistics

→ do not provide all relevant information

Objective:

Quantification of all uses of wood resources

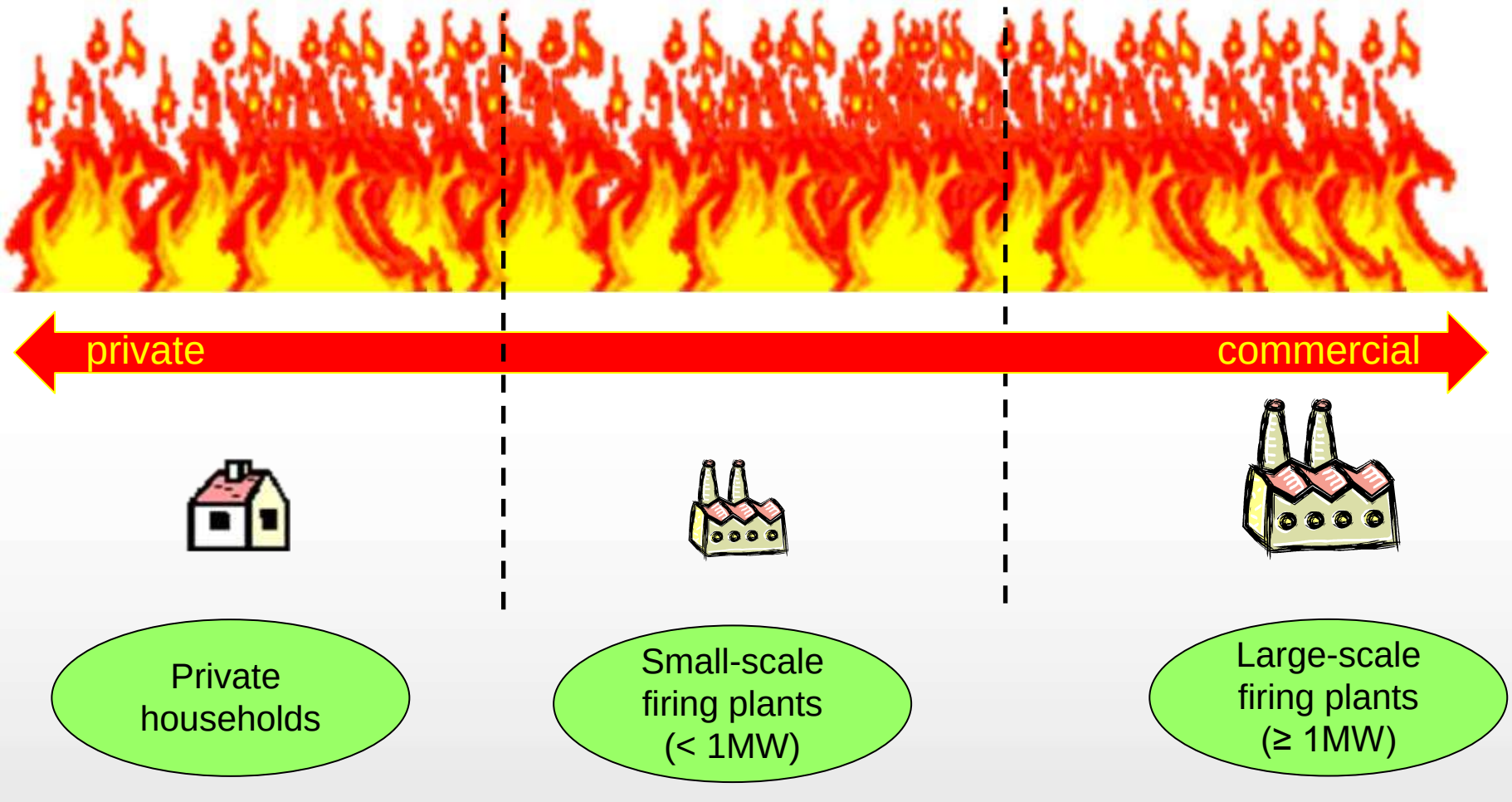
Methodology:

Undertaking empirical studies where necessary (full or sample survey; started in 1999 at UHH)

In co-operation with University of Hamburg

Methodological approach
General approach

Background: Energetic use of wood



Methodological approach
General approach

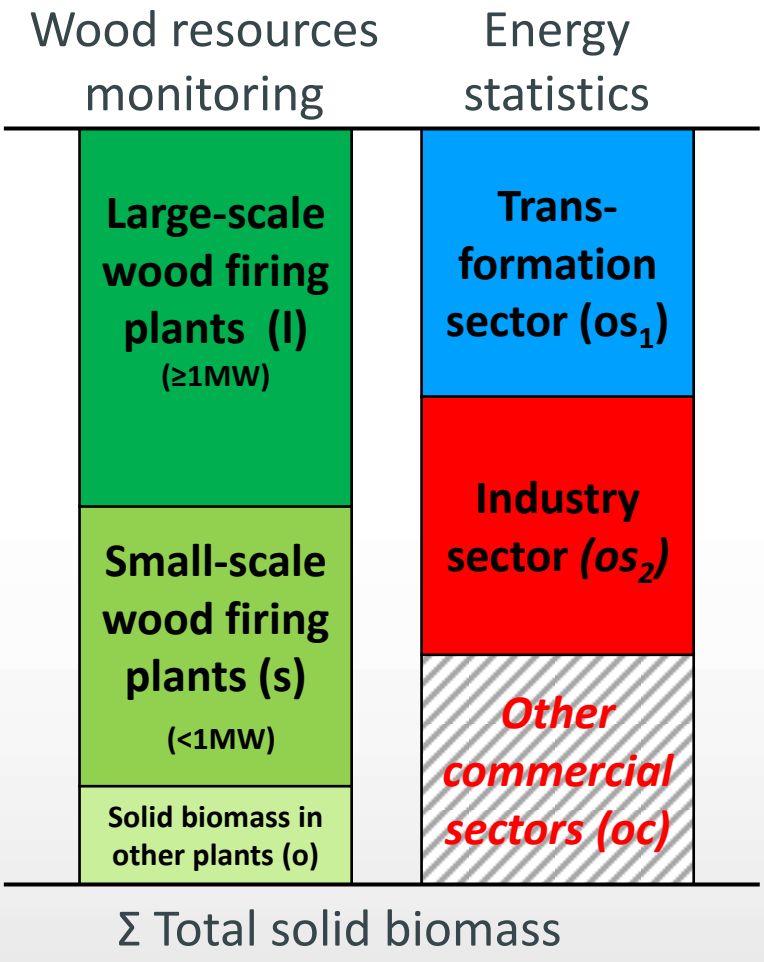
Assumptions:

1. Empirical studies (wood resources monitoring) describe the total use of woody biomass for energy generation in Germany
2. Energy statistics do accurately record primary energy consumption, except for the sectors of commercial and public services, agriculture, forestry & fishing and companies of the manufacturing sector with less than twenty people (= other commercial sectors)

$$\Rightarrow \quad PEC_{oc} = PEC_{es} - PEC_{os} \qquad (1)$$

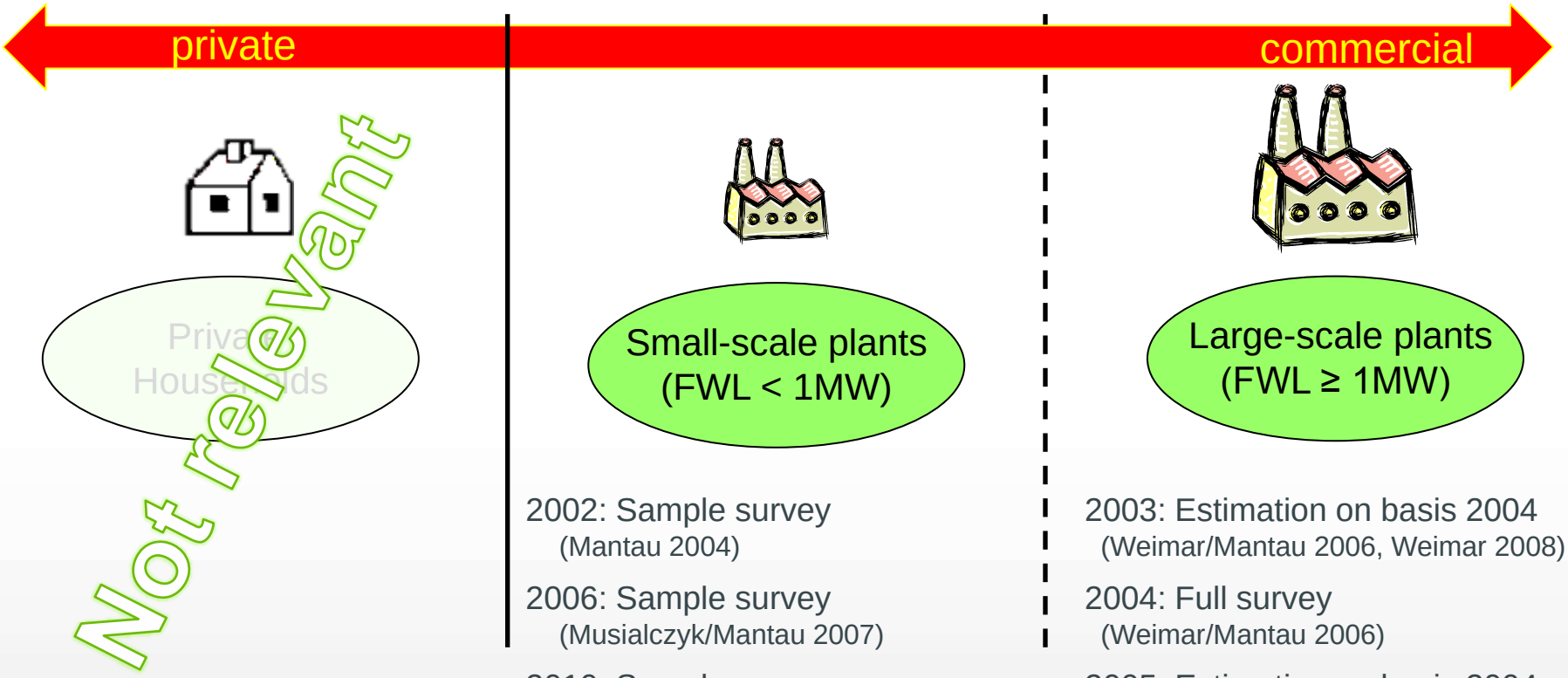
$$\Rightarrow \quad PEC_{es} = PEC_{s} + PEC_{l} + PEC_{o} \qquad (2)$$

$\Rightarrow$ *set up a time series from 2003 to 2014*



Methodological approach
General approach

Data



2002: Sample survey
(Mantau 2004)

2006: Sample survey
(Musialczyk/Mantau 2007)

2010: Sample survey
(Mantau et al. 2012)

2003: Estimation on basis 2004
(Weimar/Mantau 2006, Weimar 2008)

2004: Full survey
(Weimar/Mantau 2006)

2005: Estimation on basis 2004
(Weimar/Mantau 2006, Weimar 2008)

2011: Full survey
(Weimar et al. 2012)

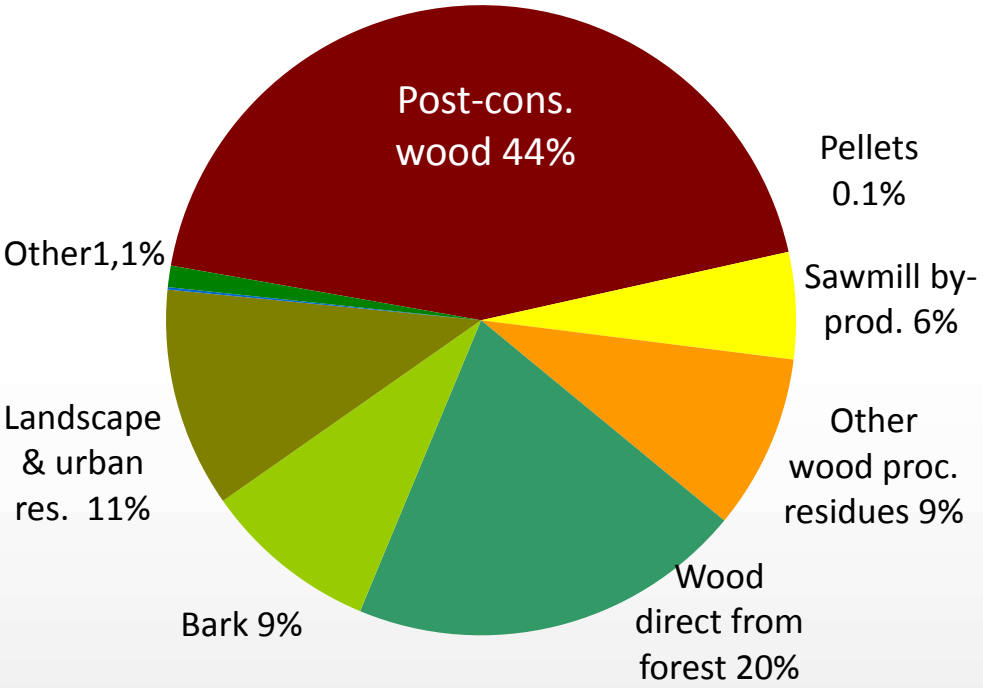
Methodological approach
Specific approach

Data on large-scale wood-firing plants

Wood use by size class

Size class by thermal cap.	Plants		Wood use [Mill. $tons_{air-dry}$]	
1 - 5 MW	298	55.1%	1.342	9.6%
5 - 25 MW	161	29.8%	4.057	28.9%
25 - 50 MW	42	7.8%	3.104	22.1%
ab 50 MW	40	7.4%	5.519	39.4%
Sum in 2011	**541**	**100%**	**14.022**	**100%**

Structure of assortments



Source: Weimar et al. (2012)

Methodological approach
Specific approach

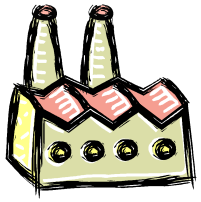
Data on small-scale wood-firing plants

Assortments	in tons$_{air-dry}$	%	in tons$_{bone\ dry}$	in m³
Waste paper	0	0%	0	0
Post-consumer wood	60,758	1.2%	48,825	105,609
Landscape & urban residues	433,156	6.6%	234,337	463,988
Roundwood from forest	583,801	10.5%	371,531	773,898
Chips from forest	1,949,144	31.0%	1,099,317	2,113,987
Sawmill by-products	379,343	6.6%	233,258	496,373
Other wood processing residues	1,244,890	29.1%	1,030,395	1,981,450
Pellets	555,489	14.1%	499,940	1,063,873
Other	43,835	0.7%	24,929	53,048
Total	5,250,414	100%	3,542,532	7,052,225

Source: Mantau et al.(2012)

Methodological approach
Specific approach

Large-scale wood firing plants:



Def.: Rated thermal input of ≥ 1 megawatt

Approach: $U_{l,j} + = \beta_0 + \beta_1 x_{1,j} + \varepsilon$ (linear)

Empirical data U_l for 2003, 2004, 2005, 2011

Data x_1: heat and power supply of industry and heating plants (in PJ) by official energy statistics

Test statistics:

	Model (N = 4)	Variables	Coefficient estimates	Standard errors	t values	p values
R^2	0.9878	β_0	2690112	343216	7.84	0.0159
R^2 (adjusted)	0.9817	β_1	30.93702	2.42931	12.73	0.0061
F-statistic	162.18					
p value	0.0061					

U – use of wood for energy generation (in oven-dry metric tons (odmt)); l – large-scale firing plants;
x_1 – heat and power supply of industry and heating plants (in PJ); j – year; β – parameters

Methodological approach
Specific approach

Small-scale wood firing plants:

Def.: Rated thermal input below 1 megawatt

Approach: $U_{s,j} + = \beta_0 + \beta_1 x_{1,j} + \beta_2 x_{2,j} + \varepsilon$ (linear)

Empirical data U_s for 2002, 2006, 2010

Data x_1: Annual turnover of manufacturer of wood products and furniture (Euro, deflated)
Data x_2: Heating degree days (in Kelvin day, Kd)

Test statistics:

	Model (N = 3)	Variables	Coefficient estimates	Standard errors	t values	p values
R^2	1	β_0	-18888361	-	-	-
R^2 (adjusted)	-	β_1	0.27235	-	-	-
F-statistic	-	β_2	3321.1630			
p value	-					

U – use of wood for energy generation (in oven-dry metric tons (odmt)); s – small-scale firing plants;
x1 – annual turn over (in Euro, deflated); x2 – heating degree days (in Kelvin day, Kd); j – year; β – parameters

Methodological approach
Specific approach

Small-scale wood firing plants:

Def.: Rated thermal input below 1 megawatt

~~Approach: $U_{s,j} + = \beta_0 + \beta_1 x_{1,j} + \beta_2 x_{2,j} + \varepsilon$ (linear)~~

Empirical data U_s for 2002, 2006, 2010

~~Data x_1: Annual turnover of manufacturer of wood products and furniture (Euro, deflated)~~
~~Data x_2: Heating degree days (in Kelvin day, Kd)~~

Test statistics:

New approach: Interpolation in between empirical data based on sub-categories of renewable energy statistics (sub-categories are assumed to reflect somehow the development of small plants)

However: If additional data are available, new tests will be run (probably in 2017)

U – use of wood for energy generation (in oven-dry metric tons (odmt)); s – small-scale firing plants;
x1 – annual turn over (in Euro, deflated); x2 – heating degree days (in Kelvin day, Kd); j – year; β – parameters

Methodological approach
Specific approach

Other firing plants:

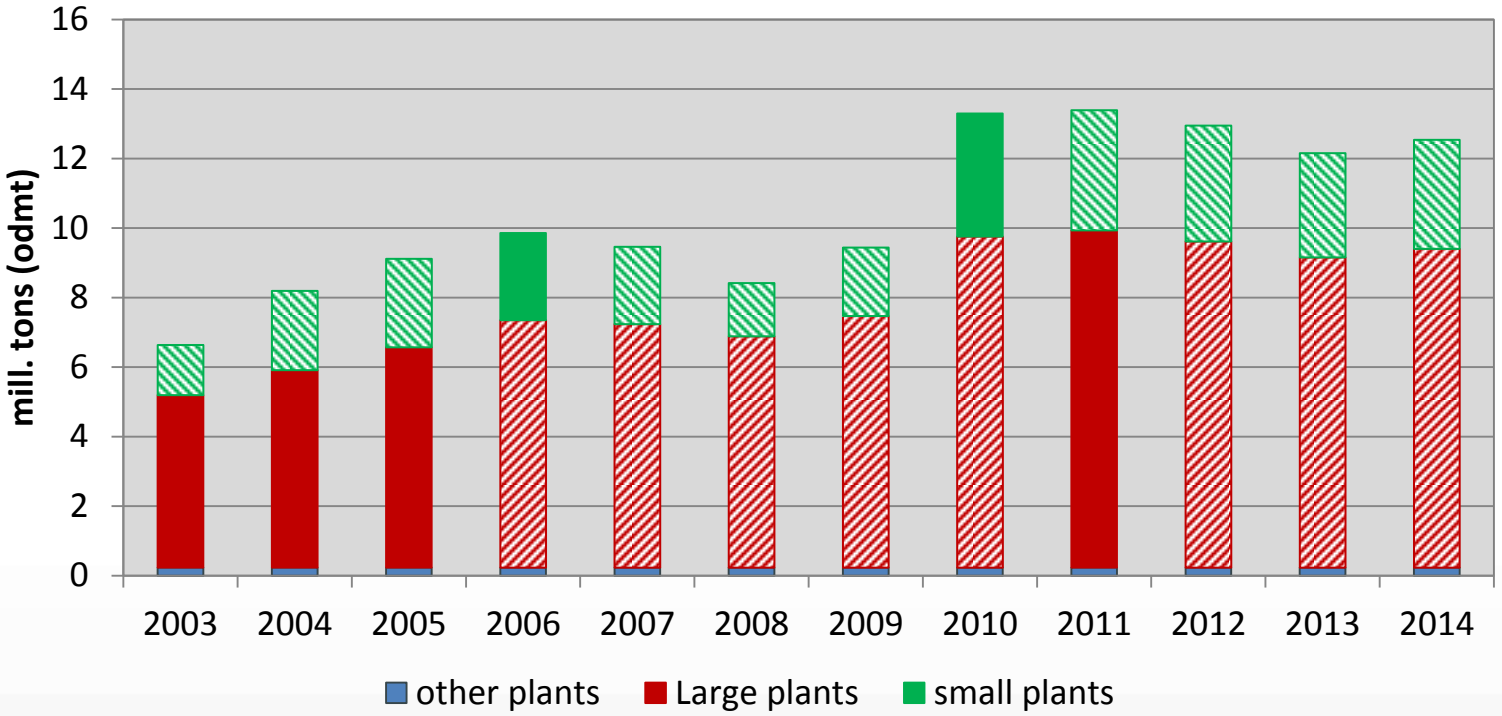
Def.: Use of solid biomass and use of wood in other plants (co-firing in e.g. coal-fired plants)

Approach: Imputation

Empirical data for co-firing: 2010

Empirical data for other solid biomass in firing plants: 2011

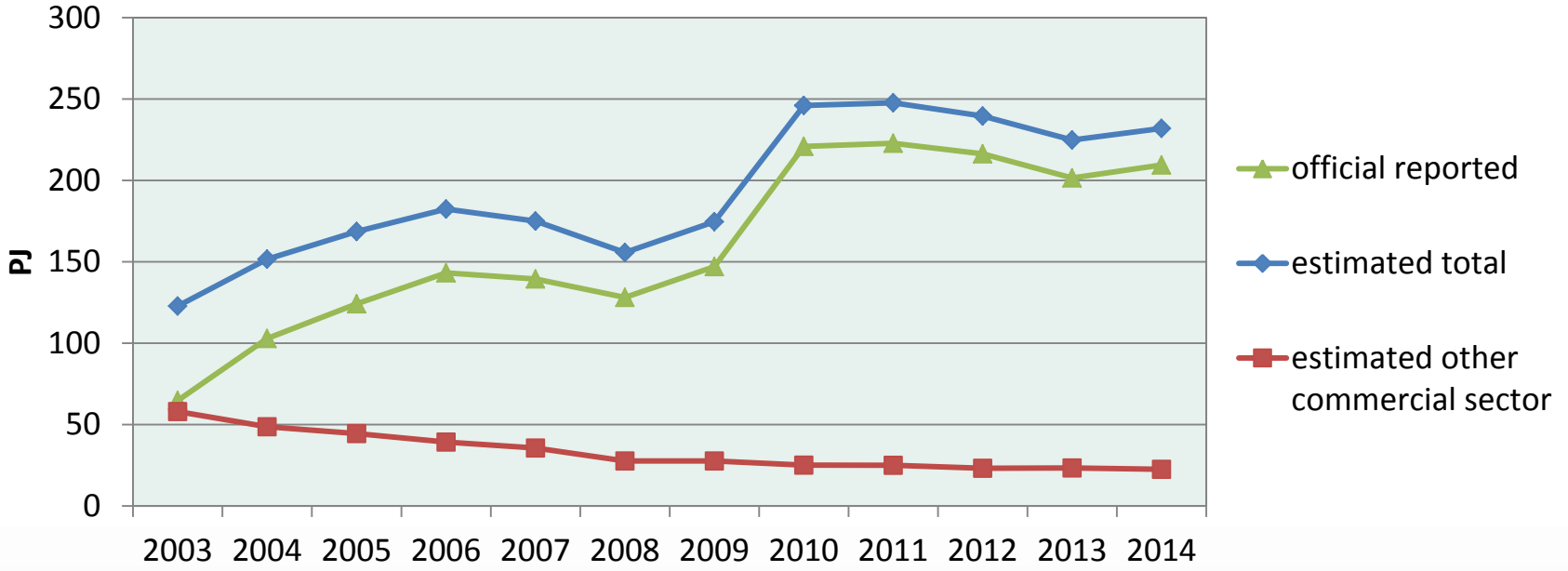
Results
Time series 2003 - 2014



Time series is a combination of empirical and estimated data:

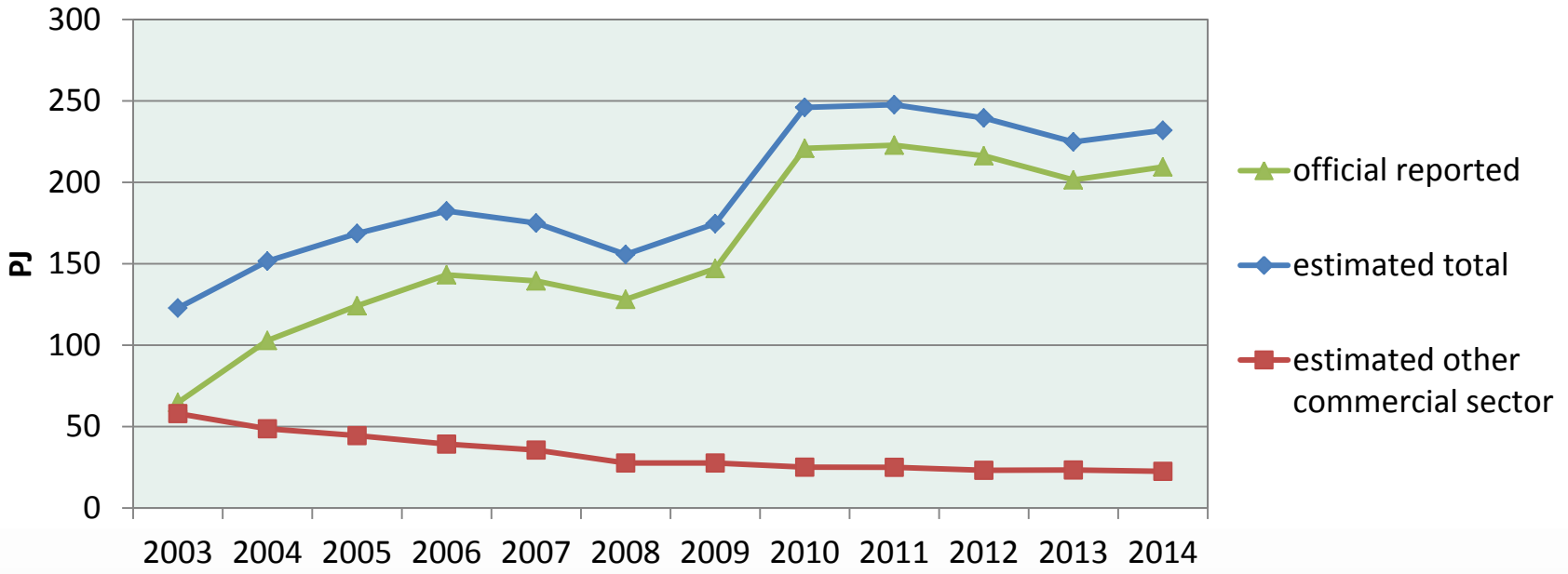
- Empirical data are taken from project wood resource monitoring (full)
- Estimated data are shaded

Results
Time series of estimated ‚other commercial sector'



	Unit	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
TOTAL: Wood & solid biomass	PJ	122.8	151.6	168.6	182.4	175.0	155.7	174.6	246.0	247.7	239.5	224.9	232.0
Official reported	PJ	64.8	102.9	124.2	143.2	139.5	128.1	147.0	220.9	222.8	216.4	201.5	209.5
Other commercial sector	PJ	58.0	48.7	44.4	39.3	35.6	27.6	27.6	25.1	24.9	23.2	23.3	22.5

Summary and conclusion
From empirical studies to bioenergy statistics: Bridging the gap…



→ Results provide data on formerly unknown segment of the wood energy sector
→ Results are within the range of comparable studies
→ Methodology is suitable to support energy statistics
! Concept will be used for estimations in future (new project upcoming)
! Next steps: re-estimate with new empirical data & calculate assortments

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Baton Rouge, US-LA
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Annex

Sources:

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Methodological approach
Specific approach

Survey on large-scale wood-firing plants

Objective ⇒ Full survey of large-scale wood-firing plants (capacity ≥ 1 MW)
Research: own database, media, external databases

Response type	N	[%]
Wood &solid biomass firing plants	563	51.8%
- operating (in 2011)	541	49.8%
- in construction	9	0.8%
- in planing stage	13	1.2%
No firing of wood/biomass	8	0.7%
No more operating plant	56	5.2%
Formerly planed, not realized	17	1.6%
Plant capacity < 1 megawatt	176	16.2%
Other	115	10.6%
Non identifiable	152	14.0%
Sum	**1,087**	**100.0%**

Source: Weimar et al.(2012)

Methodological approach
Specific approach

Data on small-scale wood-firing plants

Capacity	15 – 49 kW	50 – 99 kW	100 – 149 kW	150 -499 kW	500 – 1000 kW	Summe
Commercial 1986-2010	32,440	5,291	4,303	5,928	1,722	49,684
in %	64.9	10.6	8.7	12.2	3.6	100
Communities 1986-2010	490	218	160	458	198	1,523
in %	32.1	14.3	10.5	30.1	13.0	100
Parent population2010 Commercial & commun.	32,930	5,509	4,462	6,386	1,921	51,207

> Database: Statistics of ZIV (Annual statistics of Federal Association of Chimney Sweepers)
> Data of first measurement of plants are taken
> Assumption: Lifespan of 20 years per plant
> Additional: Statistics of BAFA are used for differentiation of private plants up to a capacity of 100 kW and for differentiation of commercial and communal plants

Source: Mantau et al.(2012)

Methodological approach
Specific approach

Data on small-scale wood-firing plants: surveyed wood consumption

Gewerbe & Kommune	15 - 49 [kw]	50 - 99 [kw]	100 - 149 [kw]	150 - 499 [kw]	500 - 1000 [kw]	Summe
Anzahl Anlagen	12	19	24	98	78	**231**
Einheit	[t_{lutro}]	[t_{lutro}]	[t_{lutro}]	[t_{lutro}]	[t_{lutro}]	[t_{lutro}]
Altpapier	0	0	0	0	0	**0**
Altholz	0	0	91	435	627	**1.153**
Landschaftspflegematerial	0	3	349	1.858	9.999	**12.209**
Waldrundholz	0	343	41	4.512	7.423	**12.318**
Waldrestholz	165	419	546	11.105	22.303	**34.539**
Industrierestholz	0	372	599	7.554	21.658	**30.184**
Sägenebenprodukte	0	1	414	2.594	5.406	**8.415**
Pellets	35	14	568	3.585	4.677	**8.878**
Sonstige	0	6	18	54	1.386	**1.465**
Gesamt	**201**	**1.159**	**2.627**	**31.696**	**73.479**	**109.161**

Commercial: 120 plants | Communities: 111 plants

Source: Mantau et al.(2012)