IREES
Institut für Ressourceneffizienz
und Energiestrategien

GfK

Fraunhofer
ISI

Lehrstuhl für
Energiewirtschaft und Anwendungstechnik
Prof. Dr.-Ing. U. Wagner

BASE
BASE-ING.

Project Number 53/09

Energy consumption of the tertiary sector (trade, commerce and services) for the years 2007 to 2010

Final Report
to the Federal Ministry of Economics and Technology (BMWi)

SUMMARY

Karlsruhe, Munich, Nuremberg, March 2013

Project Team

Fraunhofer Institute for Systems and Innovation Research (Fraunhofer ISI)
Barbara Schlomann (Project leader), Jan Steinbach
Breslauer Strasse. 48, 76139 Karlsruhe
Contact: Barbara Schlomann
Phone: +49 721 6809-136, Fax +49 721 6809-272
E-Mail: barbara.schlomann@isi.fraunhofer.de

Lehrstuhl für Energiewirtschaft und Anwendungstechnik (lfE), Technical University Munich (TUM)
Heinrich Kleeberger, Dr. Bernd Geiger
Arcisstrasse. 21, 80333 Munich
Contact: Heinrich Kleeberger
Phone: + 49 89 289-28303, Fax: +49 89 289-28313
E-Mail: hklee@tum.de

GfK Retail and Technology GmbH
Antje Pich
Nordwestring 101, 90419 Nuremberg
Contact: Antje Pich
Phone: +49 911 395-2511, Fax: +49 911 33 69 70
E-Mail: antje.pich@gfk.com

IREES GmbH
Edelgard Gruber, Michael Mai, Andreas Gerspacher
Schönfeldstrasse 8, 76131 Karlsruhe
Contact: Edelgard Gruber
Phone: + 49 721 9152636-26, Fax: +49 721 9152636-11
E-Mail: e.gruber@irees.de

BASE-ING. GmbH
Werner Schiller
Steinsdorfstrasse 19, 80538 Munich
Contact: Werner Schiller
Phone: +49 89 213194-50, Fax: +49 89 213194-11
E-Mail: werner.schiller@base.eu

Contents

Page

Figures

Page

Tables

Page

1 Starting point and objective

In 2011, around 1,355 PJ or 15.5% of the total final energy consumption in Germany were accounted for by the sector of trade, commerce and services, which is also referred to as the tertiary sector (AGEB 2012). Up to now, the availability of energy statistics for this very heterogeneous sector is not sufficient. This makes the reporting obligations on energy consumption at the national and international level complicate and also limits the statistical basis for energy forecasts and decisions in the field of energy policy. In Germany, the Energy Concept from September 2010 and the decisions on a transformation of the energy system from June/July 2011, the so-called "Energiewende", led to an increasing demand on reliable statistical data for all energy consumption sectors. This is, because the progress made towards the overall targets and the current state of implementation the agreed action plan are evaluated at regular intervals. The corresponding monitoring process "Energy of the future" was approved by the German government on 19 October 2011. The new European Energy Efficiency Directive (2012/27/EU; EED) from 25 October 2012 also provides for annual as well as more comprehensive reporting obligations at three year intervals in Article 19.

In Germany, a regular survey on energy consumption in the tertiary sector has been carried out for 10 years. [1] Within these surveys, the main consumption and structural data in the tertiary sector are collected by consumer group, energy carriers and end-uses. This should further improve the energy statistics for this sector and satisfy the requirements for information about energy. In this study, the results for the 2006 to 2011 are presented. The results for 2011 are still preliminary due to some missing statistical data.

Another focus of the study is on the use of renewable energies in the tertiary sector. The large number and variety of technologies for using renewable energies mean that there are only partially reliable data about the amount of energy actually contributed. Through a more in-depth survey of the use of renewable energies in the tertiary sector, this study also aims at improving the data situation with regard to their use there.

1 Fraunhofer ISI et al. 2004; Fraunhofer ISI et al. 2009

2 Methodology

The basis for the determination of energy consumption in the tertiary sector is a broad survey which is conducted every two years. The size of the sample is approx. 2,000 workplaces. The results shown here are based on the surveys for the years 2006, 2008 and 2010. For the survey, the tertiary sector was divided into 14 groups, which are further subdivided into more detailed splits. For the extrapolation of energy consumption in the tertiary sector in Germany, at first the fuel and electricity consumption of the companies in the groups and splits were determined from the survey results and related to the number of employees documented in the questionnaire. Interpolations and extrapolations were made for years not covered by the original surveys (2007, 2009 and 2011). The averages of the specific electricity and fuel consumption derived from the survey were then extrapolated for Germany using the total number of employees in the individual groups and splits, which are available from the official statistics. For some consumer groups, other reference units for which the energy consumption is were used for the extrapolation. [2] For electricity, several components of energy consumption which were not documented in the survey were added to the consumption value determined from the survey (mainly electricity for street lighting, for shared installations in multi-purpose buildings and for supply and disposal functions). The energy consumption of agriculture and forestry and airports was also determined using data from secondary statistics.

Another element of the surveys is to collect information about energy consumption by energy uses within the individual groups. In order to gain additional information about energy-relevant details, energy audits were carried out in 100 enterprises within the tertiary sector. These audits formed the main data basis for breaking down energy consumption in the tertiary sector by application. The electricity and fuel consumption were divided into the following end-uses: space heating, process heat, air-conditioning (AC), process cold, power, lighting, information and communication (ICT).

In order to gain more detailed information on the use of renewable energies in the tertiary sector, a special survey was carried out in two steps. To start with, 10,000 workplaces were contacted by telephone in order to find out how many enterprises actually use renewable energies. For a more detailed analysis, personal interviews were conducted in 300 selected workplaces. Technical data were requested on the existing installations (e.g. installed power, installation size) and the amounts of energy produced.

---

2 Group 5 hospitals: number of beds, schools/universities: number of pupils/students, public baths: water volume; Group 11 airports: traffic units
(number of passengers / 100 kg freight)

The second questioning was difficult since a certain number of the 1,600 out of 10,221 enterprises from the first round, who initially agreed to a second interview, finally refused the detailed questioning. As a result, less suitable enterprises had to be recruited, some of them even not part of the 10,000 sample. On the basis of the two stages of the special survey, values for the use of renewable energies per employee were derived which were typical for the technology and the branch structure involved. These then formed the basis, like in the main survey, for extrapolating the contribution of renewable energies in the tertiary sector via the number of employees in this sector and their group affiliation. On the basis of all the available results from the two main surveys and all stages of the special survey as well as other additional data sources such as the statistics of organizations and associations, studies etc., the extrapolation of the use of renewable energies in the tertiary sector was then made based on the number of employees.

3 Extrapolation of energy consumption in the tertiary sector for the years 2006 to 2011

Energy consumption by consumer groups in the tertiary sector

Table 1 shows the fuel and electricity consumption in the tertiary sector determined on this basis for the 14 different groups and individual splits. The total determined energy consumption in the tertiary sector in 2011 was around 366 TWh. Electricity accounted for 117 TWh of this and fuels (incl. district heat) for 248 TWh. The row "others" contains additional components of energy consumption which were not able to be determined via the survey, especially the energy consumption of the military and the electricity used for street lighting and communal installations.

Table 1: Projected energy consumption in the tertiary sector by consumer groups 2006 to 2011

Energy unit: TWh		2006			2007			2008			2009			2010			2011		
Group/ Split	Definition	Elec-tricity	Fuels	Total	Elec-tricity	Fuels	Total	Elec-tricity	Fuels	Total	Elec-tricity	Fuels	Total	Elec-tricity	Fuels	Total	Elec-tricity	Fuels	Total
1	Construction industry	3.7	13.5	17.3	3.6	12.0	15.6	3.3	11.3	14.6	3.3	11.9	15.2	3.4	13.1	16.6	3.4	12.0	15.4
2	Office-like enterprises	28.7	69.1	97.9	30.1	67.3	97.4	30.3	68.2	98.6	28.2	63.9	92.1	27.5	66.5	94.0	27.2	58.8	86.0
3	Manufacturing enterprises	4.6	6.3	11.0	4.2	7.1	11.3	3.5	7.6	11.2	4.0	7.5	11.5	4.3	7.8	12.1	4.4	7.1	11.5
4	Retail trade	28.1	39.4	67.5	26.4	38.1	64.6	23.6	38.7	62.3	23.5	38.6	62.2	23.3	41.7	65.0	23.4	36.8	60.3
5/1	Hospitals	7.2	12.9	20.1	6.6	11.2	17.8	6.1	10.8	16.9	6.0	11.0	17.0	5.8	12.0	17.8	5.8	10.9	16.6
5/2	Schools	3.8	19.4	23.3	3.6	18.6	22.2	3.4	19.8	23.2	3.7	19.0	22.7	4.2	20.1	24.4	4.2	17.6	21.8
5/3	Public baths	1.9	4.2	6.1	2.0	4.9	6.8	2.0	5.6	7.6	2.1	5.0	7.1	2.2	4.5	6.6	2.2	4.5	6.6
6	Hotels, restaurants, homes	15.9	46.2	62.1	15.5	43.7	59.3	15.2	44.4	59.7	17.0	45.1	62.1	18.5	47.9	66.4	18.7	44.0	62.8
7/1	Bakers	0.6	1.4	2.0	0.6	1.3	1.9	0.5	1.3	1.8	0.5	1.1	1.5	0.5	0.9	1.3	0.5	0.9	1.3
7/2	Butchers	0.6	0.6	1.2	0.6	0.6	1.2	0.5	0.6	1.1	0.5	0.5	1.0	0.4	0.5	0.9	0.4	0.5	0.9
7/3	Other food	0.1	0.2	0.4	0.2	0.2	0.4	0.2	0.2	0.4	0.2	0.2	0.4	0.2	0.3	0.4	0.2	0.2	0.4
8	Laundries	0.5	0.5	1.0	0.4	0.6	0.9	0.3	0.6	0.9	0.3	0.6	1.0	0.4	0.7	1.0	0.4	0.7	1.0
9	Agriculture	5.0	38.7	43.7	4.8	38.7	43.5	4.9	37.8	42.8	5.1	39.4	44.5	5.8	41.2	47.0	5.6	38.5	44.2
10	Horticulture	0.3	4.3	4.5	0.3	4.9	5.2	0.4	4.7	5.2	0.5	5.1	5.6	0.5	4.7	5.2	0.5	4.2	4.7
11	Airports	1.4	2.0	3.5	1.5	2.1	3.6	1.6	2.1	3.7	1.5	2.1	3.6	1.6	2.3	3.9	1.6	2.3	4.0
12	Textile, clothing, leather	0.7	2.1	2.8	1.5	2.8	4.3	1.5	2.9	4.5	1.2	3.0	4.2	0.8	3.5	4.3	0.9	3.1	3.9
13	Remaining groups (not covered by questionnaire)	1.6	0.3	1.9	1.6	0.3	1.9	1.5	0.3	1.8	1.5	0.3	1.8	1.5	0.3	1.8	1.5	0.3	1.8
14	Others	16.4	7.3	23.7	16.4	7.1	23.5	16.4	7.2	23.7	16.4	6.7	23.1	16.3	6.4	22.7	16.3	6.0	22.3
Total tertiary from extrapolation		121.3	268.4	389.7	119.8	261.5	381.2	115.4	264.2	379.6	115.4	261.1	376.5	117.3	274.2	391.6	117.2	248.4	365.6
Total tertiary from energy balance*		136.8	289.6	426.4	133.3	230.1	363.4	135.7	265.1	400.8	140.3	236.2	376.5	147.1	265.7	412.8	148.0	228.3	376.3

* As of September 2012 (AGEB 2012)

Overall, the projected results over the period 2006 to 2011 show a stagnating trend for electricity and a slightly declining one for fuels. It must be taken into account that the results show the actual energy consumption in the tertiary sector in each year by analogy with the national energy balance and were therefore not temperature-adjusted. However, the years 2006 to 2011 in this period except 2010 shared rather similar climatic conditions, so that reliable statements about trends can therefore be made for six years based on these values. Only the year 2010, which had clearly below average temperatures during the heating season, probably shows a significant temperature-related over-consumption.

When comparing the extrapolated electricity and fuel consumption with the corresponding figures of the German Working Group Energy Balances (AGEB 2012)[3], it can be concluded that the extrapolated figures for electricity are between 10 and 20 % below those of the energy balances depending on the year. On the one hand, this may be due to electricity consumption components which were not able to be determined via the survey. On the other hand, the tertiary electricity consumption figure from the energy balances contains statistical differences which do not enter the tertiary calculations made here. For fuels, there is a relatively good agreement between the extrapolated figures and the energy balance figures for most of the years, except e.g. 2007 (Table 1).

Energy consumption by energy carriers in the tertiary sector

To supplement the extrapolations of total fuel consumption, in another step, the fuel consumption was also broken down to the level of individual energy sources. Table 2 shows the respective results for the year 2010. Gaseous fuels are the dominating energy source in the tertiary sector, followed by heating oil. Liquid fuels are only used in agriculture, construction industry and military for stationary purposes (e.g. tractors in agriculture). All other fuel consumption of vehicles used in the tertiary sector is allocated to the transport sector in the German energy balance (AGEB 2011, 2012) and therefore not included in the extrapolations. Differing from the energy balance, however, both traded and non-traded (e.g. wood) energy is included in the extrapolated energy consumption, whereas the energy balance only covers traded energy sources. This mainly concerns wood which is widely used in agriculture, but also in some other consumer groups (Table 2).

In addition, Table 2 also shows the reference units used for the extrapolation of energy consumption by consumer groups and energy carriers (see for the methodology Chapter 2).

3 Note: The extrapolation of energy consumption and the comparison with the figures of the Working Group Energy Balances within this study was largely finalized in July 2012. At that time, the most recent data from the energy balances (AGEB 2012, as of 29 September 2012), which also include some revisions for the period 2003 to 2009, were not available. Therefore, earlier data (AGEB 2011, as of 4 July 2011) had to be used in the main report to this study, resulting in slight differences to the energy balance figures shown in Table 1. The main report is only available in German.

Table 2: Projected energy consumption in the tertiary sector by energy carriers 2006 to 2011

Reference year: 2010			Fuels								
Group / Split	Definition	Reference units*	Coal	Gases	Wood	Oil	Liquid	District heat	Total fuels	Electricity	Total final energy
		in 1000	TWh							TWh	TWH
1	Construction industry	2,383	0.0	5.3	1.2	4.1	2.5	0.1	13.1	3.4	16.6
2	Office-like enterprises	12,858	0.0	43.3	0.9	12.1	0.0	10.2	66.5	27.5	94.0
3	Manufacturing enterprises	907	0.0	4.7	0.4	2.2	0.0	0.4	7.8	4.3	12.1
4	Retail trade	5,406	0.2	26.8	0.4	12.3	0.0	2.1	41.7	23.3	65.0
5/1	Hospitals	674	0.0	8.2	0.0	0.5	0.0	3.3	12.0	5.8	17.8
5/2	Schools	14,182	0.0	10.2	0.2	1.6	0.0	8.0	20.1	4.2	24.4
5/3	Public baths	4,650	0.0	0.9	0.3	0.0	0.0	3.2	4.5	2.2	6.6
6	Hotels, restaurants, homes	3,919	0.1	27.2	1.3	14.2	0.0	5.0	47.9	18.5	66.4
7/1	Bakers	78	0.0	0.4	0.1	0.4	0.0	0.0	0.9	0.5	1.3
7/2	Butchers	62	0.0	0.3	0.0	0.2	0.0	0.0	0.5	0.4	0.9
7/3	Other food	23	0.0	0.1	0.0	0.1	0.0	0.0	0.3	0.2	0.4
8	Laundries	52	0.0	0.4	0.0	0.3	0.0	0.0	0.7	0.4	1.0
9	Agriculture	655	0.0	1.0	11.4	5.7	23.2	0.0	41.2	5.8	47.0
10	Horticulture	200	0.0	1.3	0.1	3.2	0.0	0.0	4.7	0.5	5.2
11	Airports	231,344	0.0	0.6	0.0	0.1	0.4	1.1	2.3	1.6	3.9
12	Textile, clothing, leather	848	0.0	2.4	0.1	0.7	0.0	0.3	3.5	0.8	4.3
13	Remaining groups (not covered by questionnaire)		0.0	0.1	0.1	0.1	0.0	0.0	0.3	1.5	1.8
14	Others		0.0	1.2	0.0	0.9	3.0	1.2	6.4	16.3	22.7
Total tertiary from extrapolation			0.3	134.6	16.6	58.7	29.1	34.9	274.2	117.3	391.6

* Group 1-4, 6-9 and 12: employees; group 5 hospitals: number of beds, schools/universities: number of pupils/students, Public baths: water volume; group 11 airports: traffic units (1 passenger / 100 kg freight)

Energy consumption by end-uses in the tertiary sector

With regard to electricity, lighting is the dominant use with around 40%, followed by the electricity for motor drives (power) (Table 2). The share of air conditioning (for cooling) in electricity consumption is still low today; only at airports and in agriculture does it reach a share of about 10%, in hospitals and parts of the food industry of about 5 %. Process cooling plays a bigger role in the tertiary sector, especially in the retail trade, in hotels and restaurants and in parts of the food industry, too.

The application structure for fuels is less differentiated; more than 70% of the energy demand in the tertiary sector is accounted for by space heating followed by process heat with almost 15 %.

Table 3: Energy consumption by end-uses in the year 2010

Reference year: 2010		Consumption		Shares															
		Electricity	Fuels	Electricity								Fuels (incl. district heat)							
Group / Split	Definition	Total	Total	Lighting	Power	Hot water	Other process heat	Process cold	AC	ICT	Space heating	Lighting	Power	Hot water	Other process heat	Process cold	AC	ICT	Space heating
		[TWh]	[TWh]	[%]								[%]							
1	Construction industry	3.4	13.1	49.6	16.2	6.2	1.6	0.9	0.9	12.6	11.8	0.0	22.9	3.1	0.4	0.0	0.0	0.0	73.7
2	Office-like enterprises	27.5	66.5	44.2	4.0	2.4	1.4	1.5	2.0	39.5	5.0	0.0	0.0	6.1	0.0	0.0	0.0	0.0	93.8
3	Manufacturing enterprises	4.3	7.8	42.7	33.9	6.7	0.8	0.7	0.4	10.3	4.5	0.0	0.6	2.6	20.1	0.0	0.0	0.0	76.8
4	Retail trade	23.3	41.7	50.9	7.9	4.2	1.8	17.8	2.1	11.7	3.7	0.0	0.0	2.7	0.1	0.1	0.0	0.0	97.1
5/1	Hospitals	5.8	12.0	32.6	26.6	3.1	19.1	1.1	4.6	12.1	0.7	0.0	0.0	17.4	8.2	0.0	3.0	0.0	71.4
5/2	Schools	4.2	20.1	65.8	7.0	1.4	1.9	2.3	0.7	12.8	8.2	0.0	0.0	3.3	2.0	0.0	0.0	0.0	94.7
5/3	Public baths	2.2	4.5	9.0	87.0	2.0	0.2	0.0	1.6	0.1	0.0	0.0	0.0	5.4	93.7	0.0	0.5	0.0	0.3
6	Hotels, restaurants, homes	18.5	47.9	33.5	29.1	5.2	8.2	15.5	1.8	4.0	2.7	0.0	0.0	5.1	22.6	0.0	0.2	0.0	72.0
7/1	Bakers	0.5	0.9	7.3	16.8	1.9	55.6	16.4	0.1	1.9	0.1	0.0	0.0	1.5	94.1	0.0	0.0	0.0	4.3
7/2	Butchers	0.4	0.5	17.3	11.8	6.7	12.6	46.1	0.3	4.5	0.6	0.0	0.0	28.1	0.9	0.0	0.0	0.0	71.0
7/3	Other food	0.2	0.3	43.0	26.1	4.7	2.2	0.3	4.8	16.0	2.9	0.0	0.0	0.3	0.0	0.0	0.0	0.0	99.7
8	Laundries	0.4	0.7	24.8	0.7	17.6	50.0	0.2	0.3	3.0	3.4	0.0	0.0	10.7	84.1	0.0	0.0	0.0	5.2
9	Agriculture	5.8	41.2	24.3	41.8	12.1	0.5	2.7	10.2	3.7	4.7	0.0	56.2	5.1	6.4	0.0	0.0	0.0	32.3
10	Horticulture	0.5	4.7	60.9	3.7	15.8	1.1	0.7	3.5	9.5	4.9	0.0	0.0	1.1	86.5	0.0	0.0	0.0	12.4
11	Airports	1.6	2.3	34.9	30.0	4.0	4.0	2.0	10.0	9.5	5.6	38.3	23.3	4.4	4.4	2.2	10.9	10.4	6.2
12	Textile, clothing, leather	0.8	3.5	69.9	7.1	4.9	1.7	0.6	0.6	15.3	0.0	0.0	0.0	2.2	8.6	0.0	0.0	0.0	89.2
13	Remaining groups (not covered by questionnaire)	1.5	0.3	44.6	21.6	15.9	0.9	0.8	0.5	10.3	5.5	0.0	0.1	2.7	17.8	0.0	0.0	0.0	79.3
14	Others	16.3	6.4	37.6	52.9	1.1	1.1	0.4	0.5	6.2	0.3	0.0	46.9	5.6	5.6	0.0	0.0	0.0	41.9
Total tertiary from extrapolation		**117.3**	**274.2**	41.5	22.3	4.1	3.7	7.0	2.2	15.6	3.6	0.3	10.8	5.2	9.8	0.0	0.3	0.1	73.4

4 Sector-specific analyses

In addition to the extrapolation, the data collected in the two broad surveys for 2008 and 2010 as well as the detailed audits in the various branches of the tertiary sector can also be used to examine energy consumption in the businesses more closely. The analyses concentrate on general and sector-specific energy-relevant features as well as indicators and their correlation with energy consumption. Generally recorded aspects included lighting, office equipment, air conditioning, break rooms and canteens as well as energy management and the perception of energy cost. Unlike the extrapolation, these evaluations are based on raw data, into which the data of all the enterprises surveyed were entered without being weighted. In view of some low case numbers in individual groups, the statements are not strictly representative. However, since the quota was essentially fulfilled, even in the sub-groups, the results are still very useful for obtaining a more detailed insight into the sectors.

Energy technology equipment by sector

From the wealth of sector-specific data obtained, only a few energy-relevant features of tertiary sector branches can be illustrated here as examples. These are mainly based on the results of the second broad survey focusing on the year 2010. Relevant changes compared to 2006 or 2008 will be mentioned.

The *construction industry* is a very heterogeneous sector with regard to company size and structure. Structural and civil engineering and prefabricated building are the main components of the building trade; plumbers/fitters and painters/varnishers are the biggest lines of business in the finishing trade. Energy consumption is split into space heating and production in the companies as well as numerous machines and appliances on building sites and building site traffic. As was to be expected, businesses in the main building trade operate many more energy-intensive appliances both within companies themselves and on the building sites. Almost all the appliances are electrically powered apart from forklift trucks and dump trucks. There are considerable problems with recording energy consumption in the construction industry, especially on building sites, e.g. for site electricity and heating containers, because the costs for these are borne by the building owner. It is also difficult to correctly split the diesel consumption of building site vehicles which is partly assigned to the tertiary sector and partly to the transport sector.

The industrial branches grouped together here under the heading of "*office-like enterprises*" cover a wide range of public and private services: banks and insurance offices, public utilities and other business services, some with an obvious office character such as lawyers, solicitors or tax advisors, but others with more energy-relevant aspects like waste disposal services, hairdressers, cleaning services or doctors. From the viewpoint of energy, however, most of these have similar structures. Space heating dominates followed by electricity applications for lighting, ventilation and air-conditioning, information and communication technologies. Air condition is

used above average of the total sector in this group. In relation to the business area 8.5% of the area is air conditioned and 3.1% is cooled. Especially bank premises have air condition (41%), mainly central systems, followed by public institutions (25%), mainly decentralised split units. As expected, office-like enterprises have more office equipment than other branches of the tertiary sector; this is especially valid for banks, insurances and public institutions.

Metalworking, the automobile trade, wood, paper and printing businesses all count as *manufacturing enterprises*. Alongside general features such as heating, lamps, office equipment and ventilation and air conditioning, sector-specific process technologies play a greater role in this group, especially with regard to electricity. Fuels, in contrast, are predominantly used for space heating. Metal working encompasses heterogeneous industrial branches with different energy intensities. Relatively, mechanical and electrical engineering, locksmiths and welding shops, the production of medical and orthopaedic products and other metal products have the biggest shares in the tertiary sector. The variety of production technologies used is correspondingly large; most of these are electrically powered, e.g. compressed air production, moulding/shaping and separating. As well as for space heating, fuels are also used for processes involving heat treatments such as, e.g. hardening, tempering, welding etc. The automobile trade is made up of car repair garages, car dealers and mixed services. The main field of activity for the repair garages is motor mechanics followed by bodywork and paintwork. There are office and sales rooms on top of this. Electricity in these companies is mainly used for lighting, powering pumps and equipment as well as for compressed air for the repair and service areas. Wood and wood products covers the manufacturing of furniture (three quarters of those surveyed) and building components (11%), each with relatively little energy-intensive equipment; the other businesses are sawmills. Suction systems represent the biggest power consumers in carpentry/joinery with a high share of the total electricity consumption. In the paper and printing trade, the small enterprises comprise printers, bookbinders, copy services. Electricity is mainly used for printing machines followed by cutting, folding and stitching. Digital printing machines, compressed air, lighting, air conditioning and operating systems in standby-mode are also relevant.

Alongside offices, *wholesale and retail trade* is the largest branch in the tertiary sector with almost 5.5 million workers. There is a significant difference in energy consumption between food and non-food lines of business. The food trade has a high demand for refrigeration and freezing. Lighting represents a large factor in trade on the electricity side. The share of fluorescent and energy-saving lamps is relatively high, but halogen lamps are used more often than in other branches, especially in shop windows. The air conditioning of salesrooms also has a noticeable impact in retailers: 15% of the companies use it. Additional energy consumers in grocers and food stores are have ovens to bake or heat bread, meat and processed meat products. 24% of the businesses questioned have one or several ovens of this type. The energy demand of modern cash registers is also not negligible. In all types of shops and in the wholesale trade space heating demand is a main energy consumer.

Hospitals, schools and public baths vary greatly with regard to energy and should therefore be regarded separately. Since the specific energy consumption based on the number of employees is limited in its meaningfulness in this sector, more suitable reference units – the number of beds, number of pupils/students and water volume - were used here. Hospitals are characterized by high space and process heat demand. The latter is particularly relevant if the hospital runs its own laundry. Apart from lighting, electricity is required mainly for ventilation and air conditioning. Schools are a very heterogeneous group ranging from kindergartens right up to universities. Space heating demand dominates the energy consumption here. Electricity is mainly used for lighting. The main distinction with regard to public baths is between indoor swimming pools and outdoor ones. "Leisure pools" represent a combination of the two which is becoming more common. A large share of the energy consumption in public baths is for the process heat used to heat the water, but also for space heating in indoor pools. Modern public baths are equipped with very complex building technology, mainly for ventilation, electrical engineering and pool technology which causes considerable electricity consumption. In addition, pools are also increasingly equipped with additional installations which are energy-intensive such as saunas, solariums, wellness and health-related areas, fitness rooms, restaurants etc.

The *hotel and restaurant sector* consists of catering and accommodation. It is true that, as a service sector, there are businesses of every size in the tertiary sector, but this area is dominated by small to very small enterprises. Space heating and thus fuel consumption is the most important in both sectors from the viewpoint of energy consumption. The second largest energy consumer after space heating is process heat for kitchens, mainly for cooking food, but also for heating food and keeping it warm, preheating and cleaning dishes. Electricity is also used mainly for cooking, followed by refrigerators/freezers, then for dishwashing, laundry and lighting. Refrigerators and freezers are becoming more significant because of the growing use of frozen products due to a greater flexibility. Lighting also plays a relatively important role for energy consumption.

Bakers and butchers are the main lines of business in the tertiary sector belonging to the *food industry*. Baking ovens have the biggest energy consumption in bakers. In the bakers covered here, which tend to be quite small enterprises, mostly discontinuous processes are used, e.g. rack ovens or deck ovens. Today outlets and production facilities including a retail outlet often have an electric oven directly in the salesroom to finish baking pre-produced raw pastries and rolls. Electricity is additionally used mainly for cooling devices. Comparatively low shares of electricity are accounted for by power applications (machines, e.g. to sieve, mix, knead and stir, as well as ventilation), lighting and hot water production. In butchers, the main consumption of energy is for producing sausages and processed meat products. Various heating processes are carried out in large cooking boilers and combi-ovens. Making raw sausages is done in maturing chambers and smokehouses. Production plants are mostly fuel-heated, fewer use electricity. The main electricity share is due to heating water, refrigerating and freezing. Electricity con-

sumption for refrigeration and freezing is on the increase because more and more refrigerated and frozen products are being used or sold.

The group of *laundries* covers the entire textile cleaning industry, i.e. laundries, dry cleaners, textile rental services, dyeing works, ironing and rotary iron services. This is a comparatively energy-intensive sector. Energy is mainly used for heat processes: washing, drying, hot pressing/mangling, cleaning and ironing. The energy required for space heating is negligible. Due to the high demand for process heat, there is usually enough waste heat available to heat the production areas. Space heating is predominantly needed for separate rooms, e.g. sales, offices and canteens. The electricity demand comes from lighting to a lower extent, but is mainly due to the electric motors used to drive machines and provide ventilation.

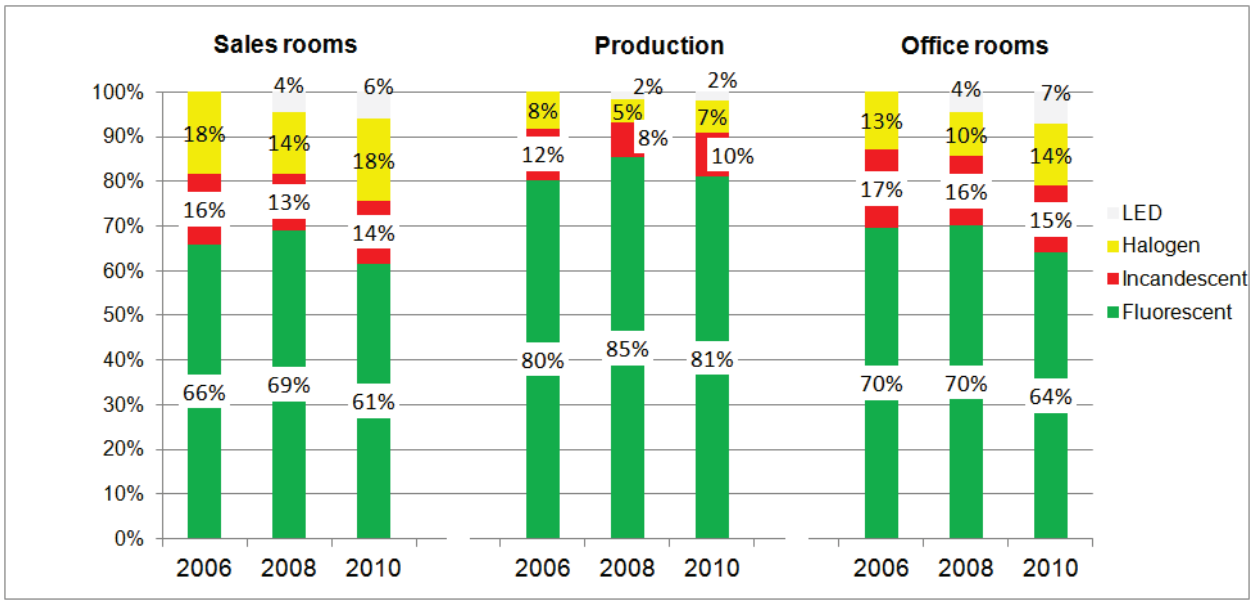
Based on the number of workers, *agriculture* is quite an energy-intensive sector. This has to do with the low average number of employees per farm. The 105 agricultural enterprises questioned in 2010 only have 3.6 workers on average, half of them actually only have one or two workers. Livestock farming has the biggest energy demand. Crop farming is not as energy-intensive with a few exceptions (grain drying), if the fuel consumption of farming vehicles is disregarded. The main electricity applications are power processes, mainly the ventilation of animal pens in intensive livestock farming, as well as for cooling milk. Process heat is needed for radiant heaters when rearing chicks and piglets. In horticulture, especially those enterprises with heated under-glass areas are very energy-intensive. Fuels are used to heat greenhouses; electricity is needed for lighting, ventilation and heating small areas of plants as well as for controlling automatic ventilation and irrigation processes.

Cross-sectoral comparison of energy-relevant features

In the following, a cross-sectoral comparison is made of lighting, office equipment, ventilation and air conditioning as well as company break rooms and canteens by evaluating the results of the second broad survey. The energy features concerned illustrate the situation at the time of the survey 2010.

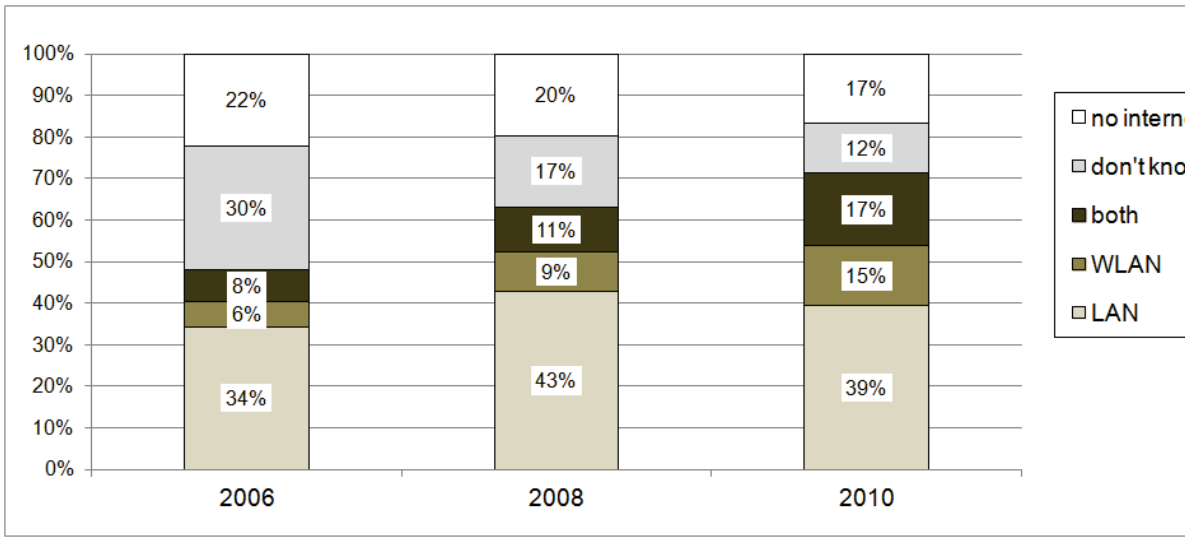
With regard to *lighting*, the rooms evaluated were those considered to be the most typical for each sector. The lighting in salesrooms was taken for the retail trade and in offices for office-like enterprises; otherwise the lighting in production was selected. In restaurants, this means the kitchens, for hotels and hospitals, the rooms, and in schools, the classrooms. It is apparent that fluorescent and energy-saving lamps are most often found in schools and least often in restaurants and hotels. With the exception of these last two branches, the share of these lamps always exceeds 80% (Figure 1). In 2008 LED lamps were recorded for the first time. They are used mainly in show rooms, sales rooms and offices and have substituted fluorescent rather than incandescent lamps.

Figure 1: Changes in types of lamps 2006 to 2010



Among the group of *office appliances*, computers are particularly interesting (Figure 2). In 2010, 29% of the questioned businesses have servers or mainframe computers, 87 % PCs or notebooks, 86 % printers, mainly combined with copiers and fax. Almost all monitors are flat screens. On average 83% of all the businesses have an internet connection, restaurants and laundries least likely. 32% of the companies use WLAN connection – a strong increase since 2006 (14%) and 2008 (20%).

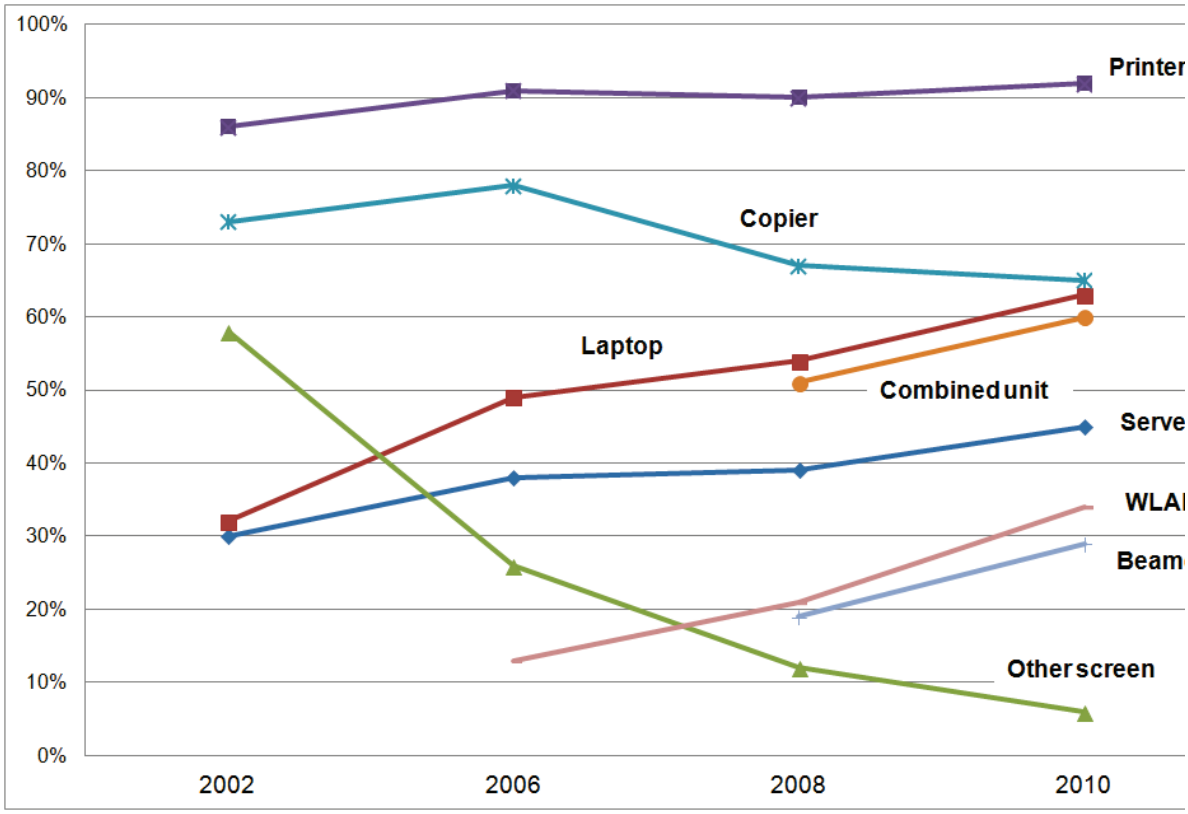
Figure 2: Internet, LAN and WLAN 2006 to 2010



In the meantime time series for offices exist since 2002 (Figure 3). They show increasing equipment with appliances such as servers, laptops and printers. Less copiers are used, but

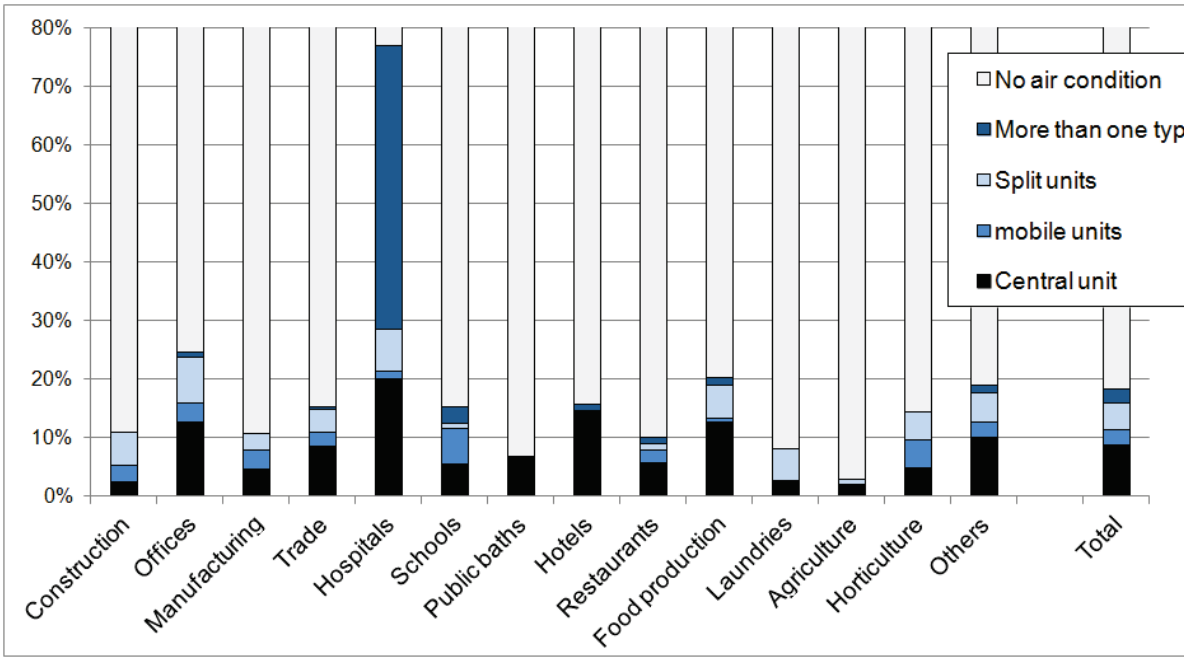
instead more combined units of copiers, printers, and fax machines. The number of companies using beamers and WLAN also increase. Ray monitors were more and more substituted by LCD flat screens.

Figure 3: Office equipment in office-like enterprises since 2002



Air conditioning (with dehumidification) or cooling (without dehumidification) with small mobile units, split appliances or a central air conditioning system, is used by 18% of enterprises, usually however only in some of the rooms. Hospitals really stand out among the different sectors, 77% of which have air-conditioned rooms (Figure 4).

Figure 4: Air conditioning in enterprises (2010)



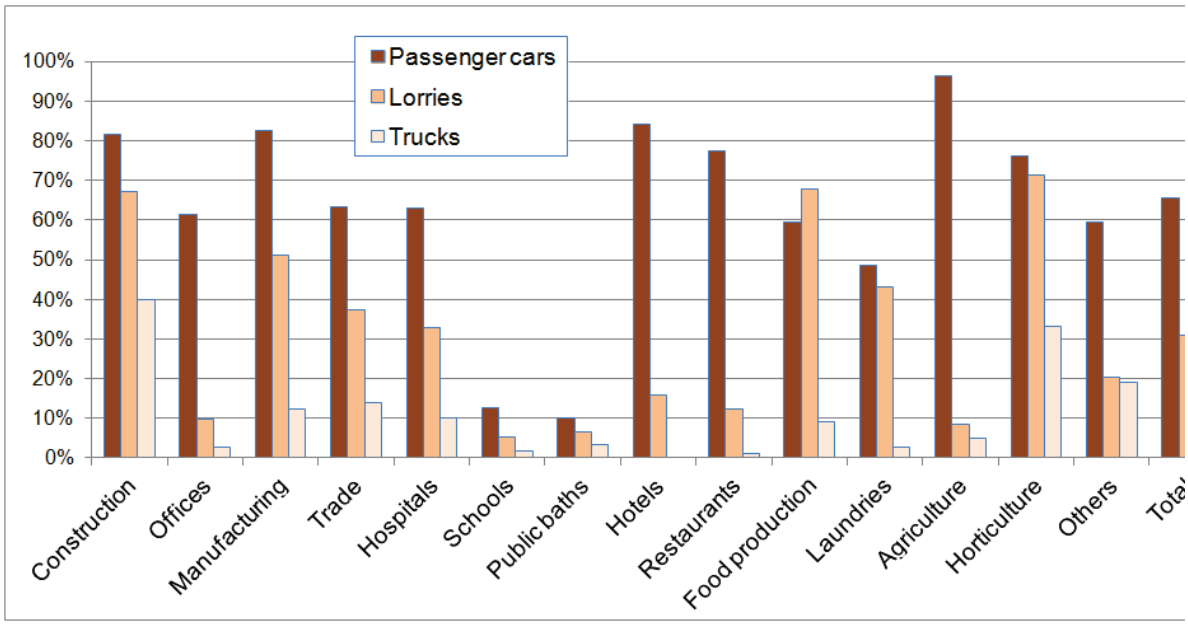
Break rooms exist in 43% and canteens in 6% of the enterprises (2010). Canteens have a remarkable influence on energy consumption, but also break rooms are often equipped with energy consuming devices: 55% with refrigerators, 8% with freezers, 8% with drinks vending machines, and 70% with coffee machines of which 40% are espresso machines. On average in the whole sector 1.7 coffee machines per 10 employees are used.

Co-generation is installed in 1.4% of the enterprises only, above all in hospitals, schools, public baths and hotels. More often excess heat is used: in 2.4% of the enterprises, mainly in agriculture, food production and hospitals.

Data about the existing *vehicle stock* for professional purposes were also asked. 65% of the companies have passenger cars (including vans), 31% lorries and 11% trucks. There are large differences between the groups (Figure 8). Passengers cars were driven 44,367 km per company and year on average, lorries 47,517 km and trucks 97,517 km. The share of private use of passenger cars is about 24%, in case of lorries and trucks the share is neglectable.

Almost all lorries and trucks and 53% of the passenger cars are running with diesel. 46% of the passenger cars use gasoline. All other fuels have very small shares below 1%, except 1.8% biodiesel for trucks. Only 34 companies (1.6%) have electric or hybrid cars, half of them in offices and manufacture. These vehicles are used relatively scarcely; they have a kilometer performance of 6,500 km on average only.

Figure 5: Vehicle stock in the sector (2010)



Energy management in the enterprises

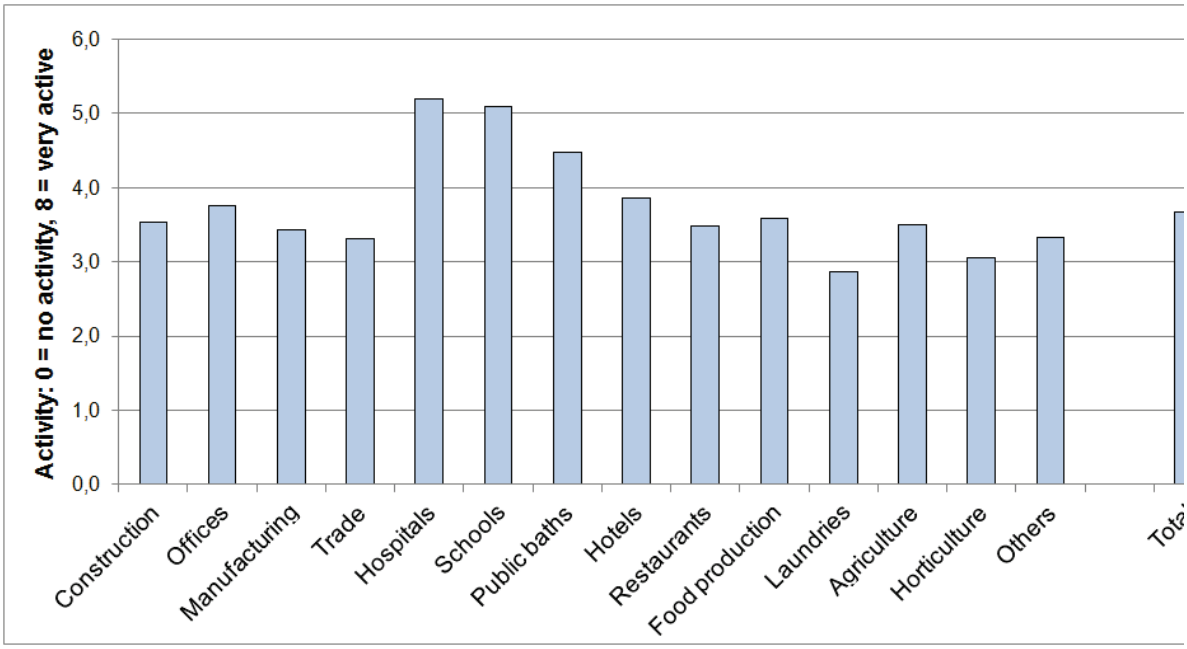
A relevant framework condition is the decision-making competence of the managers. Part of the enterprises have rented (37%) or leased (7%) premises, 56% are owners. 19% depend on a group management. Both factors influence the energy efficiency activities: owners and branch companies are more active with regard to the implementation of energy saving measures.

Regarding the question whether energy-saving measures were carried out in the last 5 to 7 years, are being carried out, or are planned to be implemented in the near future, and whether there is a need for action, the following picture emerges for the majority of companies: 54% have conducted measures, 23% have ongoing ones and 30% see a need for action. 37% have installed an energy management or at least an energy consumption check.

Of the measures already implemented, the most frequent ones cited concern behavioural issues: 76% mentioned switching off unnecessary lights or making the greatest possible use of daylight, 53% more efficient bulbs or lighting systems. One measure is also turning off energy-consuming installations (63%). Technical measures or investments were implemented by 42%.

There are some differences between the groups concerning such measures. For an overview an "activity indicator" is constructed from 8 items concerning energy management. This indicator has the highest value for the group of hospitals, schools and public baths (Figure 6).

Figure 6: Activity indicator of energy management by sector (2010)



In the framework of energy management questions the role of energy cost was deal with. 70% of the companies answered the question concerning the share of energy cost of turnover (or total cost in case of public institutions). The result was a rather high share of 6.2% on average. The highest share was mentioned by public baths, the lowest value occur in trade, hospitals and manufacturing. Also within the various groups large variations are observed, e.g. between 1% and 25% in hotels. A comparison between 2006, 2008 and 2010 doesn't show a clear trend.

As expected the evaluation of data on costs provided together with energy consumption reveals the highest cost per employee in public baths with 15,565 € per year, the lowest in the construction (610 €) and in the office sector (792 €). With regard to the perception of the costs 22% said, they are "high", 46% "moderately high", 26% "low" and 6% "negligible".

5 Use of renewable energies in the tertiary sector

From the sample drawn from the short telephone survey of 10,221 workplaces of the tertiary sector, an inventory of renewable installations in the tertiary sector was compiled. This inventory, which distinguishes 12 technologies and 11 groups (see Table 4) serves as the main database for the extrapolation of the consumption of renewable energy sources and gives a differentiated overview according to group and technologies stock specified. The other database, that is, technical properties and production potential, is obtained from the survey of 300 selected enterprises.

The stock of renewable technologies for 2011 (see Table 4) can be distinguished according to the site types “rural” and “urban & urban central”; they are distributed almost equally over these two site types. Insofar, there are also characteristic differences in the stock of renewable technologies in comparison to the data given in the survey year 2006, since at that time approximately 65 to 70 per cent of the firms taking part in the survey could be classed as “urban and urban central” sites, and approximately 30 to 35 per cent as “rural” sites. In the new telephone survey of 2011, the site type was specifically asked, since the survey in 2006 indicated that extrapolation results for the use of renewable energies can be considerably influenced by the site type.

Table 4: Inventory of renewable installations in the tertiary sector derived from the survey: as of 2011

		Enterprises		Site		Number of questionnaires with stock given for respective technology													
		Total	with exact no. of employees	Rural	urban/urban central	Solar thermal collectors	Photovoltaics	Wind power	Small hydropower	Solid biomass	Liquid biomass	Biogas	Heat pump	CHP	Bio-fuels	Biodiesel	of which Vegetable oil	Bio-ethanol	Local or long-distance heating
1	Construction industry	**927**	**895**	525	370	77	124	4	2	102	5	1	51	11	64	51	17	16	6
2	Office-like enterprises	**2,264**	**2,087**	820	1,267	120	207	5	6	115	5	19	69	97	103	70	27	45	48
3	Manufacturing enterprises	**1,164**	**952**	518	434	51	132		12	160	5	5	17	15	35	29	4	12	4
4	Retail trade	**2,225**	**2,118**	1,008	1,110	74	154	7	18	78	5	8	38	34	112	82	30	43	17
5	Hospitals / Schools / Public baths	**841**	**615**	239	376	60	136	5	3	30	5	5	22	105	14	12	1	5	41
5/21	Hospitals	**236**	**166**	70	96	11	16			7	1	1	8	27	5	5	1		12
5/22	Schools	**455**	**326**	114	212	21	97	5	1	14	2	2	7	34	7	5		3	13
5/23	Public baths	**150**	**123**	55	68	28	23		2	9	2	2	7	44	2	2		2	16
6	Hotels, restaurants, homes	**1,188**	**974**	487	487	87	83		2	115	6	3	17	49	21	18	5	7	18
7	Bakers, butchers, other food	**675**	**607**	362	245	31	57	2	11	32	2	4	24	26	33	21	11	11	4
7/5	Bakers	**272**	**246**	148	98	11	22	2	1	10			10	8	13	7	6	3	
7/6	Butchers	**300**	**278**	157	121	17	22			17	1	1	10	15	13	10	2	4	3
7/7	Other food	**103**	**83**	57	26	3	13		10	5	1	3	4	3	7	4	3	4	1
8	Laundries	**176**	**159**	67	92	4	7			4			3	3	9	7		3	
9	Agriculture	**456**	**360**	327	33	34	137	10	2	89	16	47	16	51	26	25	15	6	3
10	Horticulture	**101**	**81**	59	22	4	11	1		8			3		5	3	3	2	
12	Textile, clothing, leather	**204**	**136**	61	75	6	16			3		1	2	2	10	10	4	4	3
Total (2011)		**10,221**	**8,984**	**4,473**	**4,511**	**548**	**1,064**	**34**	**56**	**736**	**49**	**93**	**262**	**393**	**432**	**328**	**117**	**154**	**144**
Total (2006)		**20,594**		**-**	**-**	**898**	**1,365**	**59**	**101**	**863**	**40**	**106**	**492**	**-**	**839**	**577**	**-**	**-**	**-**

***) Surveyed technologies**

Table 5 gives an overview of the projected results of energy obtained from the use of renewables in the tertiary sector, in addition differentiated by the 11 groups. The total energy obtained from all technologies in Table 5 (without CHP with fossil fuels) gives a total value of 48.6 TWh.

Because of the knowledge gaps of the respondents which were also apparent in the in-depth interviews, these results should be treated critically, compared with other official statistics, reliable publications and study results and commented on.

Table 5: Derived projected results from the survey on the use of renewable energy sources in the tertiary sector for 2011

		All figures in TWh									
									CHP with fossil fuels		
		Total	Photovoltaics	Solar thermal plants	Small hydropower	Solid biomass	Biogas	Heat pump	Electricity	Heat	Use of biogas
1	Construction industry	**3.2**	1.3	0.2	0.1	1.5		0.1	0.4	0.5	
2	Office-like enterprises	**5.5**	0.5	0.7	0.2	1.1	2.8	0.2	6.7	8.2	
3	Manufacturing enterprises	**1.6**	0.7	0.0	0.1	0.5	0.3	0.0	0.2	0.2	
4	Retail trade	**9.6**	4.3	0.3	2.4	1.7	0.8	0.0	1.1	1.3	
5	Hospitals / Schools / Public baths	**2.0**	0.8	0.2		0.5	0.5	0.0	4.8	5.9	
6	Hotels, restaurants, homes	**2.8**	1.0	0.3	0.0	1.2	0.3	0.0	1.6	2.0	
7	Bakers, butchers, other food	**0.3**	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.1	
8	Laundries	**0.0**	0.0	0.0		0.0		0.0			
9	Agriculture	**22.0**	2.2	0.0	0.1	10.9	8.8	0.0	1.1	1.3	
10	Horticulture	**1.3**	0.1	0.0		1.1		0.0			
12	Textiles, clothes and leather	**0.3**	0.3	0.0		0.0		0.0	0.2	0.2	
Total (2011)		**48.6**	**11.3**	**1.8**	**2.8**	**18.7**	**13.5**	**0.5**	**16.1**	**19.9**	**0.0**

* For wind power, liquid biomass und liquid biofuels a reliable extrapolation was not possible since the sample was too small.

Photovoltaic

The electricity-producing potential of photovoltaic installations has increased rapidly in recent years, in the tertiary sector as well. Based on 164 in-depth interviews and the stock seen in Table 4, projections provide information according to which the tertiary sector produced 11.3 TWh electricity in 2011, whereby, as expected, there was an above-average high potential of 8.1

TWh in rural areas. The main focus of the total photovoltaic electricity production in the tertiary sector is found in the groups 4 and 9 with a share of 58% together.

For the total stock PV plants in Germany, BMU (2012) gives an electricity production of 11.7 TWh in 2010, which increases to a total of 19.5 TWh in 2011. Results of the comparison of the tertiary section projection and the BMU information are for 2011:

11.3 TWh / 19.3 TWh = 0.58

Thus in 2011 almost 60 % of the electricity produced using photovoltaics can be as-signed to the installations in the tertiary sector – a plausible result.

Solar collectors (solar thermal)

The extrapolation made in this study on the basis of 68 in-depth interviews indicates a stock of collectors in the tertiary sector and the year 2010 with an area of 4.42 million m². The solar thermal energy production was thus between 1.63 TWh and 1.85 TWh according to yield approach. Rural areas are a main focus of solar thermal energy production; here approx. 68% of solar thermal heat potential is produced in the tertiary sector.

BMU (2012) determines the total stock of collectors in Germany as an area of 14.044 million m² for the year 2010 and a heat supply of 5,200 GWh. For the year 2011, these figures amount to an area of 15.234 Mio. m² and a heat supply of 5,600 GWh. Results of the comparison of the tertiary sector projection and BMU (2012) information for 2011 are:

Surface area: 4.42 Mio. m² / 15.234 Mio. m² = 0.29

Heat supply: 1.63 TWh / 5.60 TWh = 0.29 resp.

1.85 TWh / 5.60 TWh = 0.33

Thus around 30% of the total stock of collectors in Germany is found in the tertiary sector, which can be regarded as a plausible result.

Wind power

According to the results of the short telephone survey of 10,221 enterprises there was a corresponding number of wind turbines in a total of 34 installations in 2011. Unfortunately only 10 in-depth interviews could be carried out, however, of which only 8 yielded fully usable information. With a view to this number of cases with 8 installations in operation, a projection on wind power electricity production is not possible.

Small hydropower

The results of the short telephone survey show that 0.5% of enterprises in the tertiary sector use small hydropower plants. This means that according to the survey, in the approx. 3.5 million enterprises in the tertiary sector, 3.5•106 * 0.5 % = 17,500 installations would be in operation. Based on the information of the German Hydropower Plants Association (AWK-D 2012), however, the total stock of small hydropower plants in Germany only amounts to around 7,500, which indicates that the survey result is considerably too high. This is also true for the projection made using 19 fully usable in-depth interviews, which indicates a potential of 2.8 TWh (here Group 4 with 2.4 TWh). This overestimation is mainly due to hydropower plants in Group 4, which, on the basis of the enterprise size given (1 employee per enterprise), give a production value per employee of 76 MWh and as a result too high an overall potential by around 1 TWh.

Solid biomass

In the short telephone survey 736 enterprises or 7.2% indicated the use of solid biomass. On the basis of the 95 in-depth interviews, of which 43% supplied fully usable information, the projection specified a consumption of solid biomass of 18.7 TWh for the year 2011. Rural areas here have a share of 14.9 TWh, with a consumer focus on agriculture of 10.6 TWh.

The energy balance “Renewable Energy Sources” (AGEB 2012) indicates the consumption of “wood, straw and similar biomass materials” in the sectors “households” and “tertiary” for 2011 in total at 67,511 GWh. Of these, however, no share is allocated to the tertiary sector. The projected consumption of solid biomass for the tertiary sector, with around 18.7 TWh or 18.7 TWh / 67.5 TWh = 0.27 indicates for the tertiary sector a share of 27% sales of total solid biomass in the household and tertiary sector.

Liquid biomass

According to the short telephone survey, 0.2% of all tertiary businesses used liquid biomass, mainly in agriculture and in Group 12. The share using this technology there equals 1.4% to 1.7%. Based on 3.5 million enterprises, this would mean around 70,000 enterprises using liquid biomass. Since liquid biomass use cannot be strictly separated from the use of bio-fuels (vegetable oil) or biogas (slurry), no further evaluation can be made here.

Biogas

Based on the short telephone survey of 10,221 enterprises, 86 businesses with biogas installations were recorded, which when answering the question about operating methods reported using the biogas produced for CHP operations for solely producing of electricity and heat. A total of 51 enterprises were included in the in-depth interviews; definite information is available for 40 of these businesses. Projections based on these 40 enterprises result in an electricity-

producing potential in the tertiary sector of 13.5 TWh. A clear focus is on rural areas with a share of 12.8 TWh. Here it must be taken into account that the stated amounts of electricity of 2.8TWh or resp. 3.2 TWh in Group 2 are to be assigned to the urban or resp. communal energy supply plants, which according to the structuring of the energy balance for Germany defined by the “Working Group on Energy Balances” have to be contained in the output in the “transformation sector”.

Thus from this point of view, biogas plants in the tertiary sector have an electricity production potential of

13.5 TWh – 2.8 TWh = 10.7 TWh resp.

The German Biogas Association (Fachverband Biogas 2012) cites a net electricity production of 18.4 TWh for 2011. In 2010 this amounted to 14.82 TWh. The projected net electricity production in the tertiary sector in 2011 with the given 10.7 TWh amounts to a share of around 58% of the total net electricity production of 18.4 TWh, which can be regarded as a plausible result.

Heat pumps

In the short telephone survey of 10,221 enterprises in the tertiary sector, first 765 enterprises indicated that they use a heat pump. A more detailed questioning identified 467 heat pumps and 36 other installations, which definitely did not belong to the technology “heat pump”. Of the remaining 262 businesses with heat pumps, 21 enterprises agreed to an in-depth interview, amongst these 19 enterprises with fully usable information. The projection supplies a regenerative heat potential in enterprises with heat pumps in the tertiary sector amounting to 0.4 TWh. Based on the number of cases of 19 enterprises, however, this result is relatively uncertain.

The energy balance “Renewable Energy Sources” (AGEB 2012) specifies the total contribution of heat pumps in the sectors “households” and “tertiary” to 6,014 GWh. Of these, 321 GWh are allocated in the same table to only to the tertiary sector. The projected heat potential of heat pumps in the tertiary sector could thus be seen as correct, despite the lower number of cases.

Bio-fuels

Due to case numbers a reliable statement on the use of bio-fuels is not possible.

CHP

In interviews of 10,221 enterprises, 393 enterprises, i.e. 3.8% specified the use of CHP. From these enterprises, 46 were selected, which supplied interesting information during on-site interviews. Only 27 installations were available for a projection, however.

The electrical utilization period of CHP (29 enterprises) amounts on average to 5,041 h/a with a range from 1,346 h/a to 8,778 h/a; the thermal utilization period reaches on average a value of 4.106 h/a, the minimum value is 399 h/a, the maximum value 8,333 h/a. The CHP co-efficient, calculated from the quotients of electricity produced and amount of heat yielded results in practical operation to a value of 0.64, which points to an operating mode giving priority to heat conduction; the range of values is between a minimum of 0.33 and a maximum of 1.67.

Projection results give an electrical potential of 16.1 TWh and a calculated heat potential of 19.9 TWh for the tertiary sector.

Comparison of extrapolations with secondary statistics

The extrapolated data on the use of renewable energies in the tertiary sector were verified and compared with other secondary data sources available for Germany as a whole or only for the tertiary sector. The results are finally summarised in Table 6.

Table 6: Comparison of extrapolations with secondary statistics

Renewable energies	Extrapolation for tertiary sector		Reference source / Institution				Area*
	Year	Number	year	Number			
Solar thermal							
Surface area	2011	4,42 Mio. m²	2011	15,2	Mio. m²	BMU 2012	GER
Heat supply	2011	1,63 TWh bzw. 1,85 TWh	2011	5,6	TWh	BMU 2012	GER
Photovoltaics							
Electricity production	2011	11,3 TWh bzw. 12,6 TWh	2011	19,3	TWh	BMU 2012	GER
Small hydropower							
Electricity production	2011	2,8 TWh	2011	1,7	TWh	ARGE Wasserkraftwerke 2012	GER
Heat pumps							
Heat supply	2011	0,398 TWh	2011	0,321	TWh	AGEB 2012	TER
Solid biomass							
Energy consumption	2011	18,6 TWh	2011	0,0	TWh	AGEB 2012	TER
Biogas							
Electricity production	2011	10,7 TWh bzw. 12,7 TWh	2011	18,4	TWh	Fachverband Biogas 2012	GER

* GER = Germany total; TER = only tertiary sector

6 Conclusions

The study provides energy consumption data differentiated by consumer groups and energy sources which can serve as the basis for efficient and improved examination of the development of energy consumption structures in the tertiary sector. Of course the data cannot match the overall accuracy of the energy balances in mapping real consumption which is defined by a series of provisions. But they do provide differentiated results for areas where the energy balance is only able to present aggregated, unstructured information, and they give insights where conventional data sources fail to do so, e.g. in biomass use or for energy sources which are only traded to a limited extent.

Because the survey has now been repeated several times, it was also possible to compile time series over a longer period – in this study 2006 to 2011 - for energy consumption in the tertiary sector by branch and energy source for Germany which are comparable at least to a certain extent. This provides another source of information on energy consumption in the tertiary sector which promises to be interesting for international comparisons. On top of this, there is also a differentiated determination of energy consumption by application at sector level, which could be based on detailed technological information from 100 energy audits conducted in the tertiary sector. That way, the quality of the energy consumption data by end-uses could be improved compared to the previous surveys (Fraunhofer ISI et al. 2004, 2009).

Above and beyond pure energy statistics, comprehensive sector-specific insights can also be gained from the survey and the audit regarding energy consumption structures, energy-relevant features, economic framework conditions and energy management in the companies. This information can be used for numerous other purposes, for example, designing energy policy measures or structuring the advice given by energy agencies, energy consumer associations and energy supply companies.

The two-stage survey on the use of renewable energies in the tertiary sector, which was conducted for the second time, proved difficult since a certain number of the 1,600 out of 10,221 enterprises from the first round, who initially agreed to a second interview, finally refused the detailed questioning. As a result, for some renewable energies (wind power, biofuels and liquid biomass) no reliable projection could be made since the remaining sample was too small. For the other renewable energies, the verification and comparison of the extrapolation results with secondary statistics seems to indicate – except for small hydropower - relatively plausible results. This was also due to the differentiation of the enterprises interviewed according to their location, since a clear preference for production of energy from renewable sources could be seen in rural areas. The results from the previous survey (Fraunhofer ISI et al. 2009) may thus also be seen from this view-point, which sometimes revealed too high a potential in the projections.

7 References

AGEB (German Working Group Energy Balances) (2011): Energy Balances of Germany 1990-2010 incl. Summary Tables and Renewable Energy Balance. As of 4 July 2011. DIW Berlin, EEFA, Köln. http://www.ag-energiebilanzen.de

AGEB (German Working Group Energy Balances) (2012): Summary Tables 1990-2011 (as of September 2012) and personal (prel.) information on the Renewable Energy Balance 2011 (as of 6 August 2012). DIW Berlin, EEFA, Köln. http://www.ag-energiebilanzen.de

Arbeitsgemeinschaft Wasserkraftwerke Deutschland (AWK-D) (2012): Bundesinformationen. Stand 9.12.2012. http://www.wasserkraft.org/wasserkraft-bund

BMU (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety) (2012): Erneuerbare Energien in Zahlen – Nationale und internationale Entwicklung. Stand Juli 2012. http://www.bmu.de/service/publikationen/downloads/details/artikel/erneuerbare-energien-in-zahlen/?tx_ttnews%5BbackPid%5D=937&cHash=03425683fa2cbd133f5373a399a86ed2

Fachverband Biogas e.V. (2012): Branchenzahlen 2011 und Branchenentwicklung 2012/2013; Stand 06/2012. http://www.biogas.org/edcom/webfvb.nsf/id/DE_Branchenzahlen/$file/12-06-01_Biogas%20Branchenzahlen%202011-2012-2013.pdf

Fraunhofer ISI, DIW, GfK, IE, IfE/TUM (2004): Energieverbrauch der privaten Haushalte und des Sektors Gewerbe, Handel, Dienstleistungen (GHD). Abschlussbericht an das Bundesministerium für Wirtschaft und Arbeit. Karlsruhe, Berlin, Nürnberg, Leipzig, München, April 2004. http://www.isi.fraunhofer.de/isi-de/x/projekte/ghd_314889_sm.php

Fraunhofer ISI, IfE/TUM, GfK (2009): Energieverbrauch des Sektors Gewerbe, Handel, Dienstleistungen (GHD) für die Jahre 2004 bis 2006. Abschlussbericht an das Bundesministerium für Wirtschaft und Technologie (BMWi) und an das Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU). Karlsruhe, München, Nürnberg, Mai 2009. http://www.isi.fraunhofer.de/isi-de/x/projekte/ghd_314889_sm.php