Zukunft Bau

SHORT REPORT

Key energy indices of passenger lifts

Determination of key indices for the energy requirements of passenger lifts in residential and non-residential buildings - a contribution towards completing the energy footprint

Reason / Starting point

The description and evaluation of the energy expenditure of buildings requires all loads to be taken into account as completely and precisely as possible at the planning stage and when recording consumption. With a share of approx. 5% of the energy expenditure, passenger lifts cannot be ignored in this process. Lifts are included in norms for the sustainability of constructions. This creates a need for suitable energy indices especially for planning purposes.

Object of the research project

The methods used for the research project are based on the experience and results of earlier (international) projects as well as on German and international standardisation activities and work done on drawing up guidelines for the energy efficiency of lifts. The approach pursued in this research project differs from previous activities in its objective of determining energy indices or ranges empirically which planners can use on a project-specific basis. The technical properties of the lift system are to be taken into account in the process, together with characteristics of the building. This method is intended to replace previous blanket approaches and overcome levels of uncertainty in describing the energy requirements of passenger lifts when in use. One of the reasons behind the need for the research project is that the energy consumption of lifts as a proportion of the total energy consumption of buildings is tending to rise (while consumption for heating and air conditioning as well as for lighting is falling). The reason why the electrical energy requirements of lifts must be considered in the planning process is that later in the usage phase it is usually registered in the building's total power consumption (even if not shown separately in every case). However, it is not currently included in the public energy certificate. The intention is for these research results to give planners a guide for lift systems, particularly for the early planning phase, to enable them to make clear statements with regard to energy consumption in the usage phase. In addition, it is generally sensible to calculate the total energy footprint in the case of sophisticated building concepts, and this includes the lift systems.

Measurements made on real systems with analyses and calculations based on them were the main criteria for conducting the project. On the one hand, established standards and guidelines were used, and on the other, new techniques developed. The plan at the start of the project was to offer different "quality levels" and degrees of accuracy for the energy indices. At best, limits and targets were to be given - but at the least, plausible ranges for a realistic estimate.

After working through existing studies, residential and non-residential buildings were categorised in order to determine the "transportation needs" (numbers of persons). While specific types for residential buildings were defined or derived from an existing categorisation, the inconsistent nature of non-residential buildings meant that it was initially only possible to divide them into broad building categories, e.g. administrative or office buildings.

The original aim was to be able to give limits and targets in the form of specific figures based on the model of the "LEE - Guide to Electrical Energy in Buildings" (IWU). However, it does not make sense to adopt the system of the LEE approach in its entirety as the usual area ratio applied for energy indices for heating, cooling, ventilation and lighting (e.g. net floor area to DIN 277) normally fails to deliver meaningful results for lifts. Instead, the aim for lifts is to give an annual consumption or requirement per system. It is conceivable to subsequently express the figures as a ratio of the floor area, but this can only serve to allocate the consumptions of lifts to known systems and to make rough comparisons - but in no way as a basis for planning.

Energy consumption measurements were carried out on 80 lift systems to VDI 4707 Sheet 1 as well as weekly measurements (mainly new systems in apartment blocks and office buildings). The number of systems measured was smaller than originally planned due to problems with the project partner, and targets and expectations had to be adjusted accordingly in the course of the project. The results were processed and compared. Due to the low sample, it is no longer possible to draw statistical conclusions for the total population. However, within the usage categories defined by VDI 4707 Sheet 1, a distribution is discernible and it is possible to give median and quartile values. This results in the ranges specified in the conclusion.

Conclusion

The project had three major objectives:

- to research and prepare the methodological foundations,
- to develop a typology of systems and buildings,
- to give specific energy indices or ranges.

The first two objectives were completely achieved, and they offer a sound springboard for future research projects. In spite of difficulties with the data, the project was successful in being able to specify ranges for annual energy consumption for various categories of use. These ranges provide planners with points of reference of practical use in early planning phases. It is recommended to repeat the measuring programme in a future research project with an expanded sample.

Key data

Abbreviated title: Key energy indices of passenger lifts

Researchers / Project Management: Dipl.-Wi.-Ing. Matthias Unholzer / Prof. Dr. Thomas Lützkendorf

Total cost: €35,680.00

Proportion of federal subsidy: €20,680.00

Duration of project: 01.09.2012 to 01.02.2014 (extended until 31.05.2015)

PHOTOS:

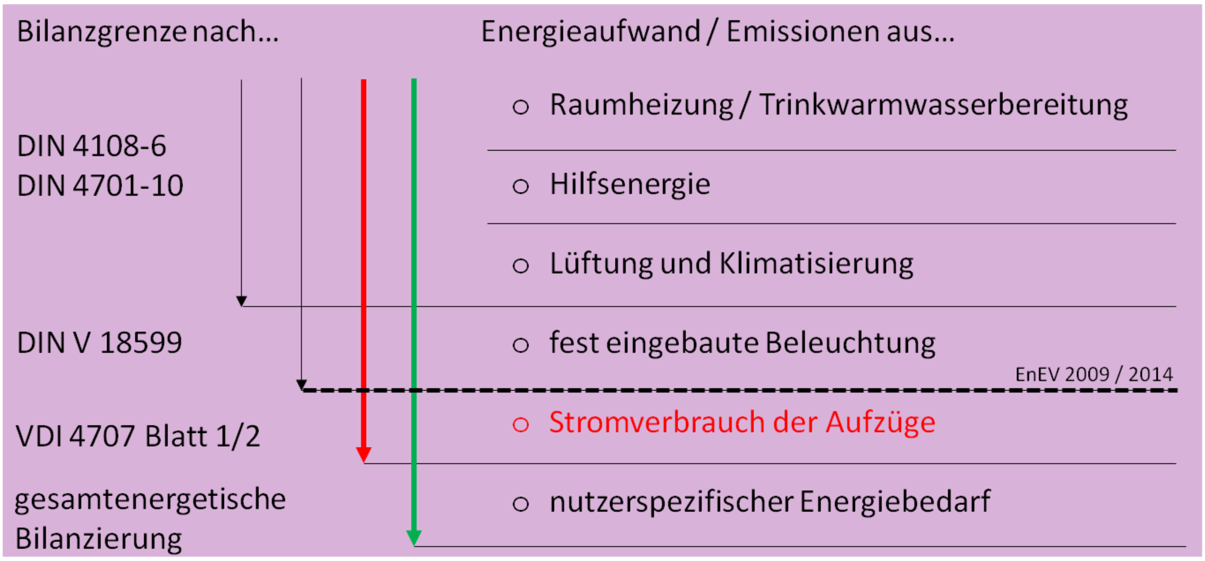

Fig. 1: Extension of energy footprint limits (source: own presentation, based on Voss 2011, file: Bild1.bmp)

Explanation:

In the case of non-residential buildings, the scope of the footprint defined by the current energy savings directive comprises the energy expenditure for room heating / providing hot water, auxiliary power (e.g. for pumps), the energy expenditure for ventilation and air conditioning as well as for fixed lighting. In the case of buildings whose total energy footprint is measured, the scope of the measurement has to be extended and it therefore includes the energy expenditure for the lifts. The comparison between the energy requirement indices calculated and measurements based on actual consumption only makes sense in principle if the scope of the measurement is identical.

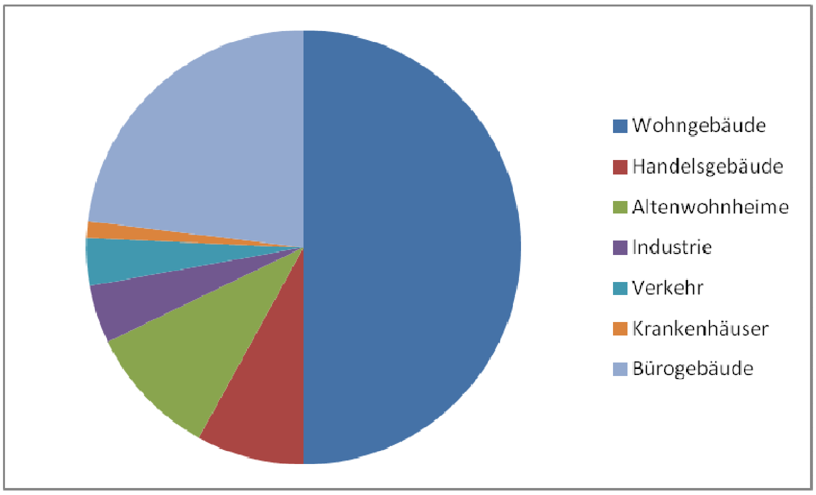

Fig. 2: Distribution of approx. 650,000 lifts in existing buildings in Germany (source: own presentation, based on Hirzel 2010, file: Bild2.bmp)

Explanation:

Most of the lifts in Germany are to be found in residential and office buildings.

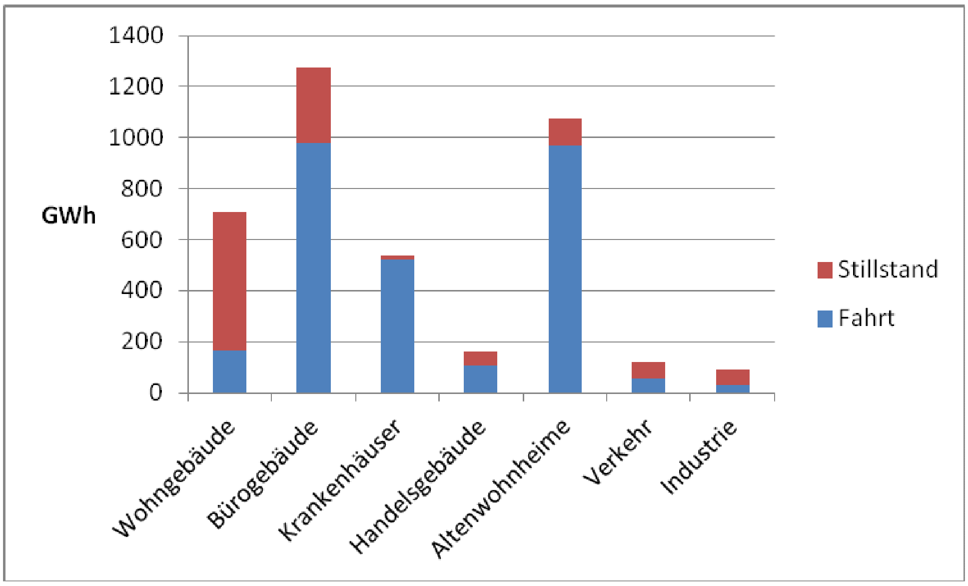

Fig. 3: Energy consumption of the approx. 650,000 lifts in Germany by type of building in GWh (source: own presentation, based on Hirzel 2010, file: Bild3.bmp)

Explanation:

It is noticeable from the extrapolation for all existing lift systems in Germany (as 2010) that standstill operation predominates in residential buildings. For other types of usage, especially office buildings and hospitals, the ratio is precisely the reverse.

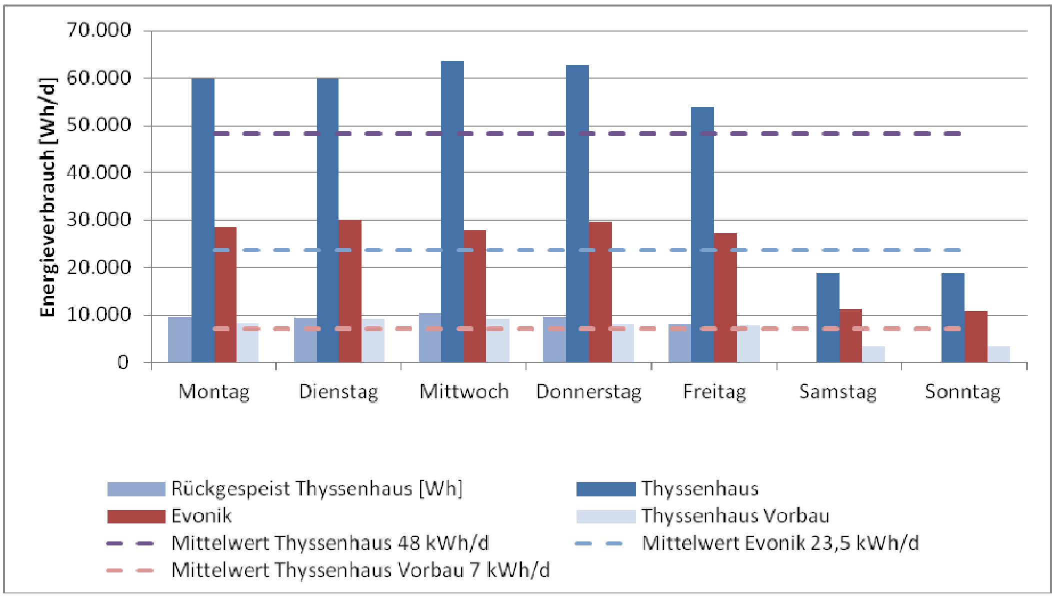

Fig. 4: Weekly measurements on three modernized lifts in large office buildings (source: ThyssenKrupp, file: Bild4.bmp)

Explanation:

The image shows the course of daily power consumption of three modernized passenger lifts in large office buildings over a week of normal occupancy. Significantly lower consumption can be seen at the weekend.

Fig. 5: Typical power consumption over the course of a day for a modernized lift in a large office building (source: ThyssenKrupp, file: Bild5.bmp)

Explanation:

The image shows the power consumption over the course of a day for a modernized lift in a large office building over a period of 24 hours. The consumption peaks in the morning up-hours and at midday are clearly recognizable. Hourly power consumption shows no further peaks for the rest of the day which can be explained, for example, by employees' flexible working hours.

Usage category to VDI 4707 Sheet 1	Annual consumption in acc. w. VDI (in kWh/a per lift)			Annual consumption from weekly measurements (in kWh/a per lift)		
	from (Q25)	Median	to (Q75)	from (Q25)	Median	to (Q75)
low (2) Residential building with up to 20 apartments, small office and administrative building	1,103	**1,265**	2,382	885	**1,322**	1,841
average (3) Residential building with up to 50 apartments, mid-sized office and administrative building	1,886	**2,370**	2,954	1,402	**1,902**	3,608
high (4) Residential building with more than 50 apartments, large office and administrative building	4,745	**7,363**	9,448	3,354	**5,995**	9,502

Fig. 6: Tabular depiction of possible ranges for the annual power consumption of a lift in kWh as a function of the usage category in accordance with VDI 4707 Sheet 1 - on the basis of the reference runs in accordance with VDI 4707 Sheet 1 and on the basis of weekly measurements (source: ThyssenKrupp measurements, own calculations, file: Bild6.bmp)

Explanation:

The results shown are based on measurements on 65 lift systems. The extrapolations are based on reference runs in accordance with VDI 4707 Sheet 1 and on the basis of weekly measurements. The results show the possible range (25% and 75% quartiles) as a function of the usage category in accordance with VDI 4707 Sheet 1. It is recommended to base calculations initially on the median of the weekly measurements in each case.