Swedish Energy Agency

End-use metering campaign in 400 households In Sweden Assessment of the Potential Electricity Savings

Author : Jean Paul ZIMMERMANN

September 2009

CONTRACT 17-05-2743

ENERTECH

Ingénierie énergétique et fluides
F - 26160 FELINES S/RIMANDOULE
Tél. & Fax: (33) 4.75.90.18.54
Courriel: contact@enertech.fr
www.enertech.fr

Preface

The Swedish Energy Agency has financed the project, “End-use metering campaign in 400 households in Sweden, assessment of the potential electricity savings”. The project is a part of the agencies program, “Improved energy statistics in buildings and industry”. In this program measurements and surveys of commercial buildings (STIL2), energy for water consumption in households and energy consumption in industry are carried out. A database, E-nyckeln, of Swedish buildings from a energy perspective is also a part of the program.

The electricity demand for households, excluding heating, has increased over a long period according to statistics based on surveys. This project has been initiated in order to increase our understanding of how electricity is used in households and what this increase consists of.

The report is written in English and is intended for decision makers, governmental agencies, researchers, consultants, utilities and other stakeholders, with an interest in this field.

A database with all measured data and data from enquiries etc. will be made available on the agencies website, www.energimyndigheten.se

In addition to the measurements, several research projects have been carried out. Some of these concerns behavioural aspects, with the aim to deepen the understanding of the user load patterns. These are also available on the website. However, the data gathered will allow for more analysis and the agency invites researchers to utilise the database.

The agency would like to thank all participating households for their cooperation and patience. A project of this size involves many individuals. The ones most involved are Zinaida Kadic (leader of the overall program), Heini-Marja Suvilehto, Ester Veibäck, Dennis Solid, Linn Stengård, Agnetha Leo, Anette Persson, and Christina Sterneus. All work by Elisabet Nilsson and Anna-Lena Johansson has been of great help. The agency also acknowledges Nils Windh and Rune Ståhl, from YIT-Sweden, who carried out the installation of metering equipment with a never ending enthusiasm and endurance.

Project leaders within the agency have been Peter Bennich, until summer 2008, and after that Egil Öfverholm.

Finally the agency would like to thank Olivier Sidler and Jean-Paul Zimmermann from Enertech for their outstanding work, for the high quality and their endurance over a long period. Enertech is a French company with extensive experience of this type of measurements. They were responsible for measurements and analysis. The author of the report is Jean Paul Zimmermann.

Eskilstuna September 2009

Caroline Hellberg
Head of unit
Unit of Energy demand
Department of System analyses

GENERALITIES

STAKES AND OBJECTIVES

Context

The investigation field of this project is the Demand Side Management of the specific electricity end-uses, in the residential sector. These end-uses represent an increasing part of the European Community states energy balance. Moreover, their impacts in terms of environmental nuisance (CO2 emissions, radioactive wastes) require rapid actions.

It has already been shown for a long time that the household electricity consumption could be reduced without any change in the rendered service, or in the comfort. A first demonstration was done between 1995 and 1997 in France with the ***Ecodrome*** project, which was lead by « Cabinet O.SIDLER » (which later became ENERTECH) and financed by the European Community (contract number 4.1031/S/94-093) and the ADEME (French Agency for Environment and Energy Management). The results of this project showed that we could save up to 40 % of the electricity-specific appliance consumption of the households by using efficient appliances. On a household scale, 1,200 kWh/year were saved. By extrapolating the French and European savings from this value, one found that 26 TWh/year could be saved in France and 180 TWh/year in Europe. The latter value represents the annual Italian consumption. The assigned objective of this project is to confirm whether ***Ecodrome*** conclusions can be generalised to Sweden.

Objectives of the project

The first objective of this campaign is to precisely describe the state and structure of the specific-electricity uses in the residential sector and to give an overview of the consumption for the common area for residential buildings. This project will produce reference information that will allow research teams, and organisations that work in the modelling and forecasting of electrical consumptions, to base their works on reliable data and on sane basis. No pertinent action can save the cost of a sharp analysis of the initial situation. This study aims at describing as carefully as possible, the state of the electro-domestic appliances in Sweden. The descriptive approach is one of the most important contributions of this project.

The second objective of this project is to evaluate the potential savings that can be achieved in the households by substituting efficient appliances for the appliances in place.

Standby powers are at the moment very particular, because there is no service at all associated with their demands. Their consumption appear like wasted energy, and most of them are probably avoidable, generally at a relatively low cost. This aspect is essential because Standby consumption seems to grow exponentially and its part in the household consumption grows in a worrying way. Therefore Standby power was monitored and analyzed with in order to define as precisely as possible the nature and the extent of the associated consumption.

Finally, this project monitored every light source in every household. This allowed a very sharp precise of the lighting consumption, and therefore of the efficient solutions.

Operationnal partners

The measurement campaigns took place in Sweden and different teams were involved;:

- The ***Swedish energy agency*** was the initiator of the project. They provided the households and the residential buildings for the project.
- ***Enertech*** in France, because of its experience in the monitoring campaign field, was in charge of providing the monitoring equipment, analysing the data.
- ***YIT Sverige AB*** was in charge of the installation and dismantling of the measurement systems. Enertech provided training session to the YIT staff on the use and installation of the monitoring equipments.

DESCRIPTION OF THE GENERAL METHODOLOGY

Generalities

The monitoring campaign was scheduled from August 2005 to December 2007. However, the time needed to achieve the required quality of data and the difficulty to find valid households extend the campaign by one year. Finally, the campaign went from August 2005 to December 2008.

General characteristics of the measurement campaigns

The goal of the study was to monitor all main electric appliances for 400 households and 20 common areas in residential blocks:

- 40 households were measured for one year. All the main electrical appliances were monitored at a time step of 10 minutes, a direct measure was done for the rest. Most of the households were located in the Mälardalen region with one of these households located in the far north of Sweden, one other in the south of Sweden. Due to the number of metering devices, it was possible to monitor 20 households at the same time. Therefore this part was achieved in two years (first year: 20 households – second year: 20 households).
- 360 households were monitored for one month. All the main electrical appliances were monitored at a time step of 10 minutes, a direct measure was done for the rest. 9 of these households were located in the far north of Sweden, 9 in the south (Skåne region) and the rest in the Mälardalen region. 26 metering equipment sets were used for that part: the campaign was a succession of “installation of the monitoring equipment” / “recording the data for one month” / “dismantling the equipment”

Table from figure 1.1 represent the equipment planned to be use per household.

Uses	Serial Wattmeter	Wattmeter with ammeter pliers	Lampmeter	Temperature sensor
General meter		3		
Heating		3		
Water heater		1		
Kitchen oven		3		
Miscellaneous		3		
Clothes-washer		1		
Dishwasher	1			
Clothes-drier		1		
TV	3			
Audiovisual site	2			
Computer site	3			
Cold appliances	2,5			
Microwave	1			
Car heating	1			
Ventilation system	1			
Lighting	1		25	
Miscellaneous	2			
Temperature				2
Total	**17.5**	**15**	**25**	**2**

Figure 1.1: planned equipment per household

The choice of the households was done by the Swedish energy agency. They had to be a good picture of the different type of households present in Sweden. The households were split in different categories (see chapter: Description of the sample).

THE MEASUREMENT SYSTEMS

Several types of metering devices were used to achieve the monitoring campaign:

- lampmeters were used to measure the consumption of the light sources that draw a constant electrical power (incandescent bulbs, CFL, etc.). All the light points with constant power were metered. The lampmeter measured the time during which the light source was switched on and the power was measured separately during the meter installation. From these two measurements, we were able to determine precisely the consumption’s of each light point in the households. We used Wattmeters connected in series with the lamp to determine the consumption’s of the halogen lights, for which the power drawn was not constant.

- the consumption’s of most of the other types of appliances (cold, audiovisual, computer site, etc.) were monitored using Wattmeters connected in series with the appliances. The serial wattmeter was directly plugged into the wall sockets. The household appliance to be monitored was then connected in the trailing socket of the wattmeter.

- some appliances (mainly heating, water heating) were monitored directly from the main switchboard of the household. These measurements were done using the Multivoies system which was installed inside the breaker board (or fuse box).

- the internal and external temperatures were monitored using thermometers.

The Multivoies system

The MULTIVOIES[tm] system from the french ***OmégaWatt*** company is designed for the measurement of a large number of channels of power consumption and energies in electrical switch boxes. It includes a Din rail mounted concentrator to measure voltages and supply power to the system, and several modules equipped with current sensors.

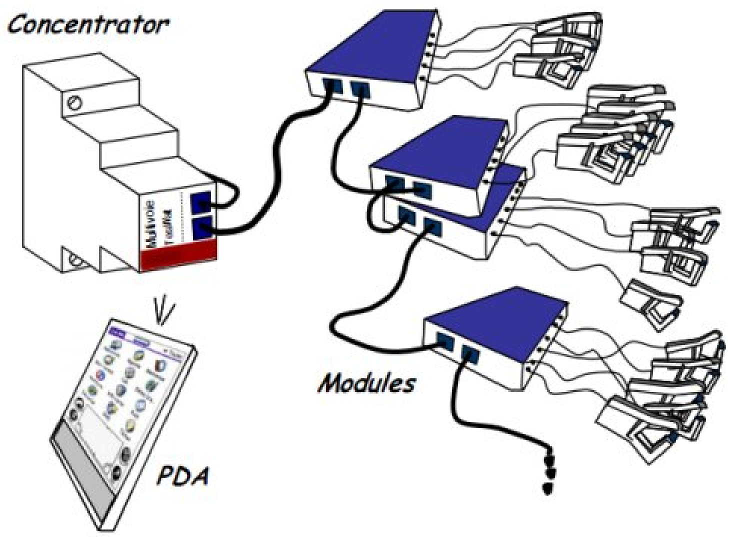


Figure 1.2 : Multivoies system overview

The system interfaces with the user thanks to a Personal Digital Assistant, using Infrared communication or low power radio (Bluetooth). The concentrator and the modules are connected to a high speed industrial data bus with factory assembled RJ11 connectors. The modules are fitted with standard closed miniature current transformers (0-45 Amps).

The main features include:

• Simultaneous measurement of electric power in tens of lines per switch box,

• Measurement of power ranging from 2 W to 230 kW per phase with a wide range of current sensors (Current jaws, miniatures current transformers, Rogowski coils). Typical accuracy: 2%.

• Recording of active energy and voltages with periods of 1 second to 60 minutes (5 month memory for 10 minutes period – independent on the number of current modules)

• Records power quality (voltage sags).

Figure 1.3 : Concentrator and Module for the multivoie system

The Serial wattmeter

The serial wattmeter developed by ENERTECH was designed with the aim of taking measurements of active energy and voltage for single-phase appliances with power level lower than 2,6 kW. Placed in serial between the standard socket-outlet 230 V~ and the plug of the appliance to be measured, it does not require any intervention on the distribution system.

The serial wattmeter is entirely autonomous and can be left in place several months according to the frequency of the selected data memorizing. At the end of the measurement period the memorized data are read using the Oscar software which transfer them to a PC for analysis.

Figure 1.4 : Serial wattmeter overview

The features for the serial wattmeter includes:

- Voltage area: between 0 - 250 Vac (the power supply for the serial wattmeter is not taken on that entry - measurements continuous even in the absence of voltage sector)
- Maximum load: 12 amps
- Serial wattmeter power supply by standard batteries: 2 X LR6 (AA) 1.5V (autonomy: 400 days)
- Current measurement with two automatic gauges
- Resolution: 0.1 Wh - the resolution decrease with the power (progressive coding)

- Working Led: a short impulse every 4 seconds.
- Period of measurement: adjustable from 1 to 60 minutes
- The drift of the clock is of approximately 10 minutes per year
- 65 KB of memory: 1,3 year of autonomy in term of memory size for recordings at 10mn.

The Wattmeter with am pliers and Pulsmeter

The Wattmeter was designed by ENERTECH to be used mainly upstream electric installation (Switch box, etc). Each Wattmeter is associated with a Pulse meter, a small electronic device in charge of data recording.

The function of the Wattmeter is to convert the active energy information into pulses recorded by the Pulse meter. The weight of one pulse is 0,5 Wh.

Pulse meters for the Wattmeter are electronic recorders of reduced size connected directly on the Wattmeter. The number of pulses is stored in its memory.

Pulse meters are entirely autonomous and can be left in place several months according to the frequency of selected data memorizing. At the end of the measurement period, the memorized data are transferred to a PC using the Oscar software.

Figure 1.5 : Wattmeter with am pliers and Pulsmeter

The features for the Wattmeter are:

- Measurement range: 3W – 22kW
- Voltage range 180V - 250V
- Amp pliers: 100 A: cat III 640 V
- Pulse meter connector: max 10mA: 12 V

The features for the Pulse meter include:

- a micro controller with very low electric consumption,
- a nonvolatile memory of large capacity (64Ko) allowing 65024 records,
- standard Lithium battery allowing an autonomy higher than 4 years,
- programmable period from 1 minute to one hour
- saving the pulses in memory: memorizing 0 to 2175 pulses per period with a precision always better than 1,5%.

The Lampmeter

The lampmeter is an electronic recorder of reduced size. It can be installed in the immediate proximity of the appliance to evaluate, without requiring connection with the electrical supply network.

An optical sensor ensures the detection of the durations of lighting for the equipments. This allows a very fast assembly without intervention on the electric circuits. You just have to fix it near the lamp to be analyzed and to direct the sensor towards the source of light. A LED flickering indicates then if the sensor is correctly positioned.

Entirely autonomous, they can be left in place several months according to the frequency of selected data memorizing. At the end of the period of measurement the data is recovered using the Oscar software which transfer the data on to a PC where they will be analyzed.

Figure 1.6 : Lampmeter

The design features include:

- A micro controller with very low electric consumption,
- A nonvolatile memory of strong capacity (64Ko) allowing a recording going until 32000 events,
- A standard Lithium battery allowing an autonomy higher than 4 years,
- An indicator of operating condition of the appliance. (The LED is active during 4 minutes after connection with the PC interface but it is not necessary to connect the interface to the PC.)
- Events recording (lightings and extensions):
  - Resolution for duration is one second.
  - Precision for the dating of the events is 4 seconds.

The Thermometer

The thermometer is an autonomous electronic data logger of reduced size provided with a temperature sensor. It takes regularly measurements and stores at selected time steps the average of several measurements (2 minutes interval between each measurement except at the time step of 1 minute) (ex: carry out the average of 5 measurements for a 10 minutes step).

The thermometer has a very broad range of measurements (-50°C to 120°C).

Figure 1.7 : Thermometer – Indoor and Outdoor models

The data are stored in a non volatile memory of strong capacity (64Ko) allowing a recording going up to 65000 measurements (1 byte per data, for an autonomy of approximately 1 year and 3 months for recordings with the step of 10 minutes).

The recorder uses standard Lithium battery (standard CR 2032) allowing an autonomy equal to 2 years for a 10 minutes step and one year for a one minute step.

The Optical reader

The optical reader is used for measuring the main electrical consumption by recording the led flash that you will find on the “electronic type” electric meter only.

There is no electric connection to provide as the sensor is an optical type. You only need scotch to install logger.

The optical reader consists of a sensor to place against the pane of the meter, of a black box and a wire which connects these two elements. The box contains batteries which make it possible for the device to be autonomous during more than one year (alkaline batteries).

Memory autonomy for the device can reach 14 month for measurements at 10 minutes time.

Figure 1.8: Optical reader

TREATMENT OF THE COLLECTED DATA

Once the data was received by ***Enertech***, it was later on controlled by a software tool aimed at certifying the coherence of the transmitted records. This data was subsequently assembled in a database. The filtering and preparation work is very long and meticulous. But it is necessary to be sure that the data used is trustable. We decided to remove from the database any record that was doubtful or not reliable.

The data were stored in 4 different databases: appliances monitored one month (54 million data), lighting monitored one month (53 million data), appliances monitored one year (55 million data) and lighting monitored one year (54 million data).

The sums per families of appliances (cold, audiovisual, etc) and per type of room for lighting (bedroom, kitchen, etc) were also calculated and introduced into new databases. This allowed an easier approach to the appliance analysis.

DESCRIPTION OF THE SAMPLES

Distribution of apartments and houses

As we can see in figure 1.9 the distribution between apartments and houses is very well balanced. The sample includes one less house than apartments.

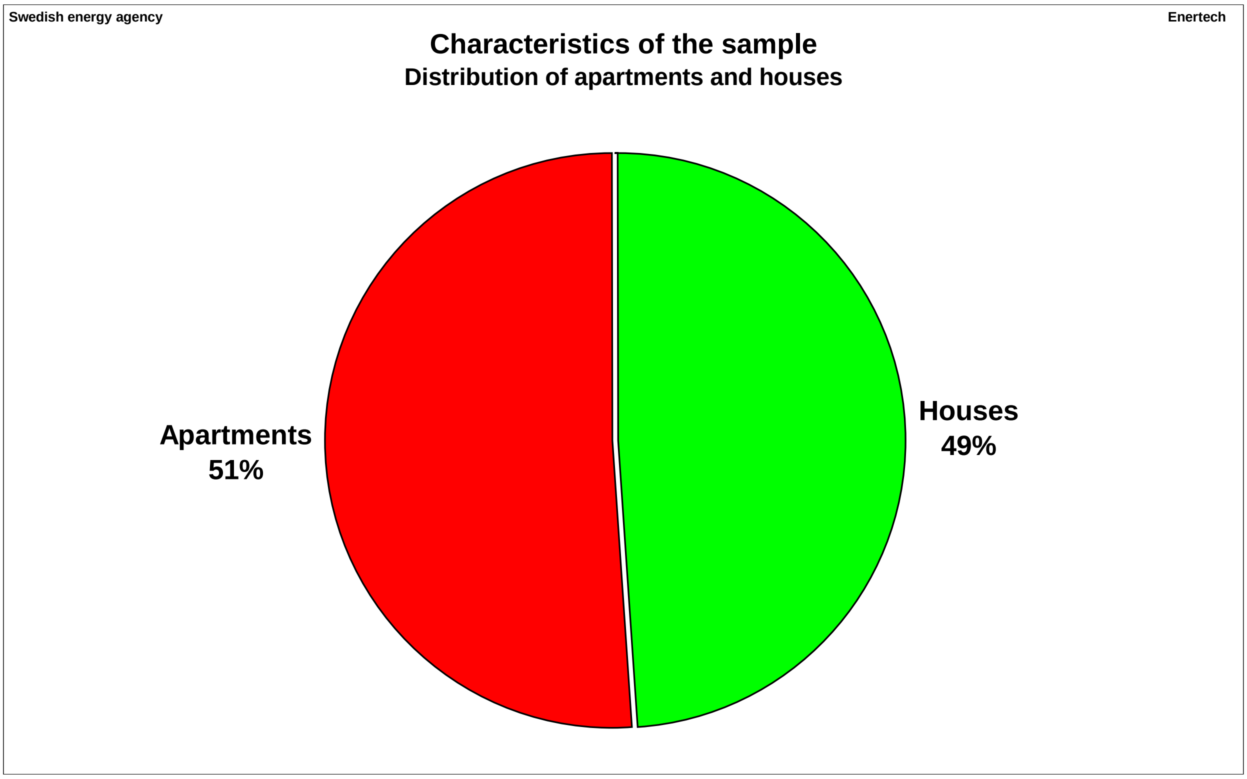


Figure 1.9: Distribution of apartments and houses

Number of inhabitants per household

Figure 1.10 shows the distribution of the number of persons per household. 35% of the houses have two inhabitants (couples without children or one adult with one child), 32% of the houses have four inhabitants (couples with two children). 37% of the apartments have two inhabitants (couples without children or one adult with one child), 28% of the apartments are for single persons.

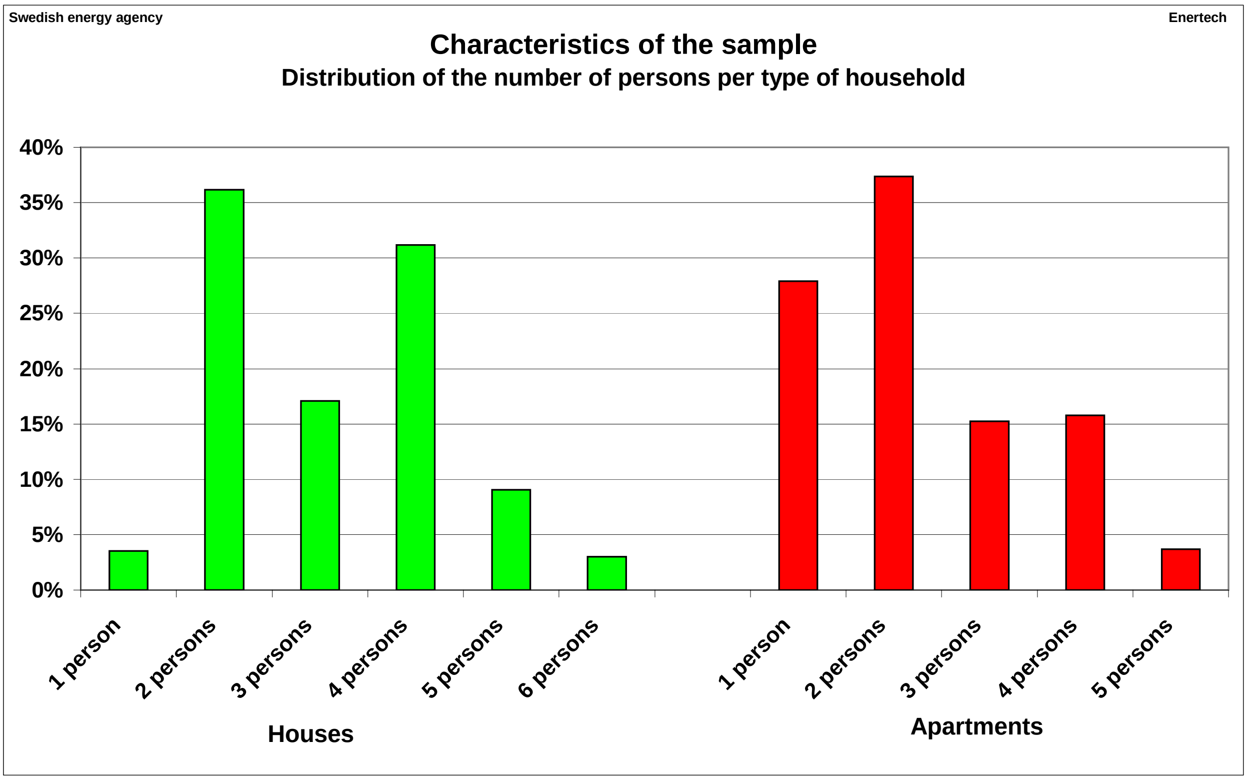


Figure 1.10: Distribution of the number of persons per type of household

Sizes of the households

Figure 1.11 shows the average area per type of household. The houses are 1.67 greater than the apartments.

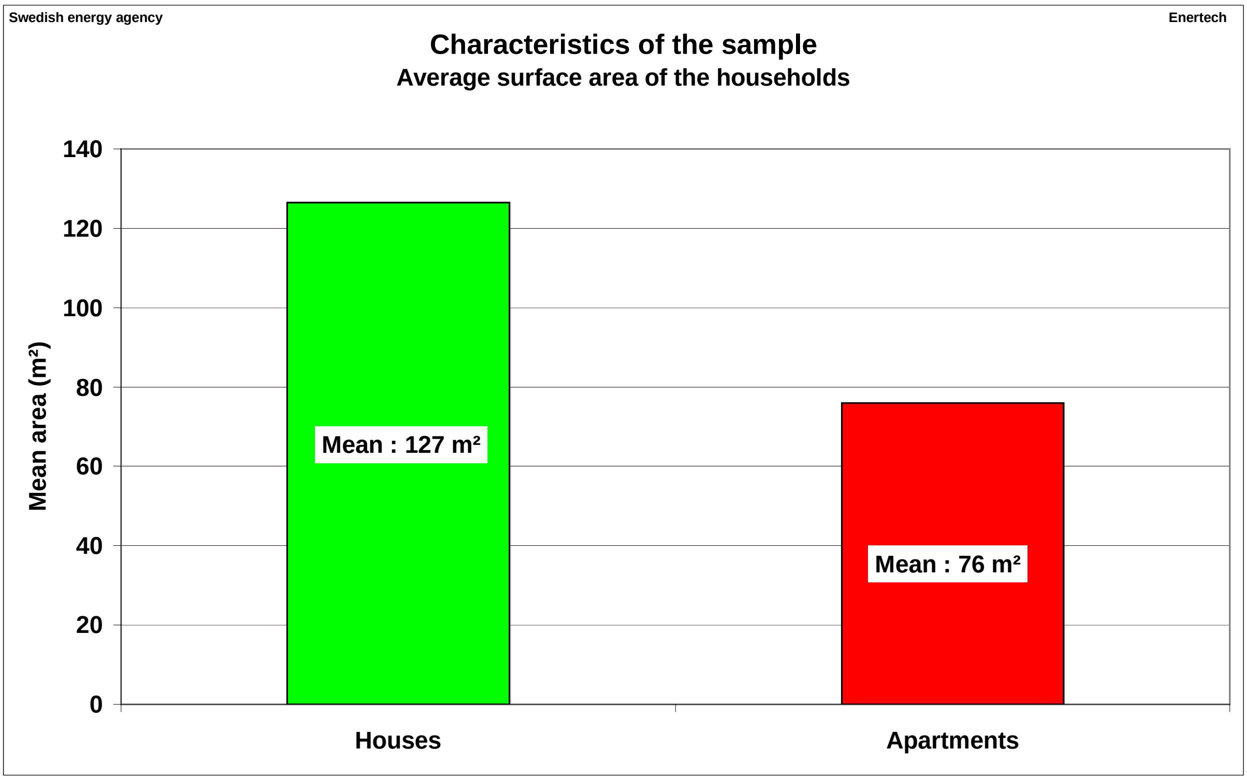


Figure 1.11: Average surface area for the households

Inhabitants type

Figure 1.12 represent the number of households per categories of inhabitant:

- For the two types of household, the first category is "family between 26 and 64 years old". For the families, we include couples with a child (or children) or a single person with a child (or children),
- There are far less single persons in houses than in apartments,
- "Single person less than 25 years old" are only present for apartments.

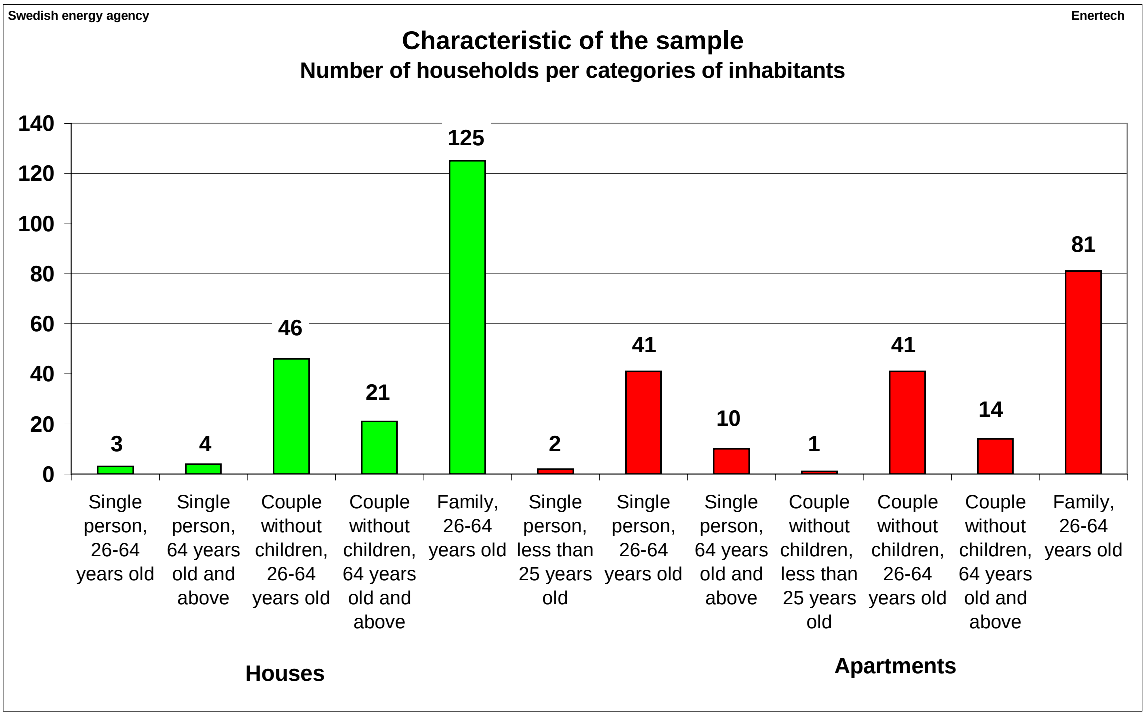


Figure 1.12: Number of households per categories of inhabitant

RESULTS OF THE MEASUREMENT CAMPAIGN

GENERAL ELECTRICITY CONSUMPTION

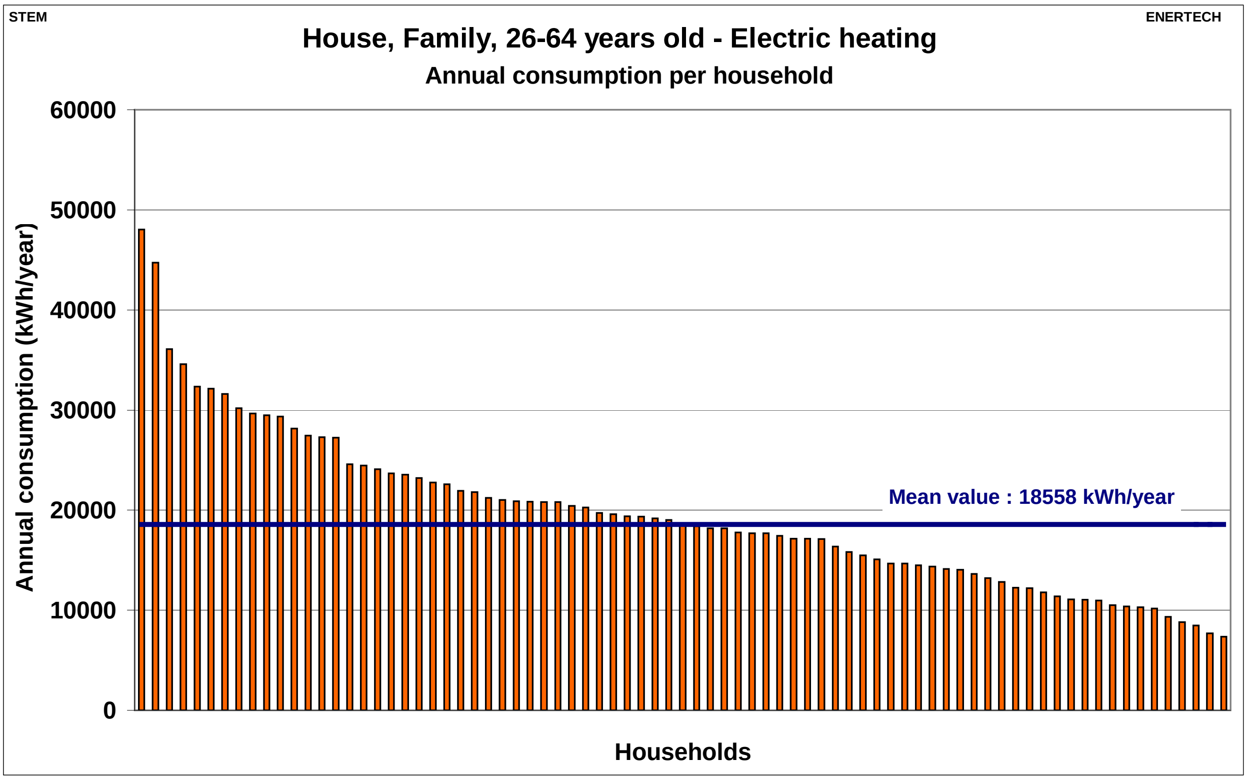
Total annualized households electricity consumption

Figure 2.1 to 2.31 represents the distribution of the total household electricity consumption for the different type of households. The total electricity consumption was always monitored for the household from the main electric switchboard and contains the specific consumption like cold appliances, lighting etc but also heating and water heating. There are different types of heating depending on the energy used: direct electric heating, heat pump, gas, wood, district heating. Each type of heating needs different devices to work properly: electric radiators, heat pump, circulation pump for hot water etc. In this monitoring campaign, all the consumption involved in the heating production were monitored, generally directly from the switchboard. According to the questionnaire that each household owner had to fill in, the households were split in two categories: the ones “with direct electric heating” (radiators or electric furnace) and the ones “without direct electric heating” (district heating, heat pump or other types of energy). Refer to the Heating/Water heating chapter for more information about the systems. For the houses, there are also graphs for the specific consumption (all consumption minus heating and water heating). The specific consumption lets us compare the houses with the apartments. The graphs with the consumption per m² and per persons are also presented and give us good indicators to compare the households:

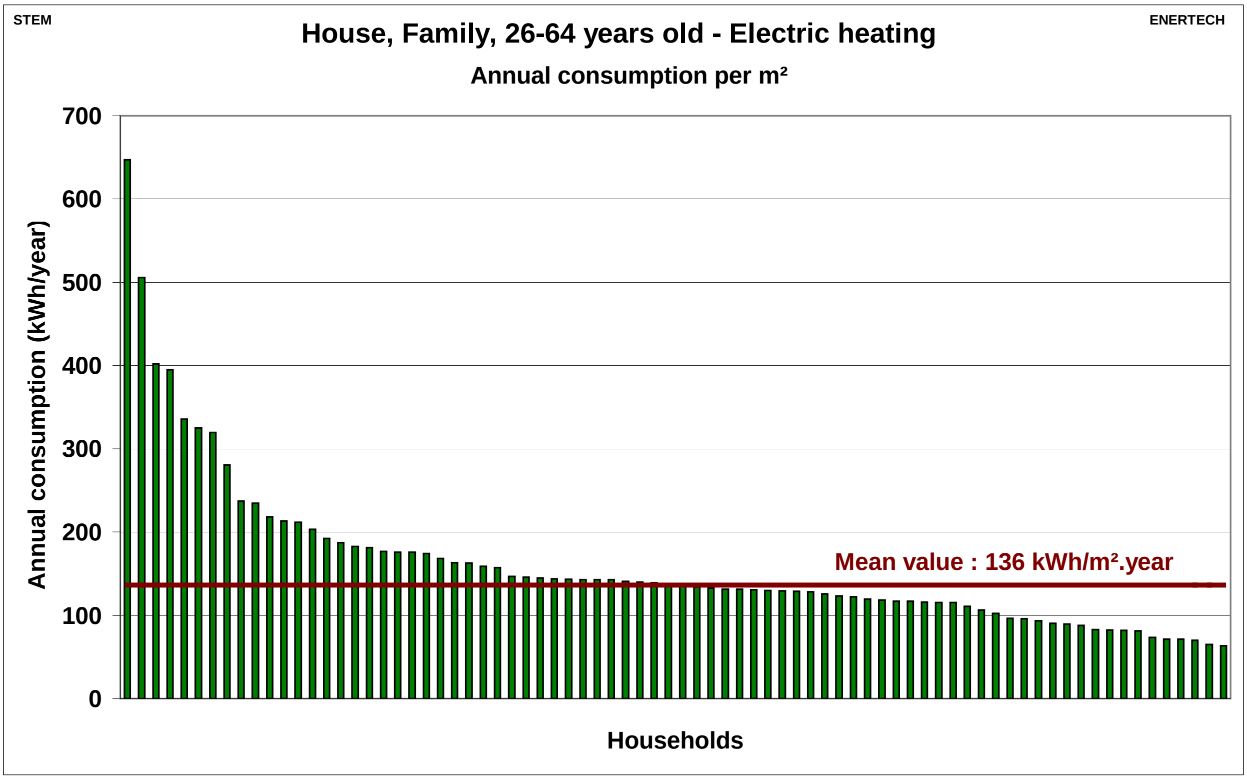
- the average consumption is maximum for houses with electric heating where families or couples without children between 26 and 64 years old are living: 18558 kWh/year and 17173 kWh/year respectively.
- the consumption per m² for families and couples without children between 26 and 64 years old are very close: 136 and 139 kWh/m²/years for houses with electric heating, 76 kWh/m²/year for houses without electric heating and 44 and 36 kWh/m²/year for the apartments.
- for the houses, the couples without children between 26 and 64 years old have an annual consumption per person that is far more important than for families. As the consumption per m² is equivalent (see point above), the consumption per person is automatically higher. One explanation is that the consumption for cold appliances or heating are less dependant of the number of persons in the household than cooking or lighting for example.
- the minimum to maximum ratio is always greater then 5. The type of household allow us to split the data in different categories but the number of parameters that can explain the consumption level are too high to be taken into account.

Table of figure 2.32 list all the results contained in the graphs.

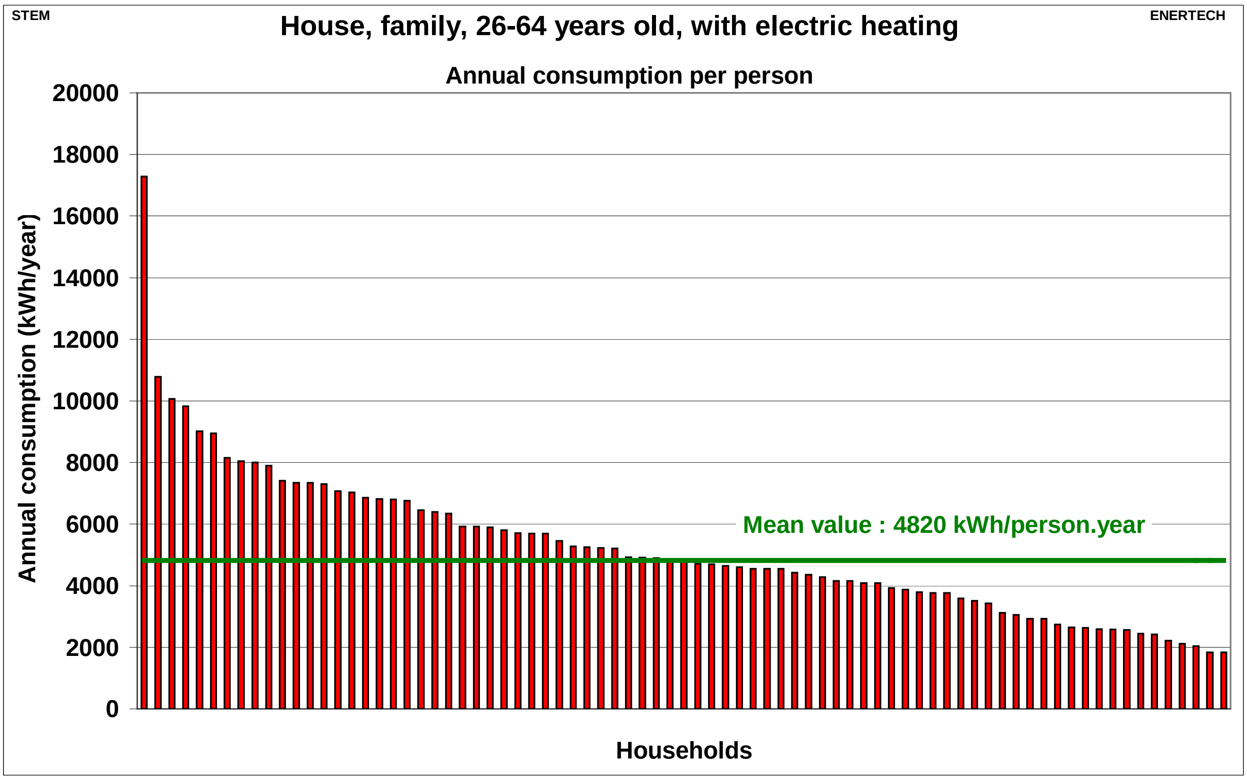
Family, 26-64 years old



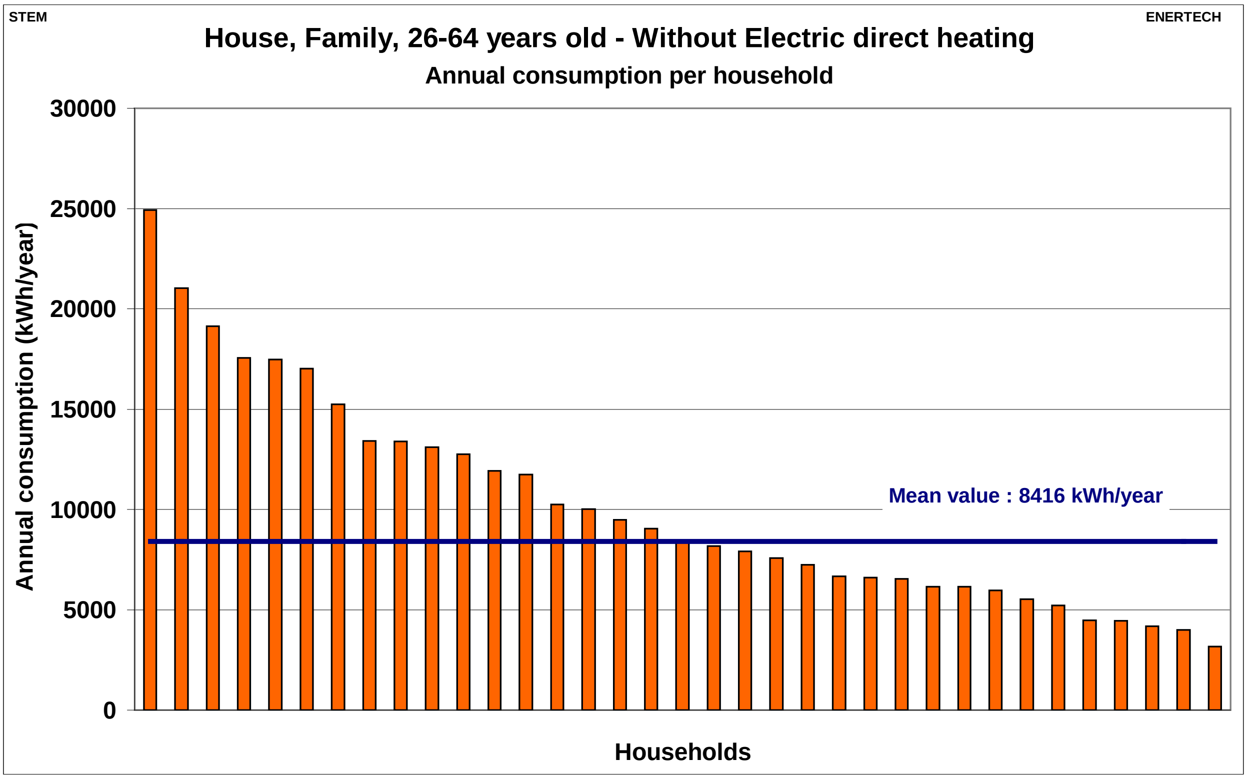
Figures 2.1: Total annualized electricity consumption – Houses with electric heating



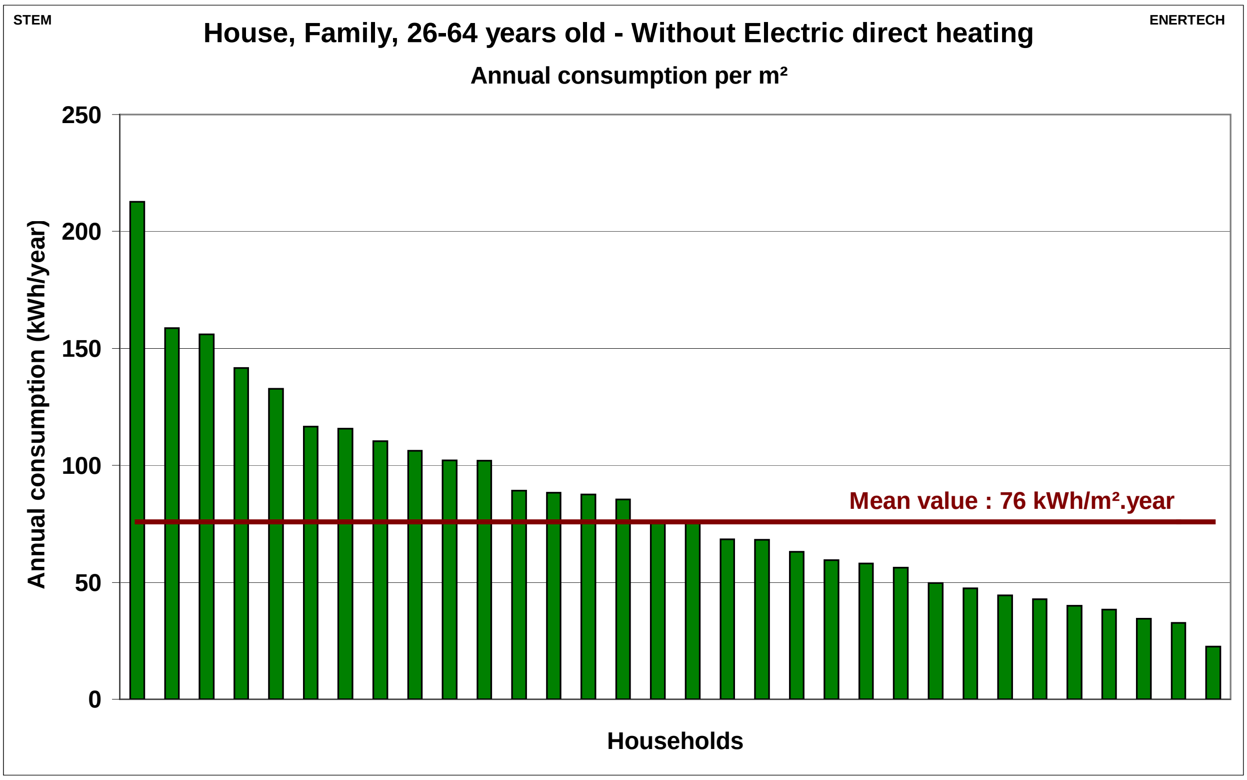
Figures 2.2: Total annualized electricity consumption per m² – Houses with electric heating



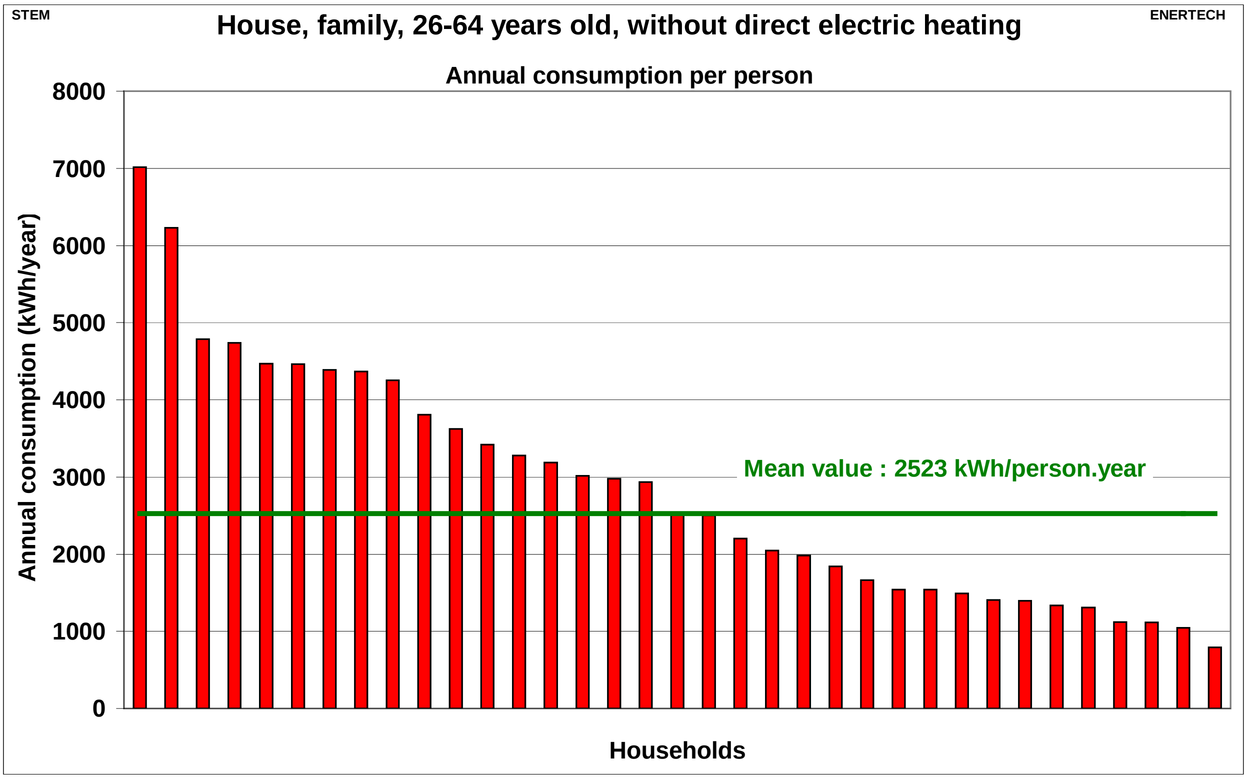
Figures 2.3: Total annualized electricity consumption per person – Houses with electric heating



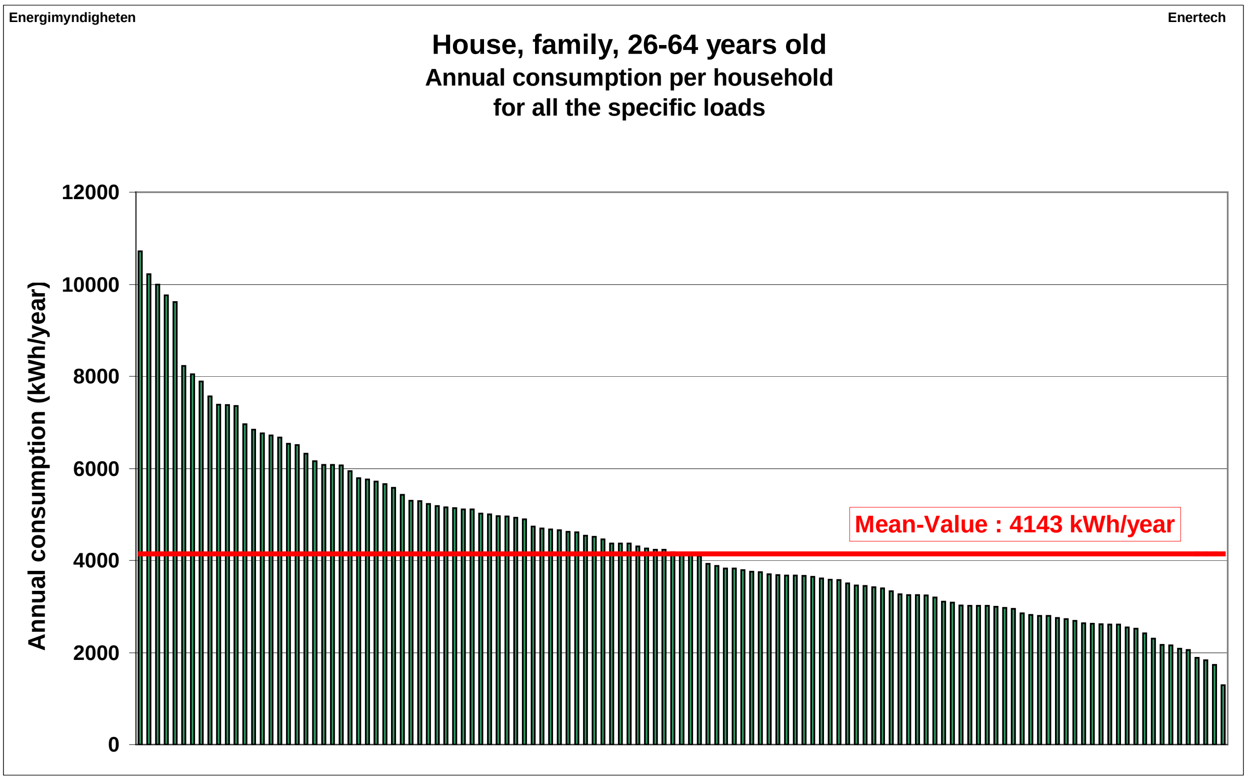
Figures 2.4: Total annualized electricity consumption – Houses without electric heating



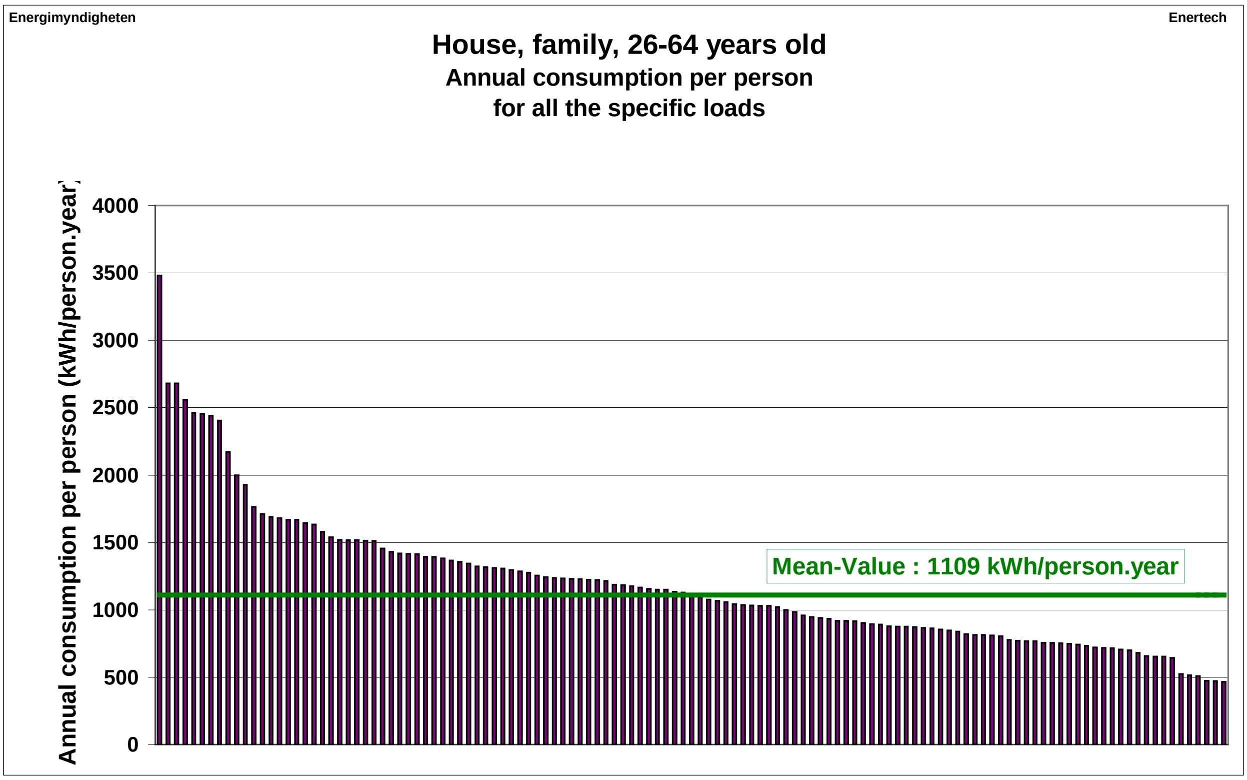
Figures 2.5: Total annualized electricity consumption per m² – Houses without electric heating



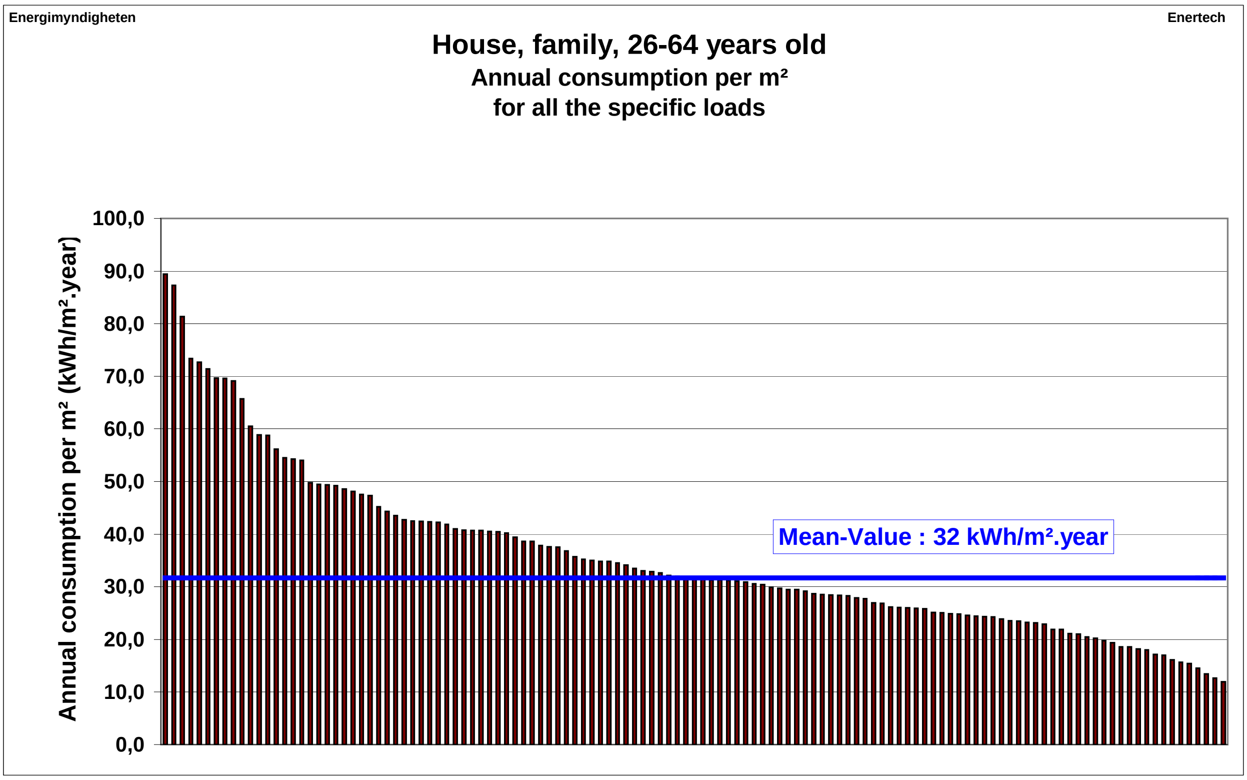
Figures 2.6: Total annualized electricity consumption per person – Houses without electric heating



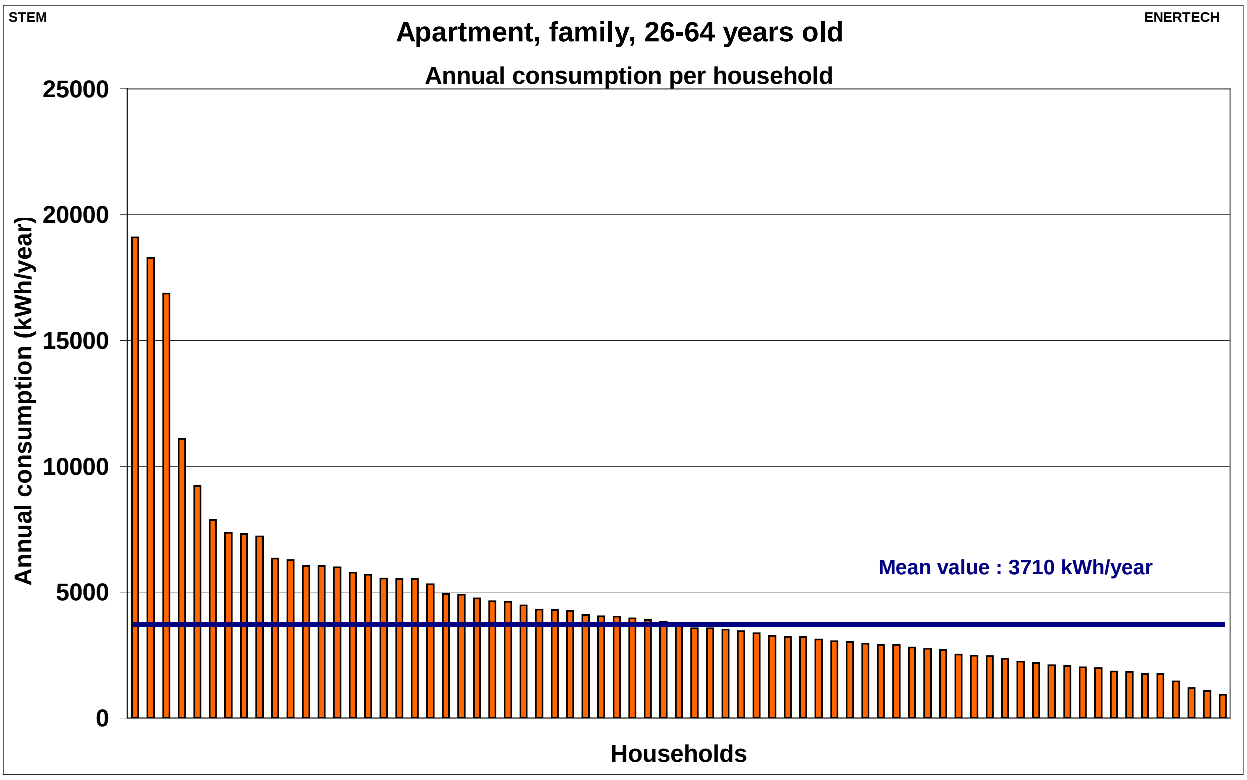
Figures 2.6-B: Total annualized electricity consumption per household – Specific consumption only - Houses



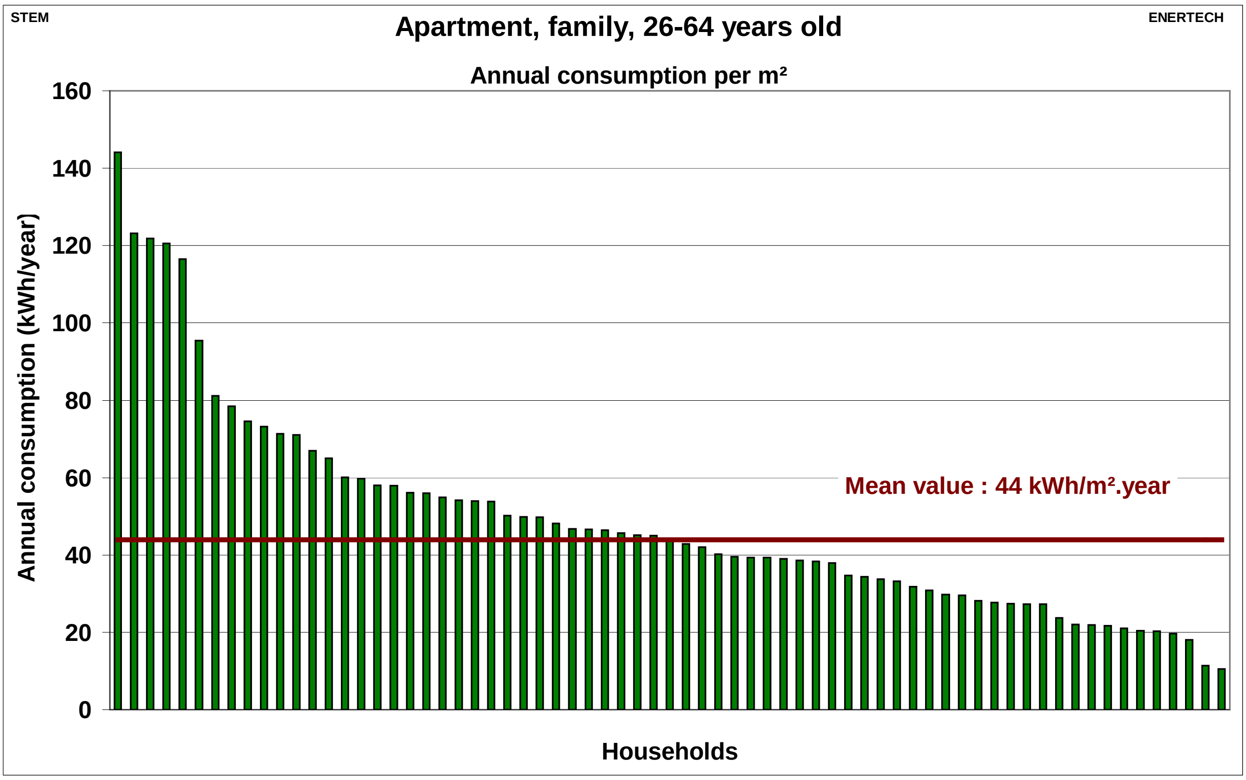
Figures 2.6-C: Total annualized electricity consumption per person – Specific consumption only - Houses



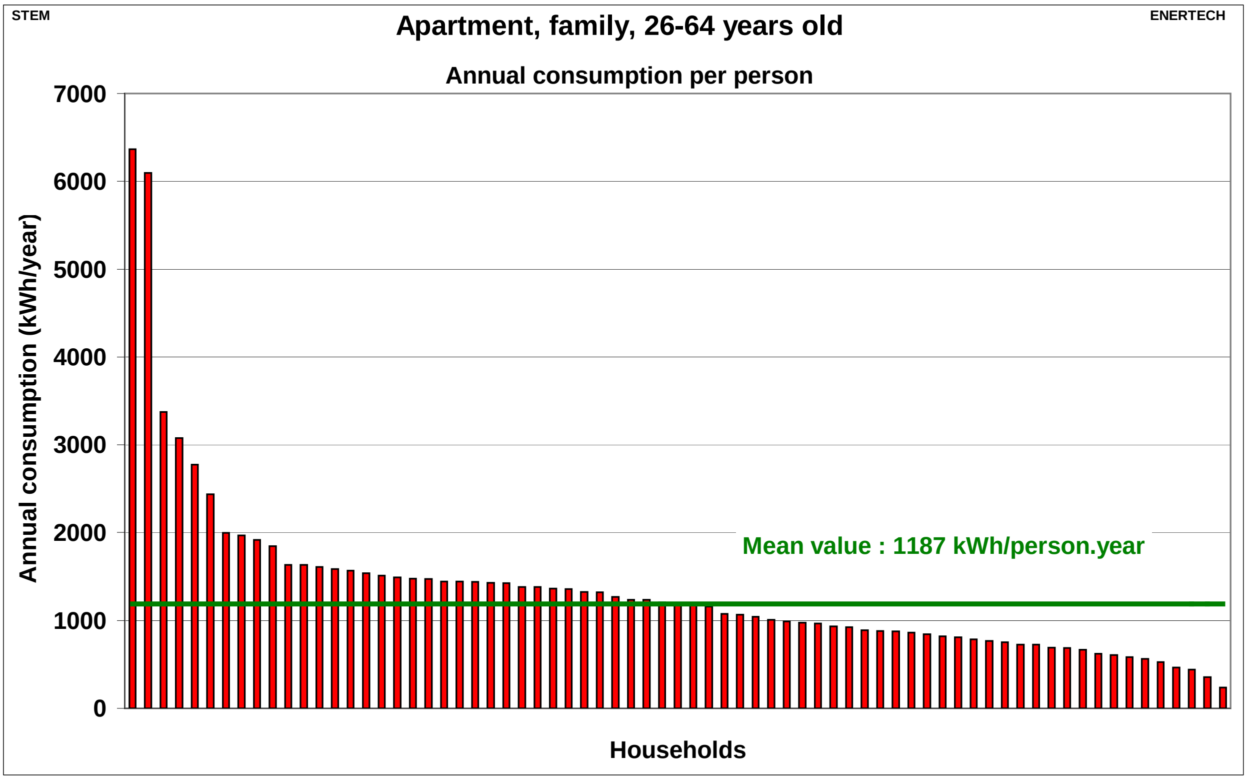
Figures 2.6-D: Total annualized electricity consumption per m² – Specific consumption only - Houses



Figures 2.7: Total annualized electricity consumption – Apartments

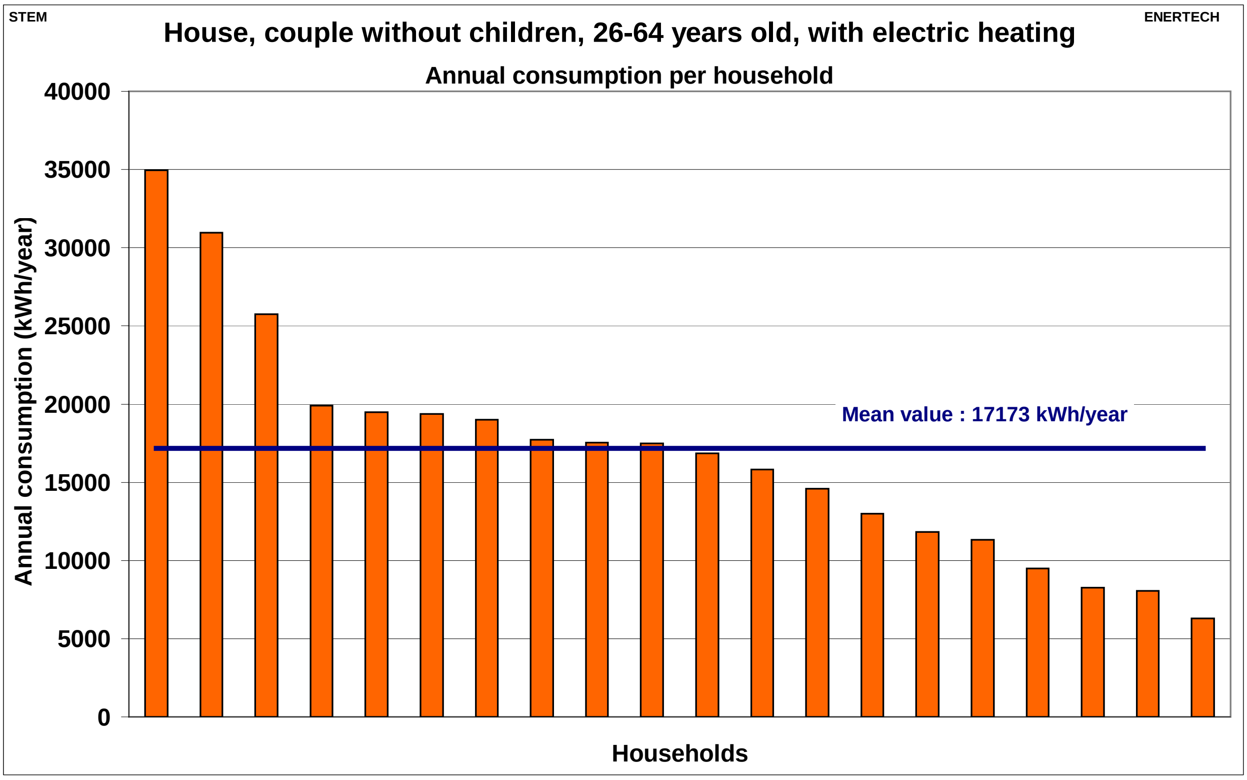


Figures 2.8: Total annualized electricity consumption per m² – Apartments

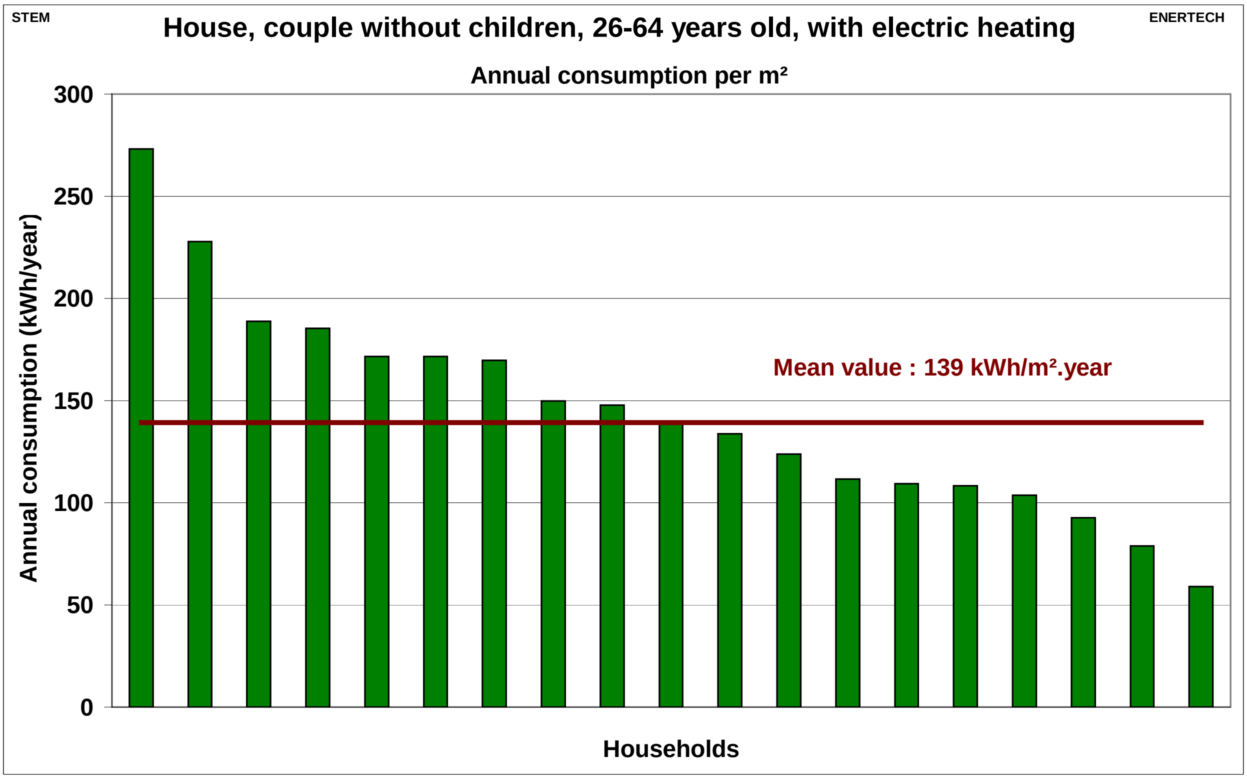


Figures 2.9: Total annualized electricity consumption per person - Apartments

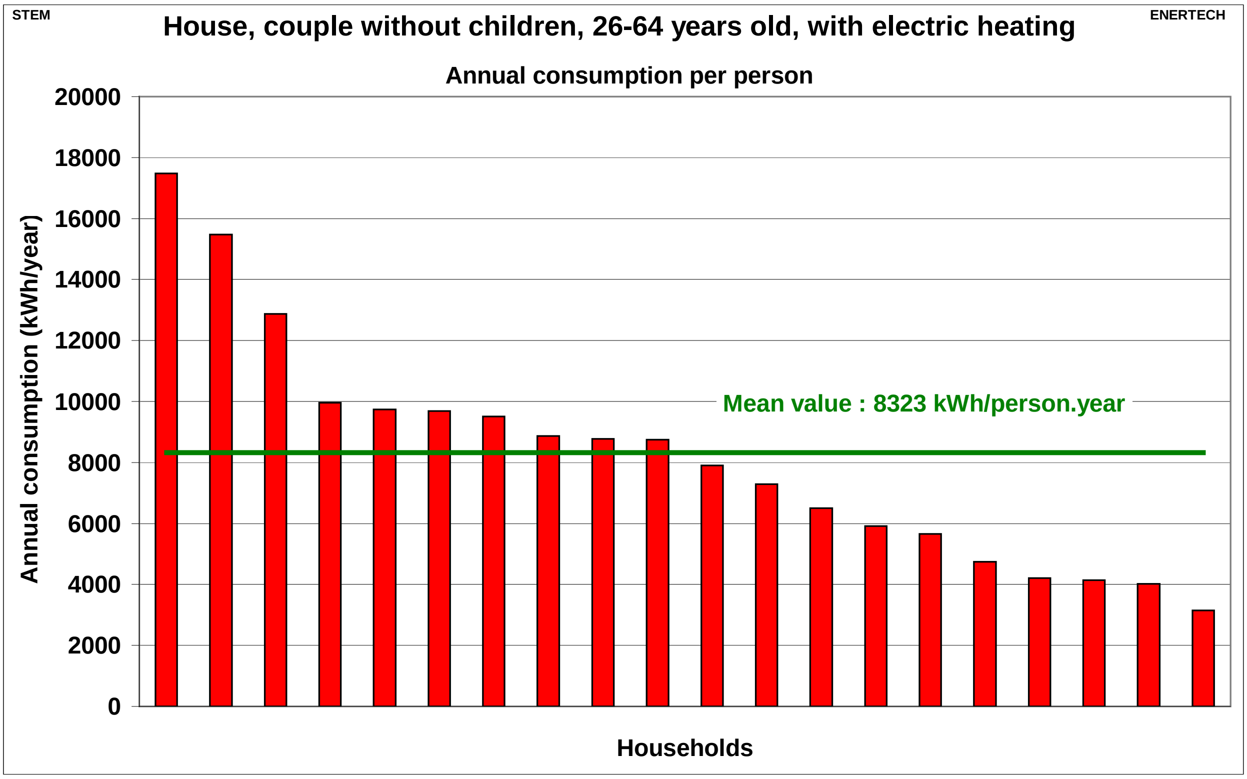
Couples without children, 26-64 years old



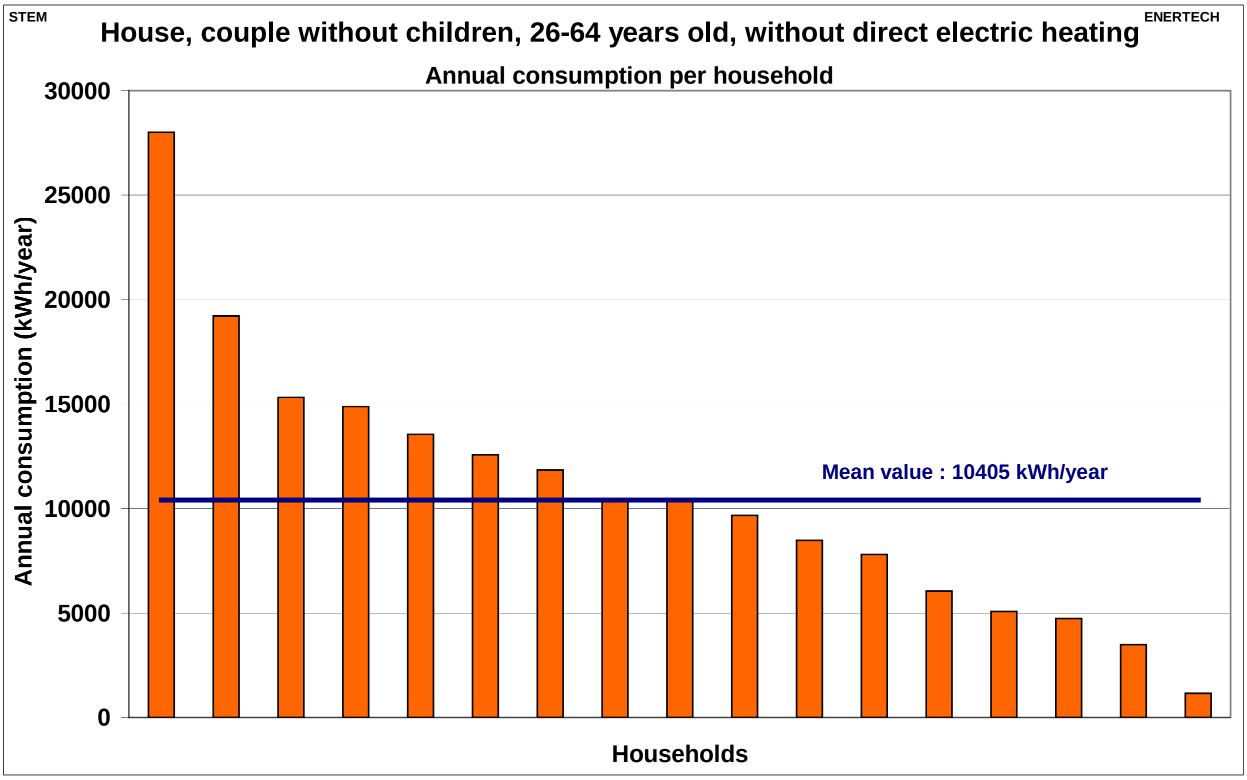
Figures 2.10: Total annualized electricity consumption– Houses with electric heating



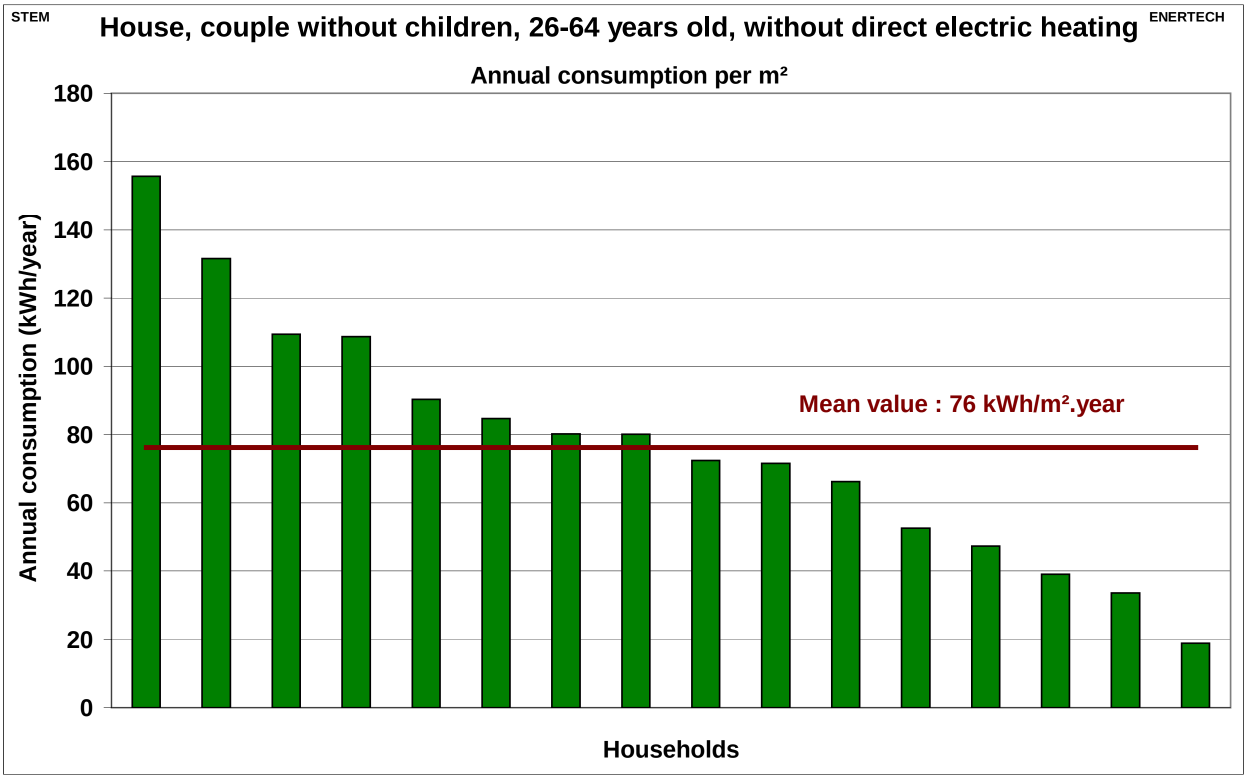
Figures 2.11: Total annualized electricity consumption per m² – Houses with electric heating



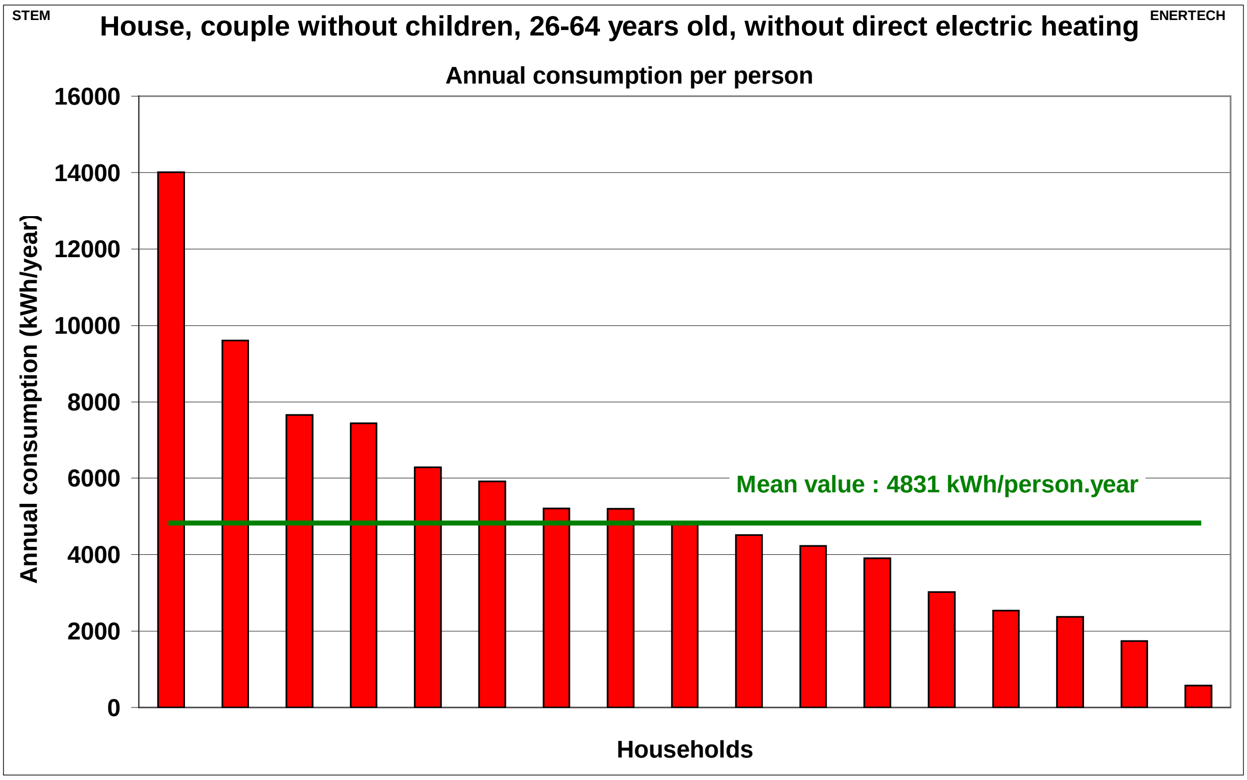
Figures 2.12: Total annualized electricity consumption per person – Houses with electric heating



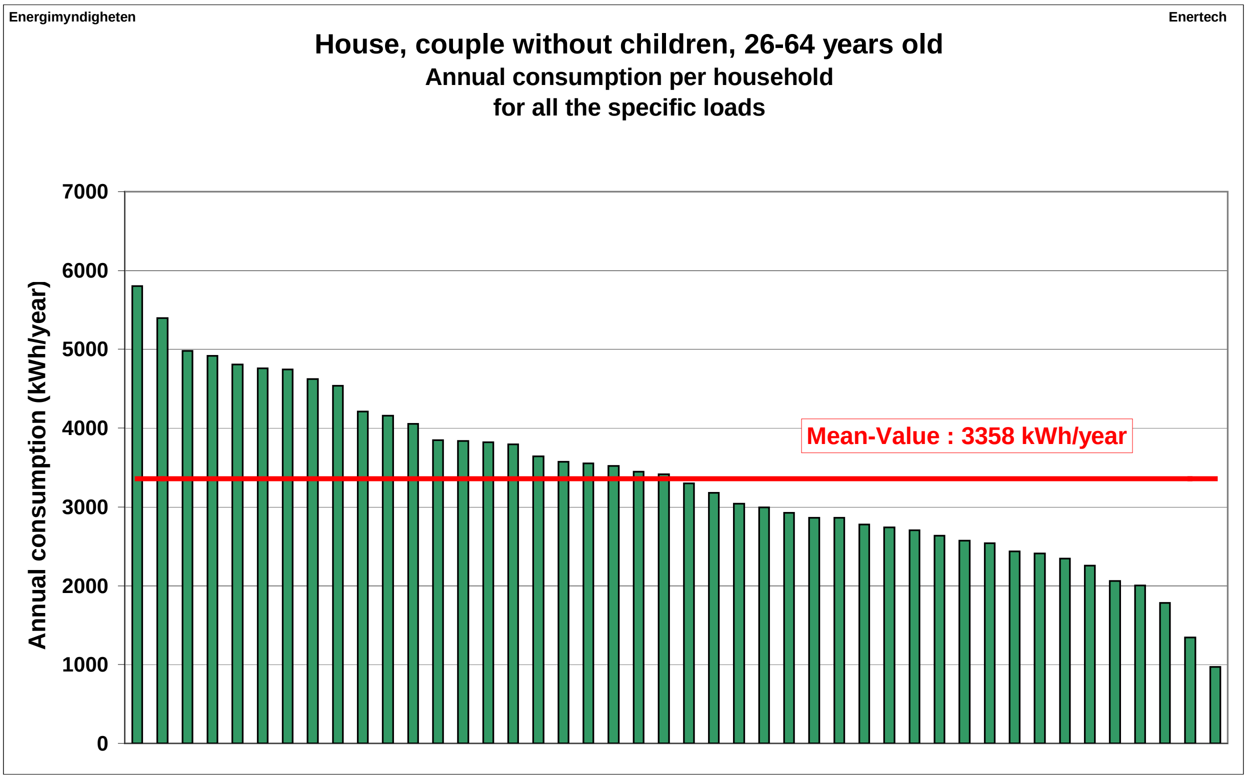
Figures 2.13: Total annualized electricity consumption – Houses without direct electric heating



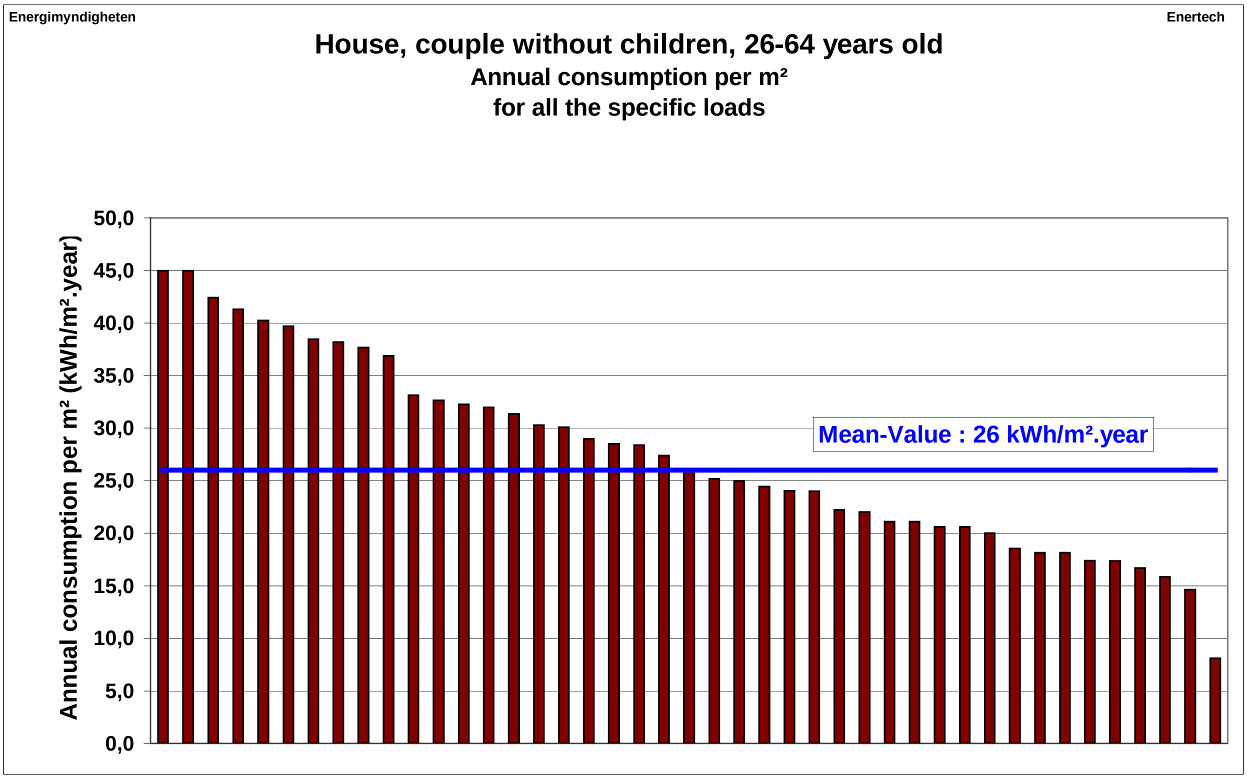
Figures 2.14: Total annualized electricity consumption per m² – Houses without direct electric heating



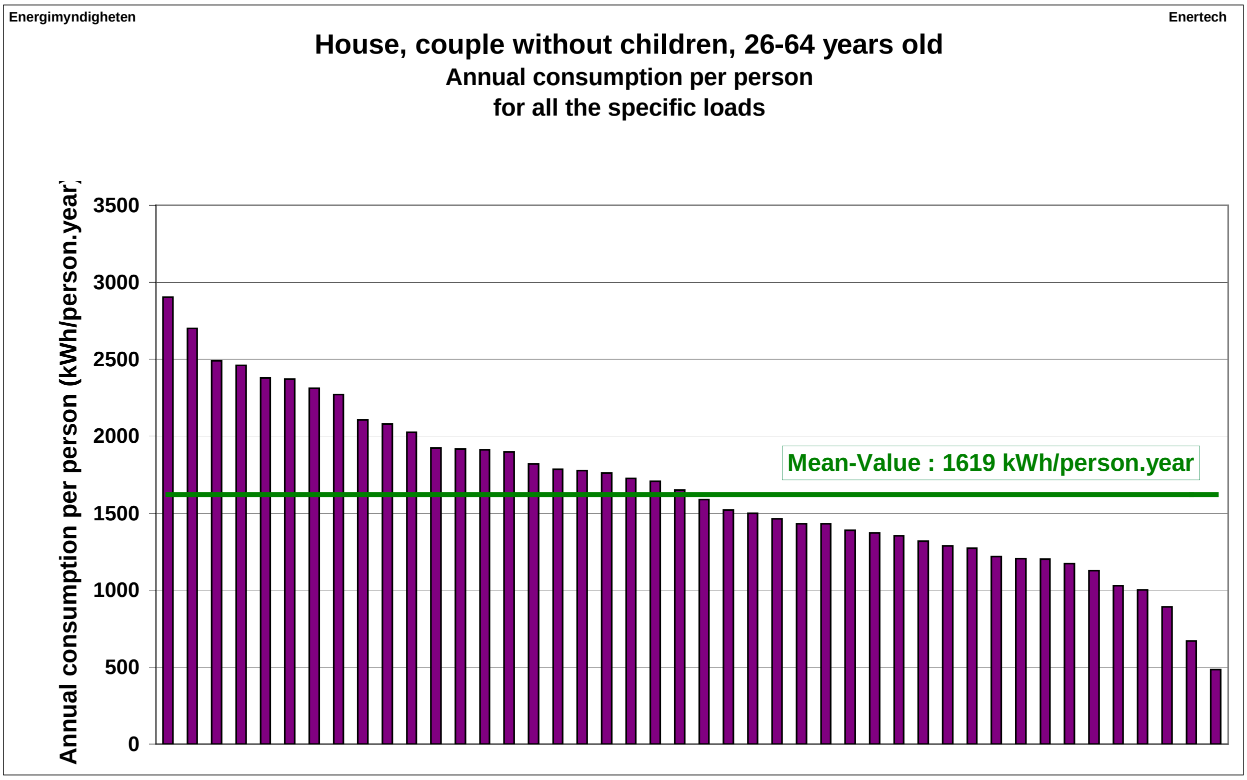
Figures 2.15: Total annualized electricity consumption per person – Houses without direct electric heating



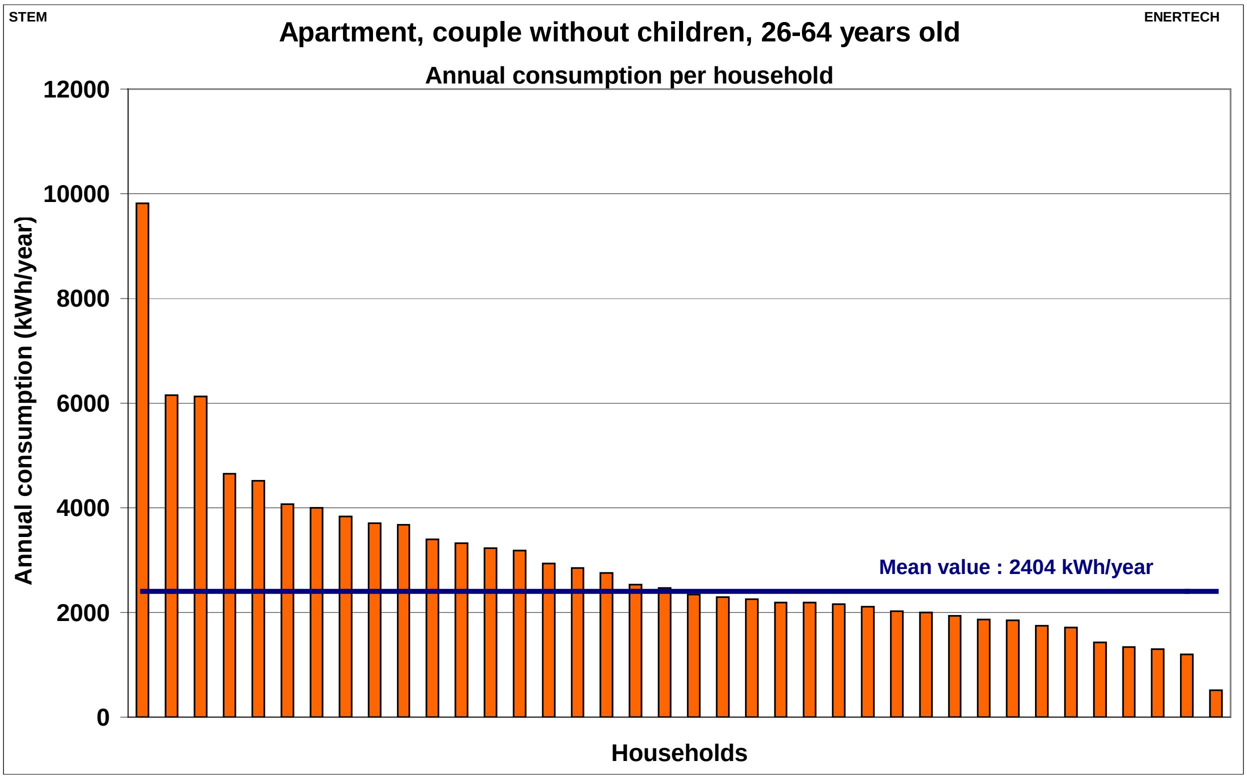
Figures 2.15-B: Total annualized electricity consumption per household – Specific consumption only - Houses



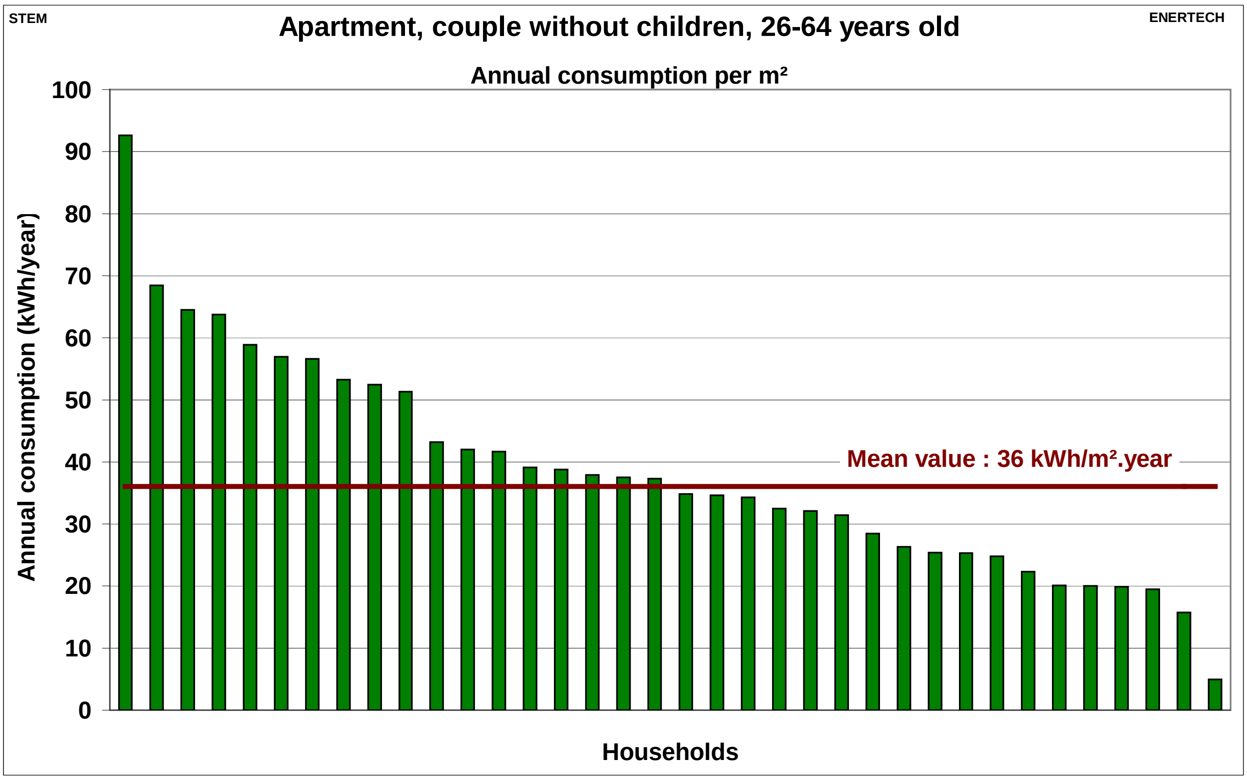
Figures 2.15-C: Total annualized electricity consumption per m² – Specific consumption only - Houses



Figures 2.15-D: Total annualized electricity consumption per person – Specific consumption only - Houses



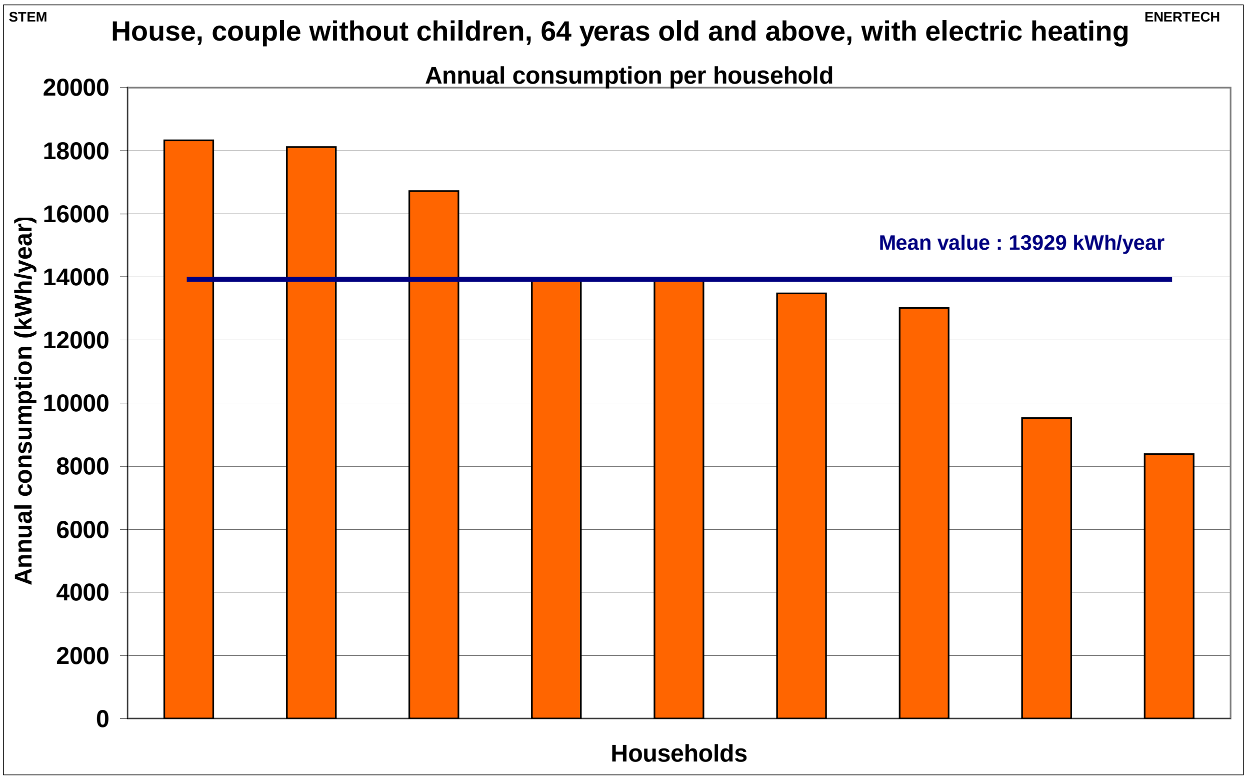
Figures 2.16: Total annualized electricity consumption – Apartment



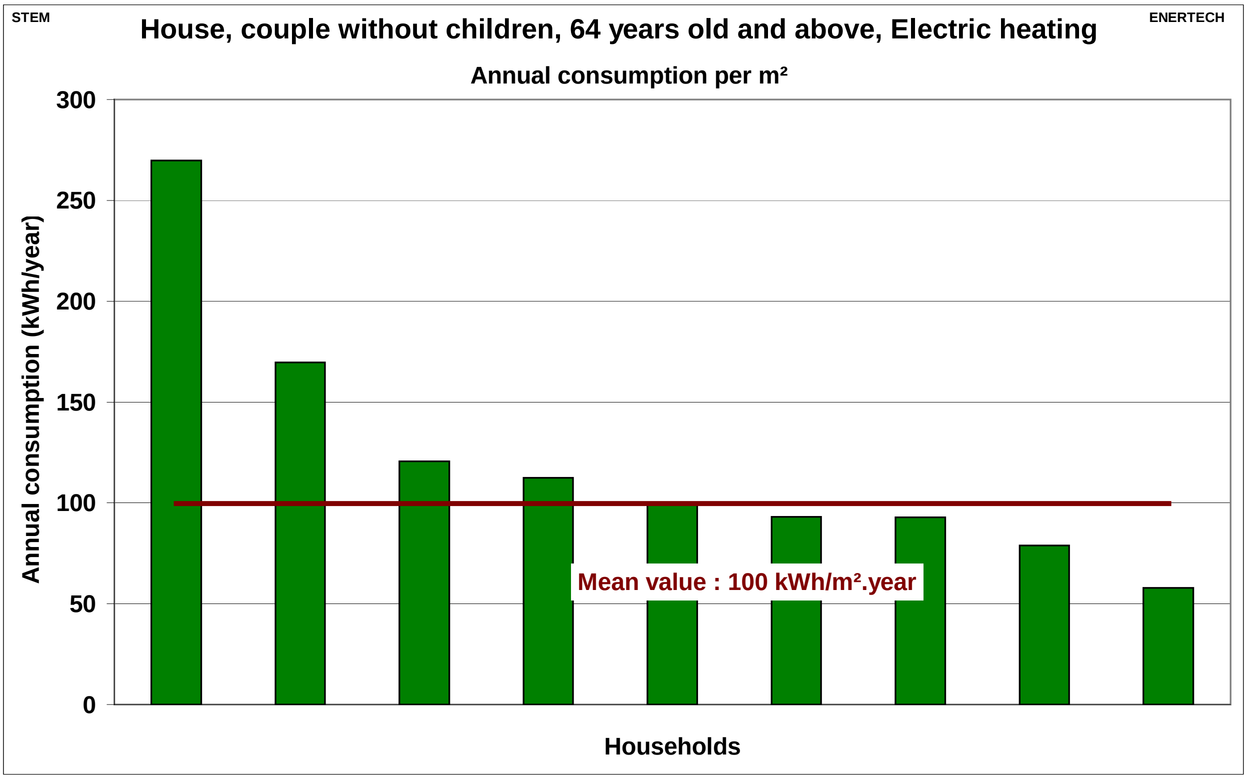
Figures 2.17: Total annualized electricity consumption per m² – Apartment

Figures 2.18: Total annualized electricity consumption per person – Apartment

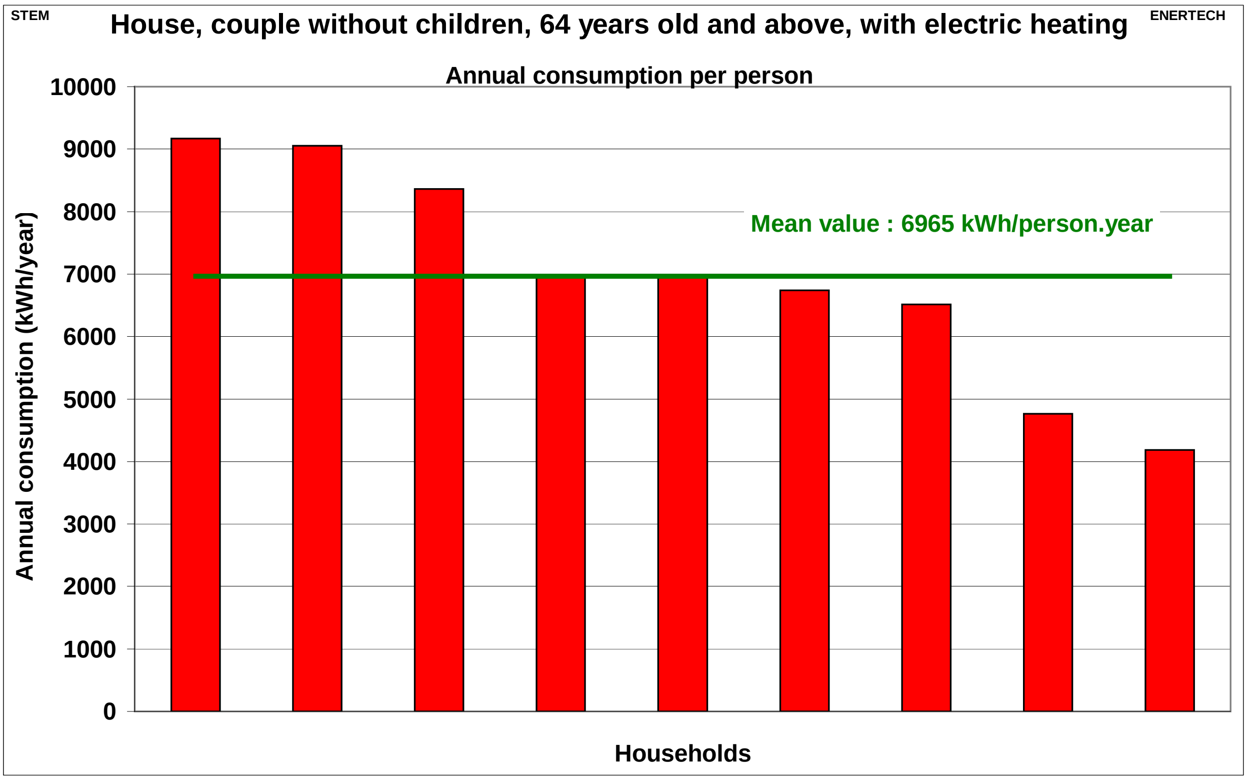
Couples without children, 64 years old and above



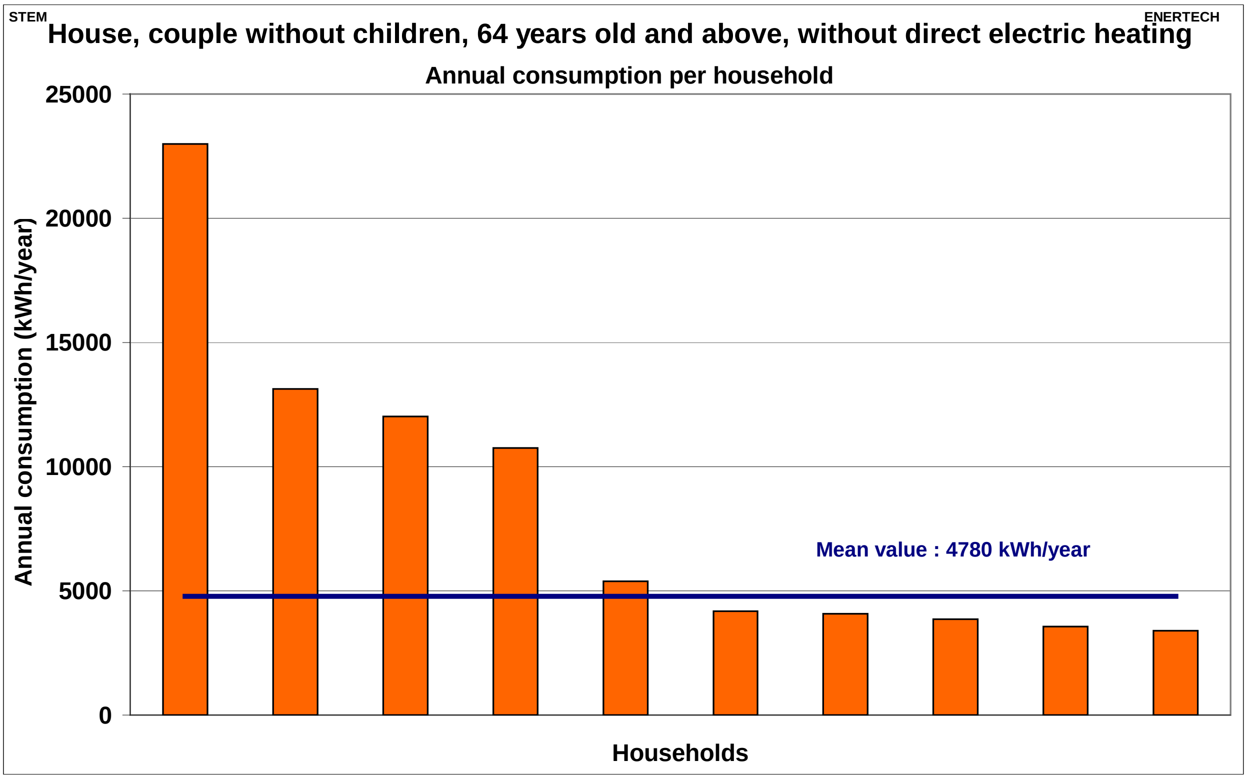
Figures 2.19: Total annualized electricity consumption– Houses with electric heating



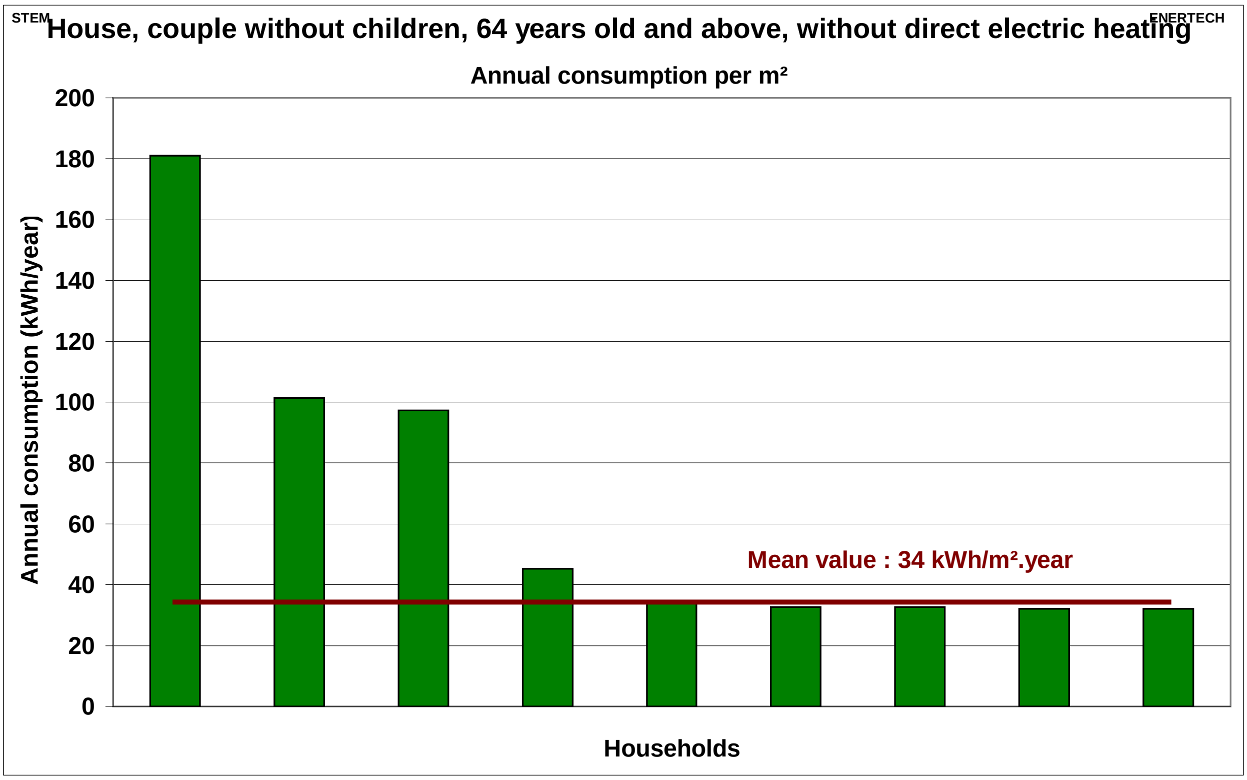
Figures 2.20 Total annualized electricity consumption per m²– Houses with electric heating



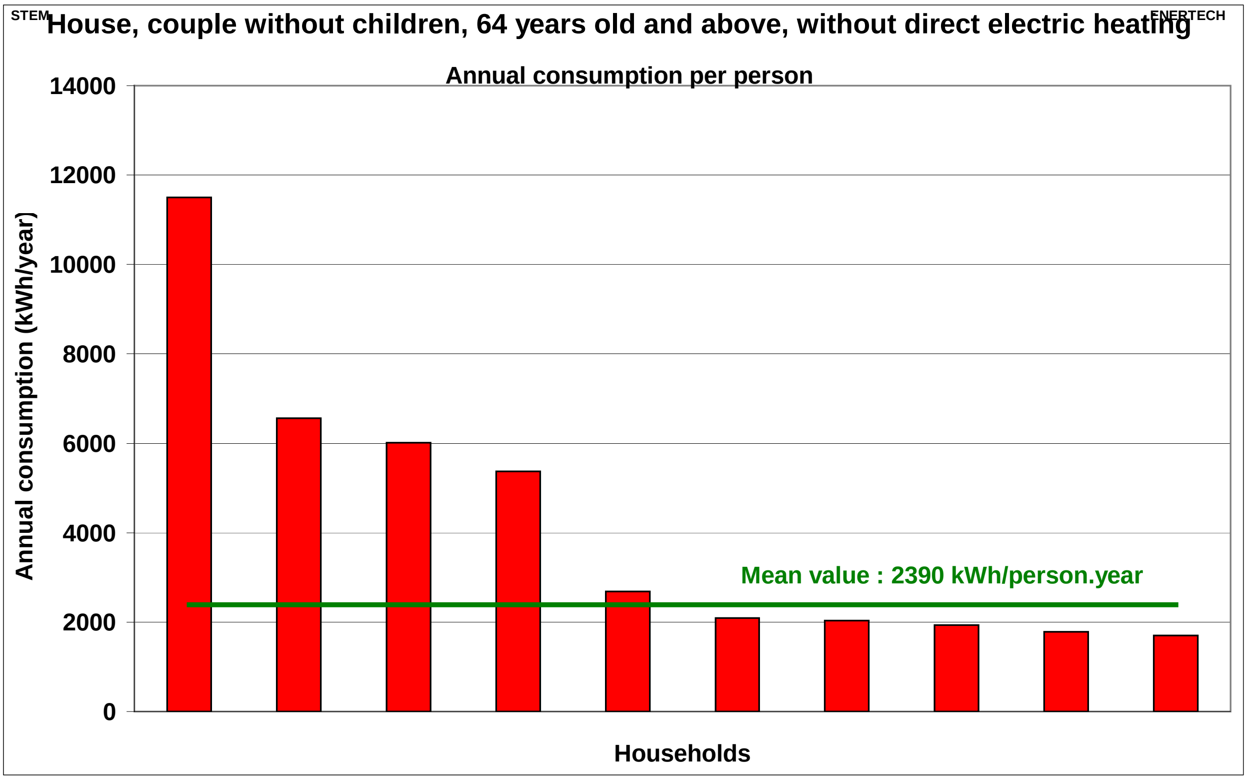
Figures 2.21: Total annualized electricity consumption per person– Houses with electric heating



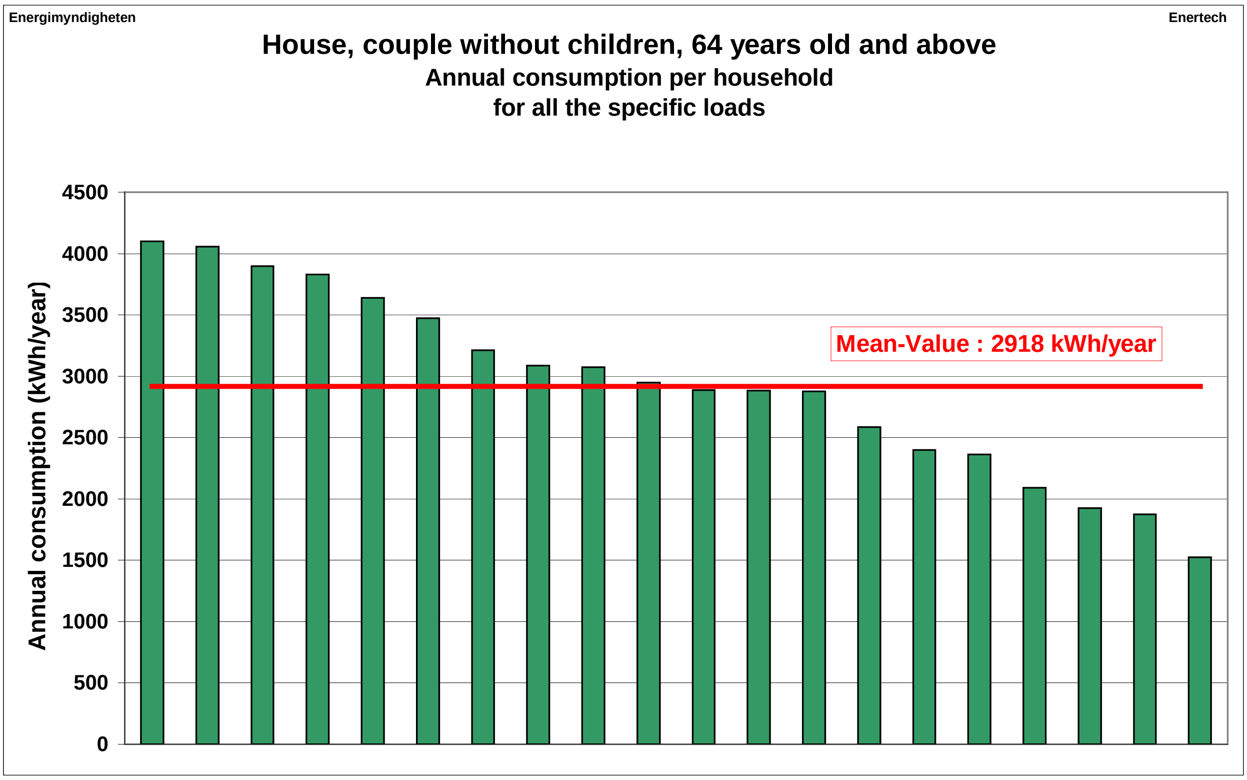
Figures 2.22: Total annualized electricity consumption – Houses without direct electric heating



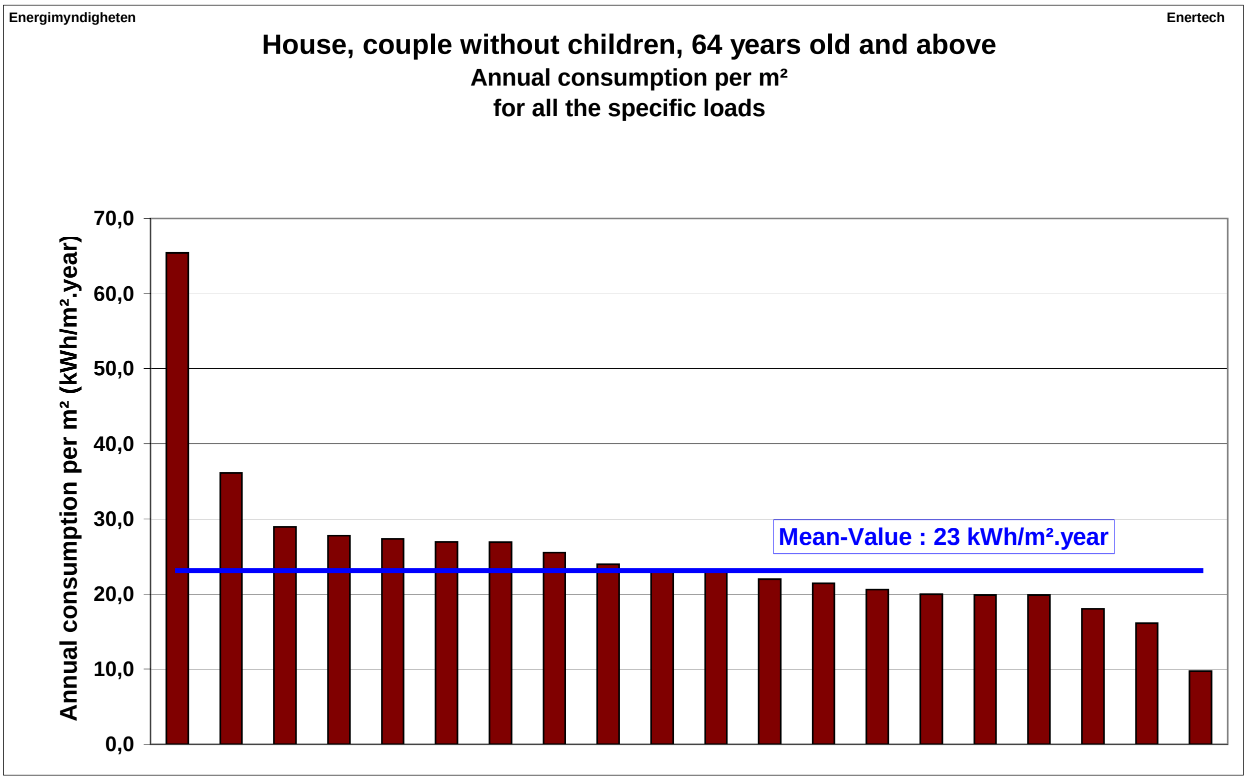
Figures 2.23: Total annualized electricity consumption per m² – Houses without direct electric heating



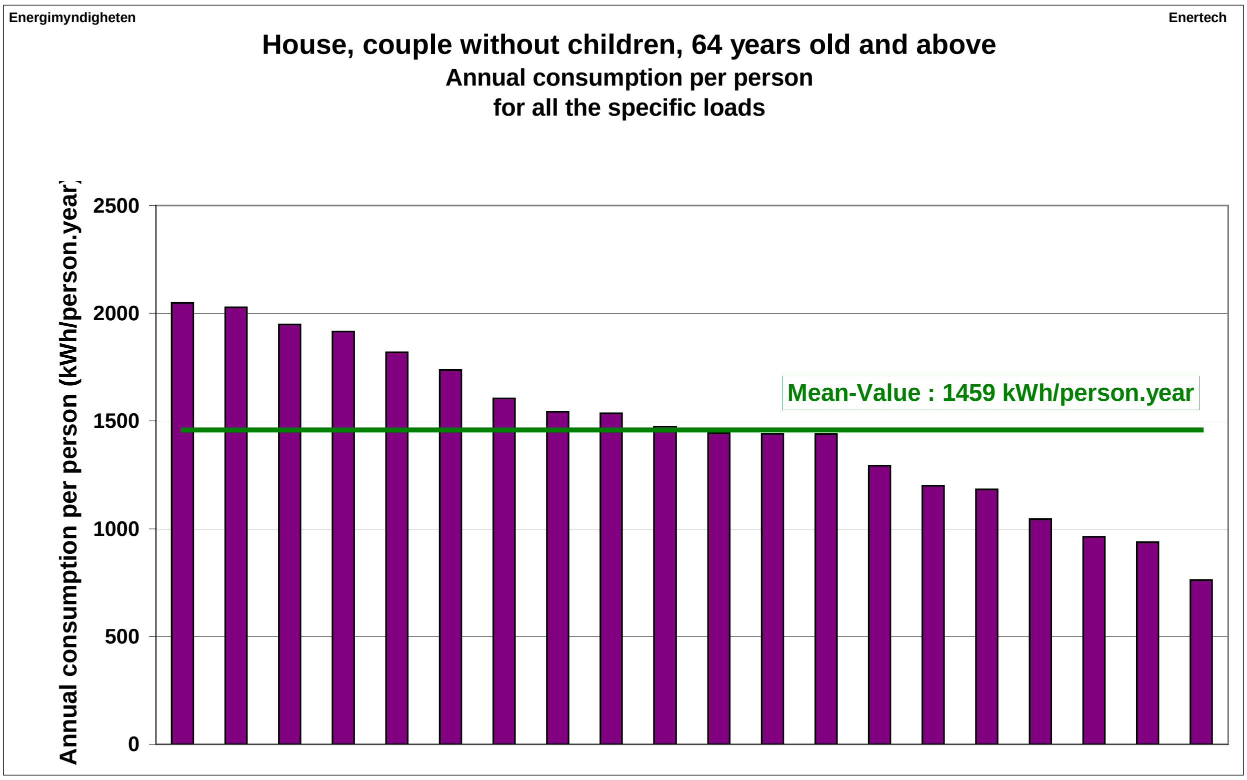
Figures 2.24: Total annualized electricity consumption per person – Houses without direct electric heating



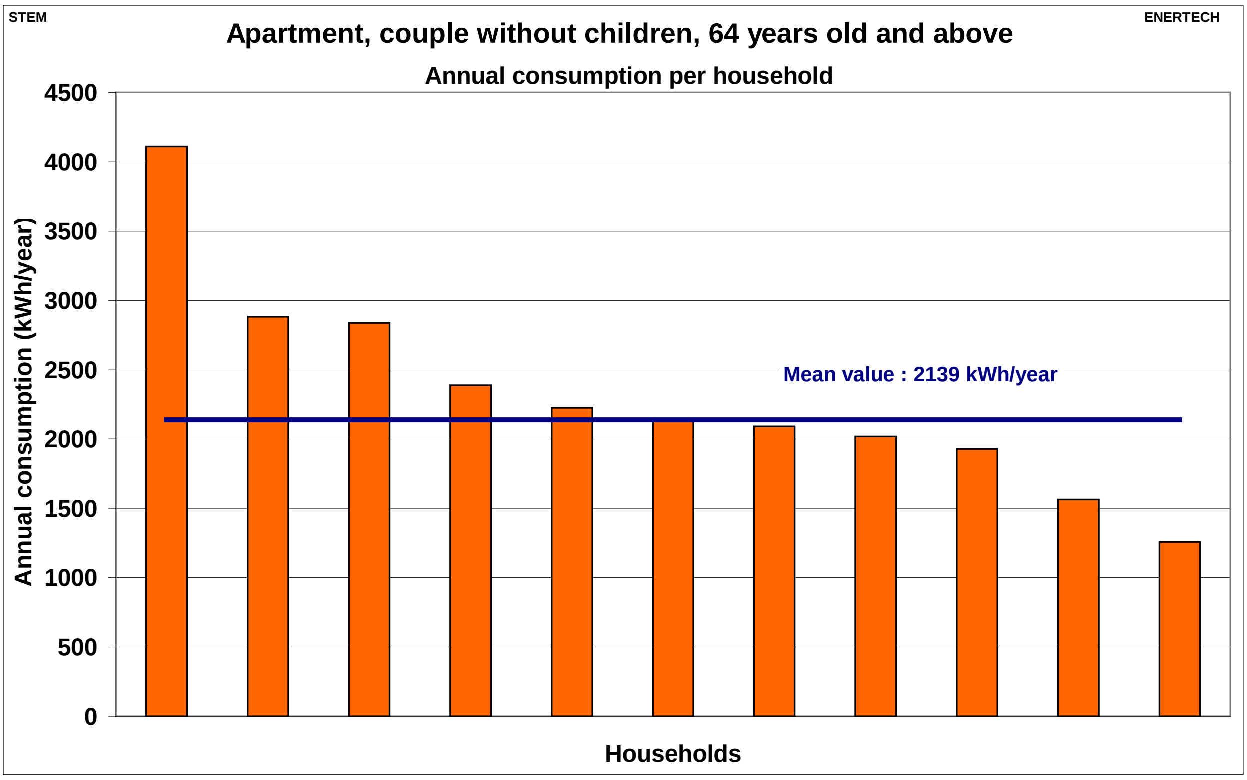
Figures 2.24-B: Total annualized electricity consumption per household – Specific consumption only - Houses



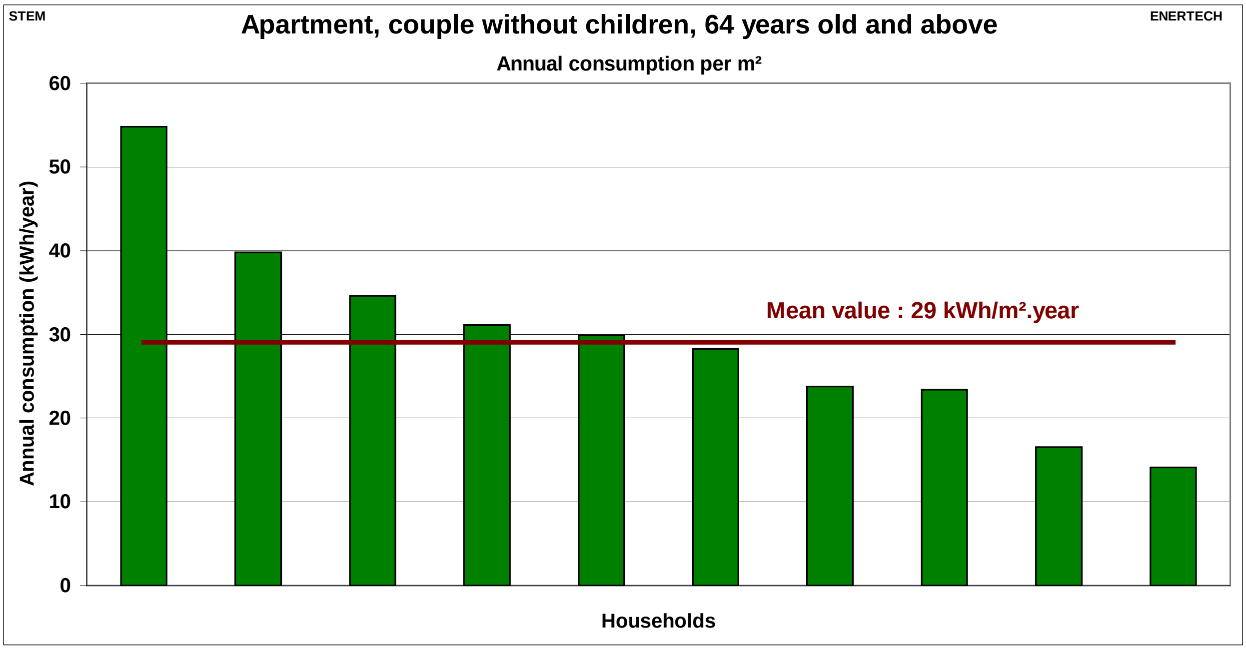
Figures 2.24-C: Total annualized electricity consumption per m² – Specific consumption only - Houses



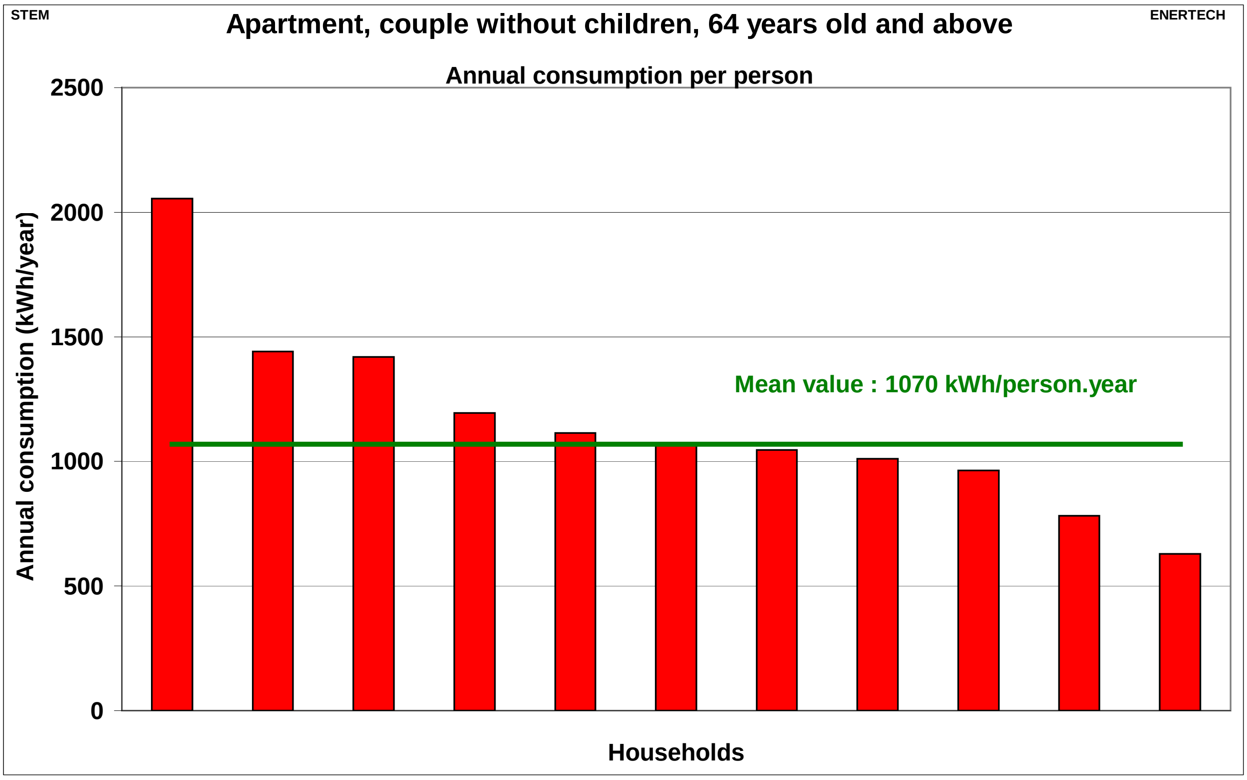
Figures 2.24-D: Total annualized electricity consumption per person – Specific consumption only - Houses



Figures 2.25: Total annualized electricity consumption – Apartment

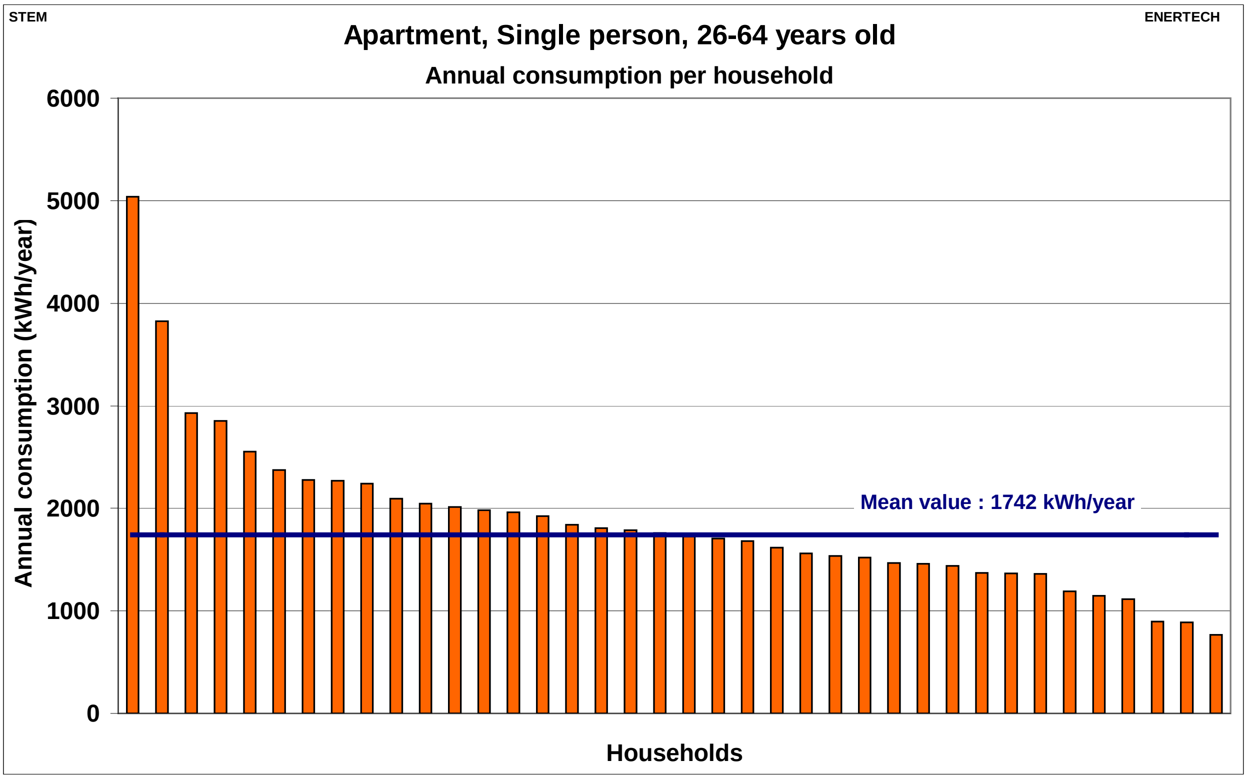


Figures 2.26: Total annualized electricity consumption per m² – Apartment

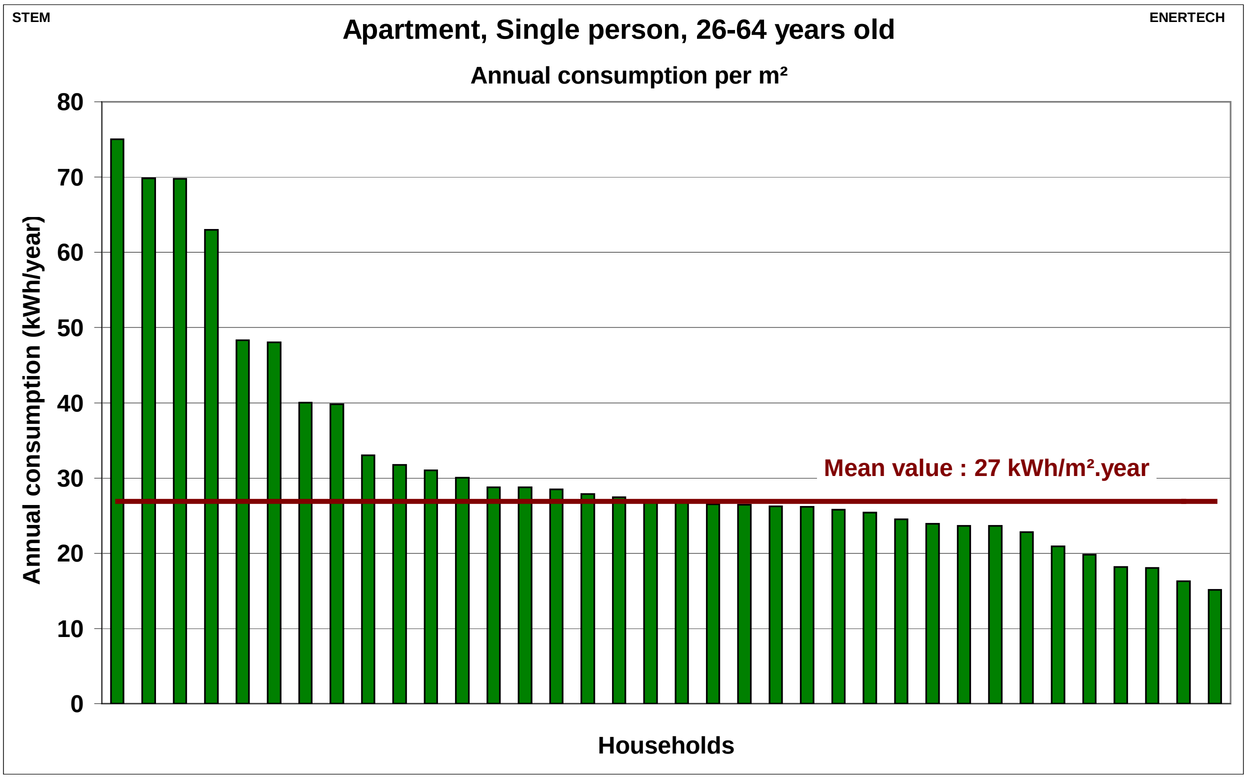


Figures 2.27: Total annualized electricity consumption per person – Apartment

Single person, 26-64 years old

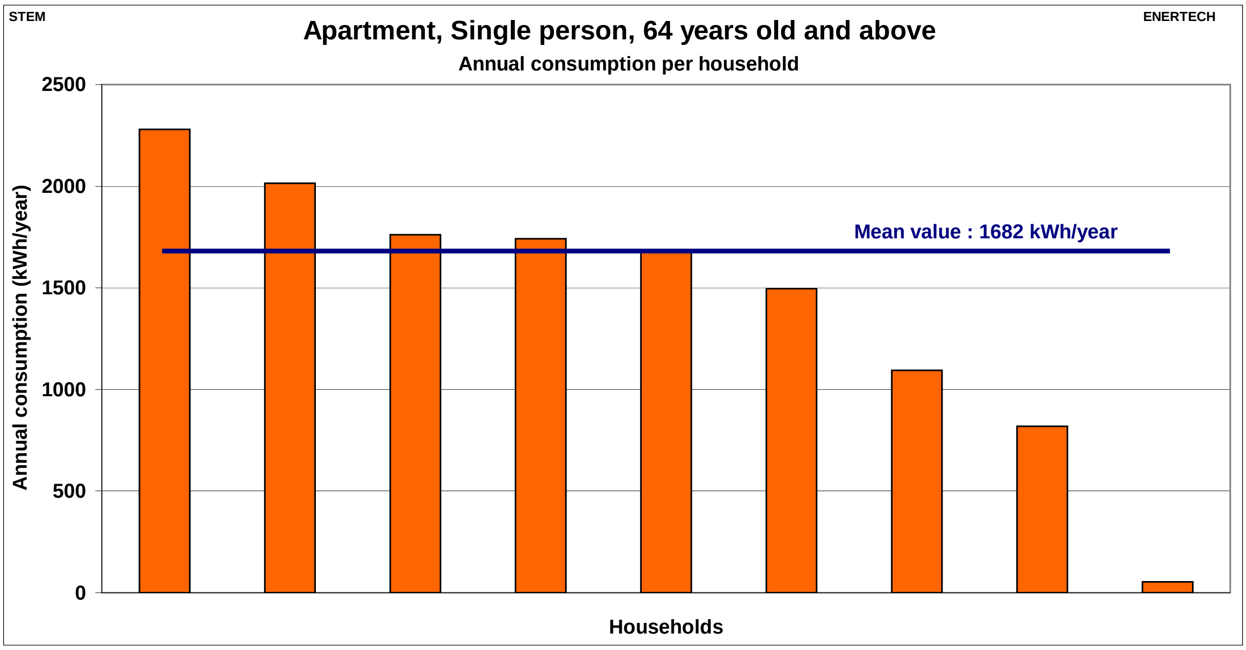


Figures 2.28: Total annualized electricity consumption– Apartment

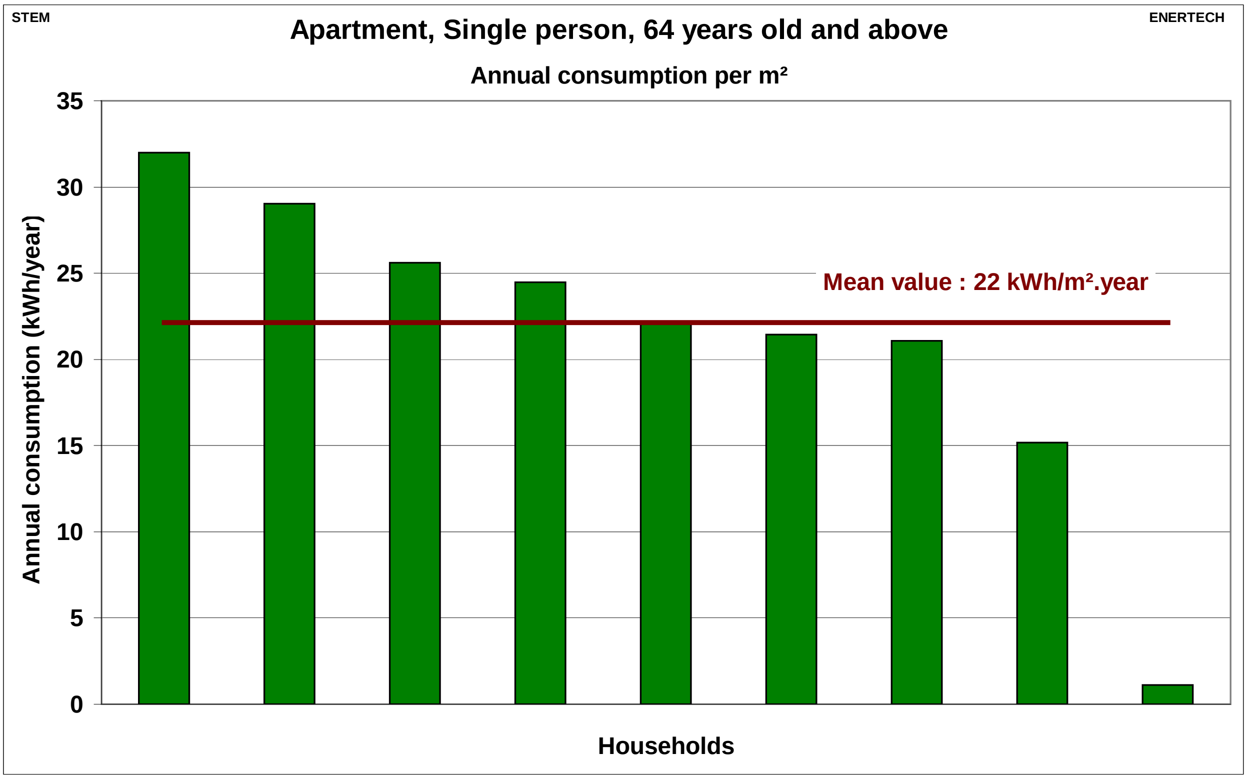


Figures 2.29: Total annualized electricity consumption per m² – Apartment

Single person, 64 years old and above



Figures 2.30: Total annualized electricity consumption – Apartment



Figures 2.31: Total annualized electricity consumption per m² – Apartment

	Family, 26-64 years old			
	House, ***with electric heating***	House ***without electric heating***	House, ***specific consumption only***	Apartment
per household	18558	8416	4143	3710
per m²	136	76	32	76
per person	4820	2523	1109	1187

	Couples without children, 26-64 years old			
	House, ***with electric heating***	House ***without electric heating***	House, ***specific consumption only***	Apartment
per household	17173	10405	3358	2404
per m²	139	76	26	76
per person	8323	4831	1619	1202

	Couples without children,64 years old and above			
	House, ***with electric heating***	House ***without electric heating***	House, ***specific consumption only***	Apartment
per household	13929	4780	2918	2139
per m²	100	34	23	29
per person	6965	2390	1459	1070

	Single person, 26-64 years old			
	House, ***with electric heating***	House ***without electric heating***	House, ***specific consumption only***	Apartment
per household				1742
per m²				27
per person				

	Single person, 64 years old and above			
	House, with electric heating	House without electric heating		Apartment
per household				1682
per m²				22
per person				

Figure 2.32: Annual consumption per type of household, per m² and per person. Houses without electric heating include water heating and specific consumption. Specific consumption is all loads except heating and water heating.

Maximum power demand drawn by the households

The maximal power demand reached is an interesting indicator, as it fixes the power level to be subscribed from the electricity distributor. We calculated it hereafter, by using the monitored consumption during 10 minutes. It is therefore not a proper instantaneous power demand. But experience shows that power measured every 10 minutes, and powers calculated by using the 10 minutes consumption are very similar (the difference is generally under 2 %).

From the grid point of view, this calculation method is right and is used by most of the electricity distributors.

Figure 2.33 to 2.43 represents the maximum power demand for different household types.

Family, 26-64 years old

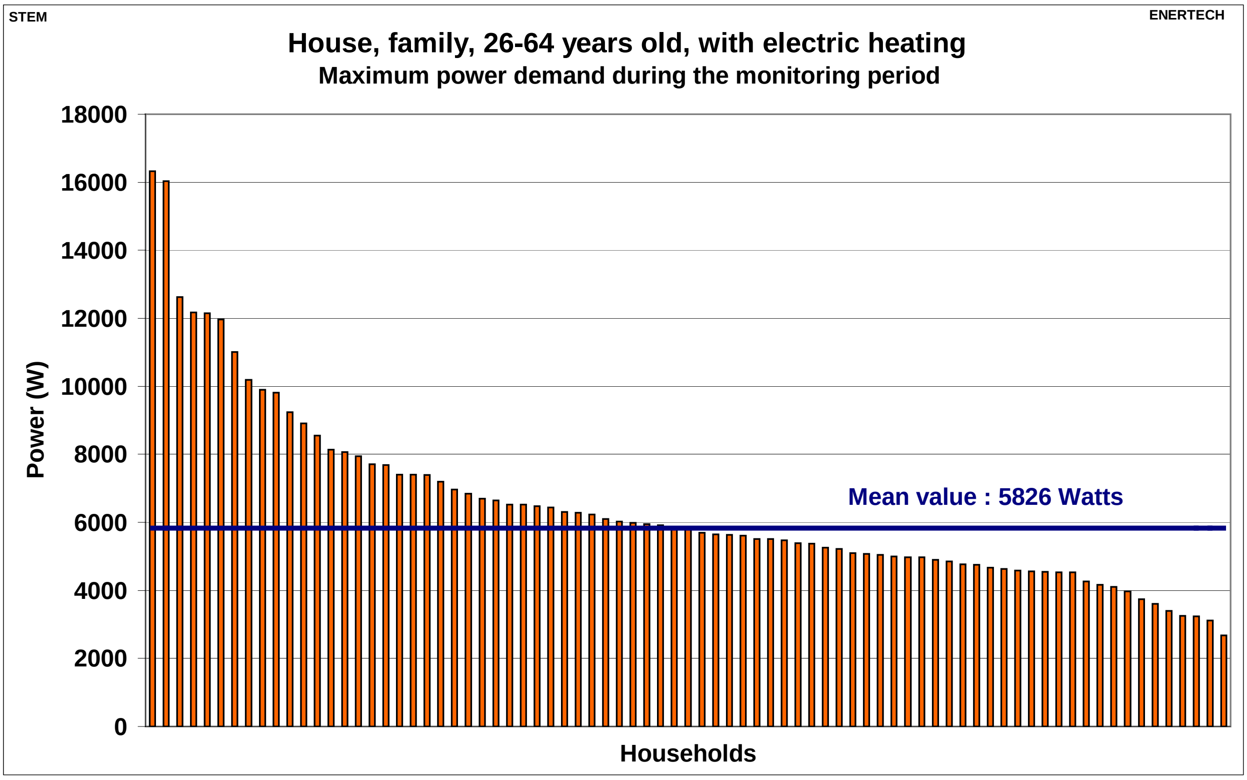


Figure 2.33: Maximum power demand – Houses with electric heating

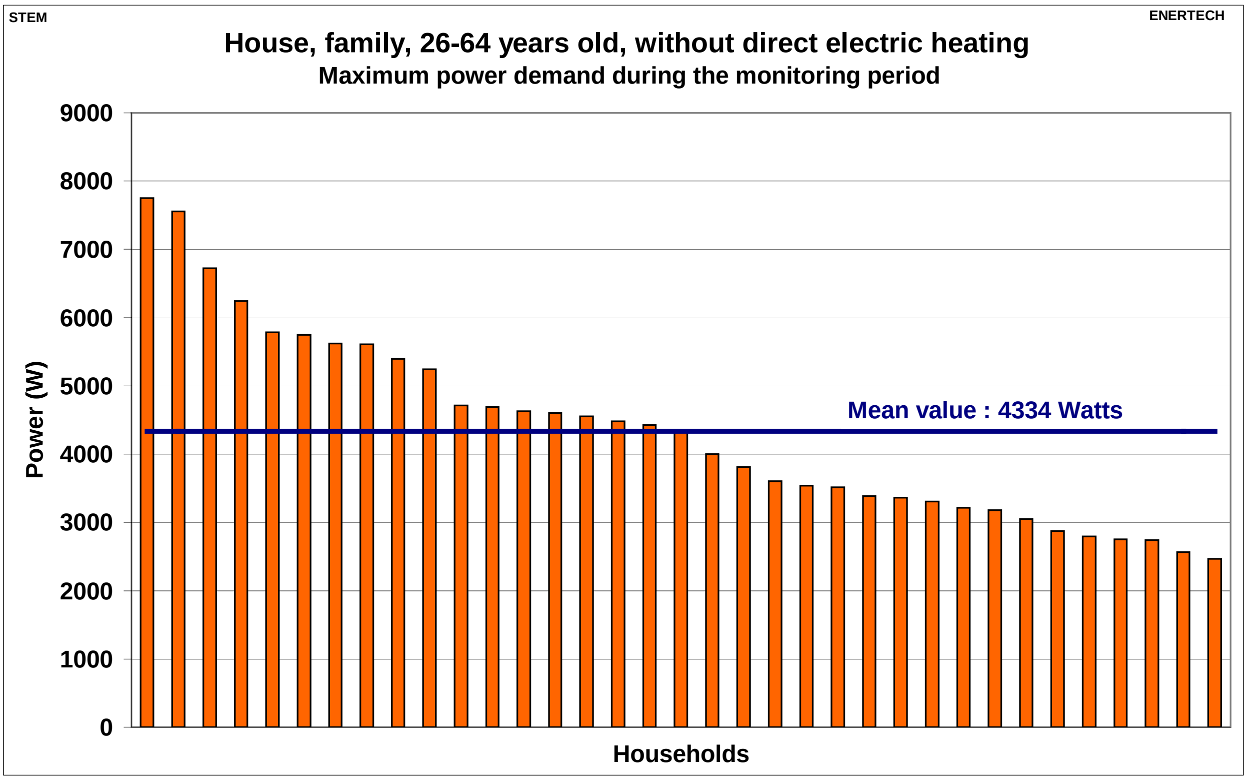


Figure 2.34: Maximum power demand – Houses without direct electric heating

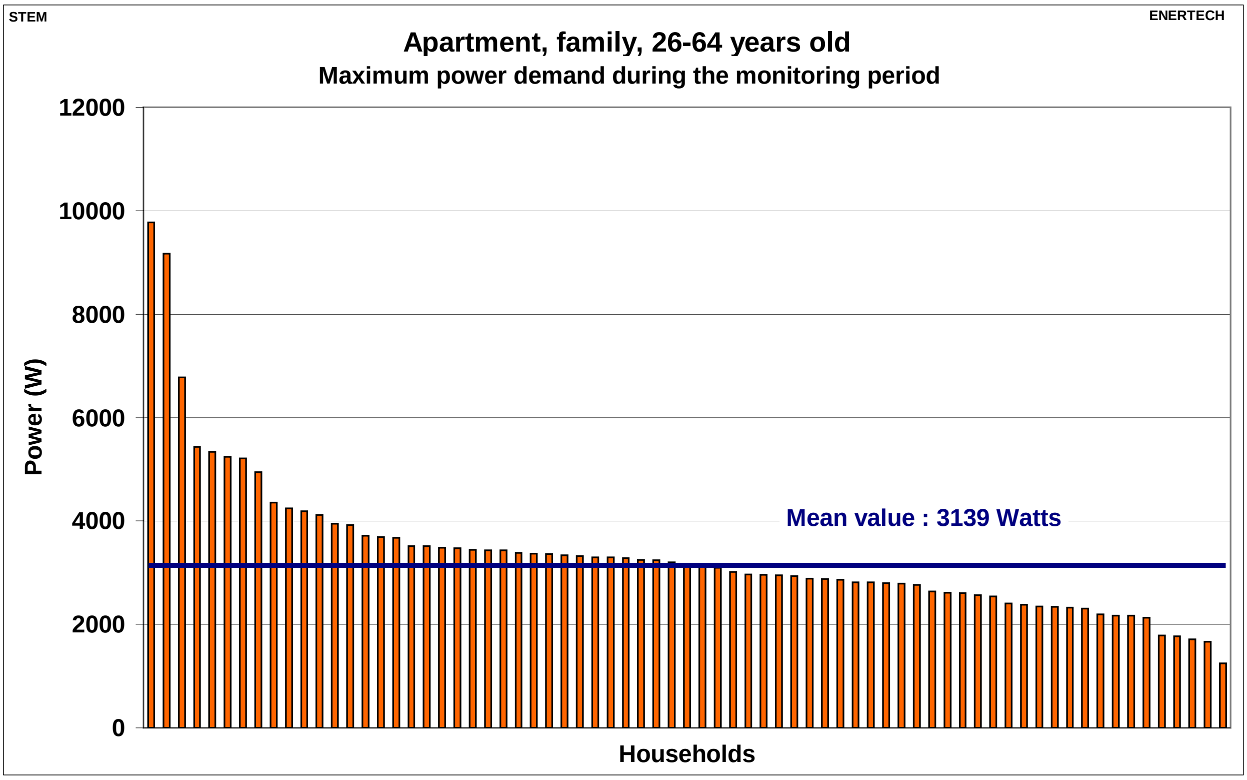


Figure 2.35: Maximum power demand – Apartment

Couples without children, 26-64 years old

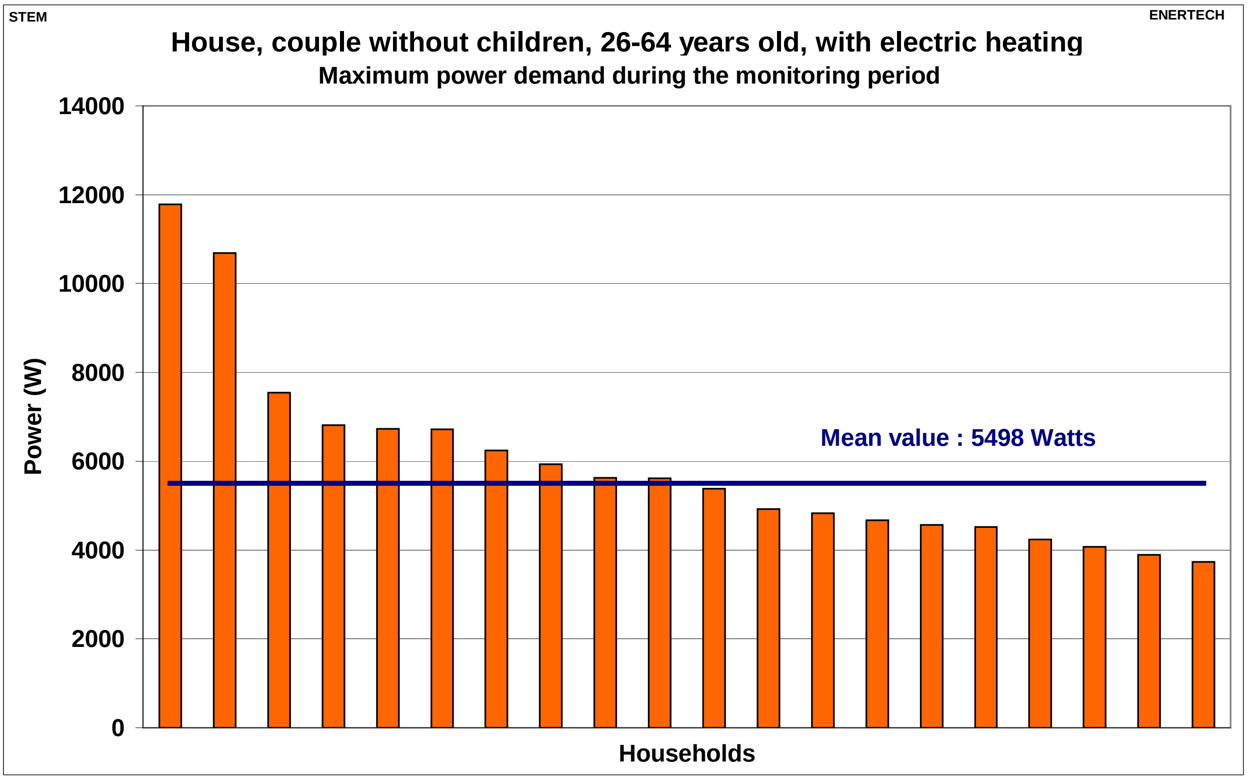


Figure 2.36: Maximum power demand – Houses with electric heating

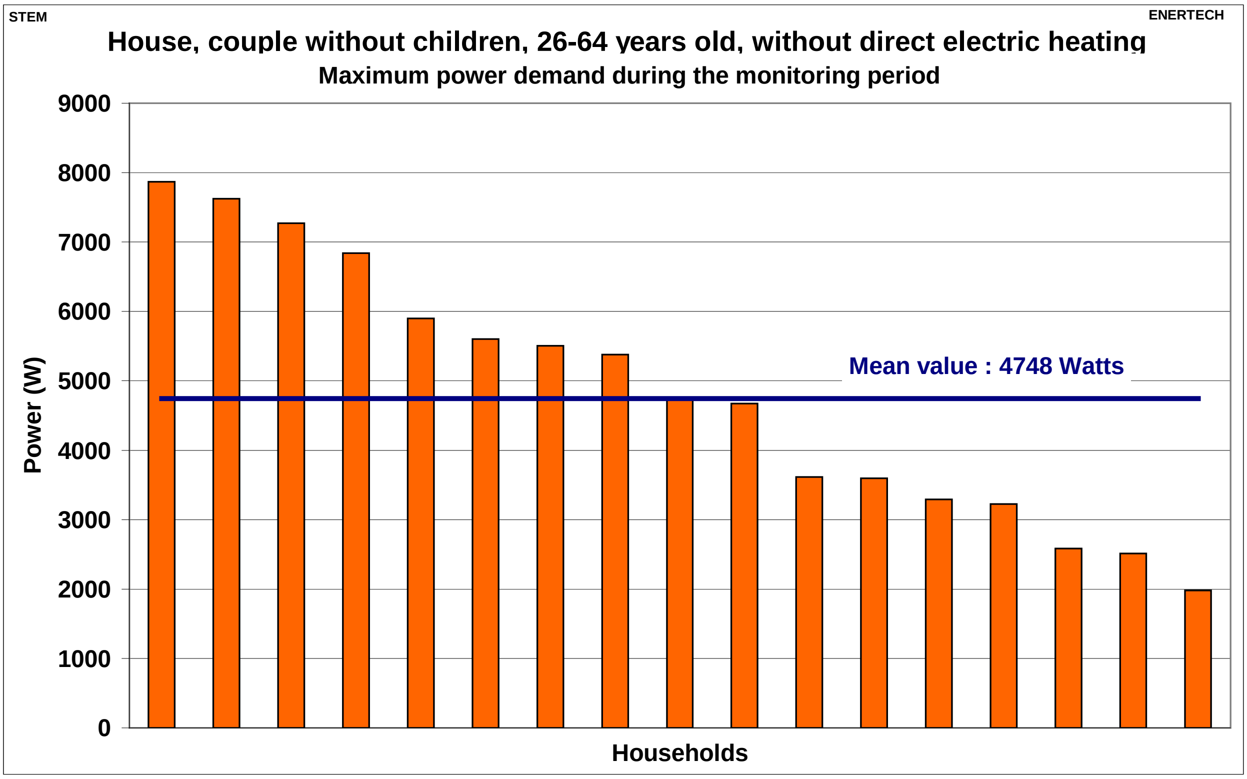


Figure 2.37: Maximum power demand – Houses without direct electric heating

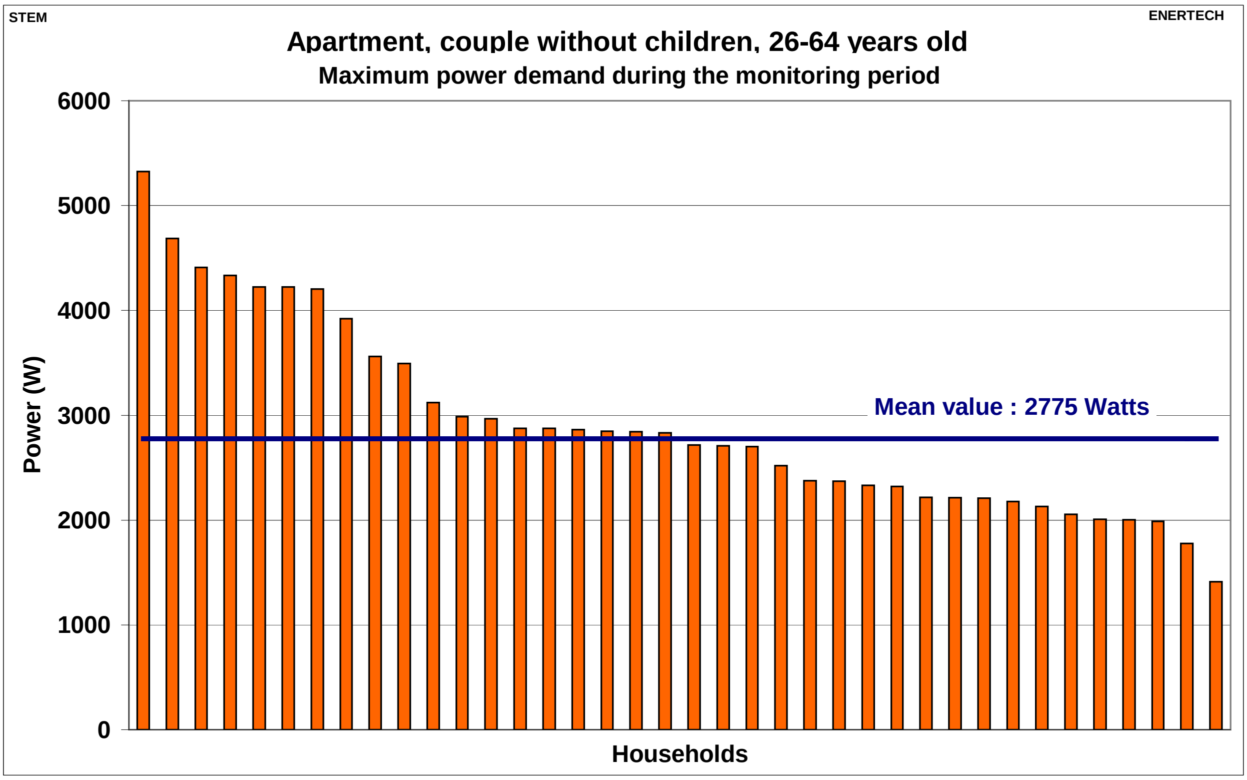


Figure 2.38: Maximum power demand – Apartment

Couples without children, 64 years old and above

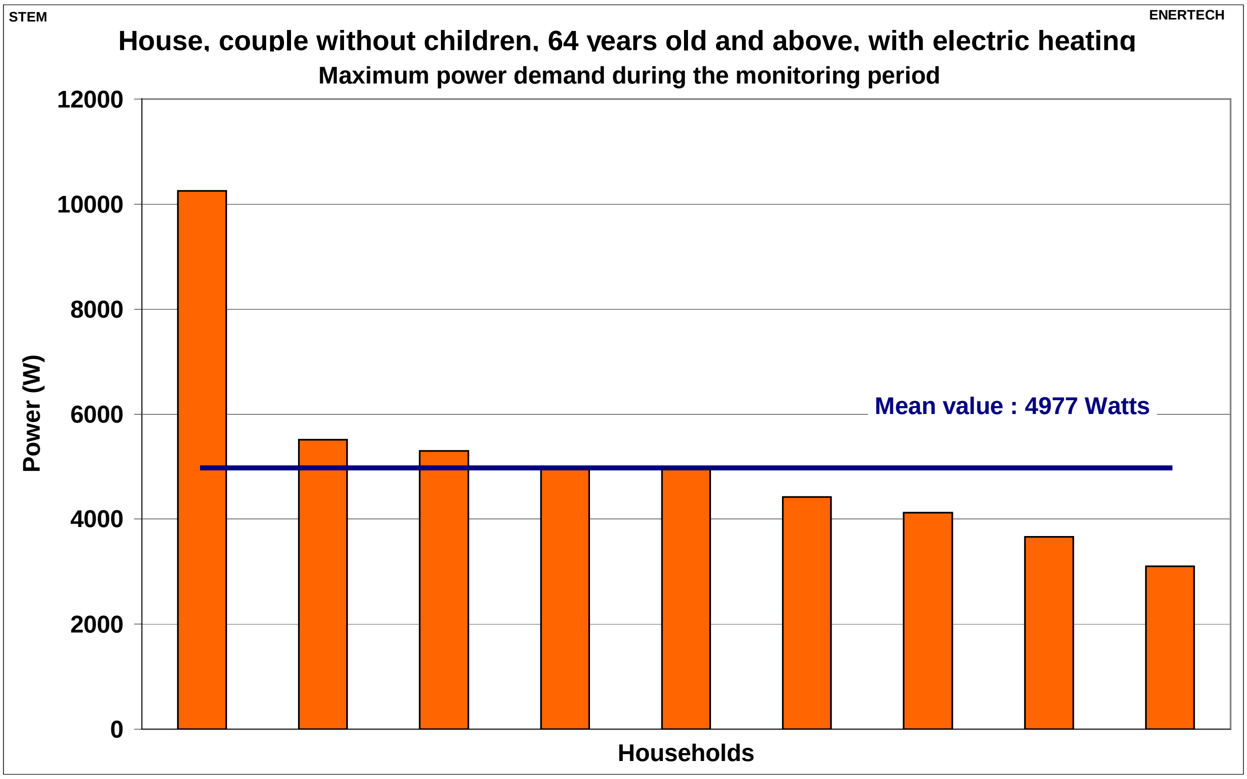


Figure 2.39: Maximum power demand – Houses with electric heating

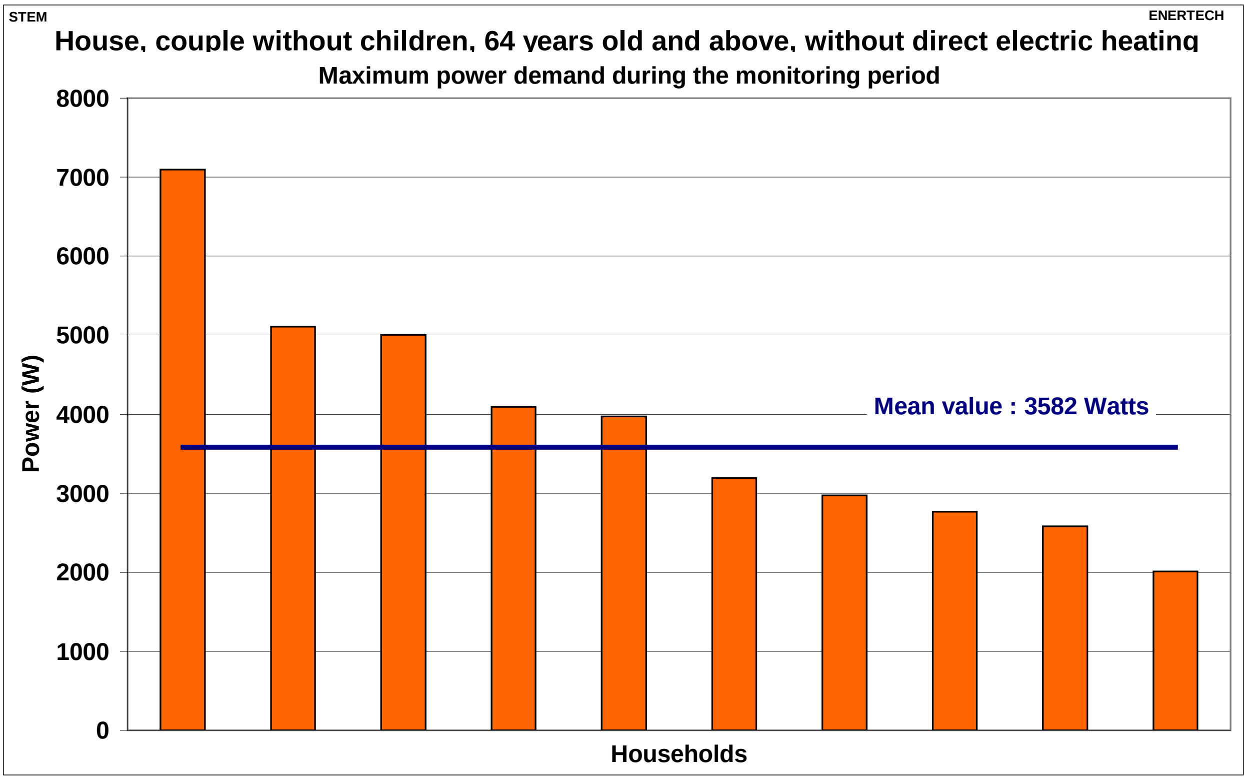


Figure 2.40: Maximum power demand – Houses without direct electric heating

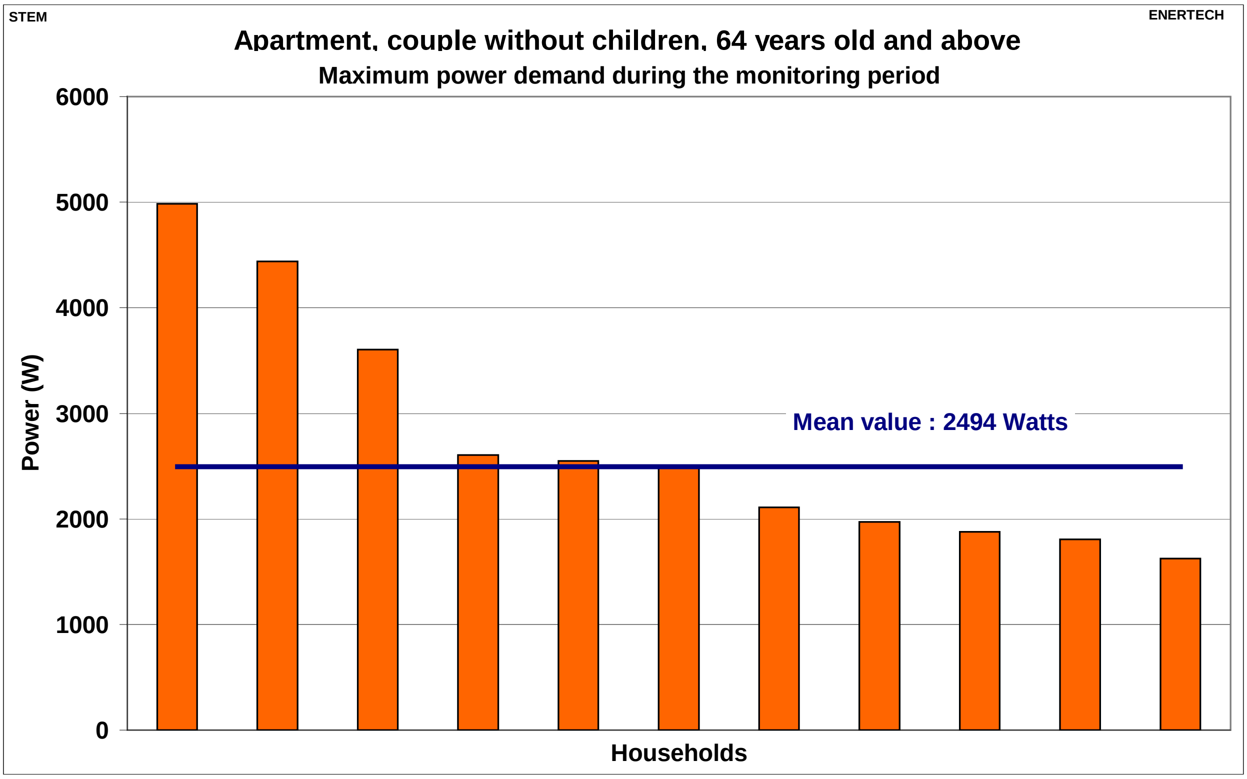


Figure 2.41: Maximum power demand – Apartment

Single person, 26-64 years old

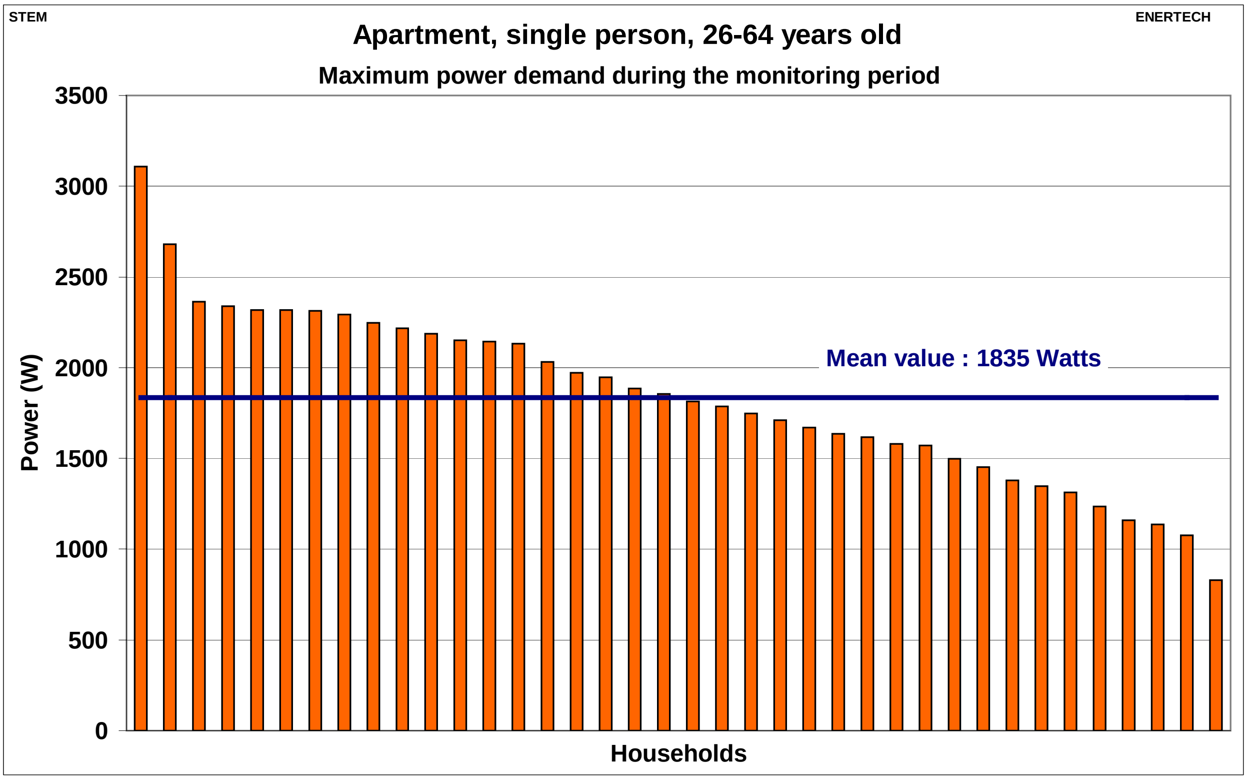


Figure 2.42: Maximum power demand – Apartment

Single person, 64 years old and above

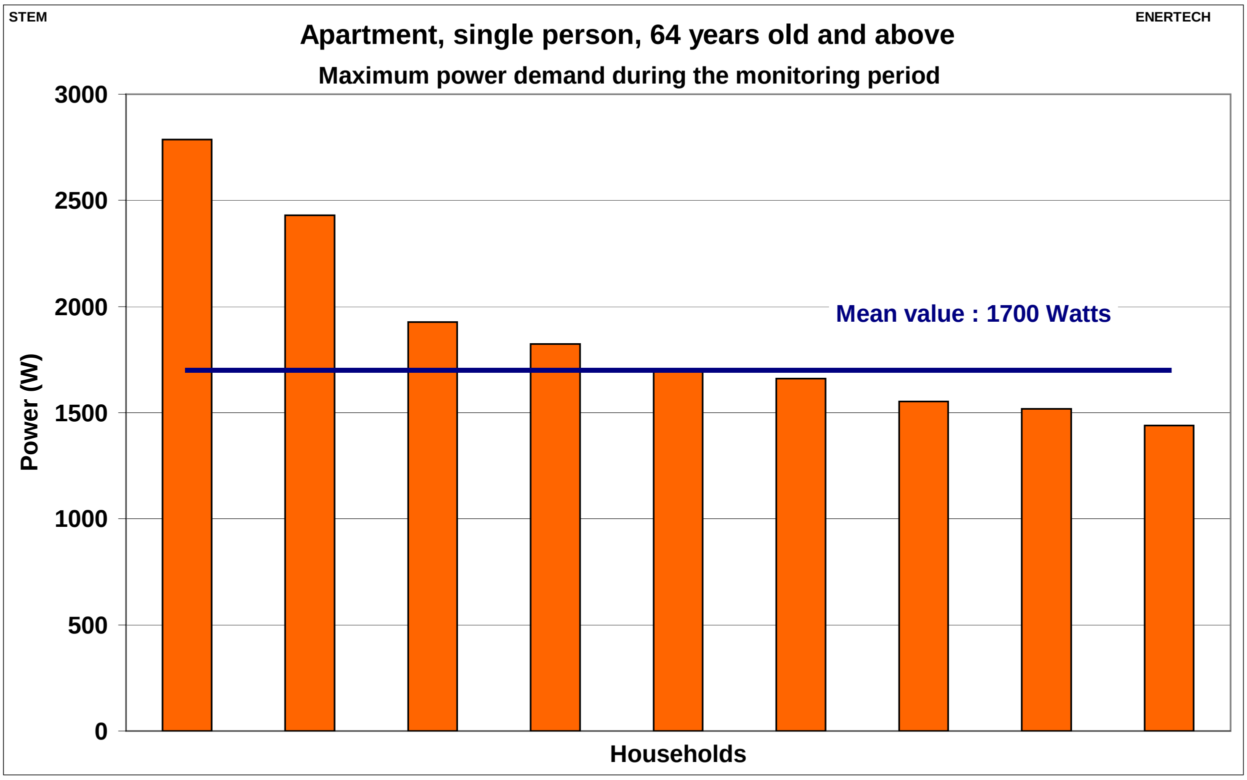


Figure 2.43: Maximum power demand – Apartment

Table of figure 2.44 completes the information given in figure 2.33 to 2.43

		Maximum (W)	Average (W)	Ratio Average/Maximum
House, couples without children, 26-64 years old	With direct electric heating	11782	5498	1: 2,1
	Without direct electric heating	7872	4748	1: 1,7
House, couples without children, 64 years old and above	With direct electric heating	10250	4977	1: 2,0
	Without direct electric heating	7098	3582	1: 2,0
House, family, 26-64 years old	With direct electric heating	16331	5826	1: 2,8
	Without direct electric heating	7749	4334	1: 2,8
Apartment, couples without children, 26-64 years old		5324	2775	1: 1,9
Apartment, couples without children, 64 years old and above		4984	2494	1: 2,0
Apartment, family, 26-64 years old		9770	3139	1: 3,1
Apartment, single person, 26-64 years old		3108	1835	1: 1,7
Apartment, single person, 64 years old and above		2786	1700	1: 1,6

Figure 2.43: Extreme values of maximum power demands

General observations:

v the maximum to average ratio is always between 1,6 and 2, except in certain cases: *House, family, 26-64 years old* - *Apartment, family, 26-64 years old* where disparities are higher,

v the power demand level is greater then 10000 for all the houses with electric heating and in the range 7000-8000 for the ones without direct electric heating,

v families will always have the maximum power demand for houses and apartments.

Cumulative frequencies of power demands, from the grid point of view

Figures 2.44 to 2.54 shows for each type of household, the cumulative frequency curves of the average power demand reached in the households, from the grid point of view. This results have not to be mixed up with the maximum power demand as calculated in the previous chapter: the max. power was calculated for each house separately - the powers from this chapter are an average value between all the household of a specific categorie. To get this kind of curve, we calculated every ten minutes from the 1st of January to the 31st of December, the average power demand for each type of household that drew power at this precise time.

Then, we classified all these values. The obtained power is told to be seen « from the grid » because this is the average power that the distributor observes and supplies to each household of the sample.

Family, 26-64 years old

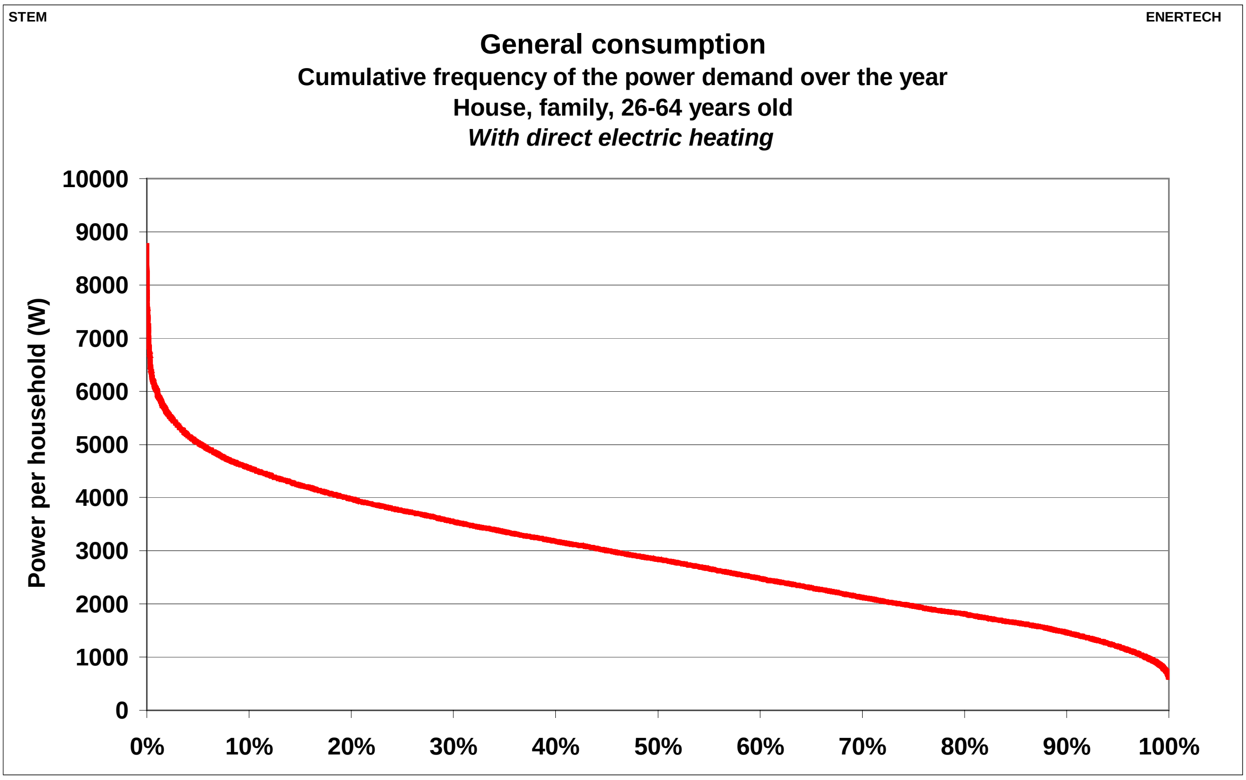


Figure 2.44: General consumption – Cumulative frequency of the power demand over the year, from the grid point of view – House, family, 26-64 years old - With direct electric heating

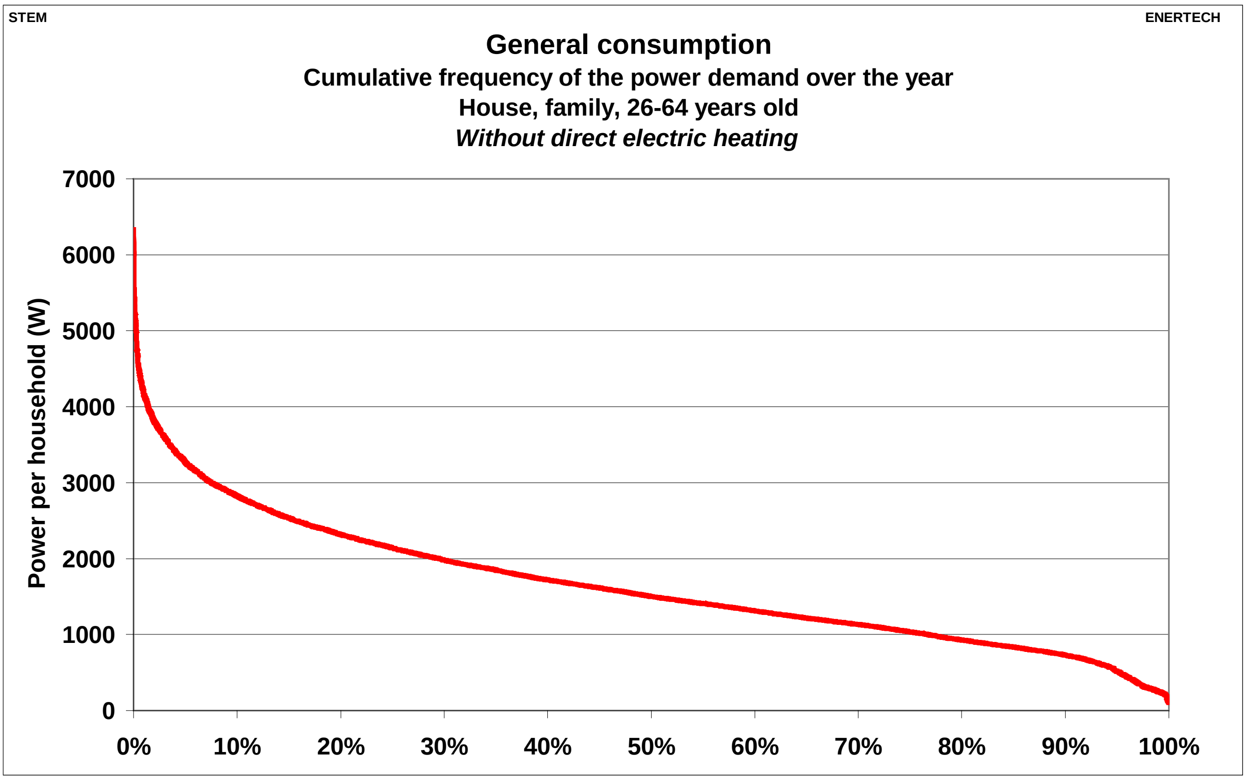


Figure 2.45: General consumption – Cumulative frequency of the power demand over the year, from the grid point of view – House, family, 26-64 years old - Without direct electric heating

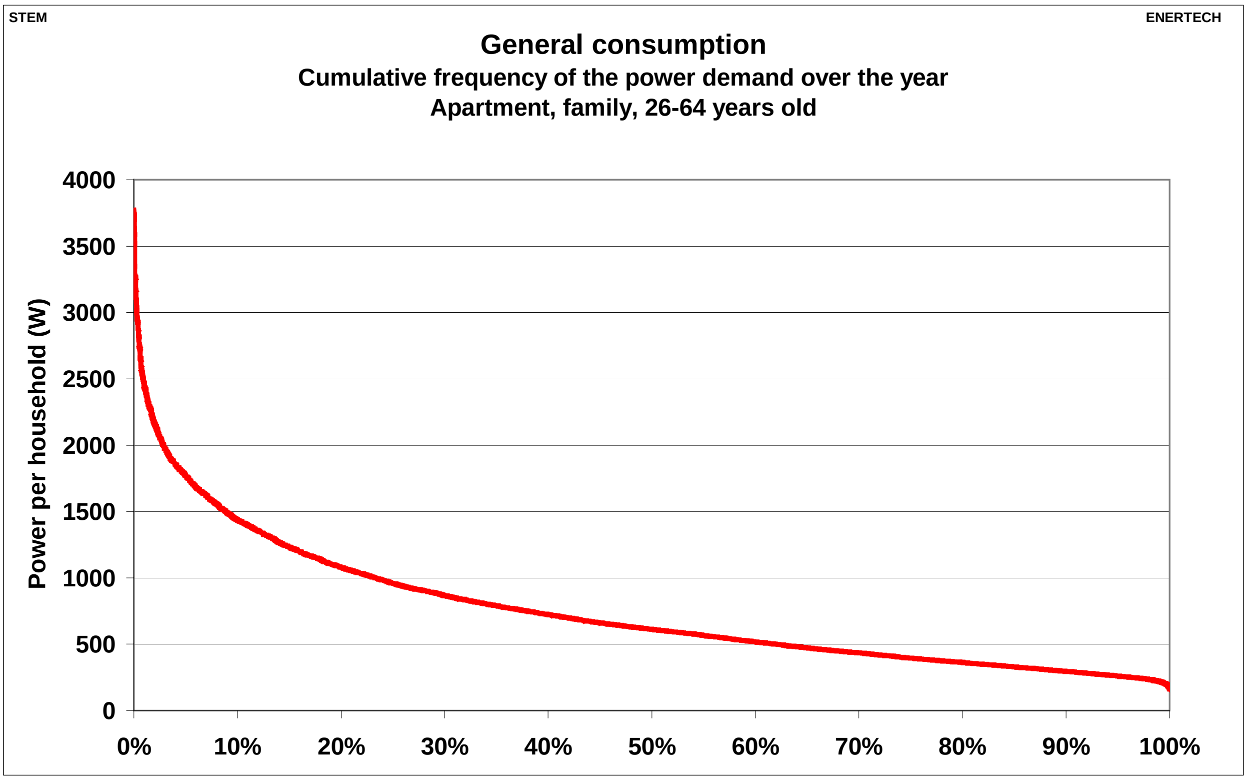


Figure 2.46: General consumption – Cumulative frequency of the power demand over the year, from the grid point of view – Apartment, family, 26-64 years old

Couples without children, 26-64 years old

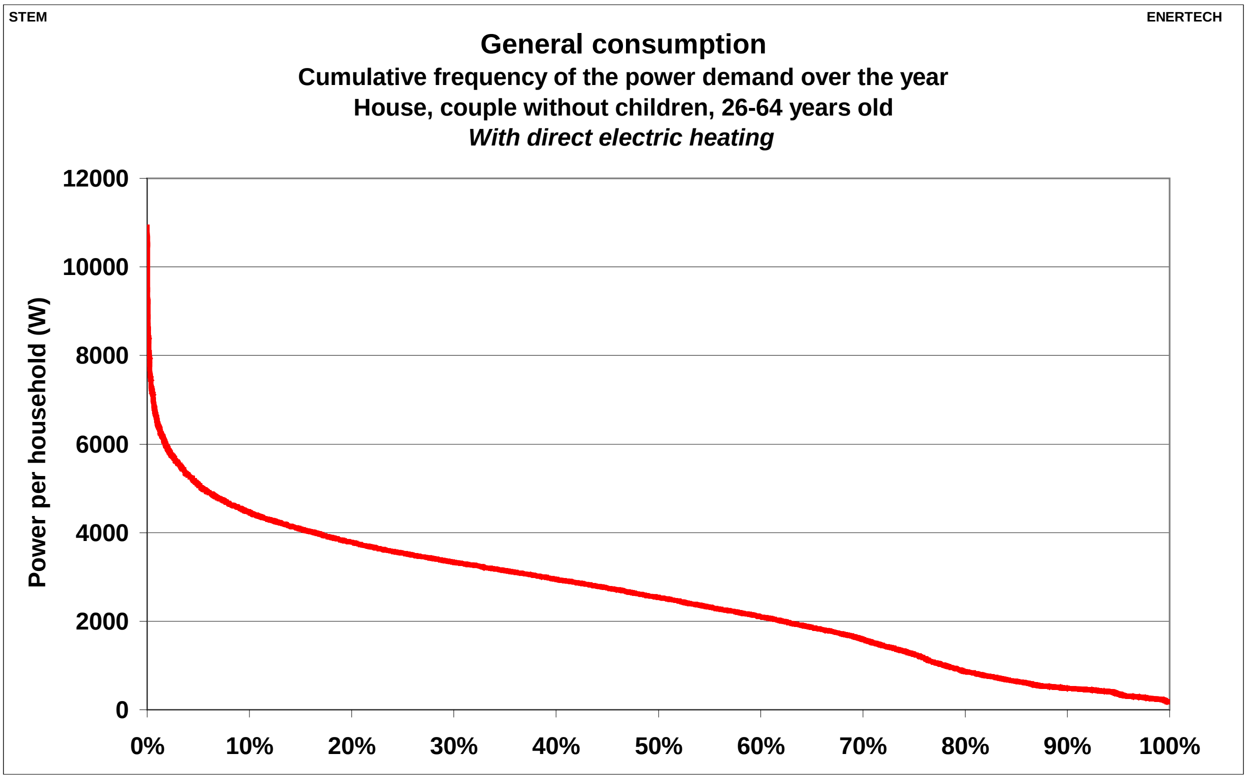


Figure 2.47: General consumption – Cumulative frequency of the power demand over the year, from the grid point of view – House, couples without children, 26-64 years old – With direct electric heating

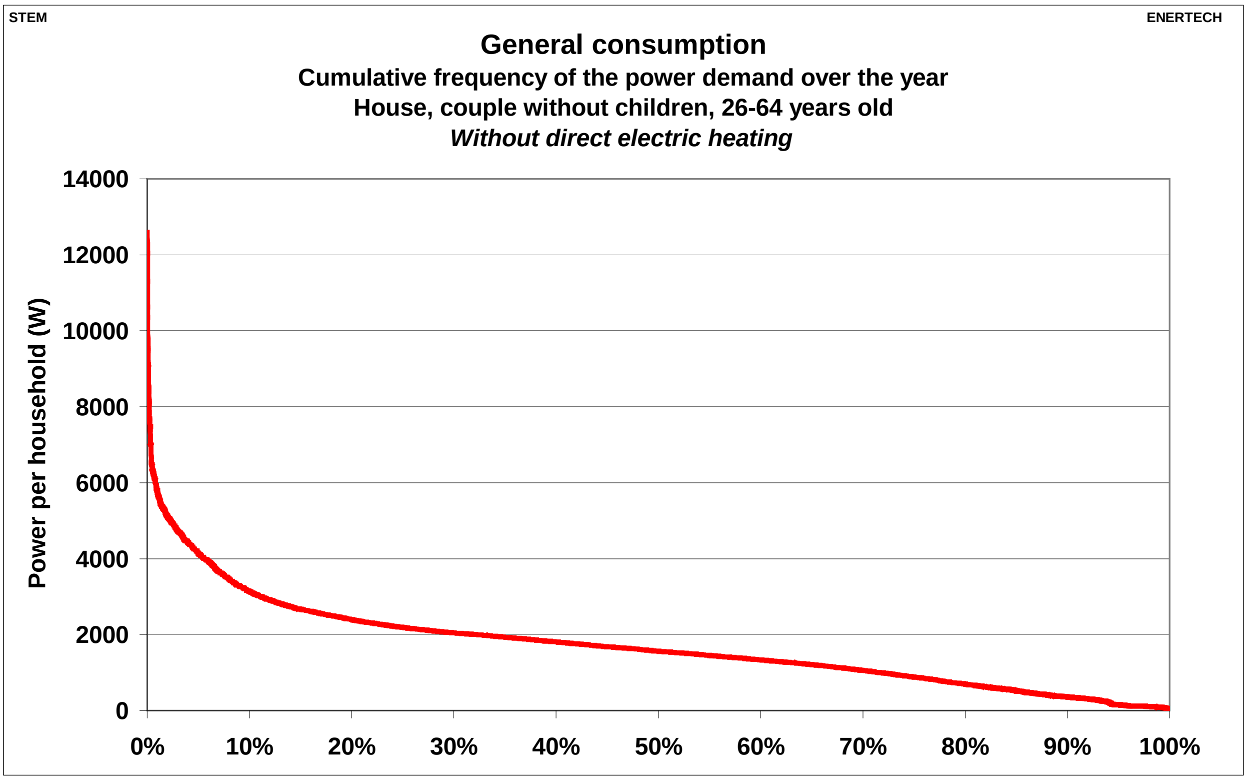


Figure 2.48: General consumption – Cumulative frequency of the power demand over the year, from the grid point of view – House, couples without children, 26-64 years old – Without direct electric heating

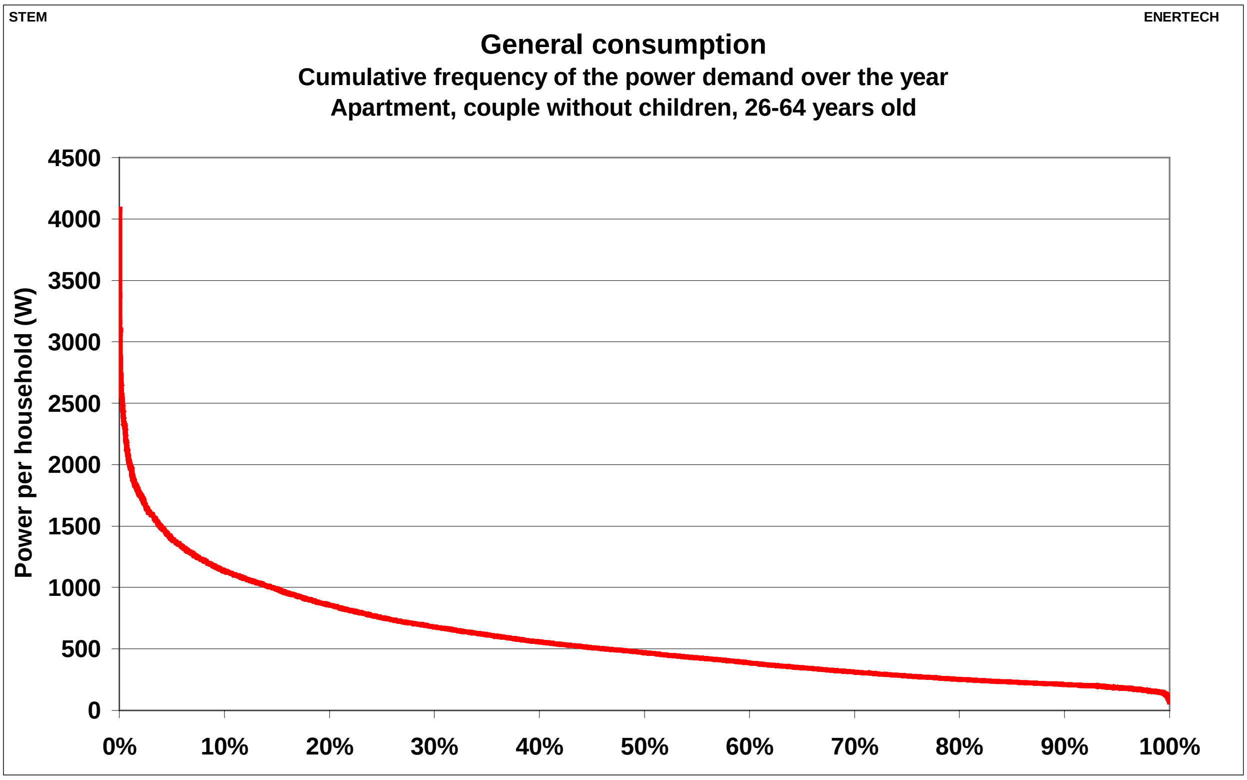
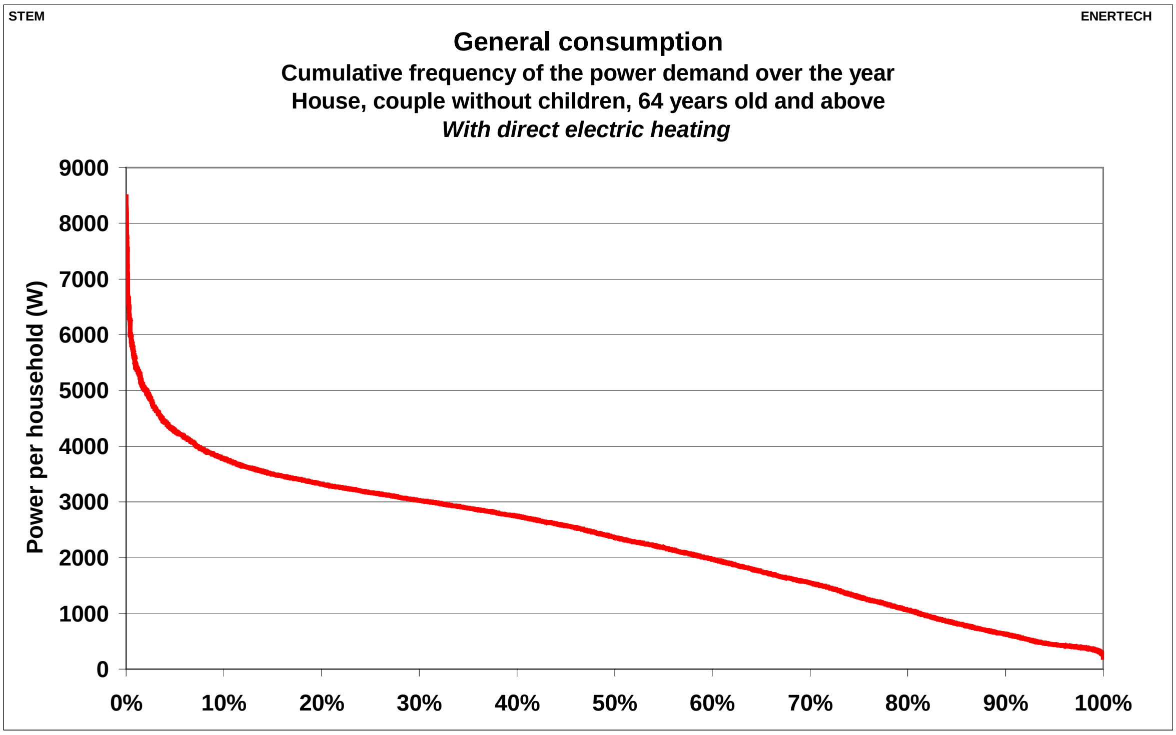


Figure 2.49: General consumption – Cumulative frequency of the power demand over the year, from the grid point of view – Apartment, couples without children, 26-64 years old

Couples without children, 64 years old and above

Figure 2.50: General consumption – Cumulative frequency of the power demand over the year, from the



grid point of view – House, couples without children, 64 years old and above – With direct electric heating

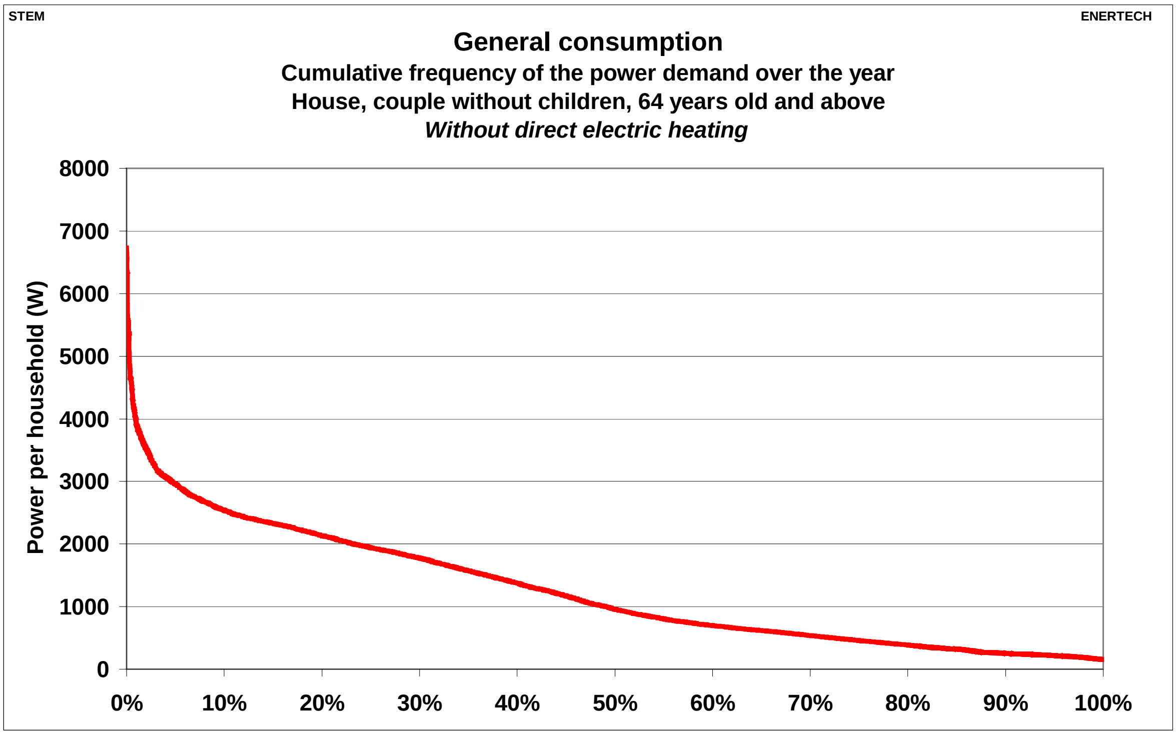


Figure 2.51: General consumption – Cumulative frequency of the power demand over the year, from the grid point of view – House, couples without children, 64 years old and above – Without direct electric heating

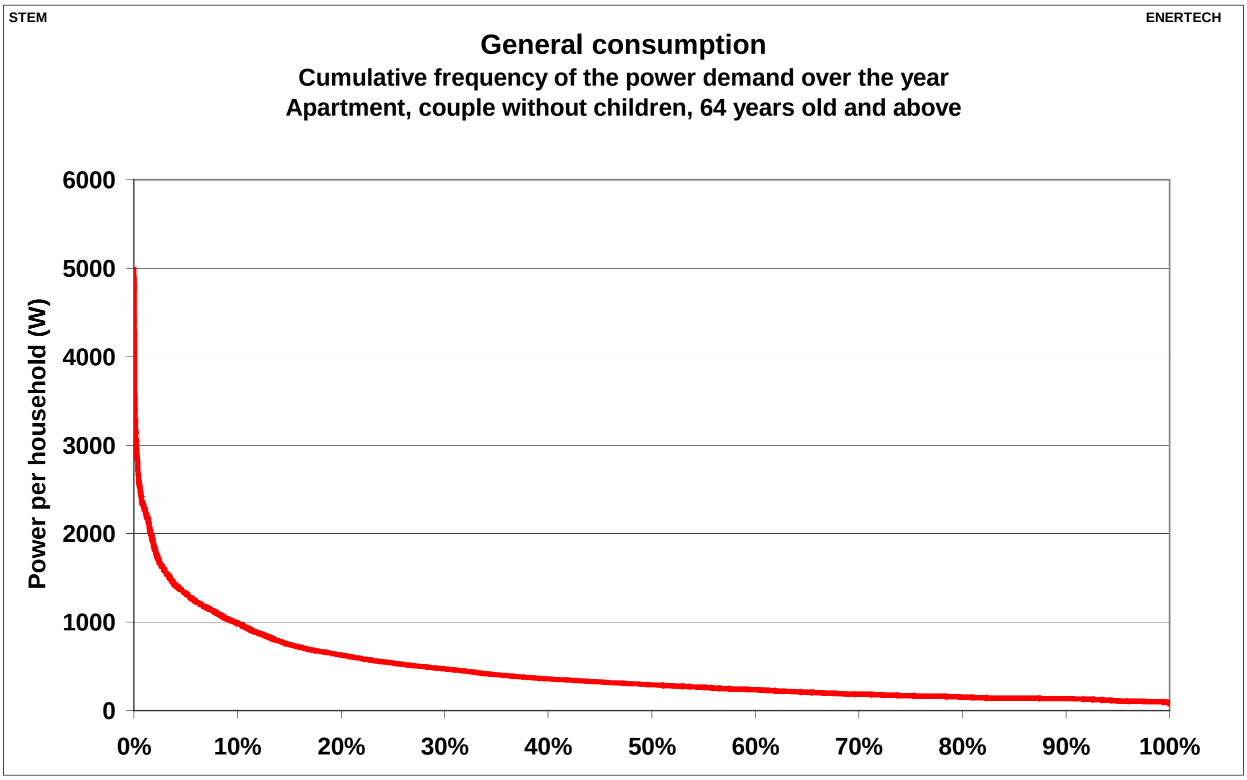


Figure 2.52: General consumption – Cumulative frequency of the power demand over the year, from the grid point of view – Apartment, couples without children, 64 years old and above

Single person, 26-64 years old

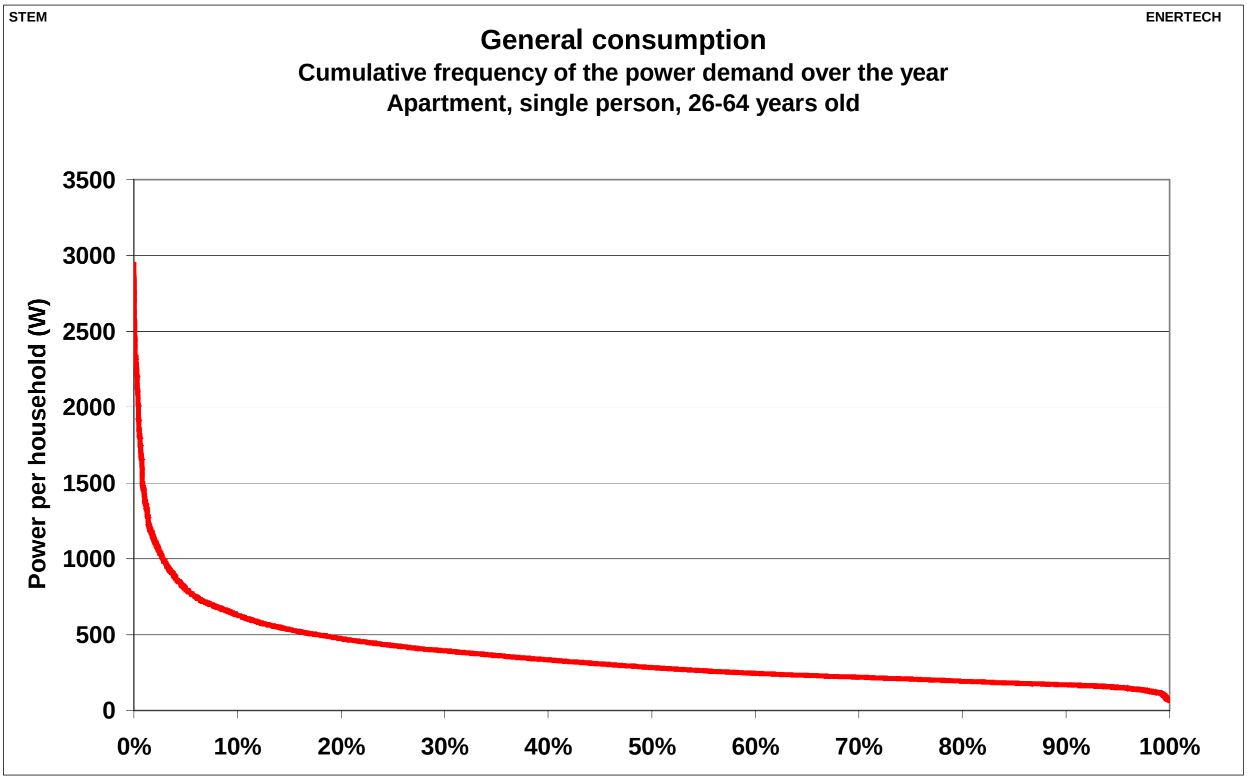


Figure 2.53: General consumption – Cumulative frequency of the power demand over the year, from the grid point of view – Apartment, single person, 26-64 years old

Single person, 64 years old and above

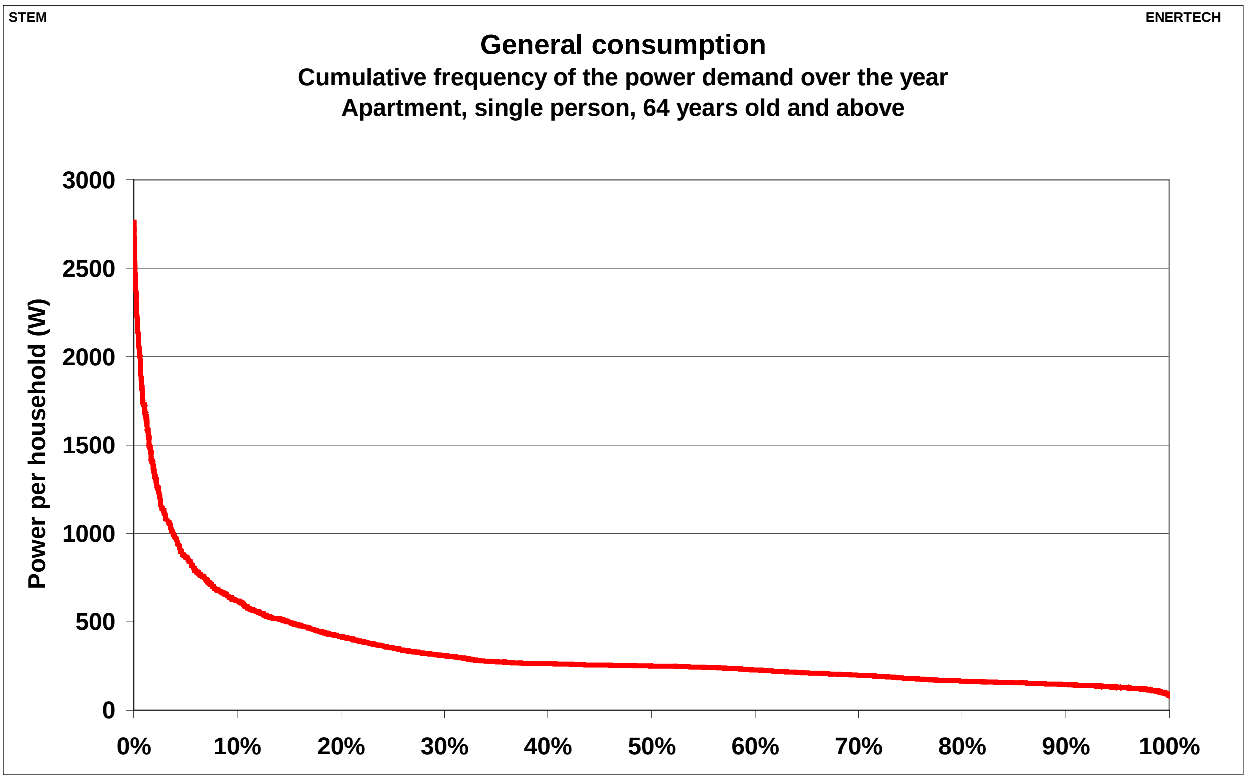


Figure 2.54: General consumption – Cumulative frequency of the power demand over the year, from the grid point of view – Apartment, single person, 64 years old and above

Table 2.55 gives precision about figure 2.44 to 2.54, by showing the average power drawn during 20 % and 80 % of the time for each type of household:

	Average maximum power demand reached during 20 % of the time	Average maximum power demand reached during 80 % of the time	Average power exceeded during 1% of the time
Apartment, couples without children, 26-64 years old	207	422	2672
Apartment, couples without children, 64 years old and above	128	273	3205
Apartment, family, 26-64 years old	295	558	3131
Apartment, single person, 26-64 years old	163	267	2260
Apartment, single person, 64 years old and above	142	227	2347
House, couples without children, 26-64 years old without direct electric heating	365	1265	8029

House, couples without children, 26-64 years old with direct electric heating	510	1991	8103
House, couples without children, 64 years old and above without direct electric heating	267	895	5262
House, couples without children, 64 years old and above with direct electric heating	652	1901	6753
House, family, 26-64 years old without direct electric heating	668	1330	5063
House, family, 26-64 years old with direct electric heating	1415	2491	6911

Figure 2.55: specific values of the cumulative frequency curve of the reached average power demand, from the grid point of view

It is interesting to note that the average power exceeded during 1% of the time is maximum for houses with couples without children between 26-64 years old. There is no big difference between the houses with direct electric heating and the one's without.

Structure of the average hourly load curve

Figures 2.56 to 2.121 shows, for different type of households, the split between holidays (Saturday and Sunday) workdays (Monday-Friday) and the sum of the two, the structure of the 'load curves', which shows the average hourly energy demand. These curves were calculated by averaging the individual load curves for each household. The 10 minute values are merged per hour in order to obtain 24 values (one per hour) given in Watt.

This structure was obtained using all the monitored devices merged per type of appliance (cold appliances, lighting, audiovisual sites, computer sites, cooking, washing, heating etc.). The graphs are split in two: a first set with all the different consumptions including heating and water heating, a second set displaying only the specific consumptions.

Family, 26-64 years old

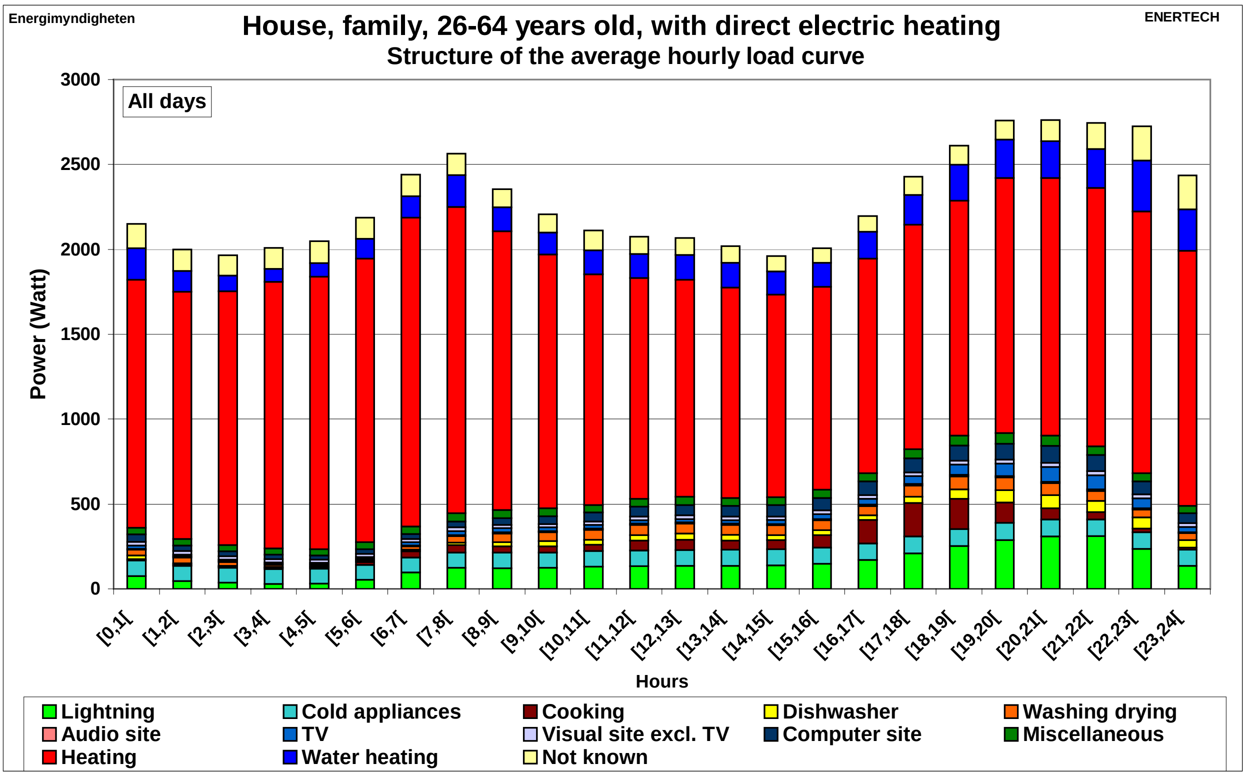


Figure 2.56: Structure of the average hourly load curve – Houses with direct electric heating - All days

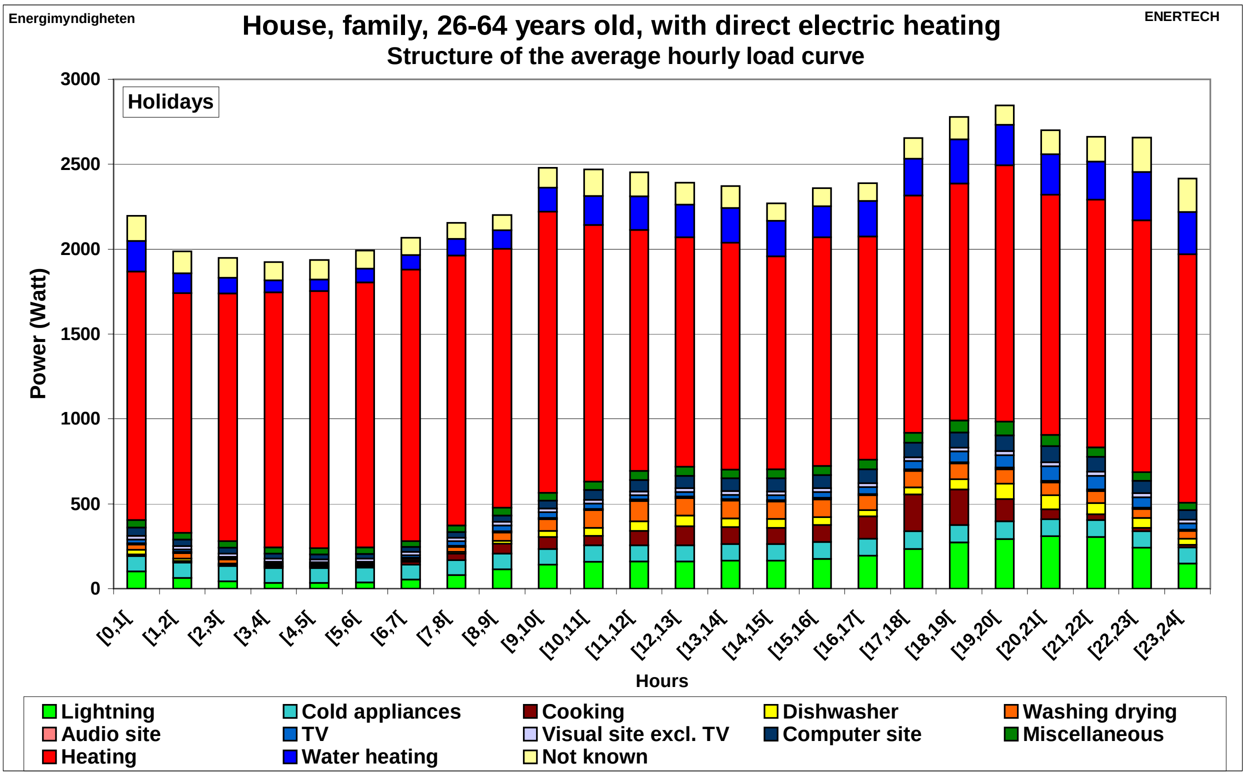


Figure 2.57: Structure of the average hourly load curve – Houses with direct electric heating - Holidays

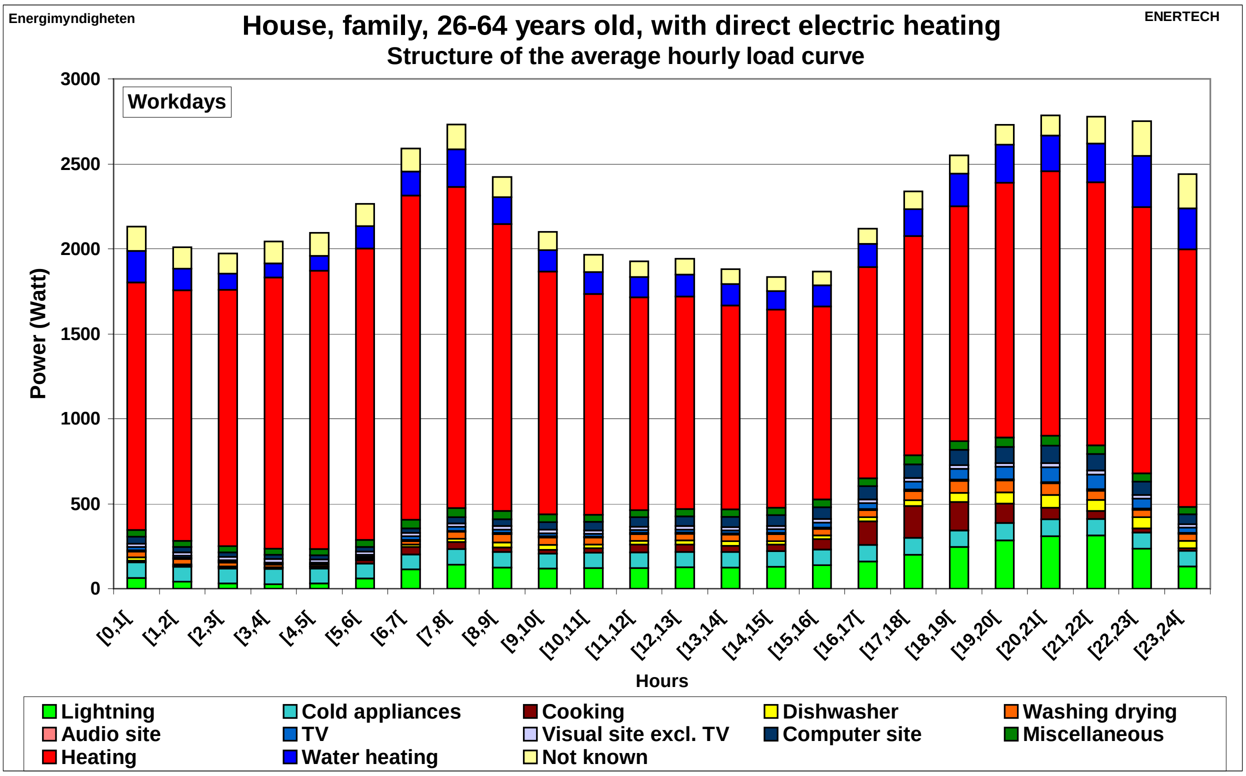


Figure 2.58: Structure of the average hourly load curve – Houses with direct electric heating – Workdays

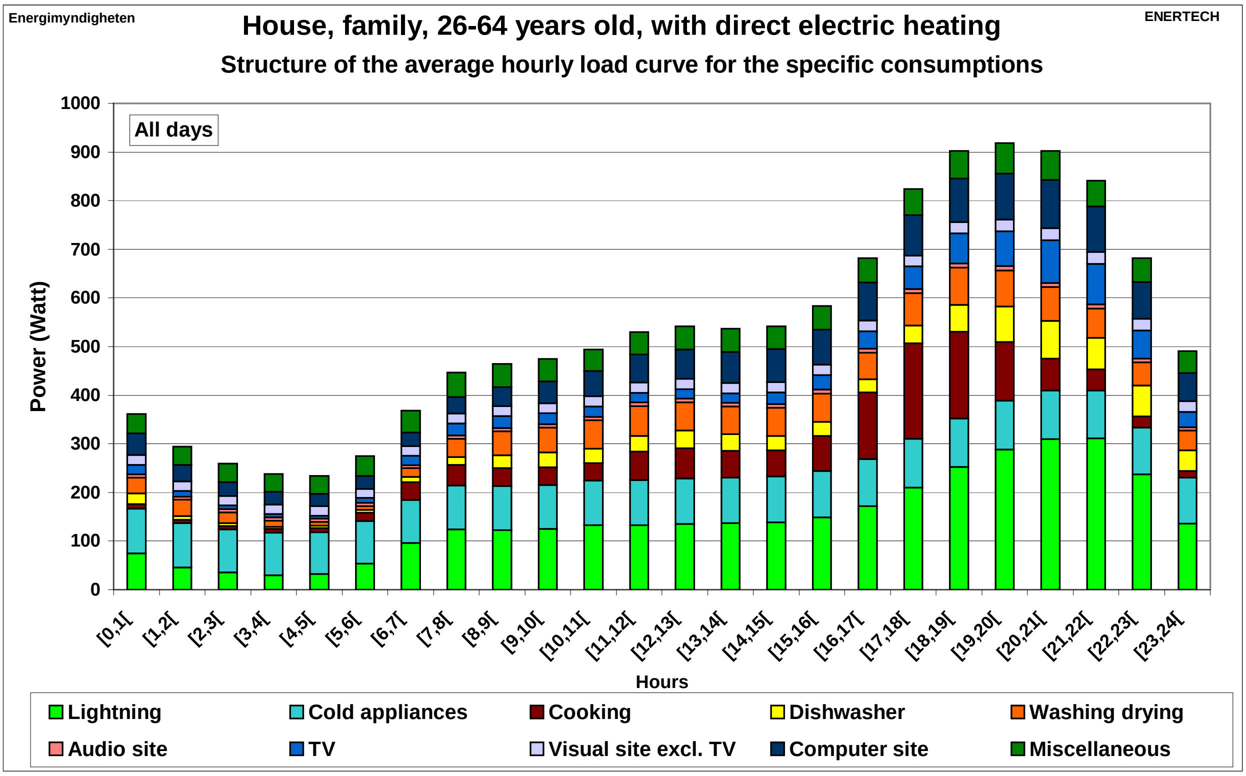


Figure 2.59: Structure of the average hourly load curve for the specific consumption– Houses with direct electric heating - All days

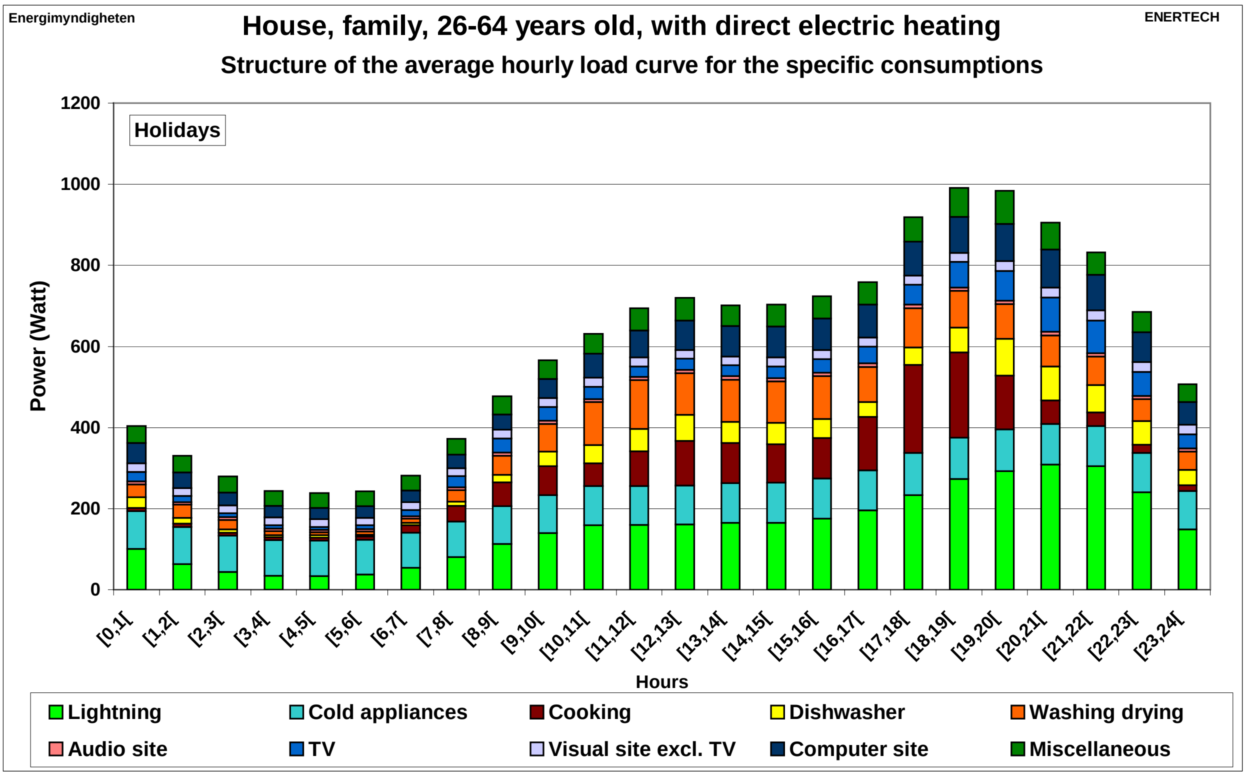


Figure 2.60: Structure of the average hourly load curve for the specific consumption– Houses with direct electric heating - Holidays

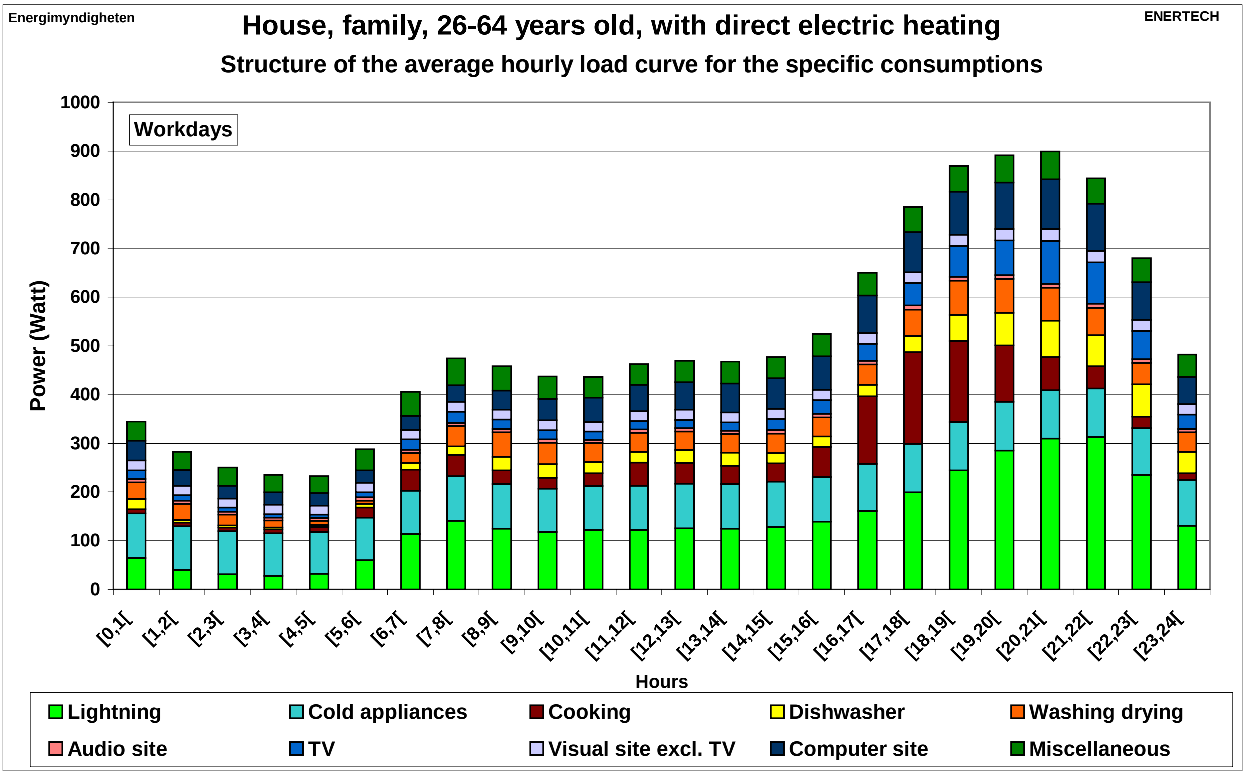


Figure 2.61: Structure of the average hourly load curve for the specific consumption– Houses with direct electric heating – Workdays

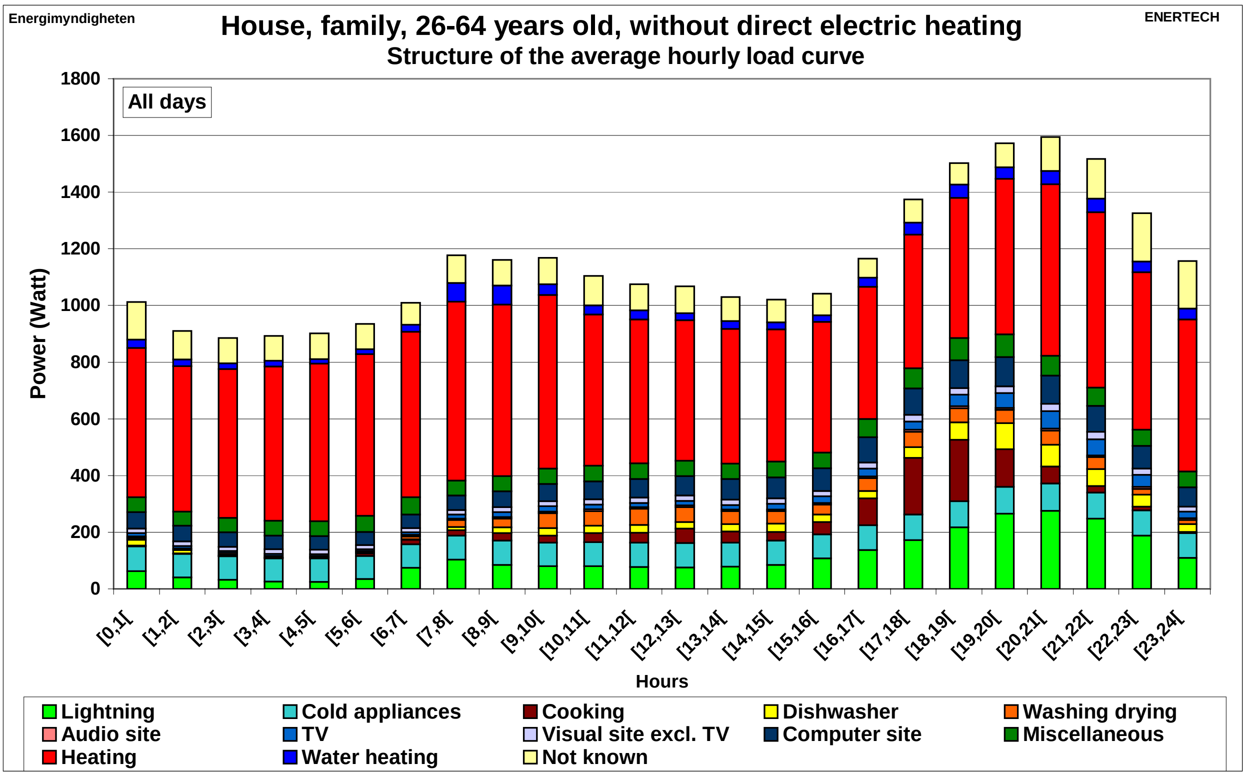


Figure 2.62: Structure of the average hourly load curve – Houses without direct electric heating - All days

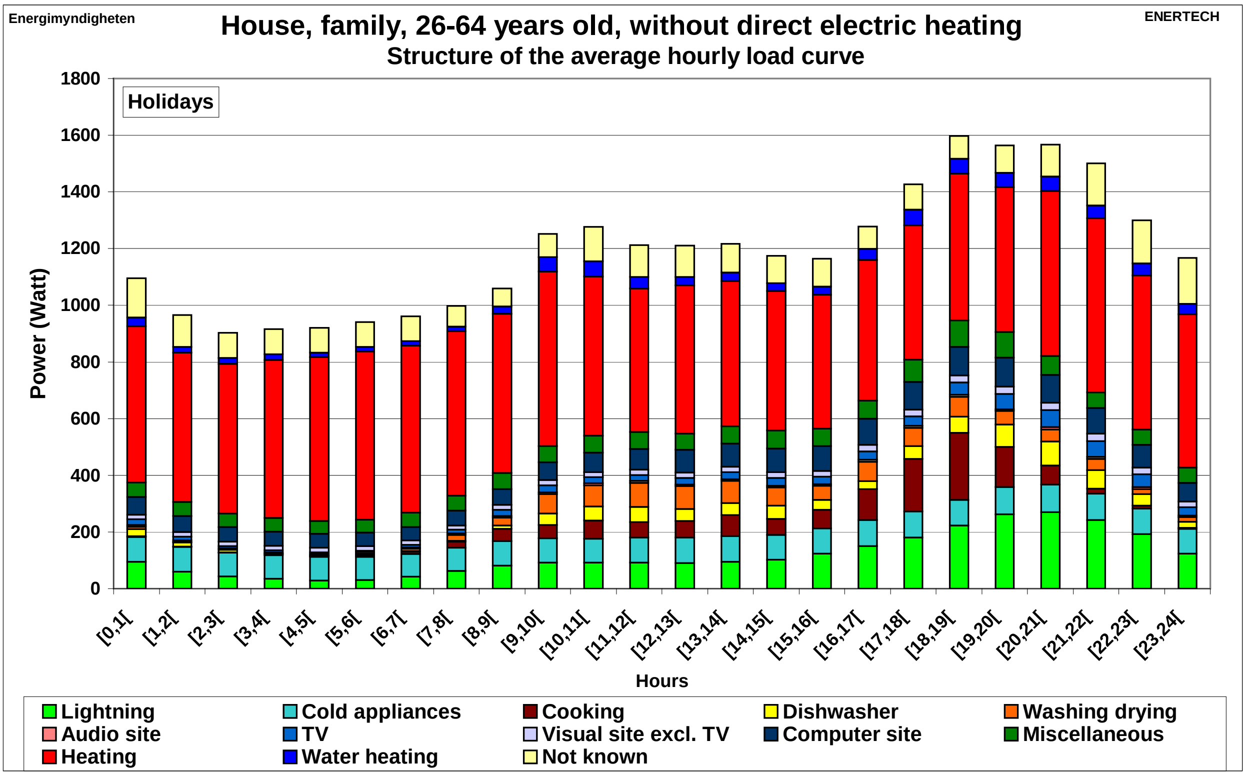


Figure 2.63: Structure of the average hourly load curve – Houses without direct electric heating - Holidays

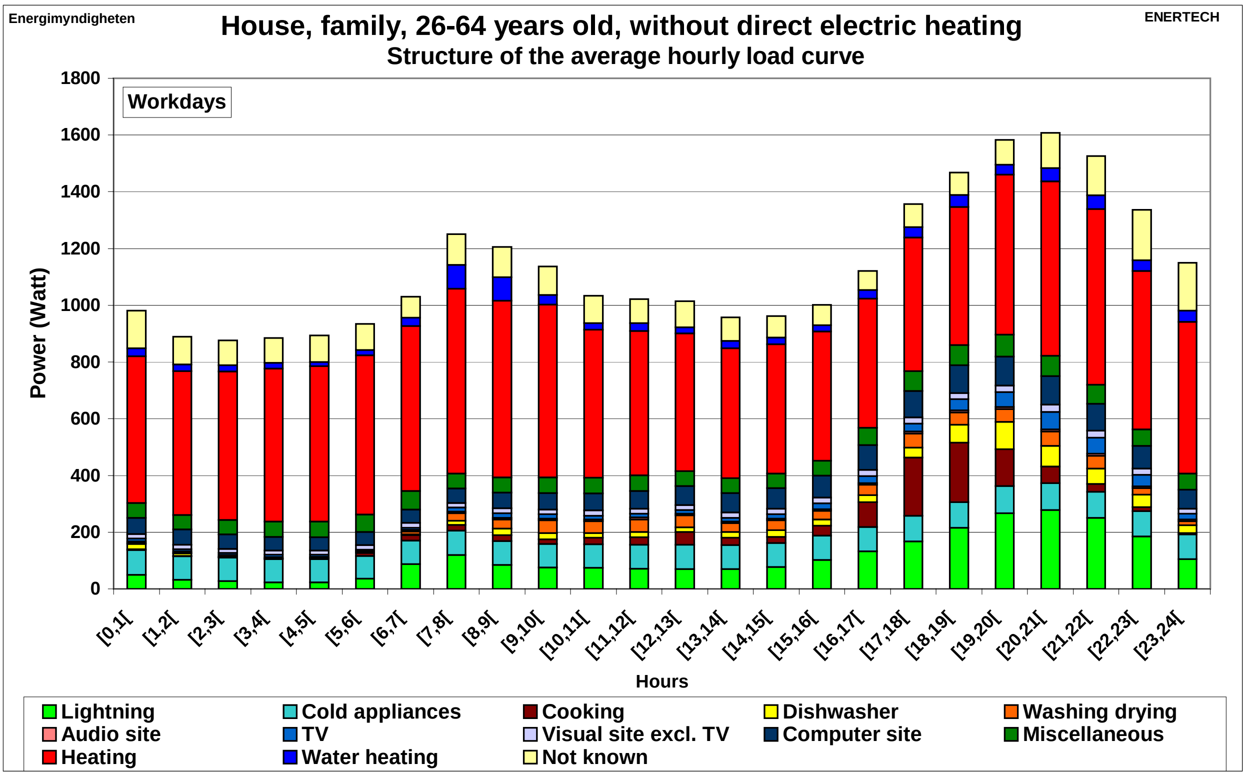


Figure 2.64: Structure of the average hourly load curve – Houses without direct electric heating – Workdays

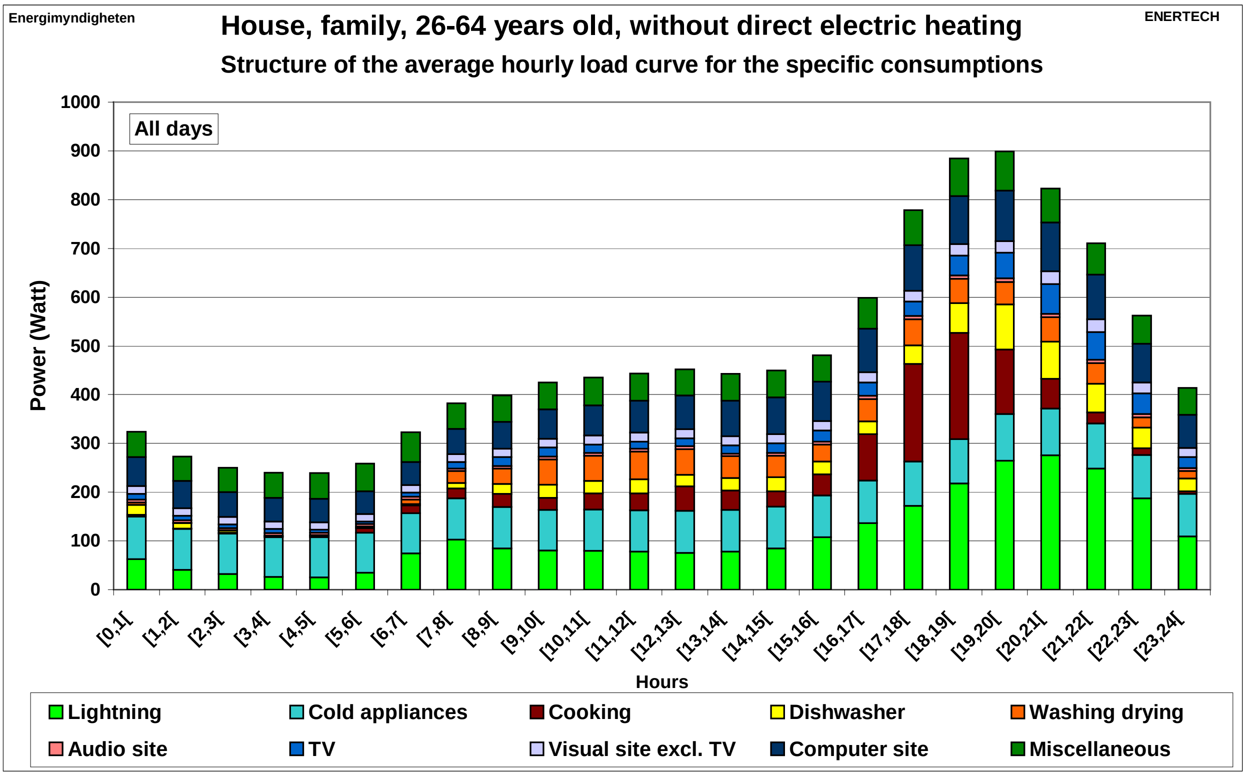


Figure 2.65: Structure of the average hourly load curve for the specific consumption– Houses without direct electric heating - All days

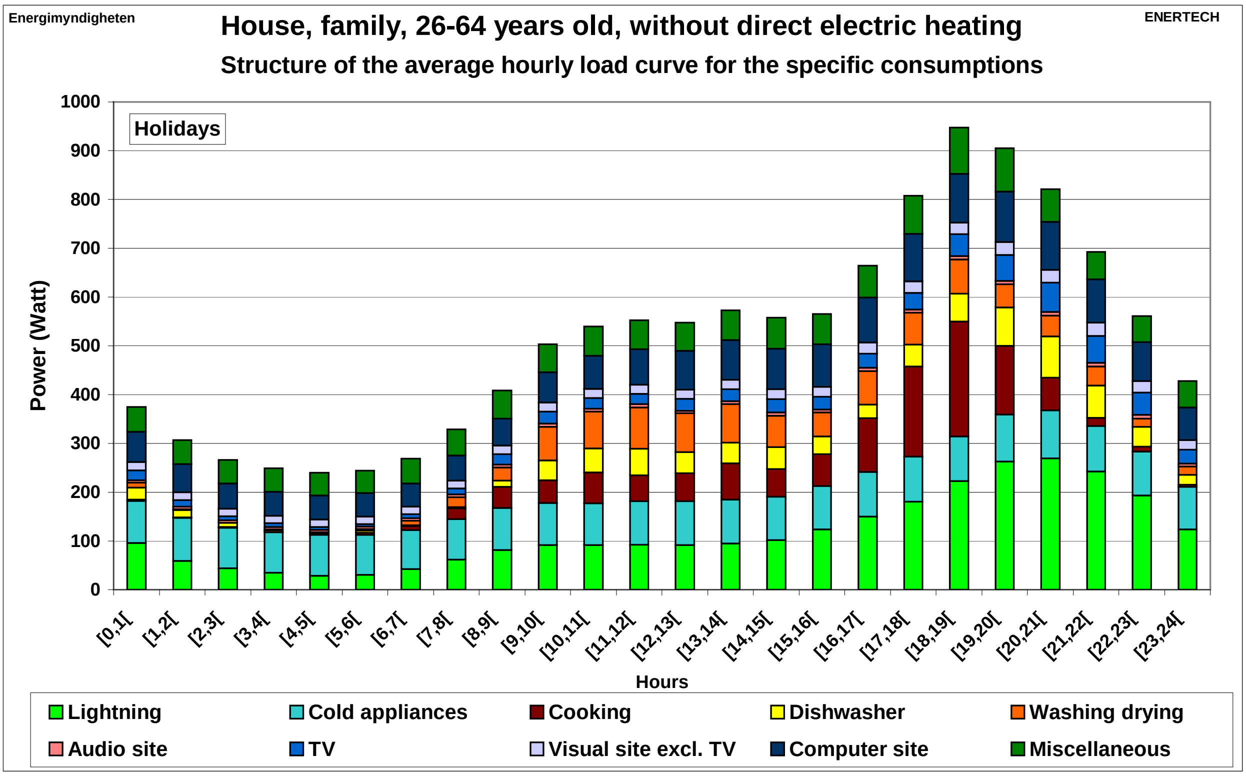


Figure 2.66: Structure of the average hourly load curve for the specific consumption– Houses without direct electric heating - Holidays

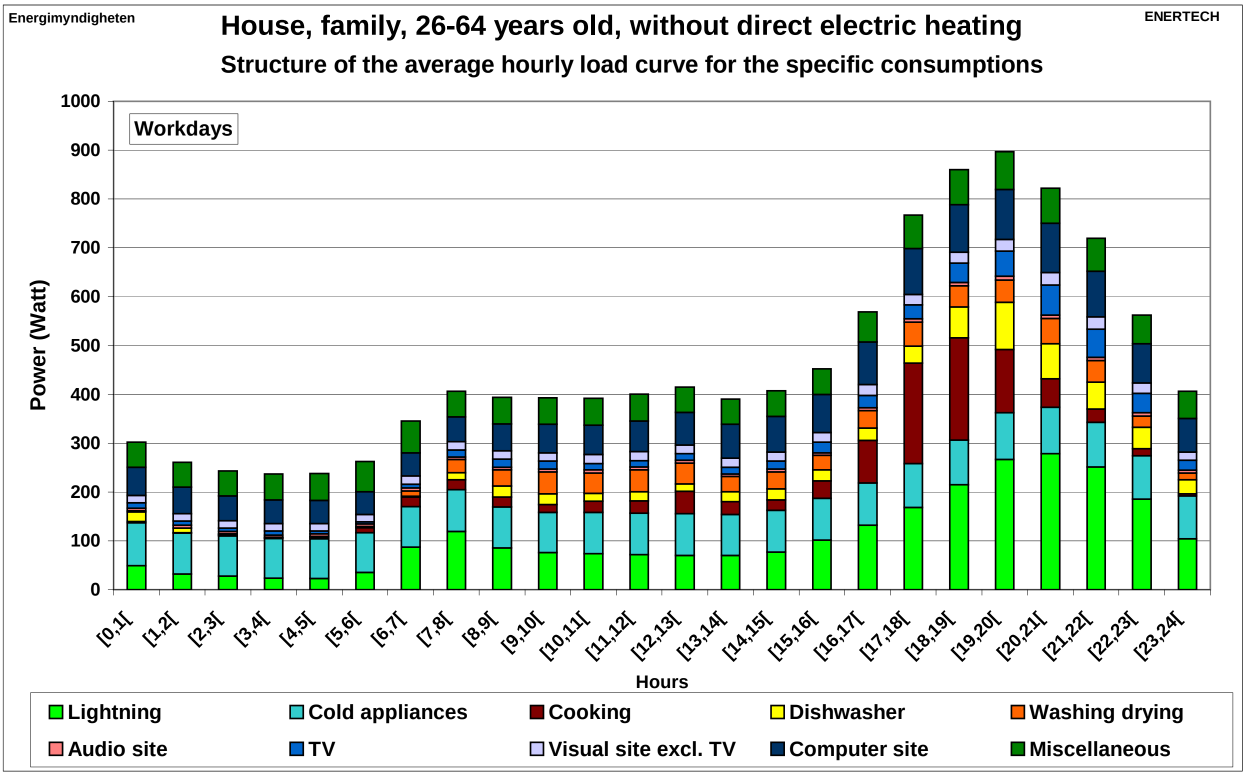


Figure 2.67: Structure of the average hourly load curve for the specific consumption– Houses without direct electric heating – Workdays

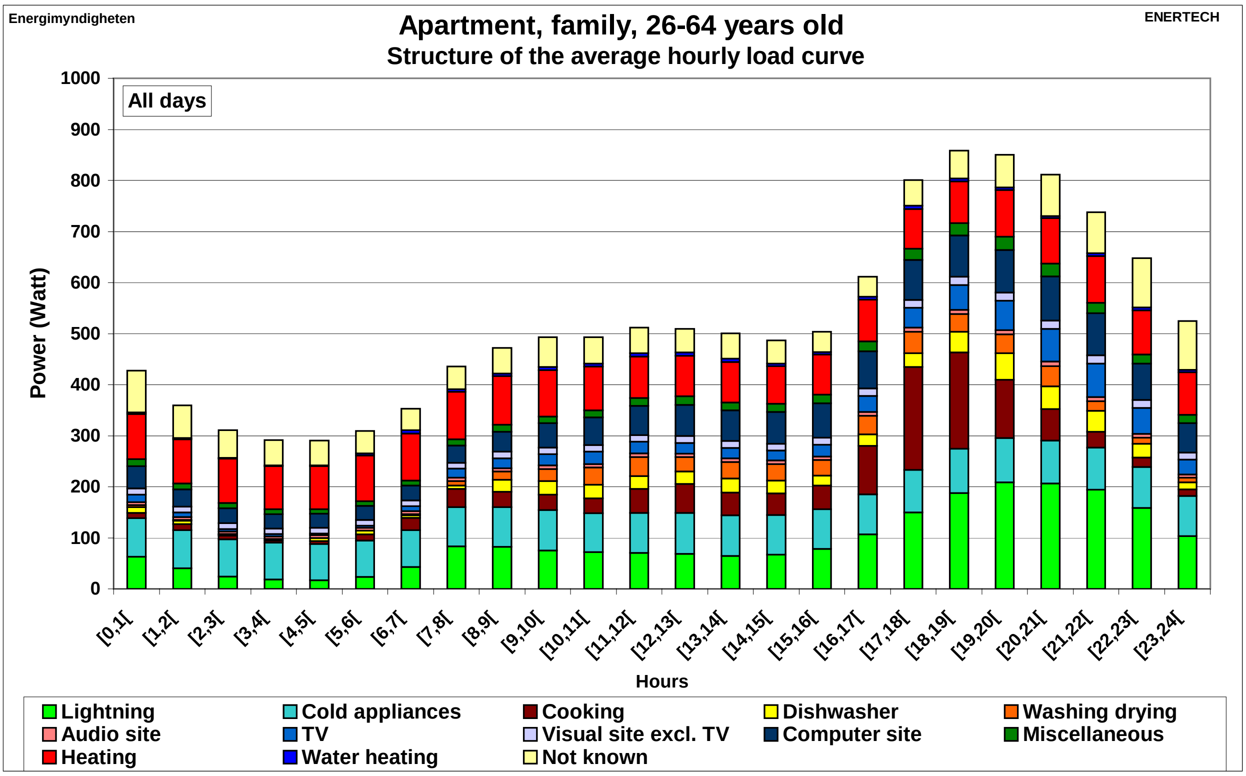


Figure 2.68: Structure of the average hourly load curve – Apartments - All days

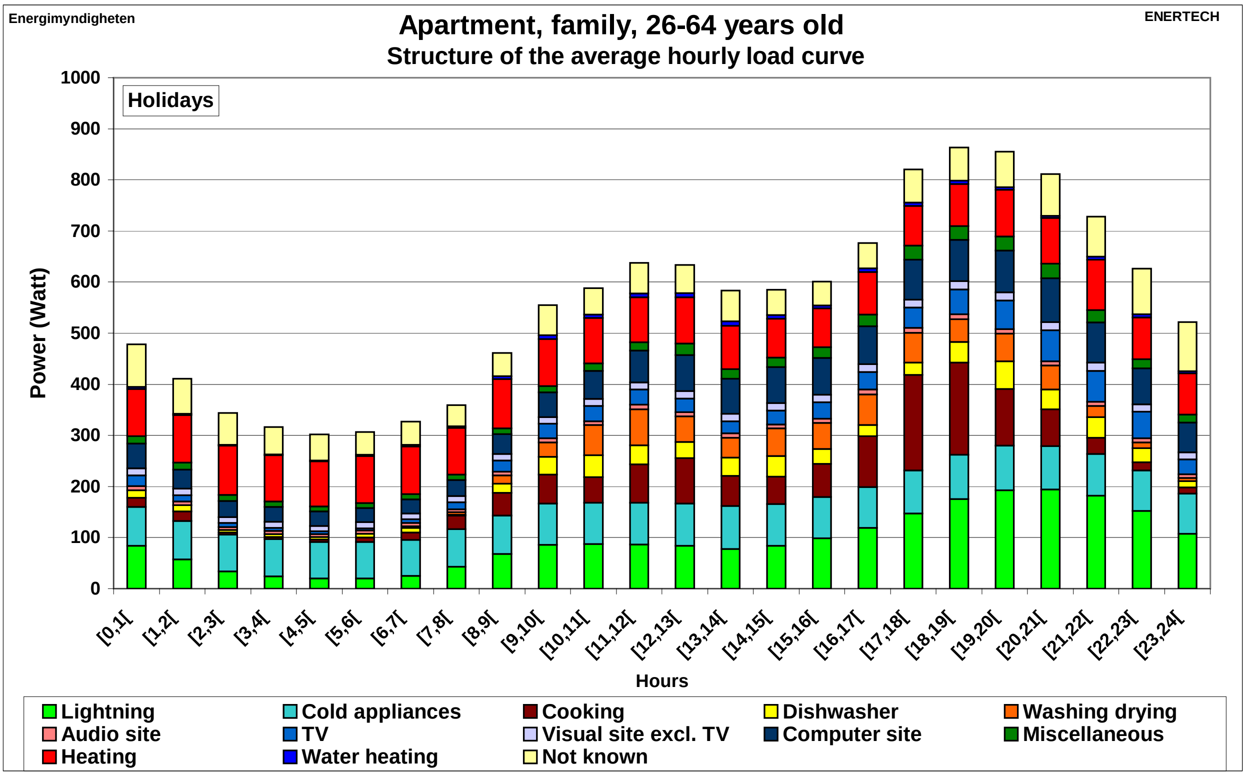


Figure 2.69: Structure of the average hourly load curve – Apartments - Holidays

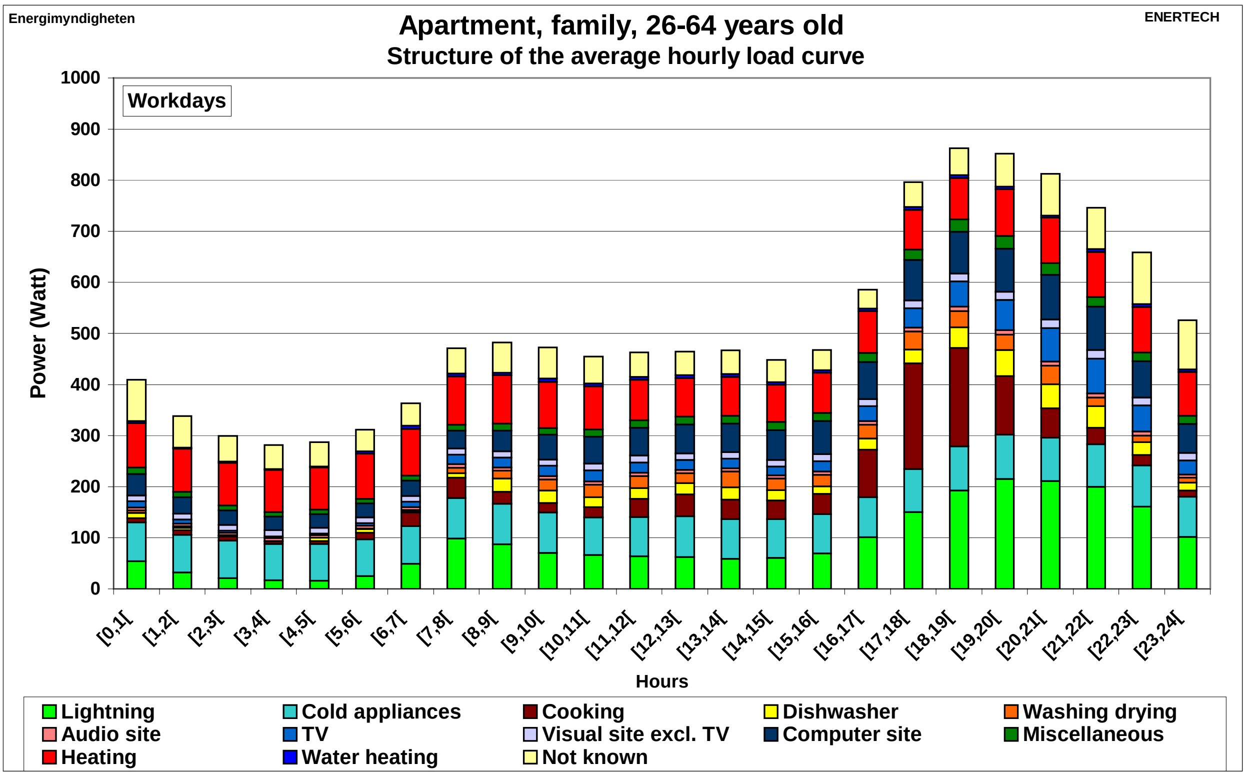


Figure 2.70: Structure of the average hourly load curve – Apartments - Workdays

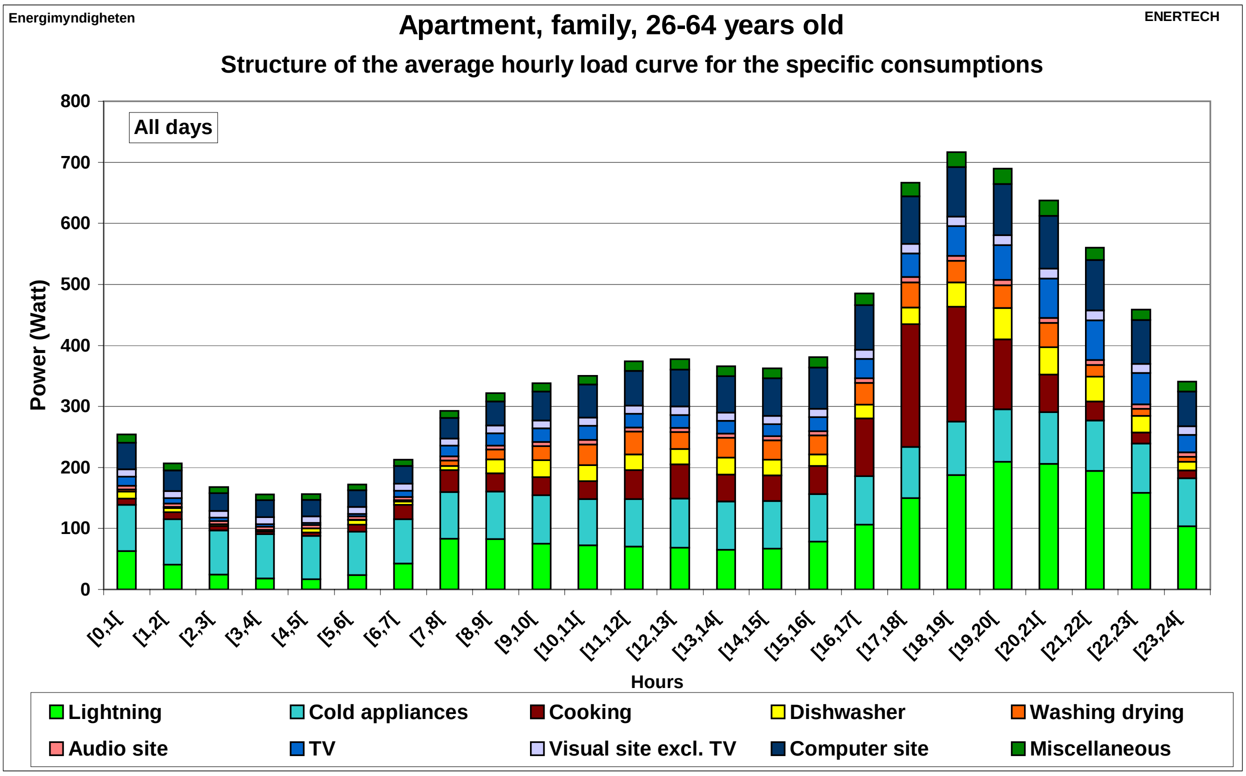


Figure 2.71: Structure of the average hourly load curve for the specific consumption– Apartments - All days

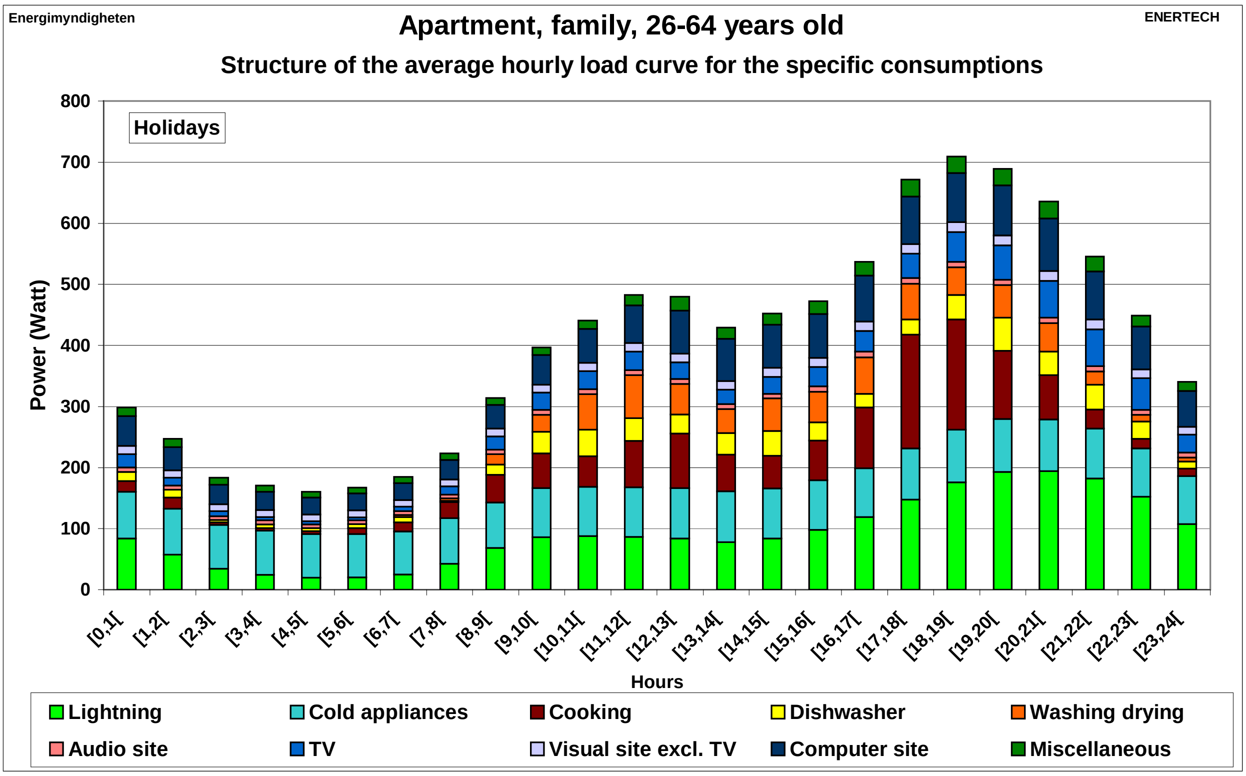


Figure 2.72: Structure of the average hourly load curve for the specific consumption– Apartments - Holidays

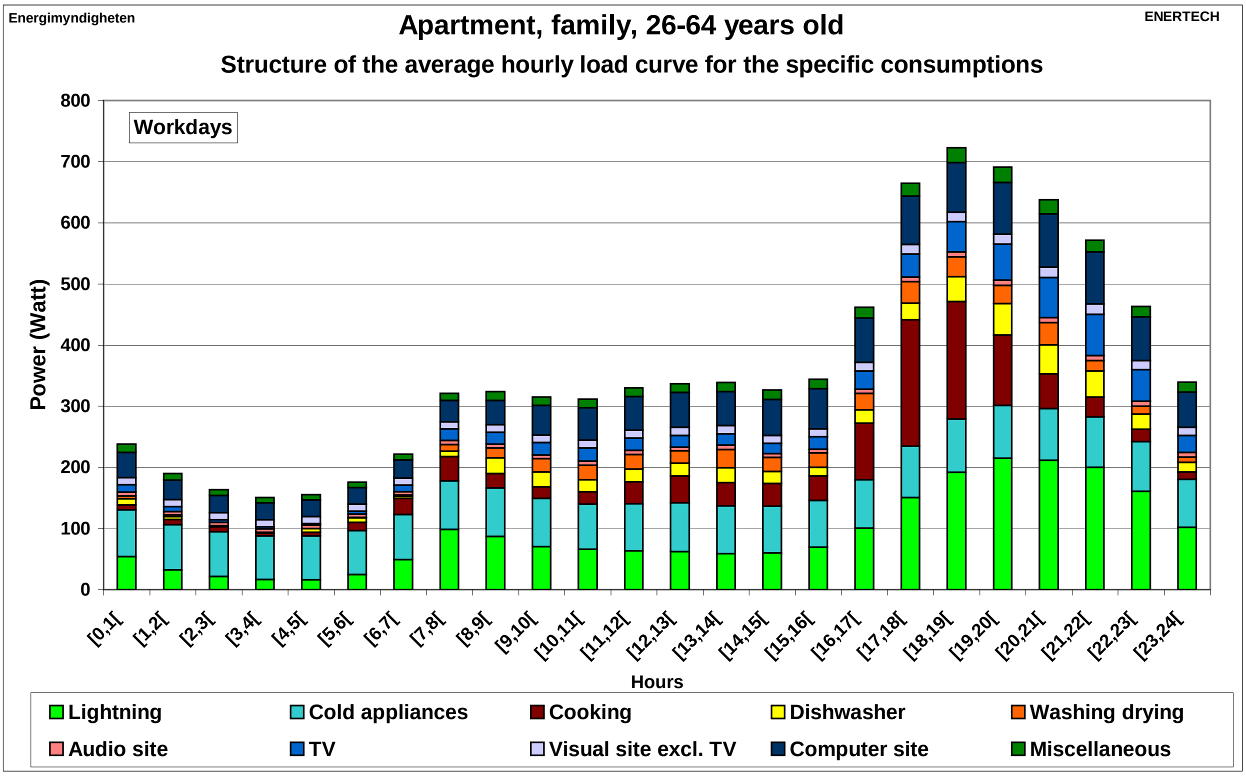


Figure 2.73: Structure of the average hourly load curve for the specific consumption– Apartments - Workdays

Couples without children, 26-64 years old

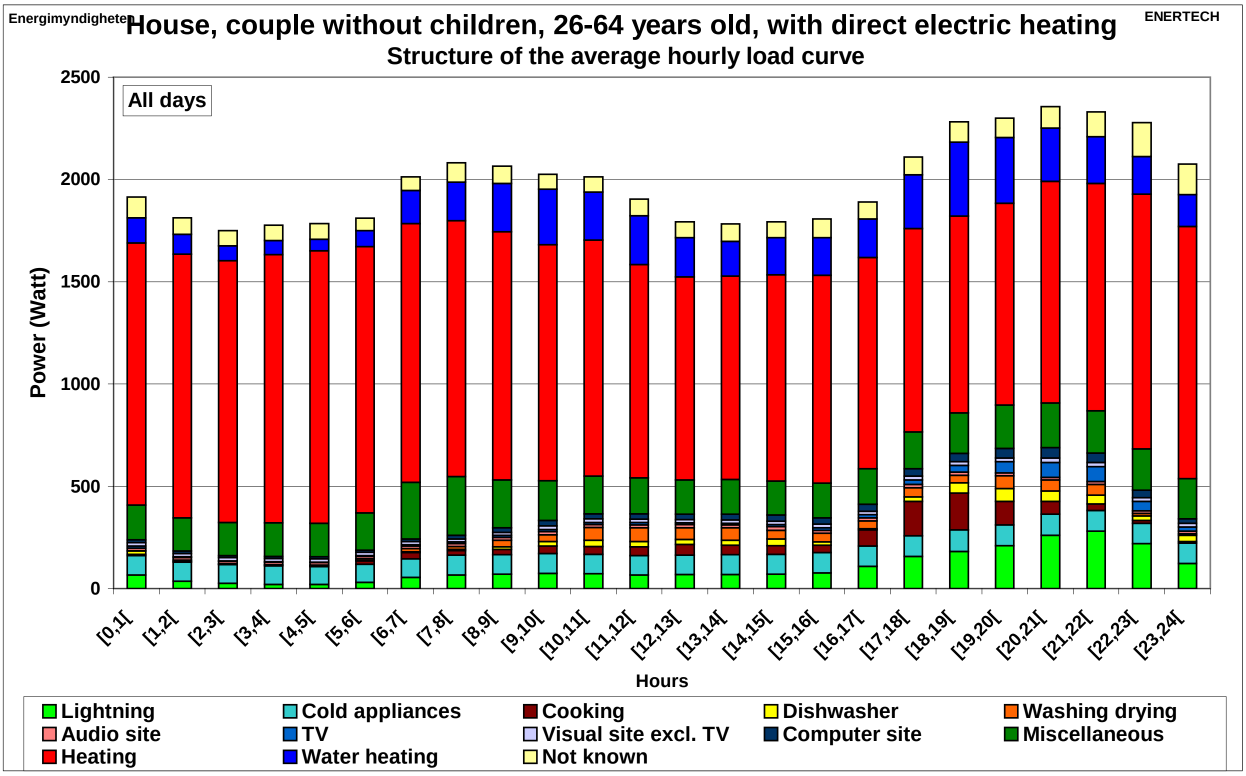


Figure 2.74: Structure of the average hourly load curve – Houses with direct electric heating – All days

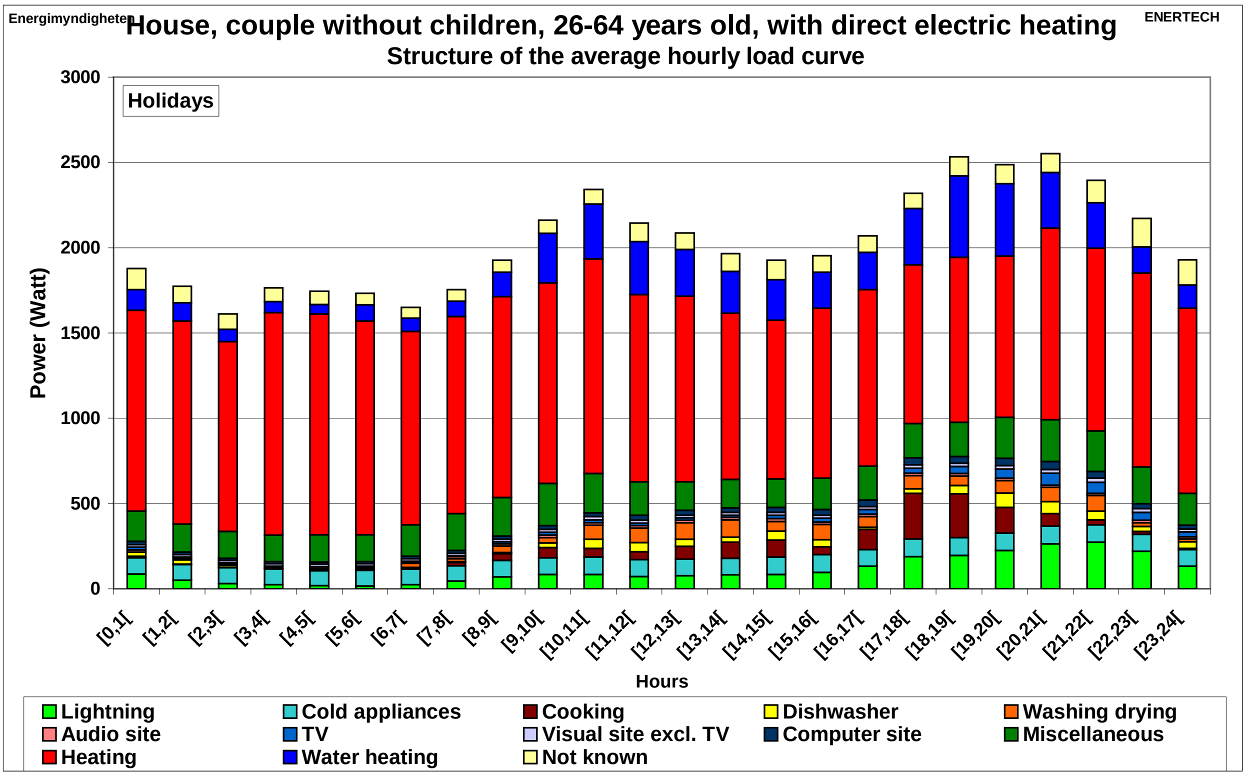


Figure 2.75: Structure of the average hourly load curve – Houses with direct electric heating – Holidays

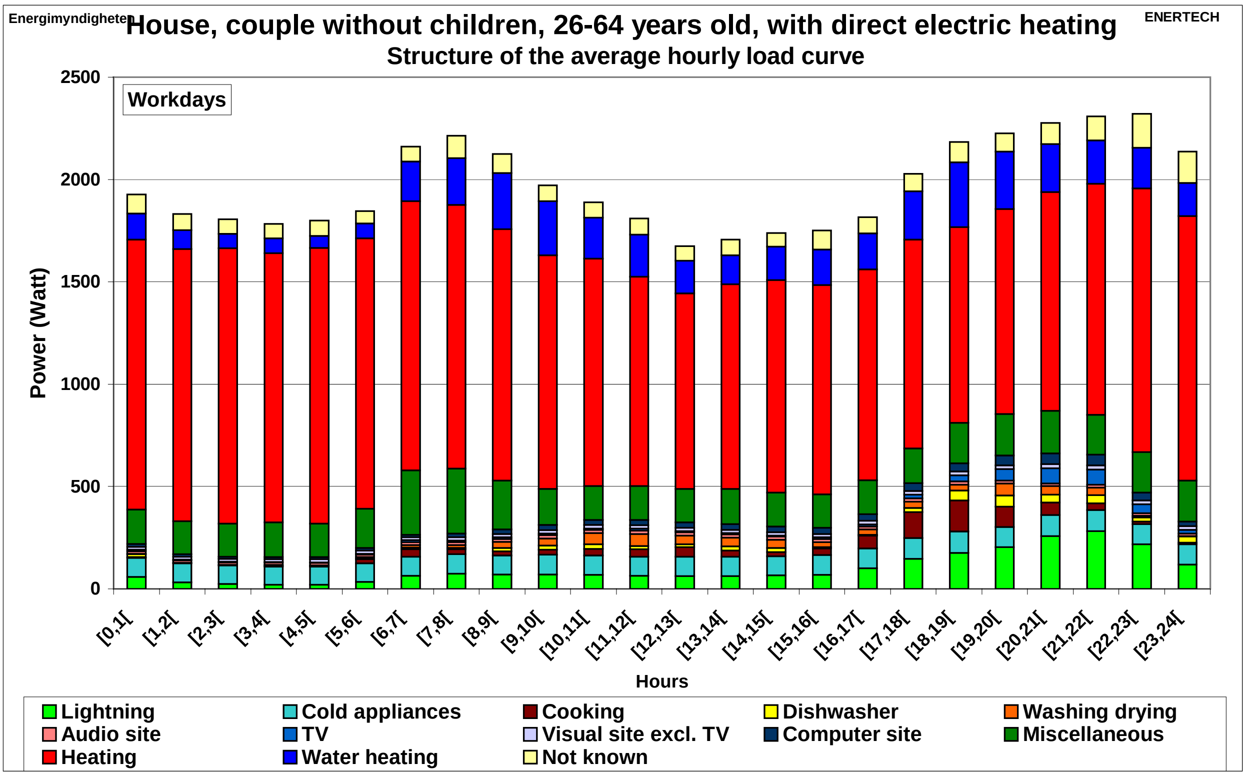


Figure 2.76: Structure of the average hourly load curve – Houses with direct electric heating – Workdays

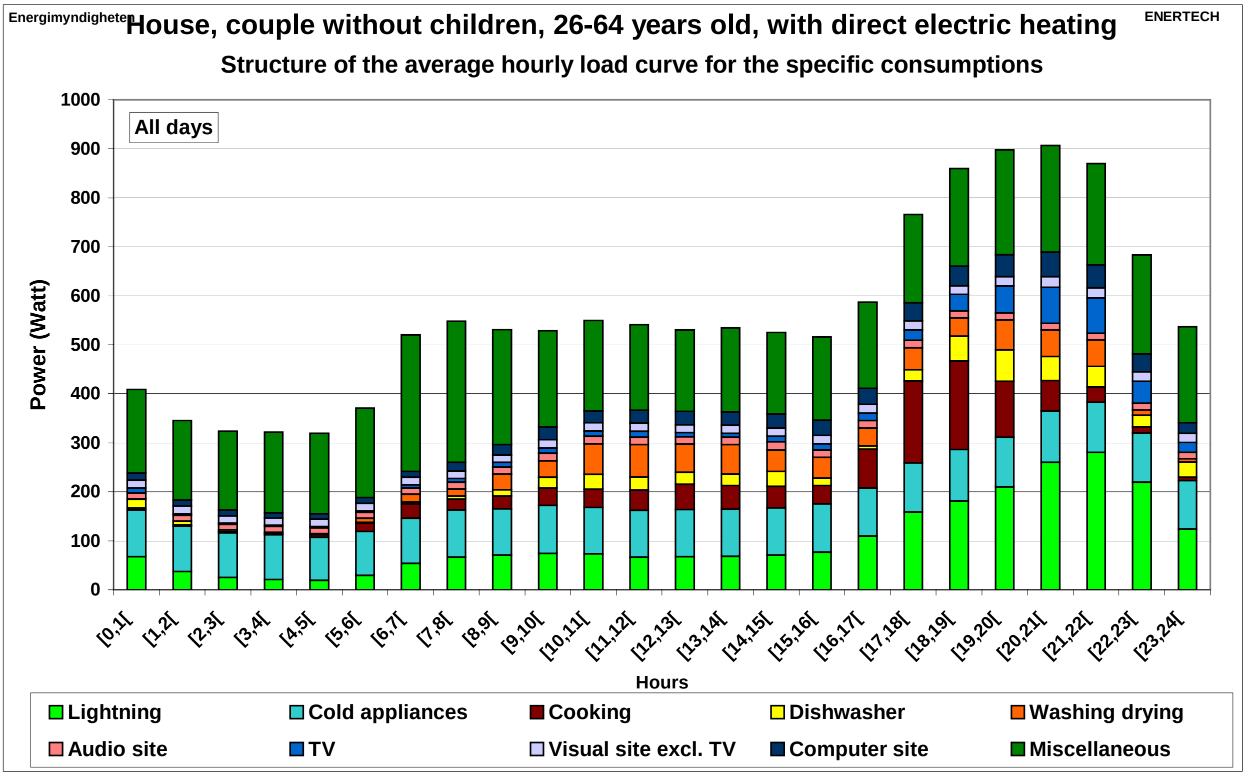


Figure 2.77: Structure of the average hourly load curve for the specific consumption– Houses with direct electric heating – All days

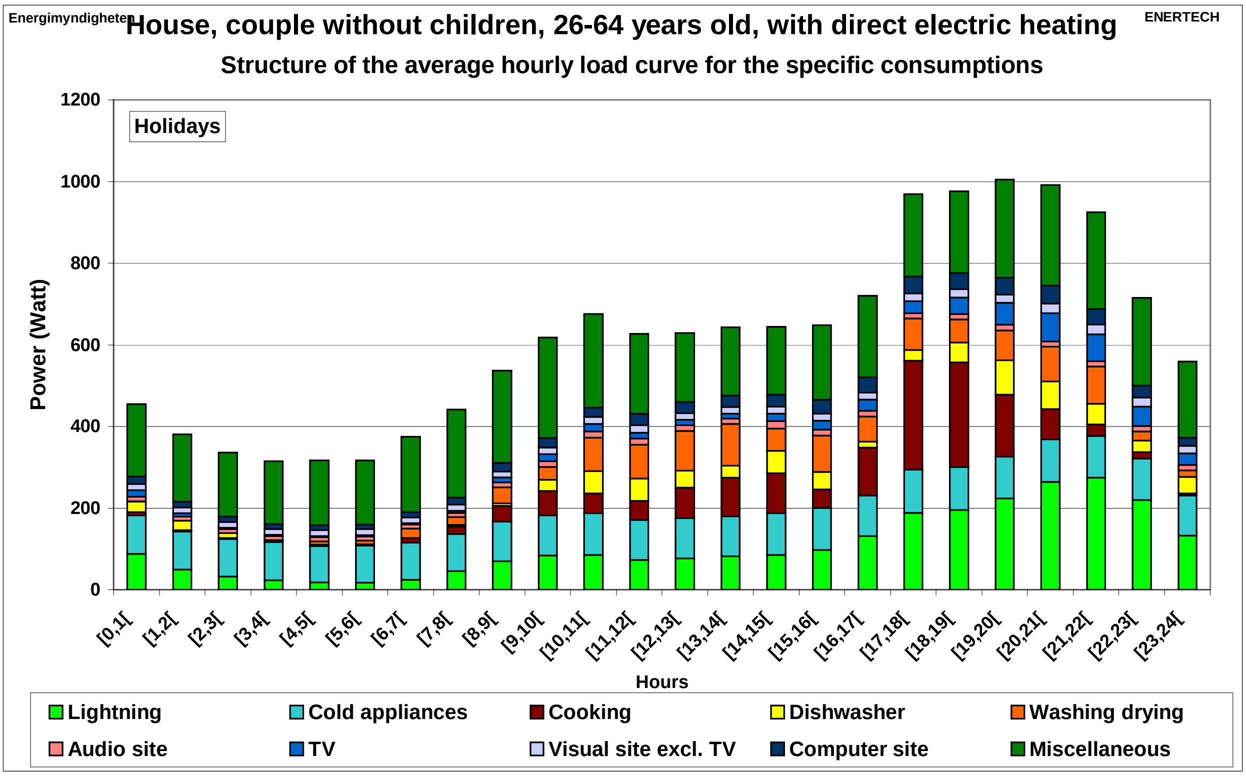


Figure 2.78: Structure of the average hourly load curve for the specific consumption– Houses with direct electric heating – Holidays

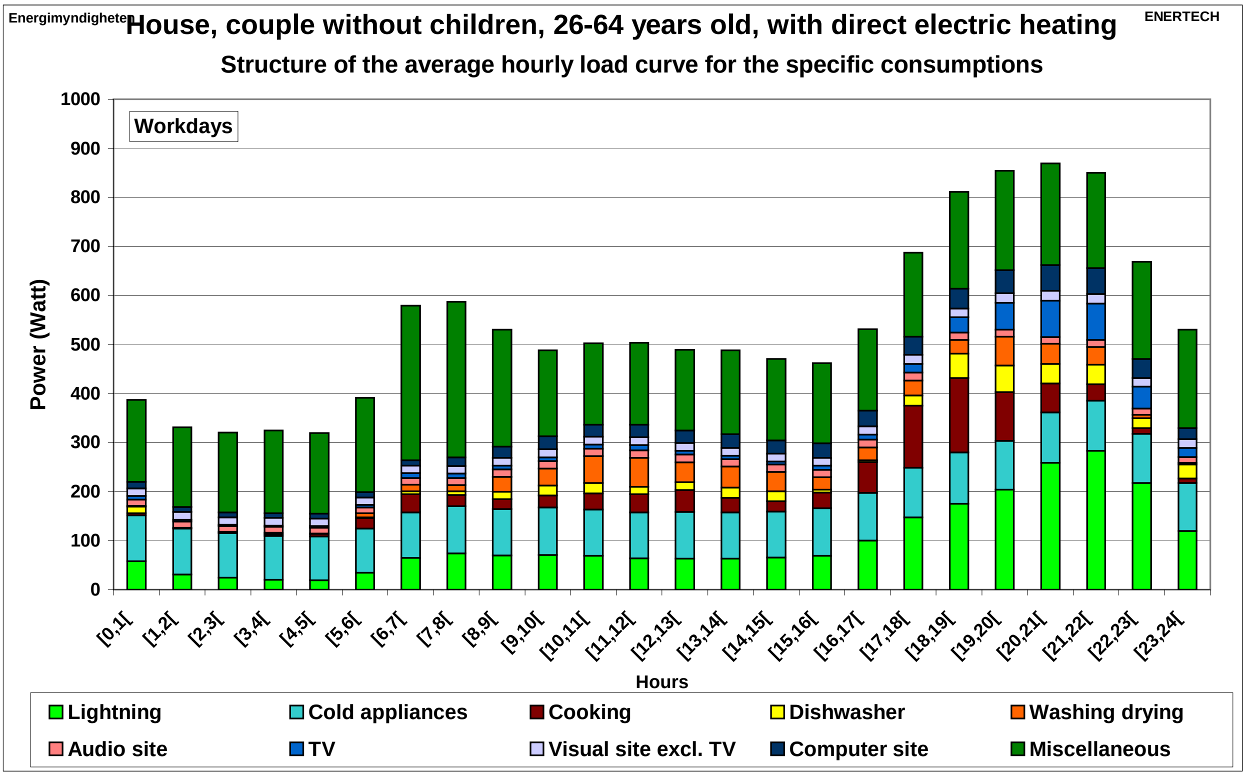


Figure 2.79: Structure of the average hourly load curve for the specific consumption– Houses with direct electric heating – Workdays

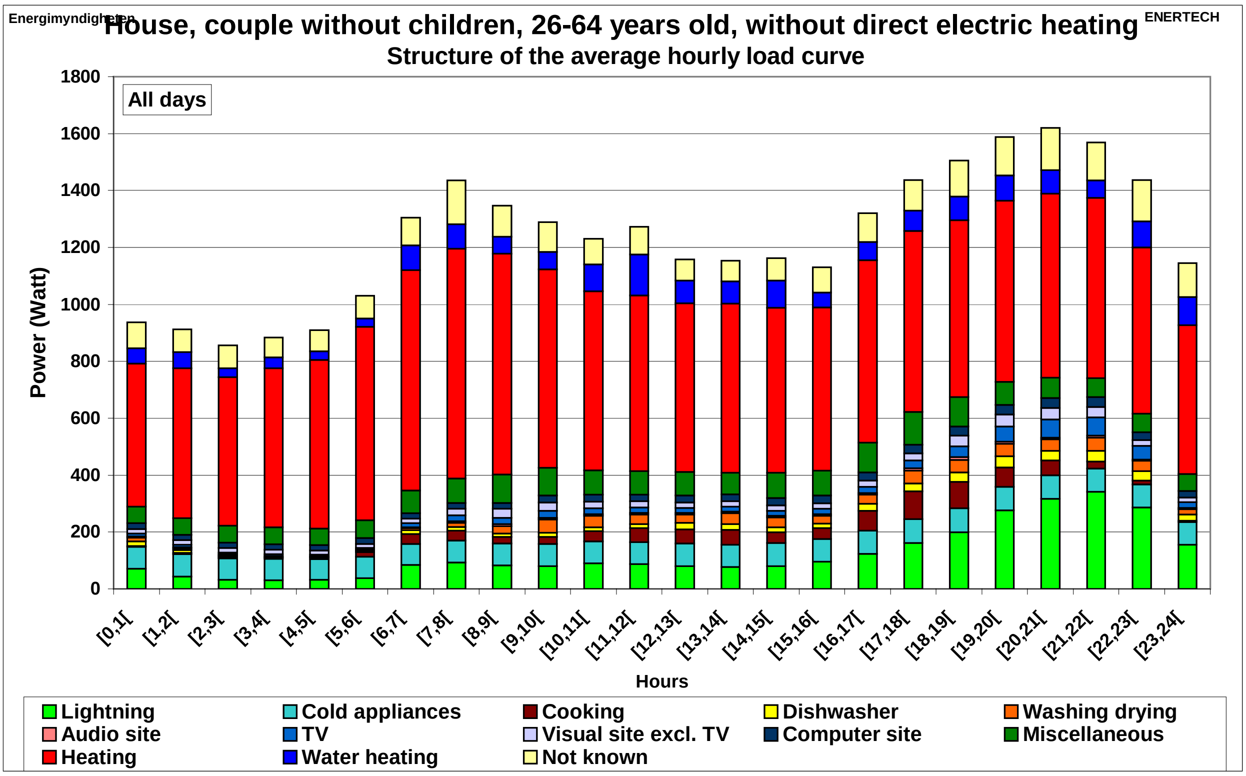


Figure 2.80: Structure of the average hourly load curve – Houses without direct electric heating – All days

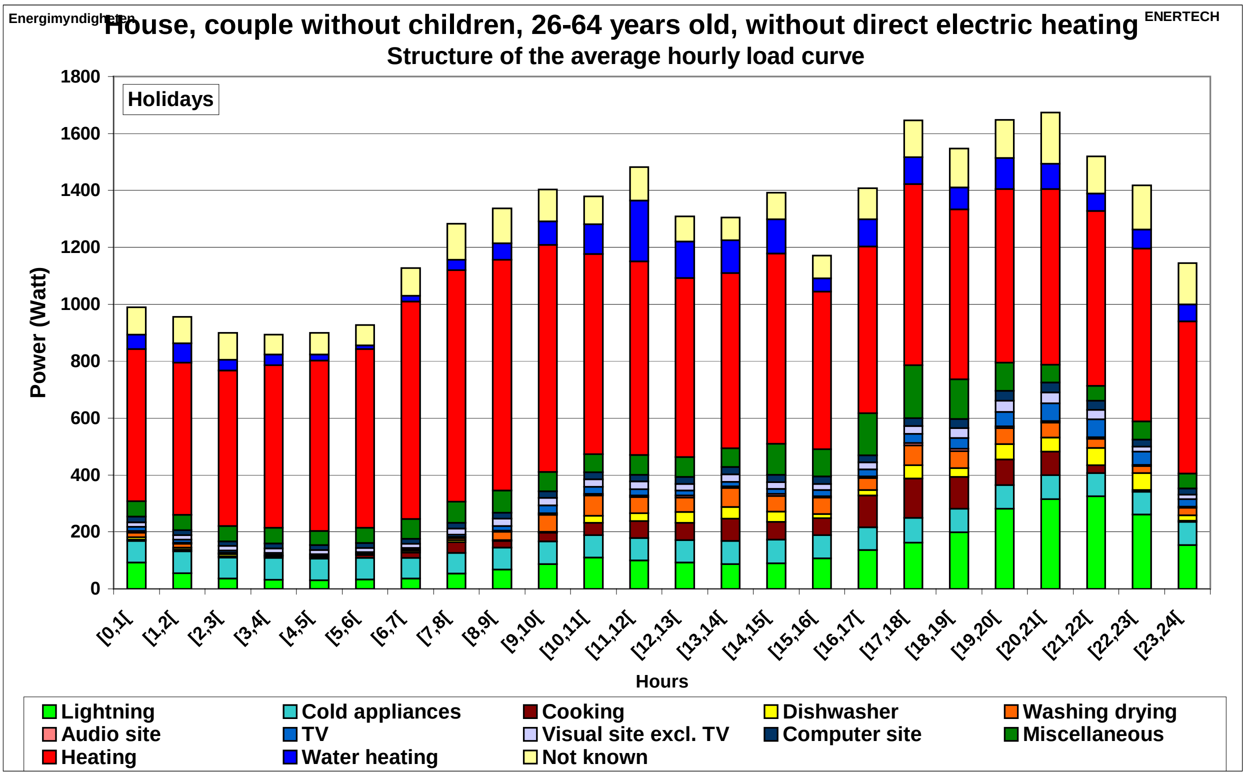


Figure 2.81: Structure of the average hourly load curve – Houses without direct electric heating – Holidays

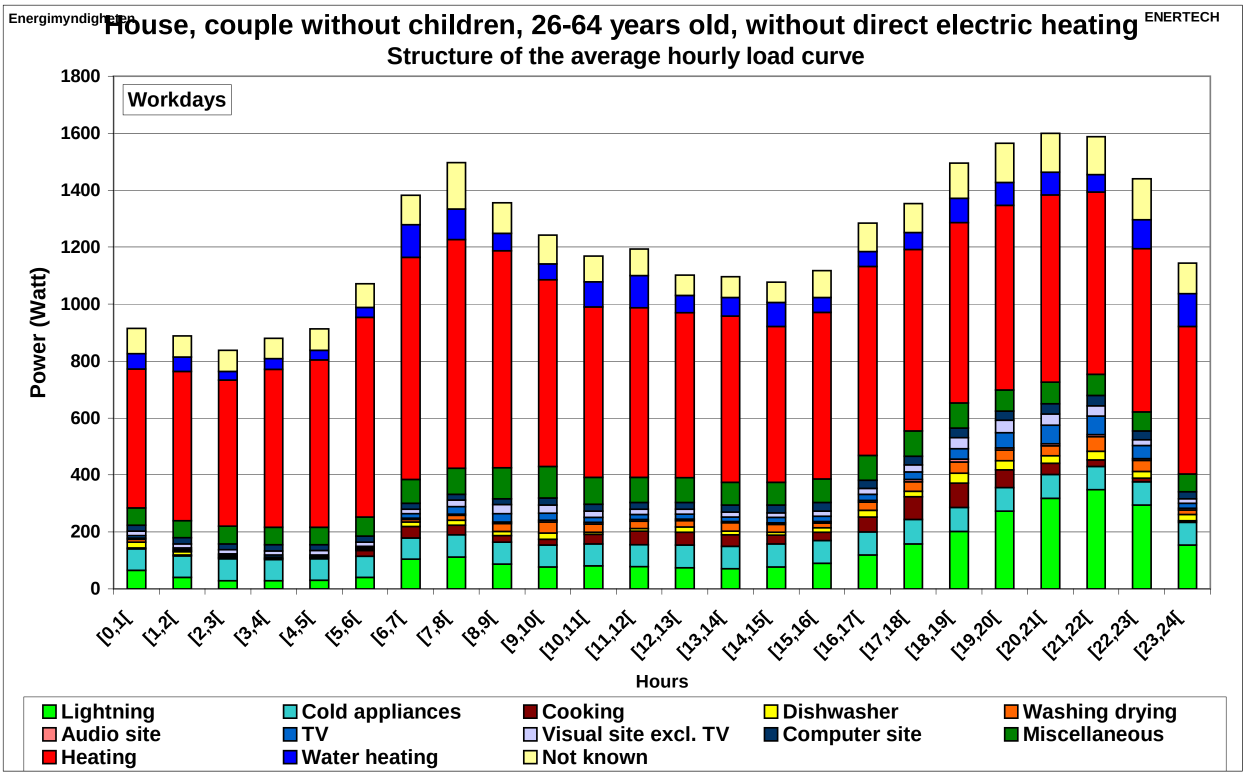


Figure 2.82: Structure of the average hourly load curve – Houses without direct electric heating – Workdays

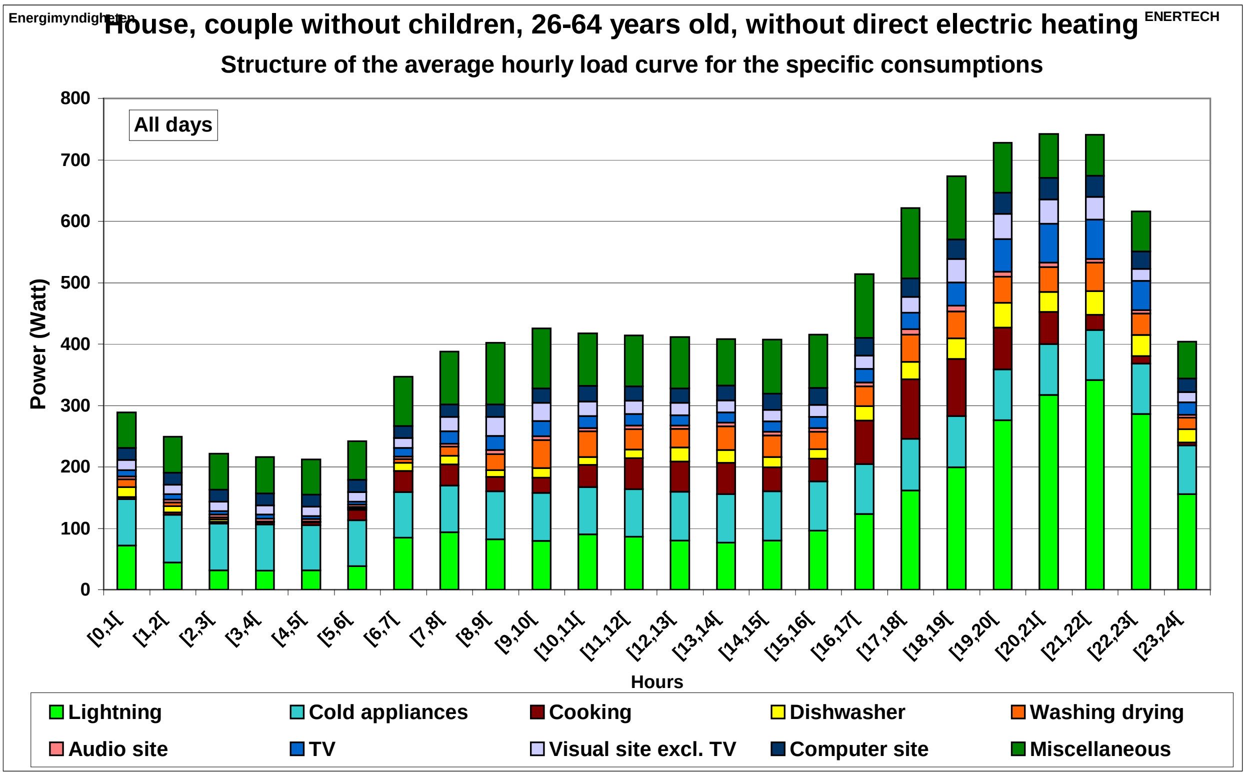


Figure 2.83: Structure of the average hourly load curve for the specific consumption– Houses without direct electric heating – All days

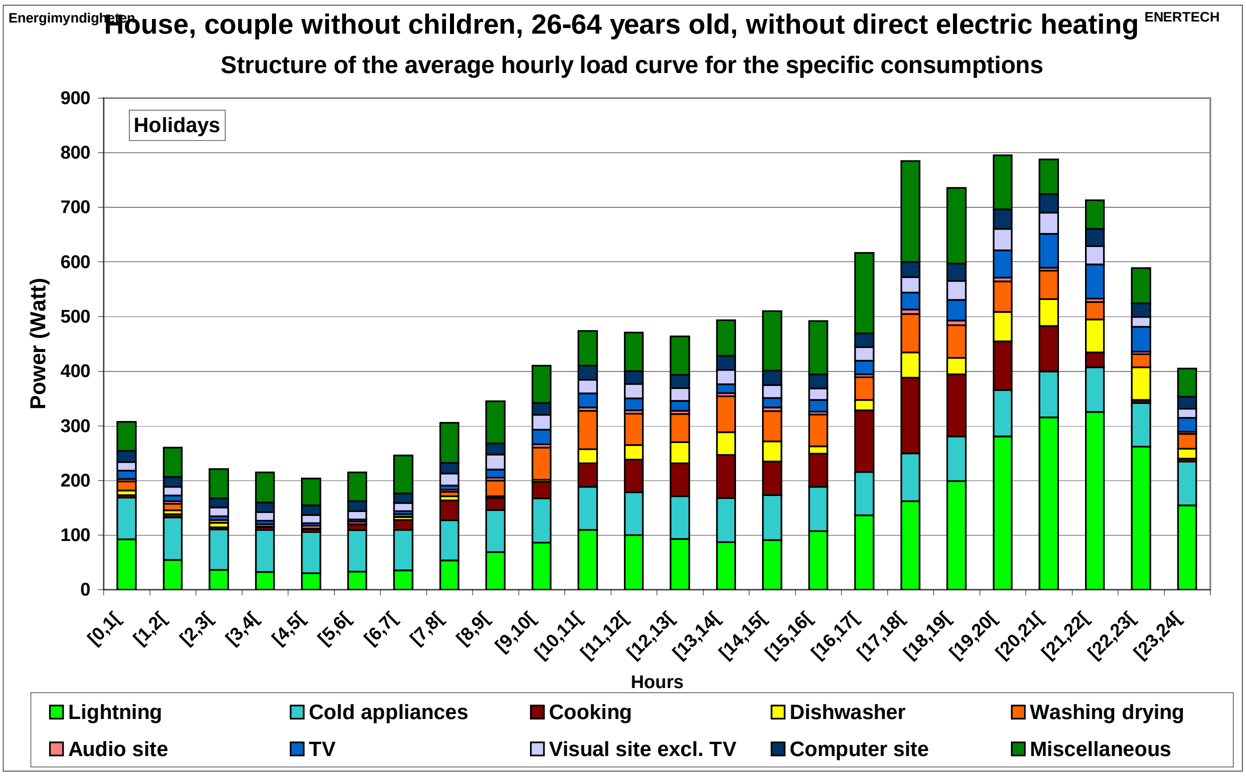


Figure 2.84: Structure of the average hourly load curve for the specific consumption– Houses without direct electric heating – Holidays

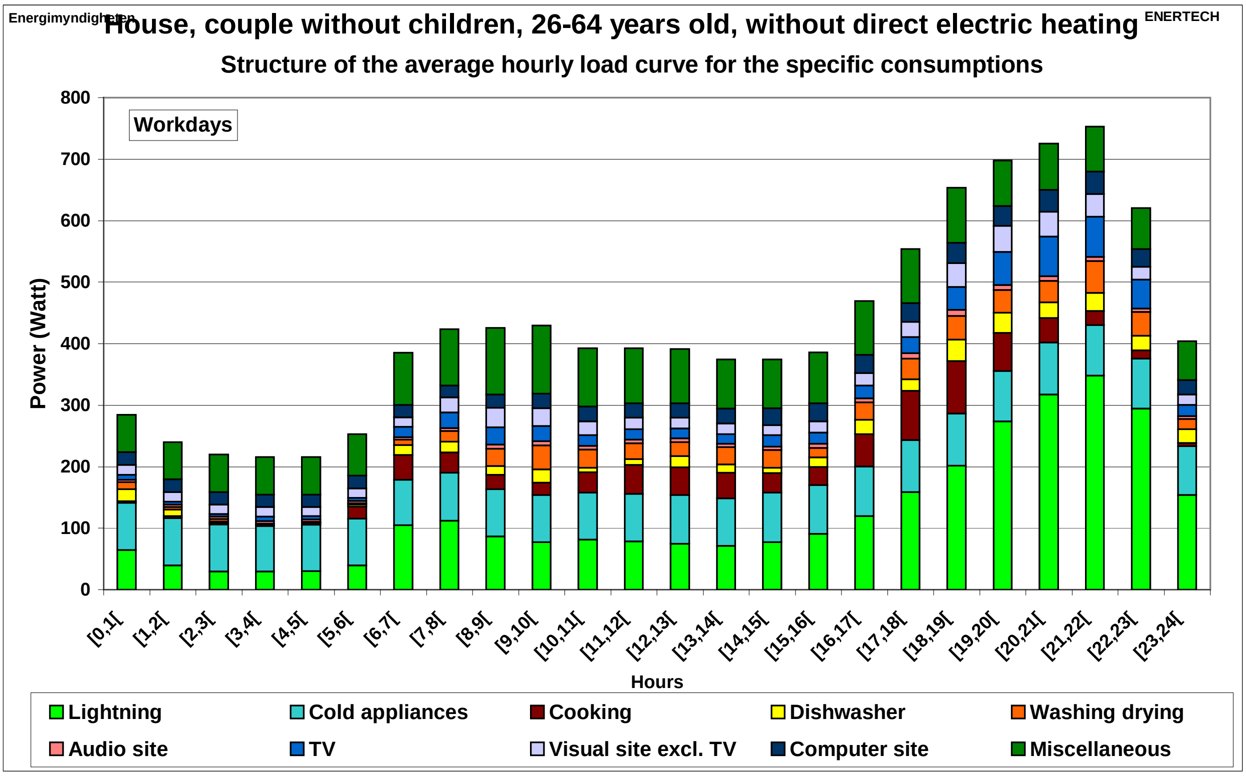


Figure 2.85: Structure of the average hourly load curve for the specific consumption– Houses without direct electric heating – Workdays

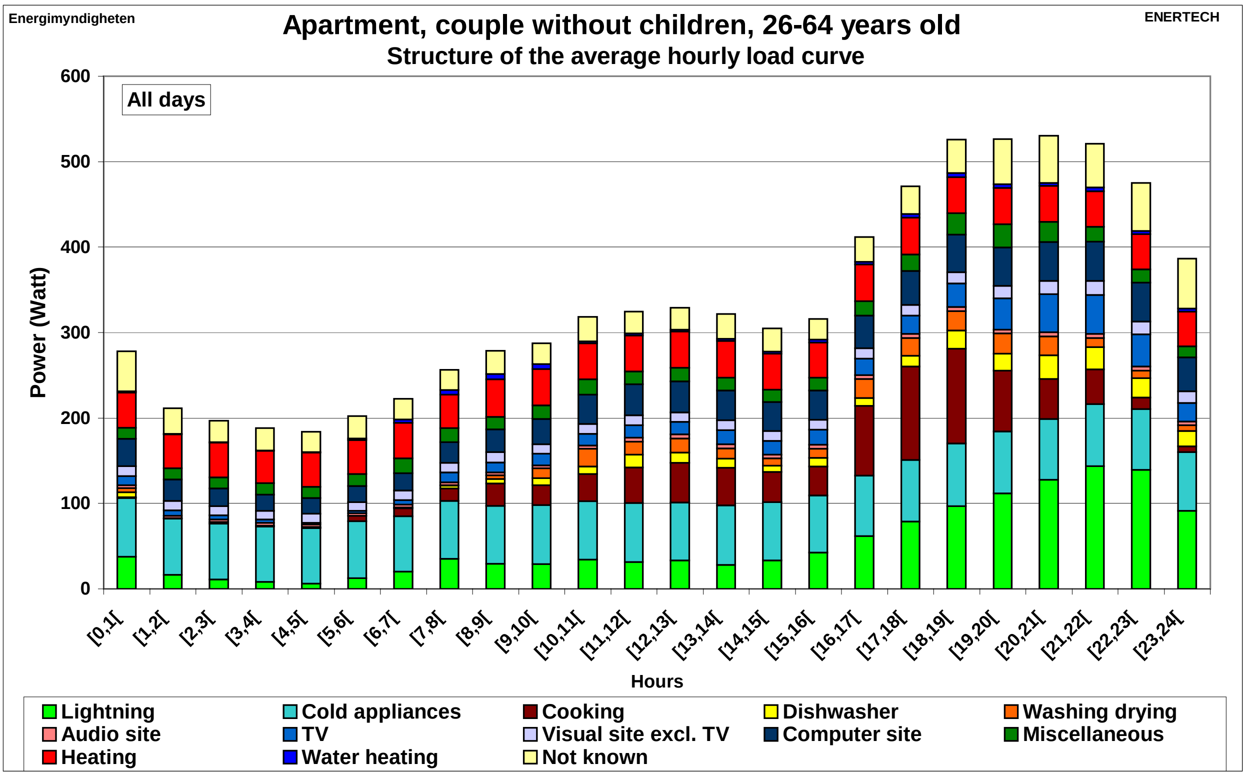


Figure 2.86: Structure of the average hourly load curve – Apartments – All days

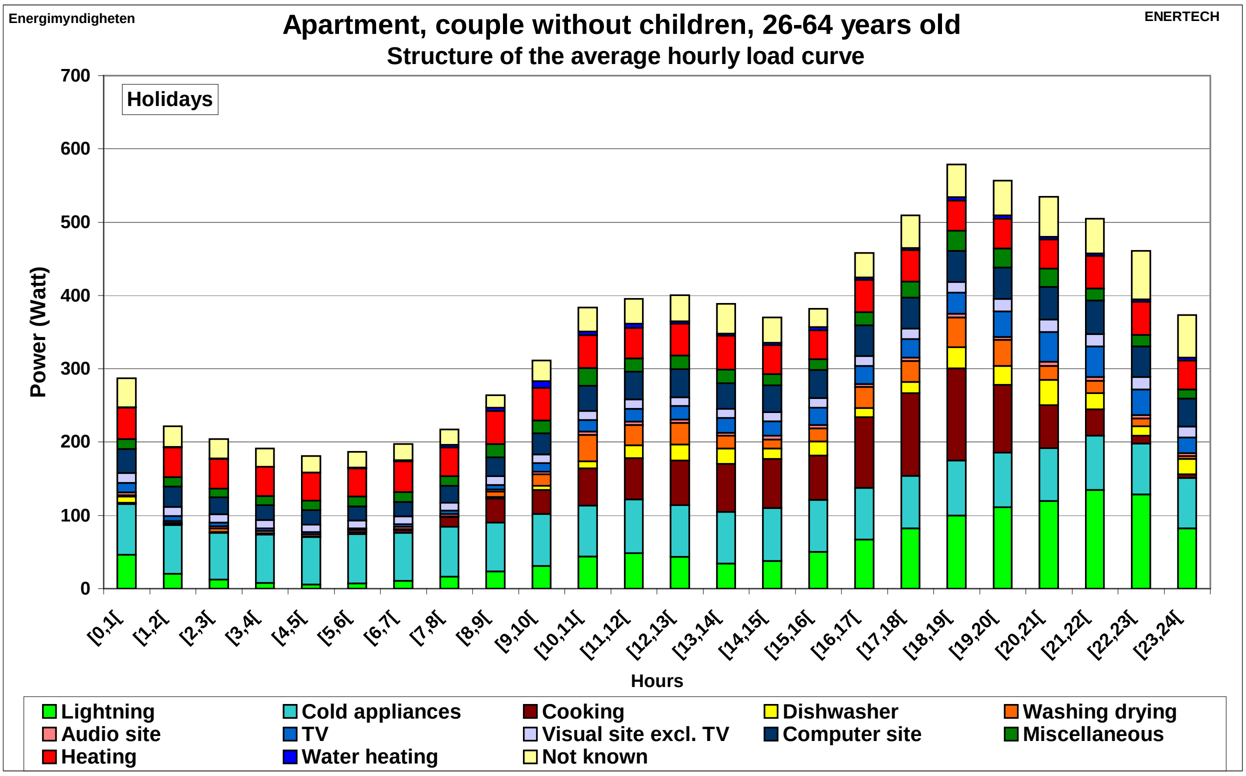


Figure 2.87: Structure of the average hourly load curve – Apartments – Holidays

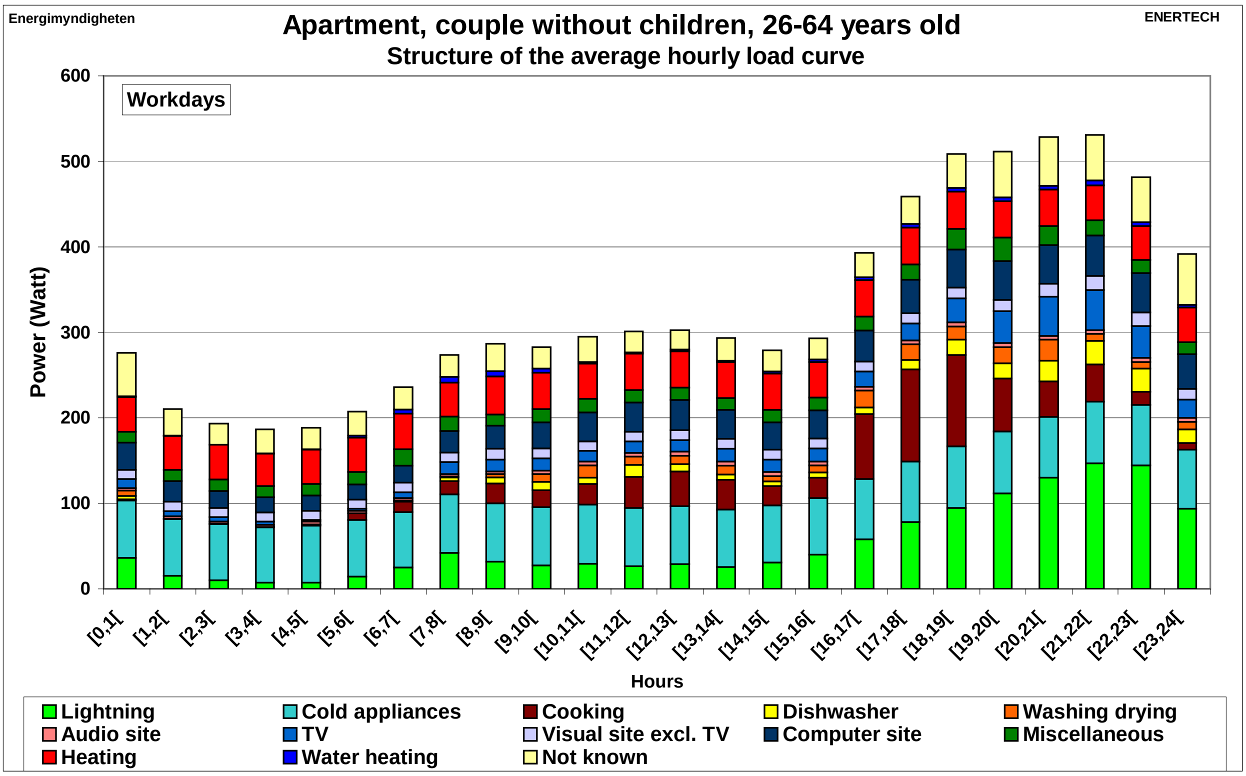


Figure 2.88: Structure of the average hourly load curve – Apartments – Workdays

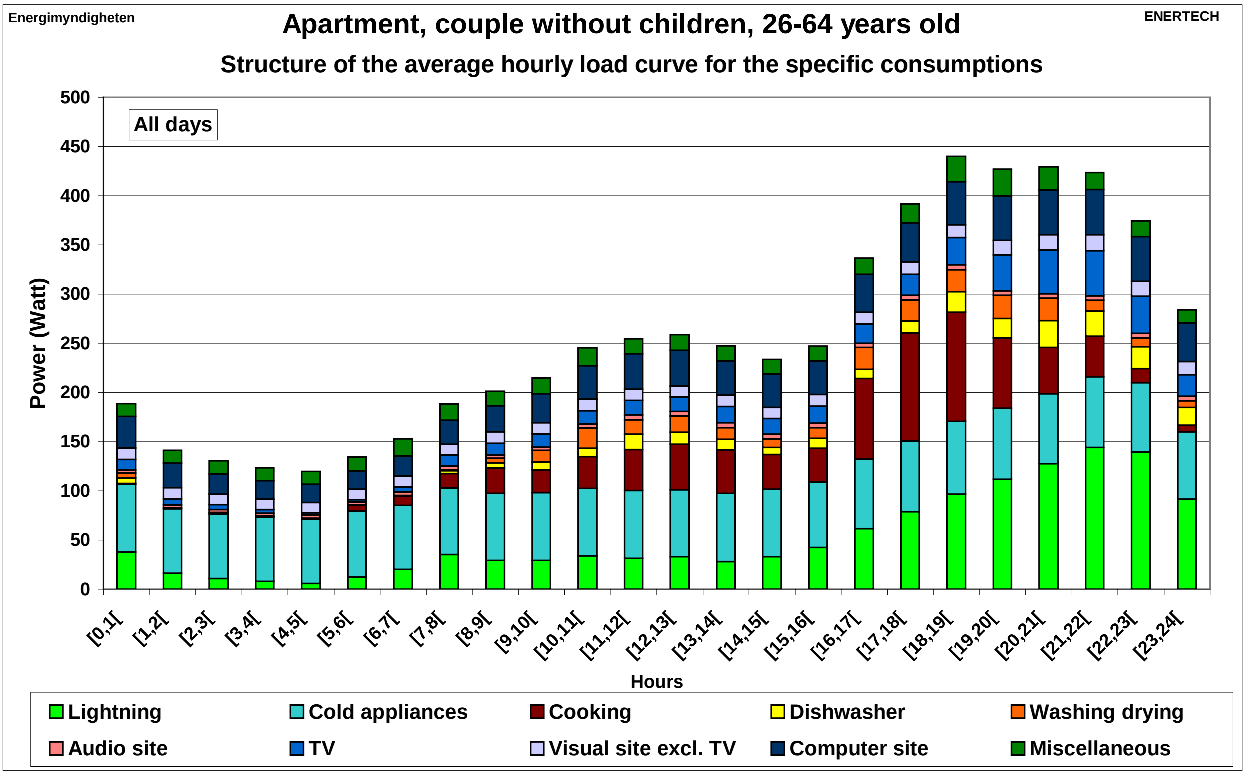


Figure 2.89: Structure of the average hourly load curve for the specific consumption– Apartments – All days

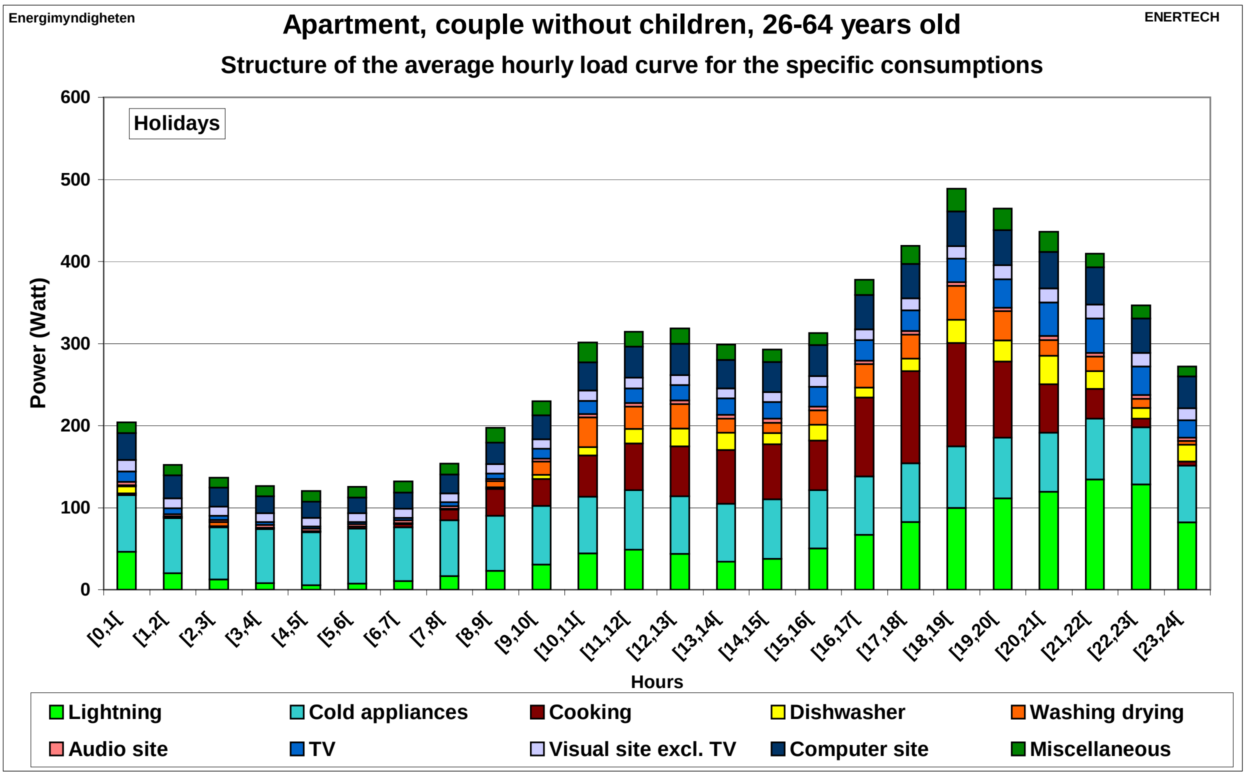


Figure 2.90: Structure of the average hourly load curve for the specific consumption– Apartments – Holidays

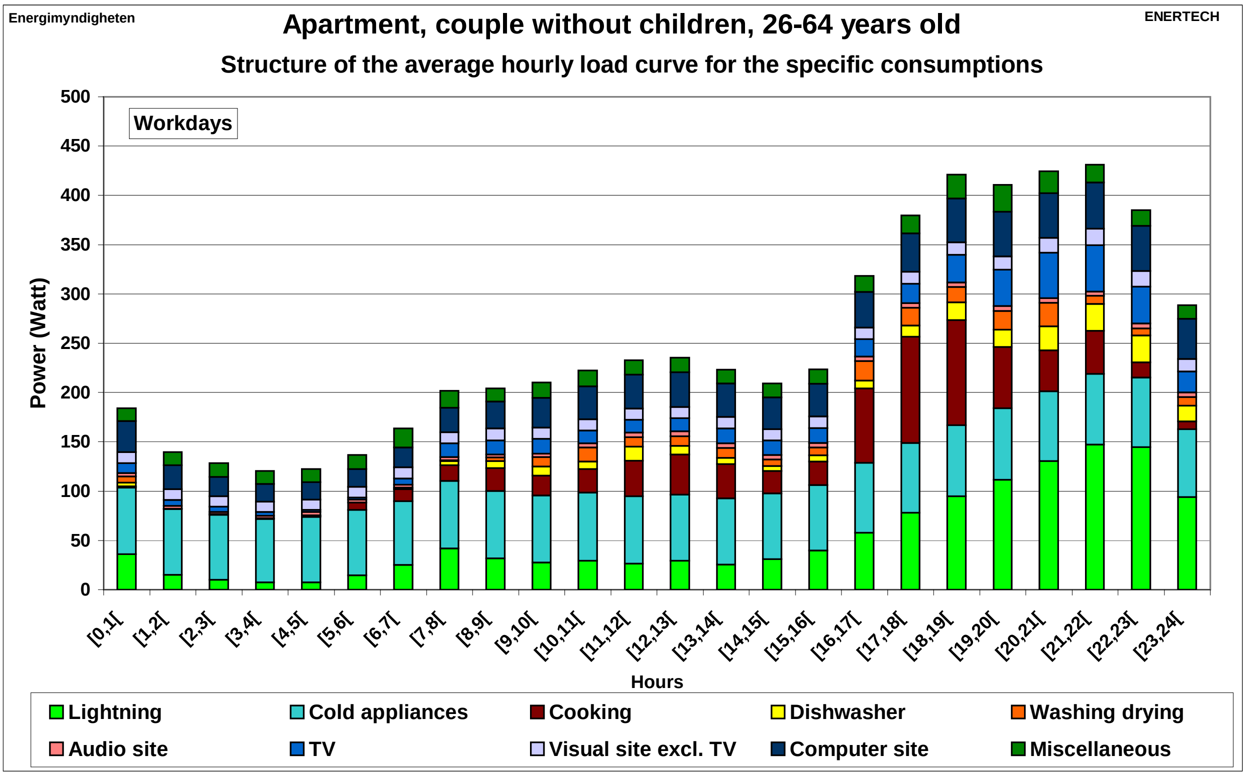


Figure 2.91: Structure of the average hourly load curve for the specific consumption– Apartments – Workdays

Couples without children, 64 years old and above

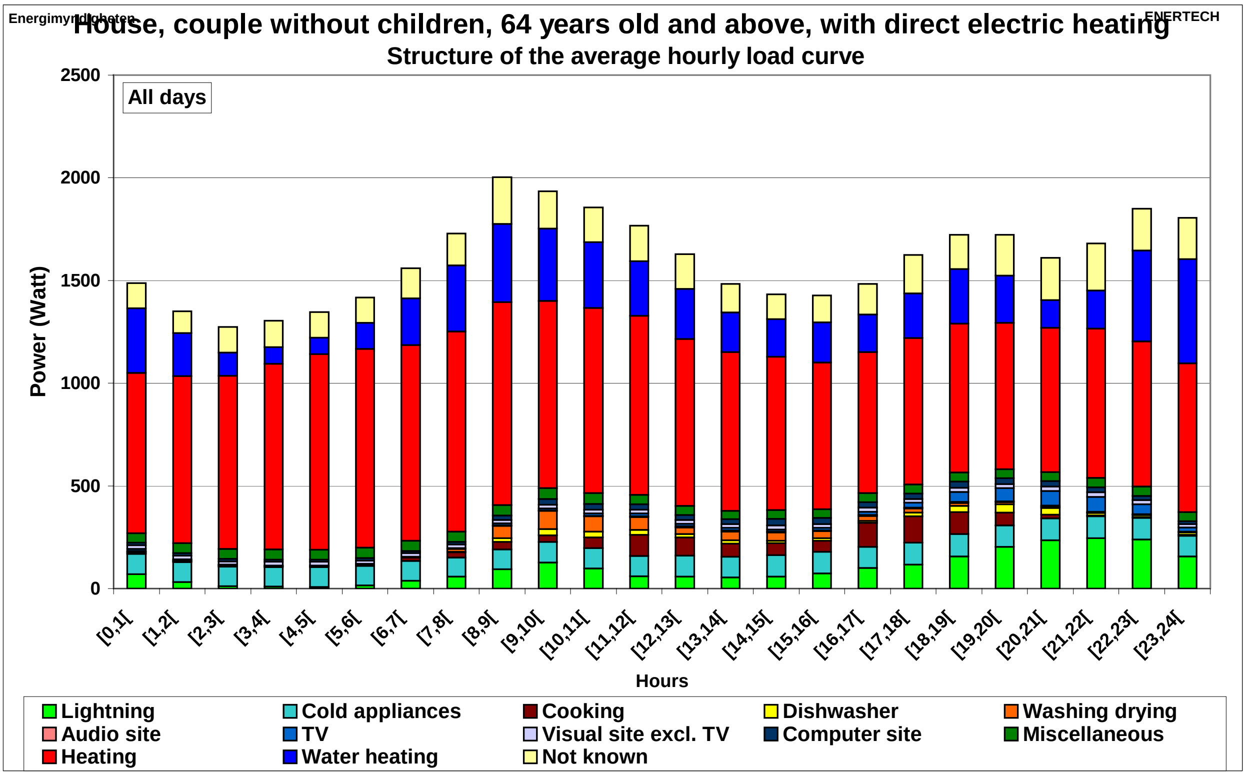


Figure 2.92: Structure of the average hourly load curve – Houses with direct electric heating – All days

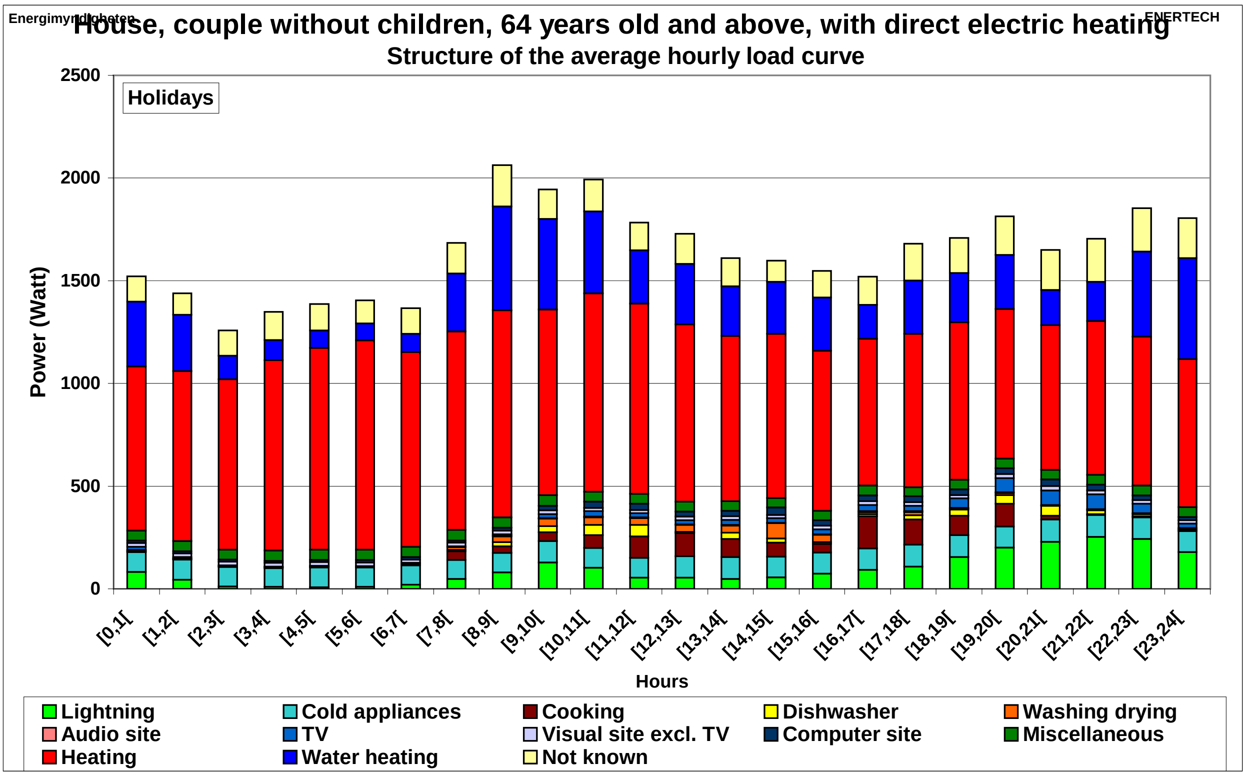


Figure 2.93: Structure of the average hourly load curve – Houses with direct electric heating – Holidays

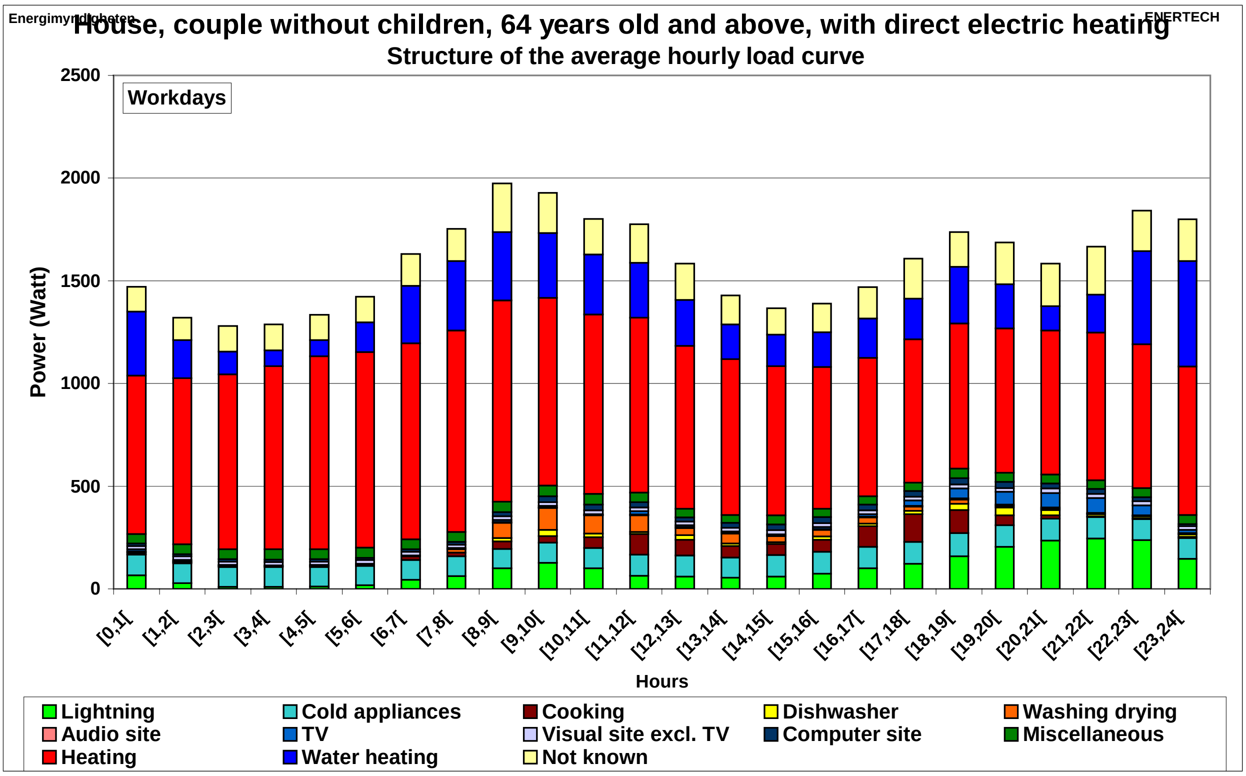


Figure 2.94: Structure of the average hourly load curve – Houses with direct electric heating – Workdays

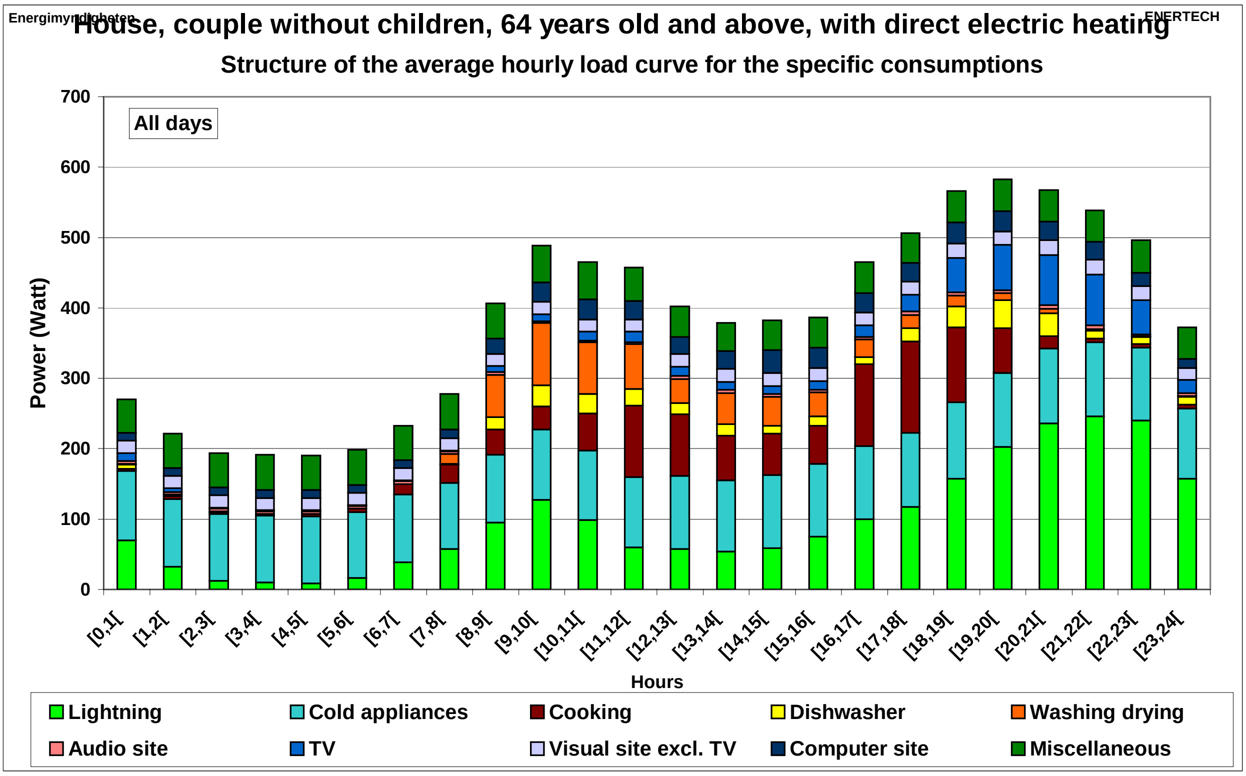


Figure 2.95: Structure of the average hourly load curve for the specific consumption– Houses with direct electric heating – All days

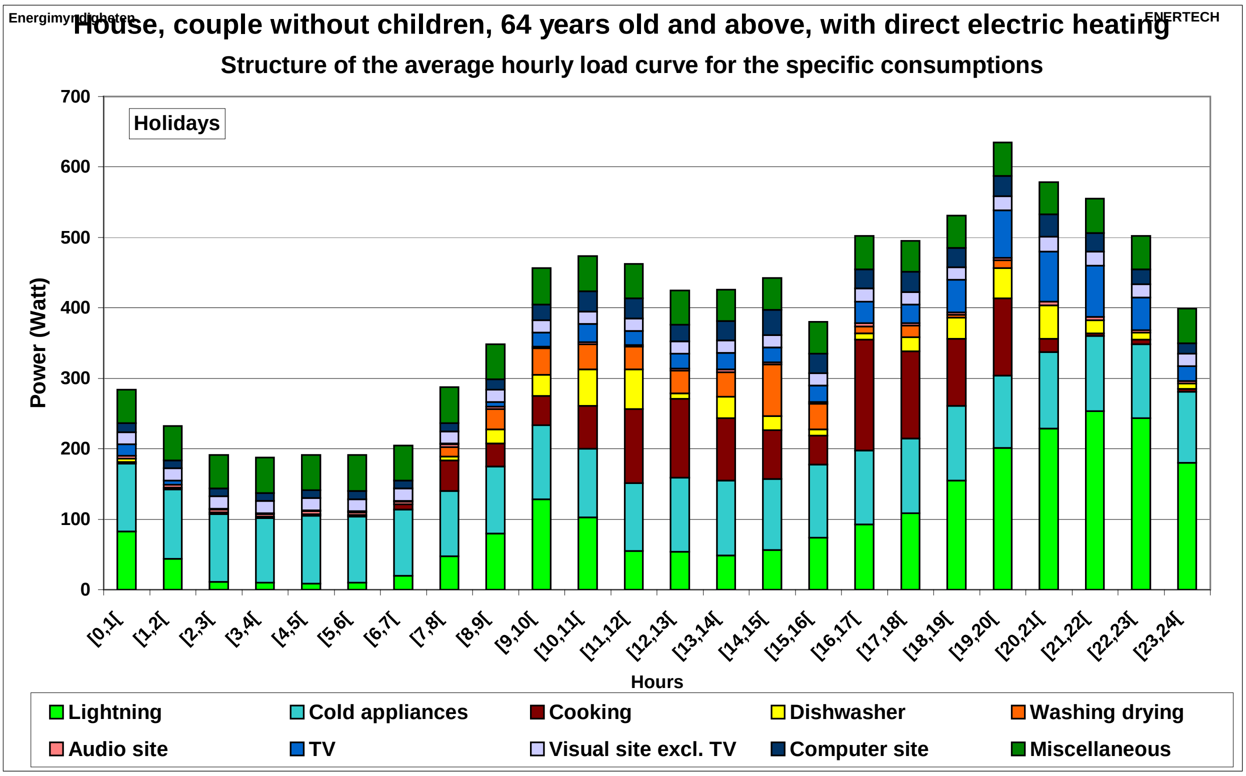


Figure 2.96: Structure of the average hourly load curve for the specific consumption– Houses with direct electric heating – Holidays

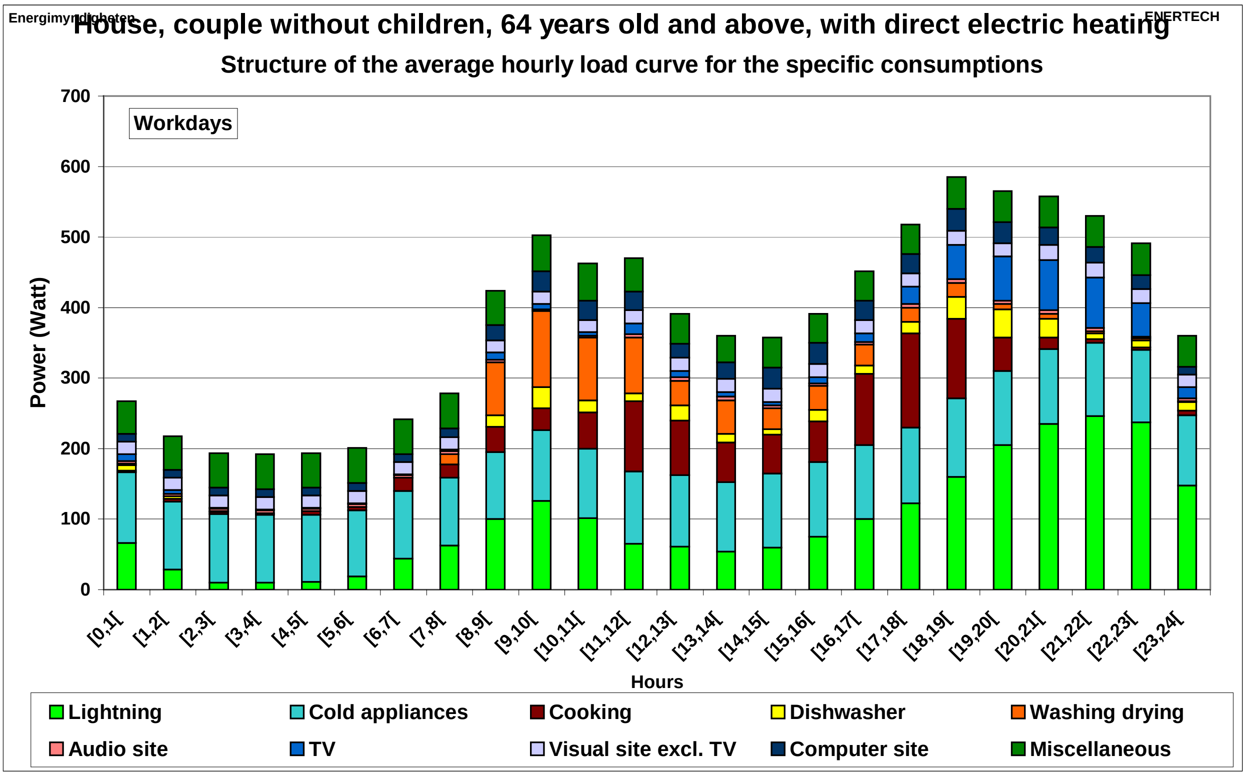


Figure 2.97: Structure of the average hourly load curve for the specific consumption– Houses with direct electric heating – Workdays

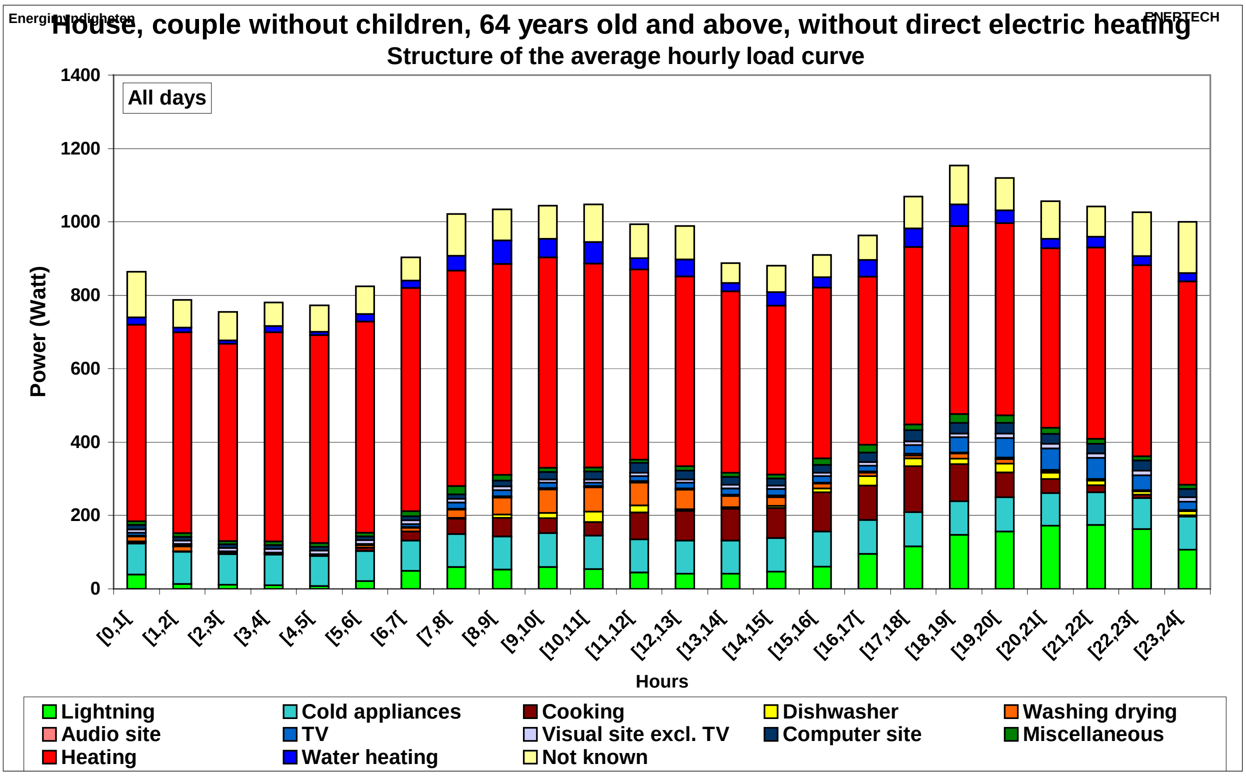


Figure 2.98: Structure of the average hourly load curve – Houses without direct electric heating – All days

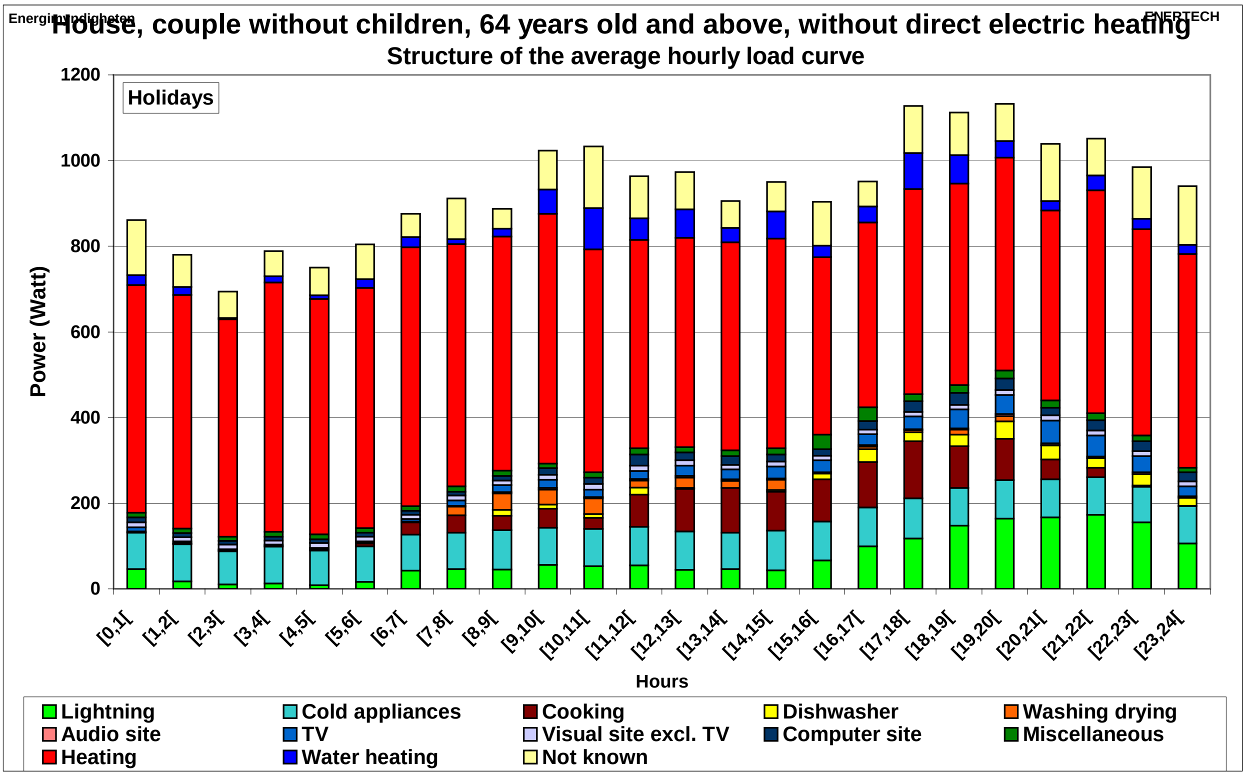


Figure 2.99: Structure of the average hourly load curve – Houses without direct electric heating – Holidays

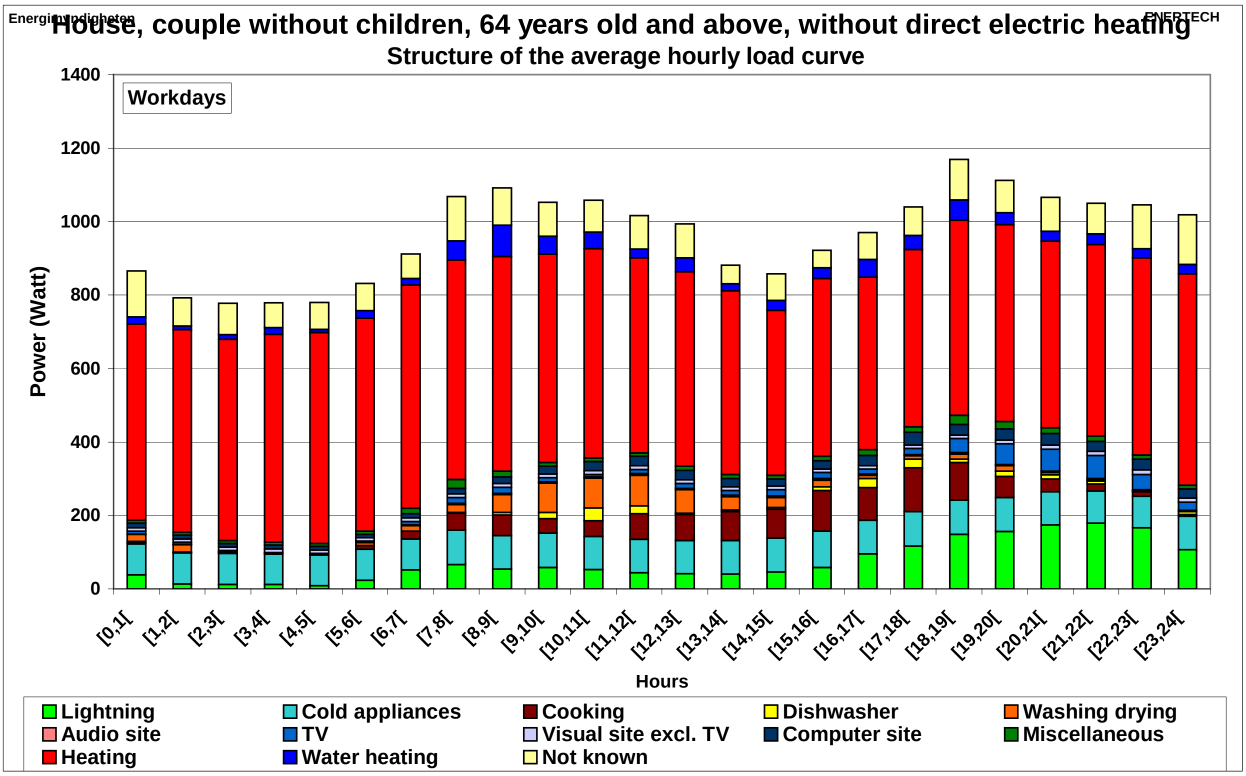


Figure 2.100: Structure of the average hourly load curve – Houses without direct electric heating – Workdays

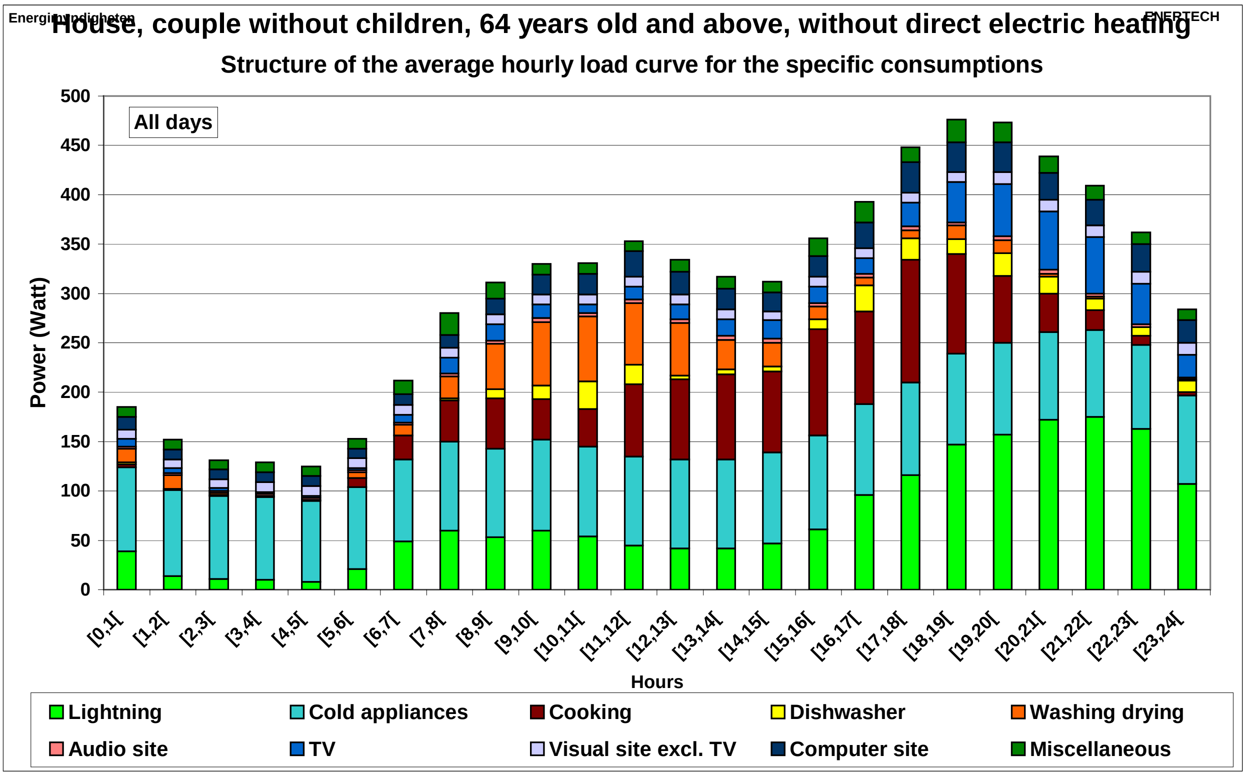


Figure 2.101: Structure of the average hourly load curve for the specific consumption– Houses without direct electric heating – All days

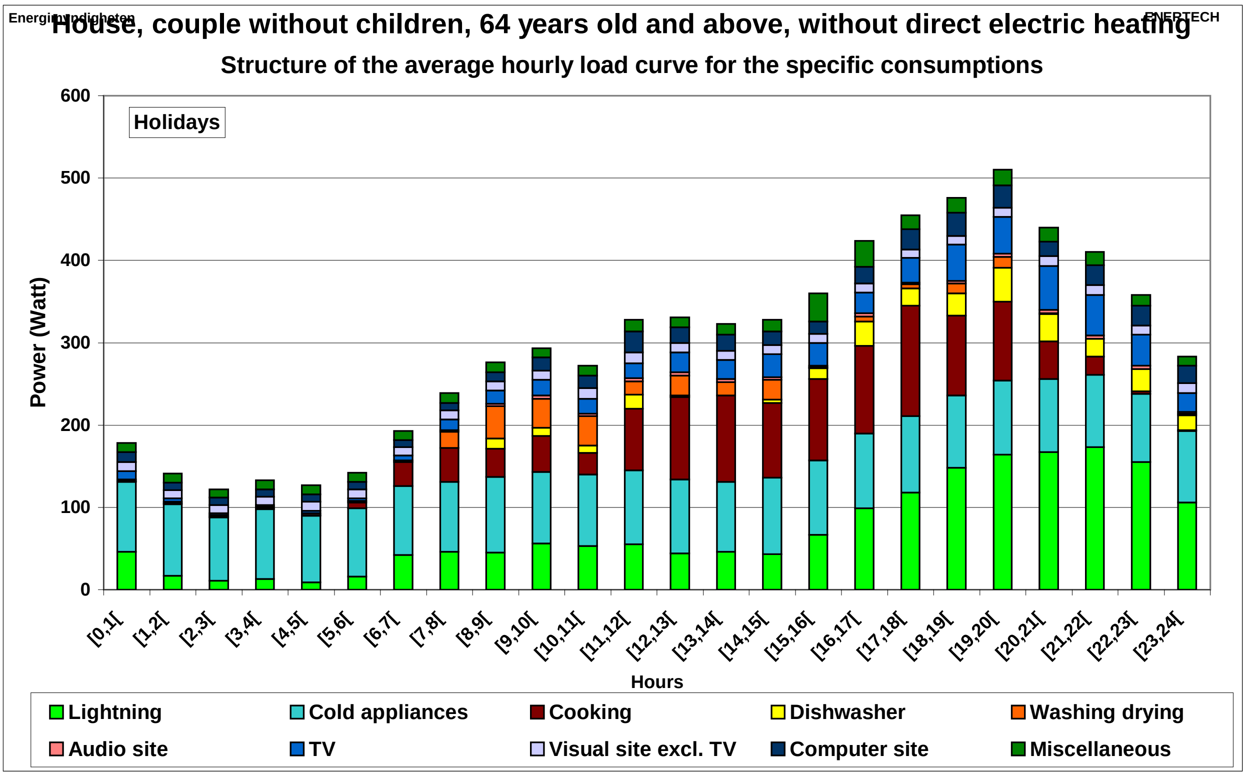


Figure 2.102: Structure of the average hourly load curve for the specific consumption– Houses without direct electric heating – Holidays

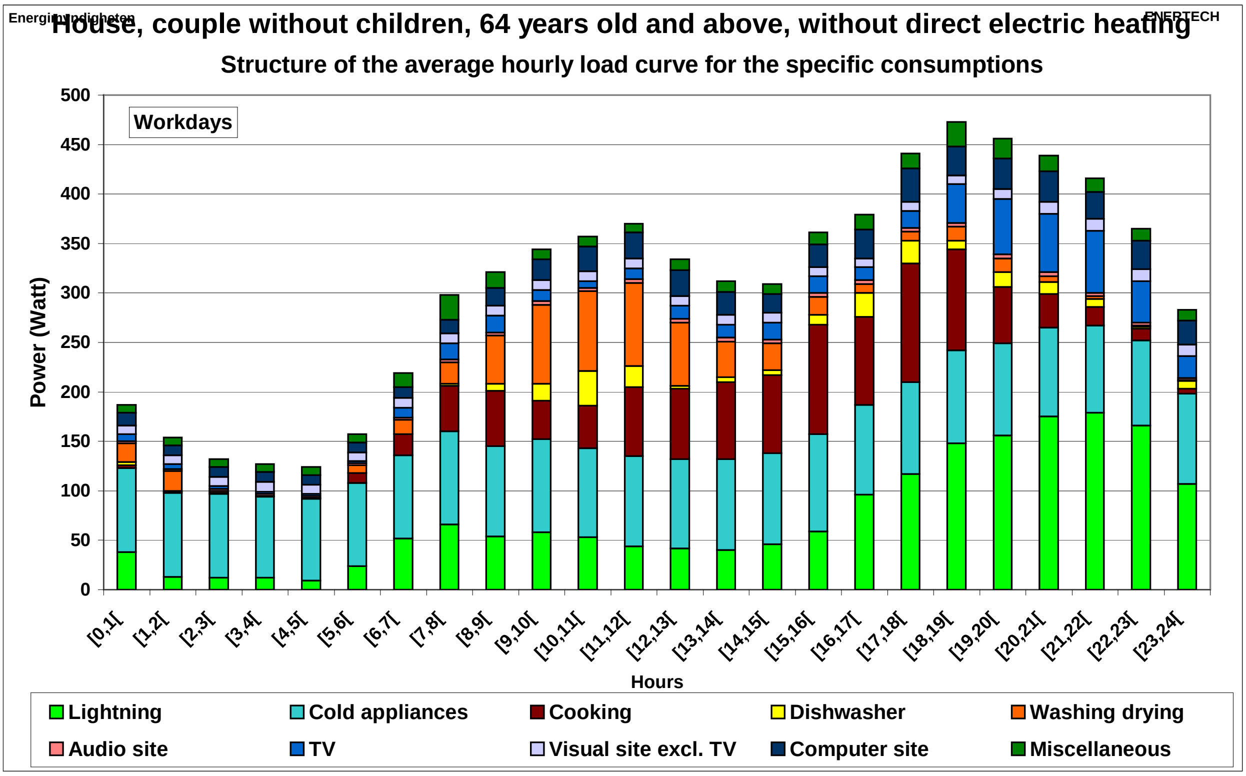


Figure 2.103: Structure of the average hourly load curve for the specific consumption– Houses without direct electric heating – Workdays

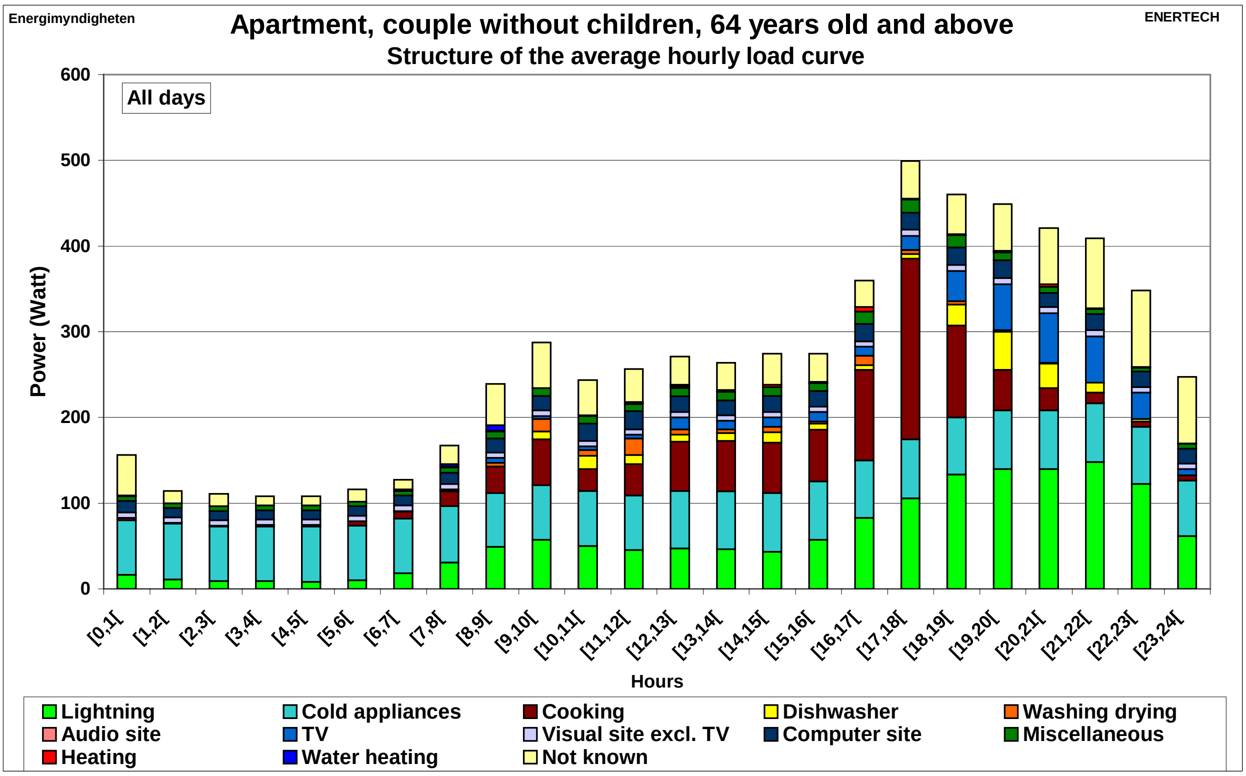


Figure 2.104: Structure of the average hourly load curve – Apartments – All days

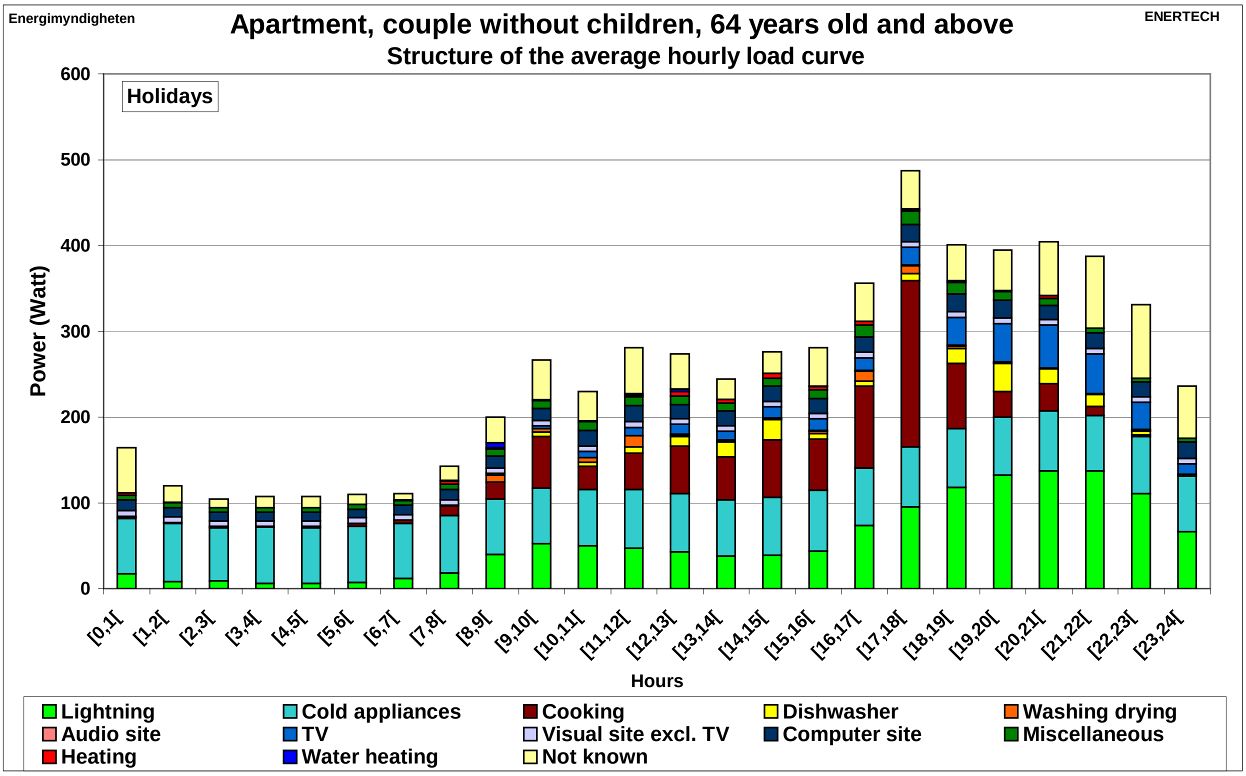


Figure 2.105: Structure of the average hourly load curve – Apartments – Holidays

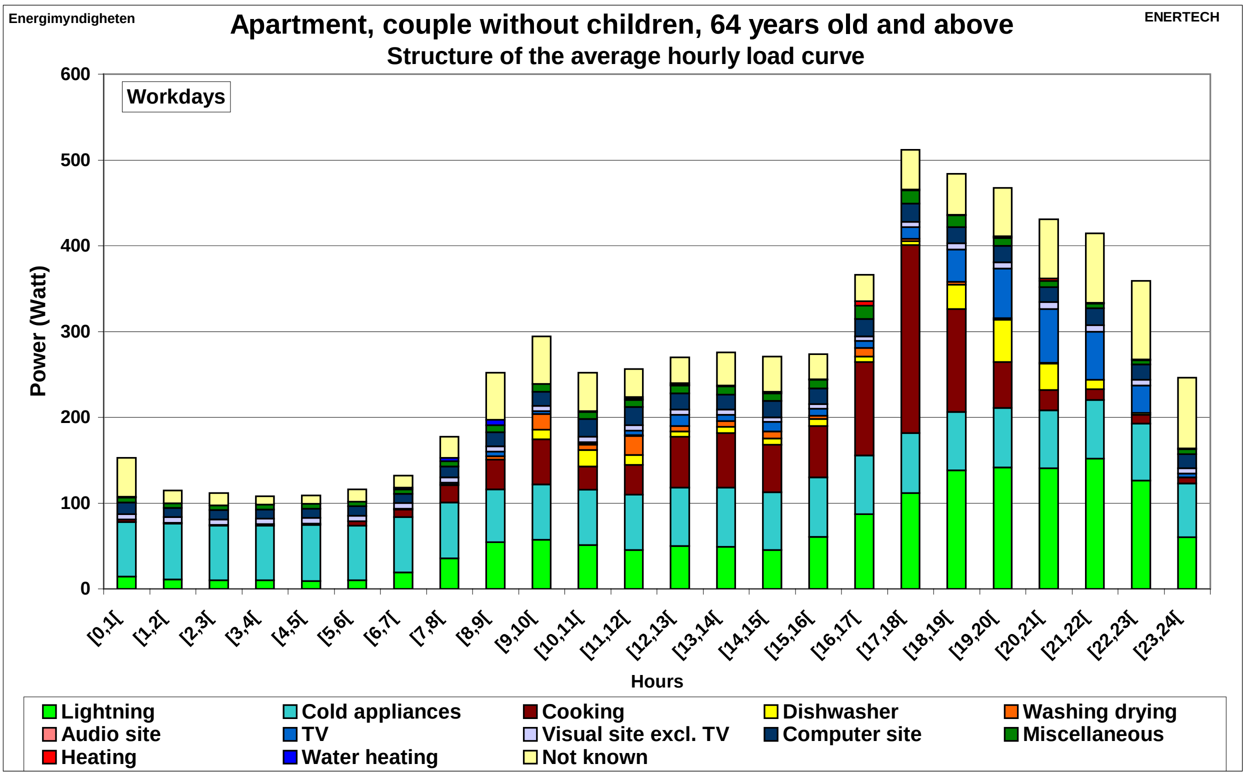


Figure 2.106: Structure of the average hourly load curve – Apartments – Workdays

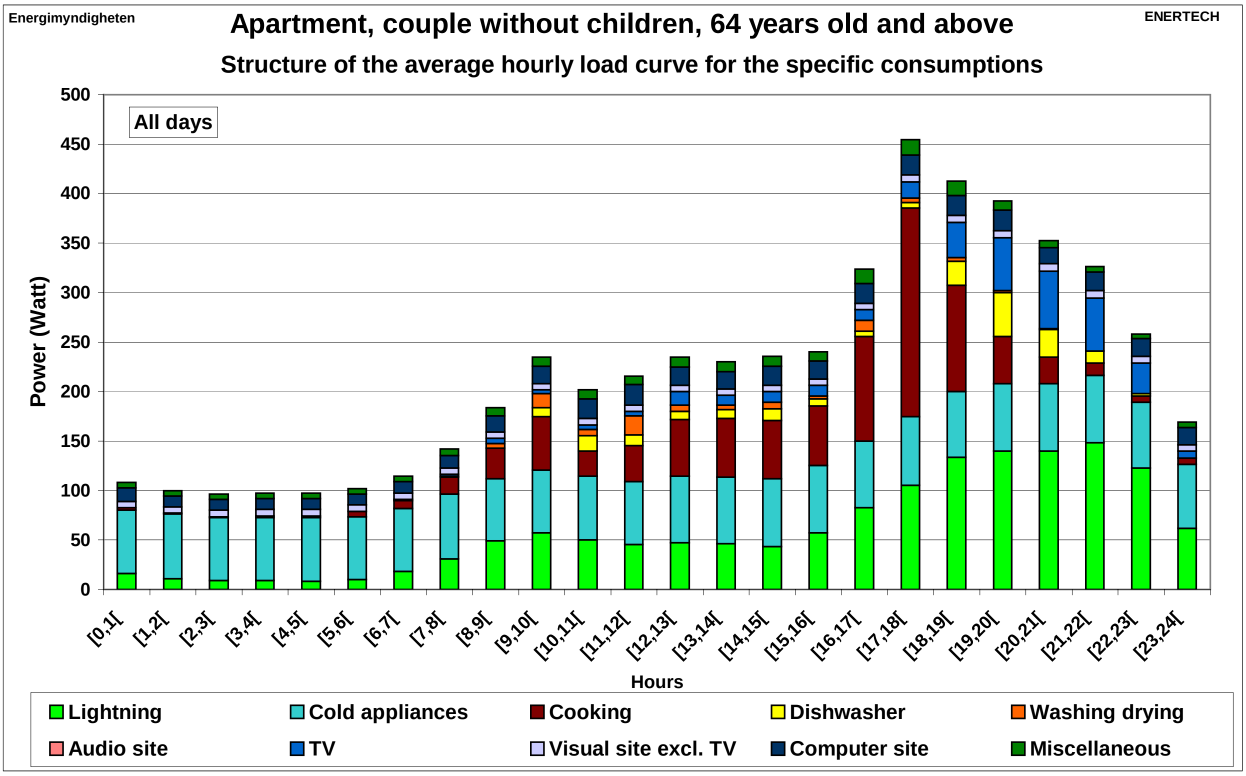


Figure 2.107: Structure of the average hourly load curve for the specific consumption– Apartments – All days

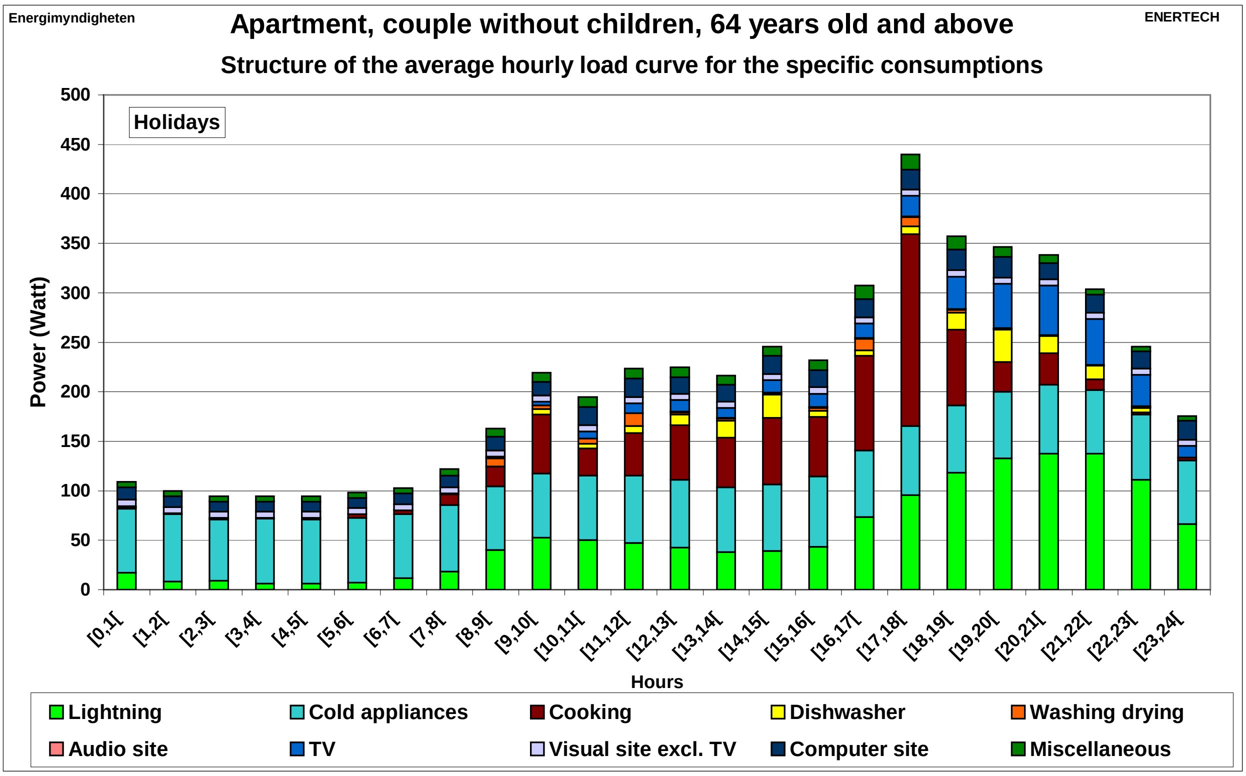


Figure 2.108: Structure of the average hourly load curve for the specific consumption– Apartments – Holidays

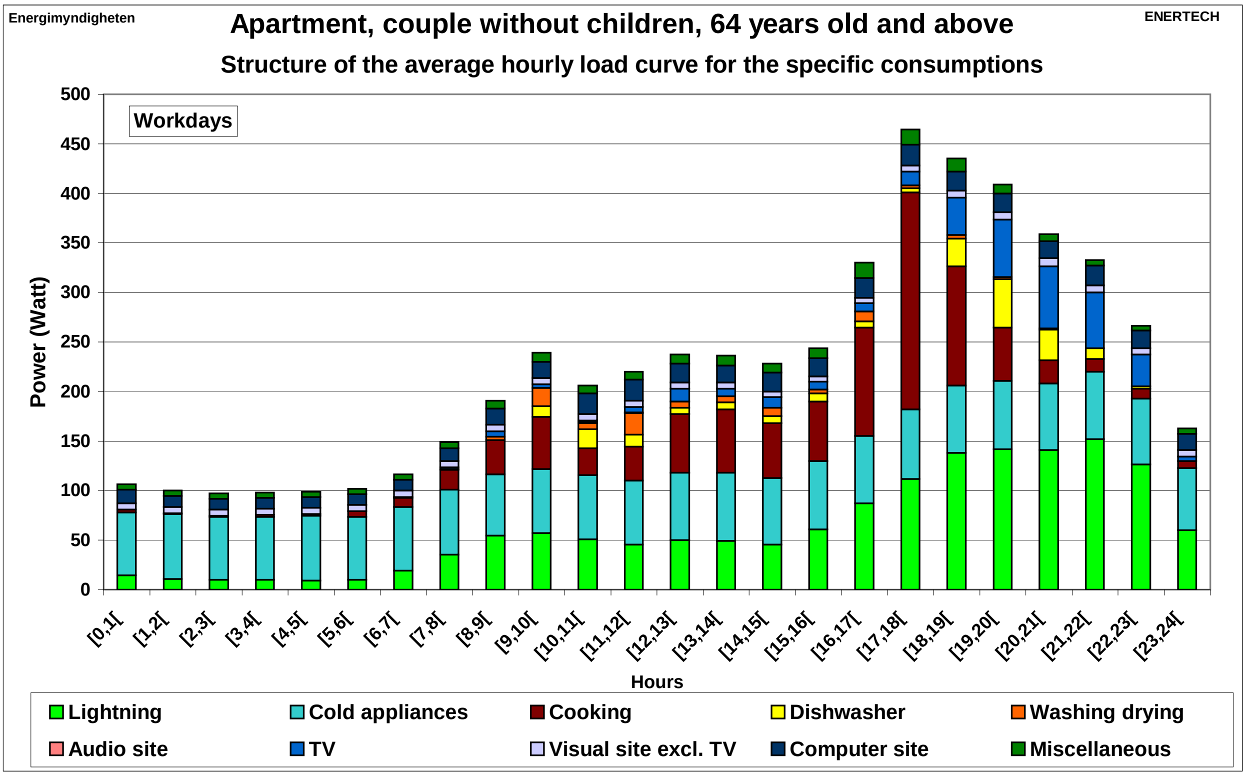


Figure 2.109: Structure of the average hourly load curve for the specific consumption– Apartments – Workdays

Single person, 26-64 years old

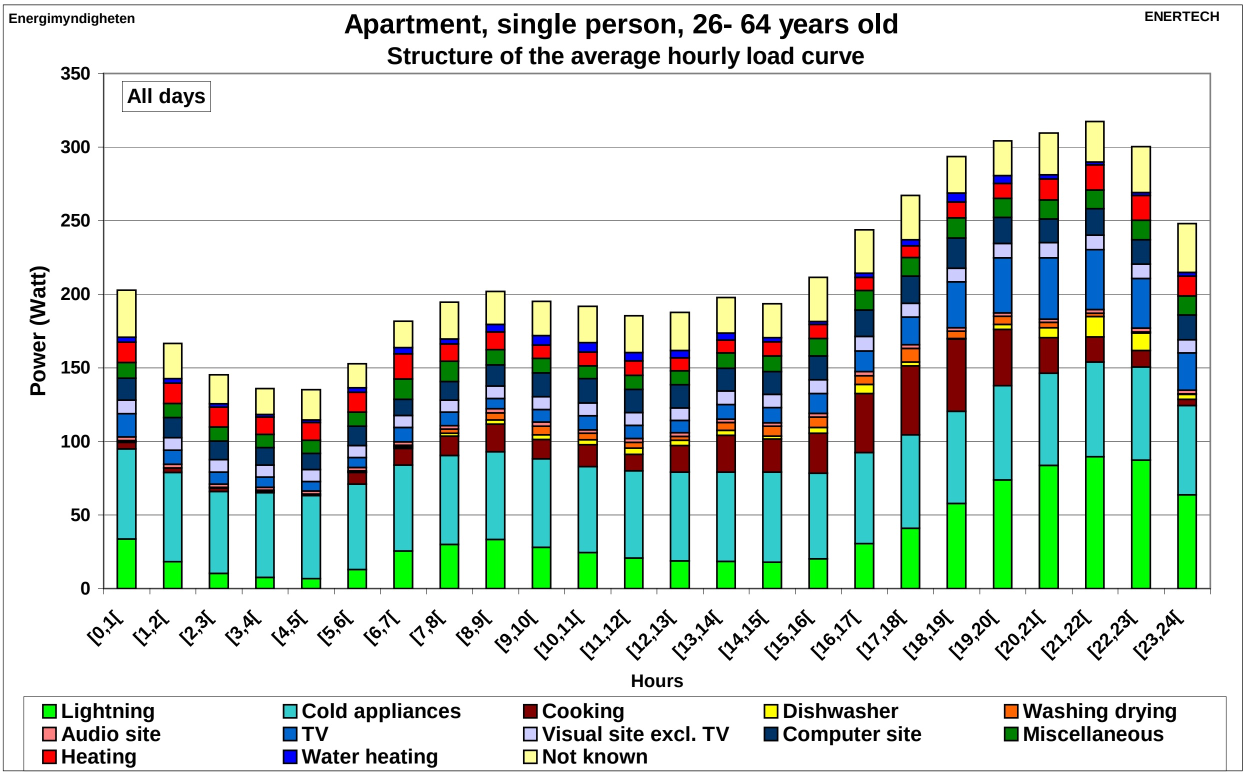


Figure 2.110: Structure of the average hourly load curve – Apartments – All days

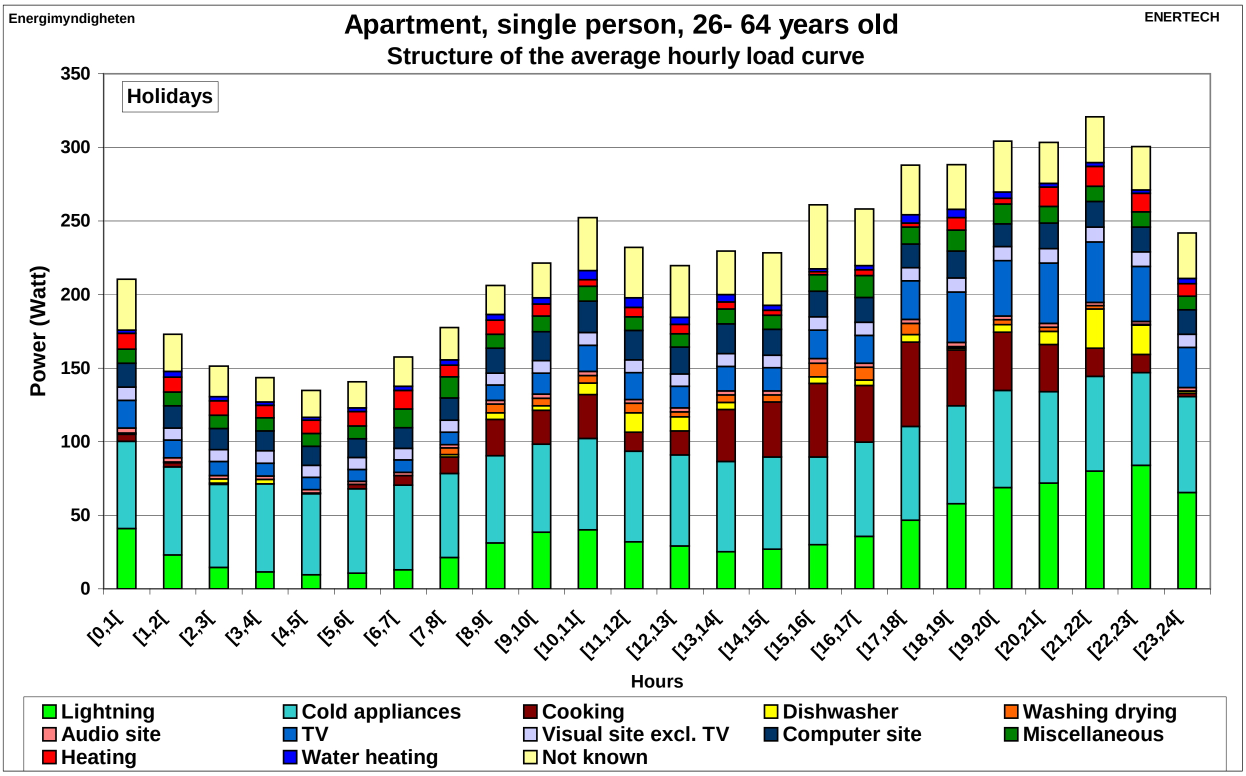


Figure 2.111: Structure of the average hourly load curve – Apartments – Holidays

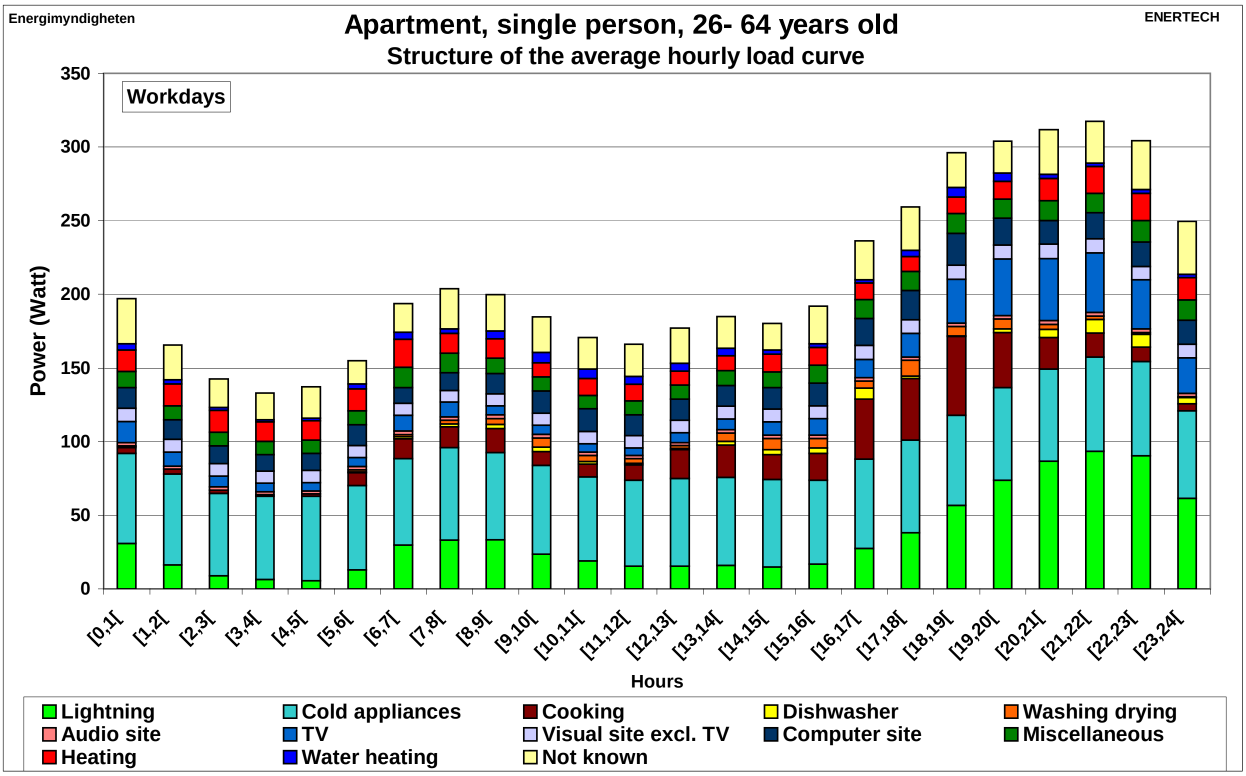


Figure 2.112: Structure of the average hourly load curve – Apartments – Workdays

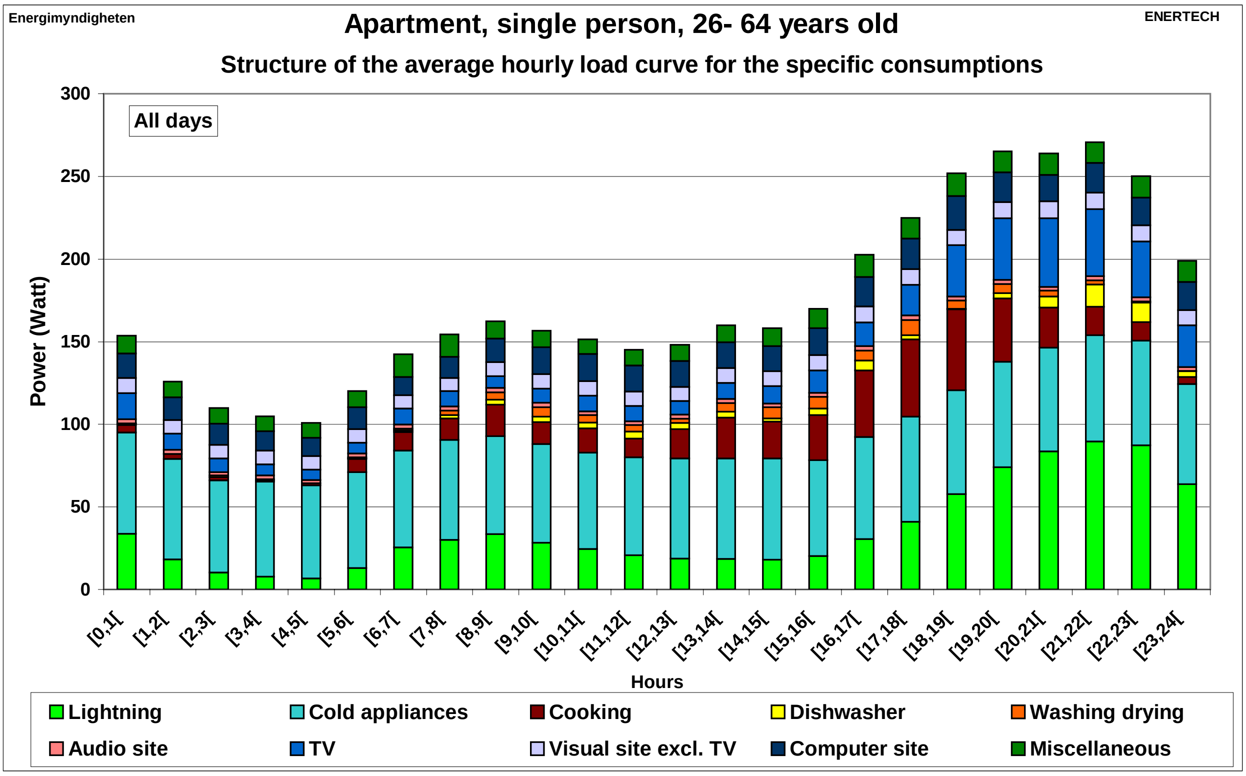


Figure 2.113: Structure of the average hourly load curve for the specific consumption– Apartments – All days

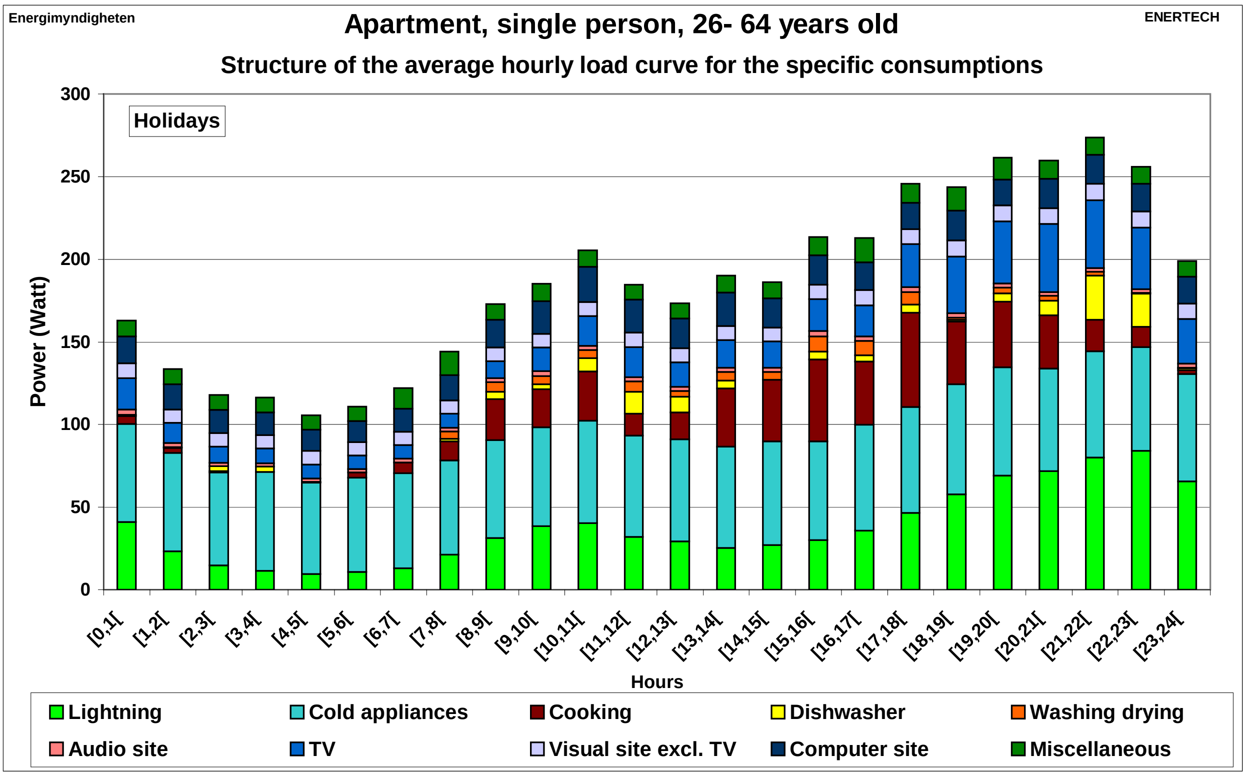


Figure 2.114: Structure of the average hourly load curve for the specific consumption– Apartments – Holidays

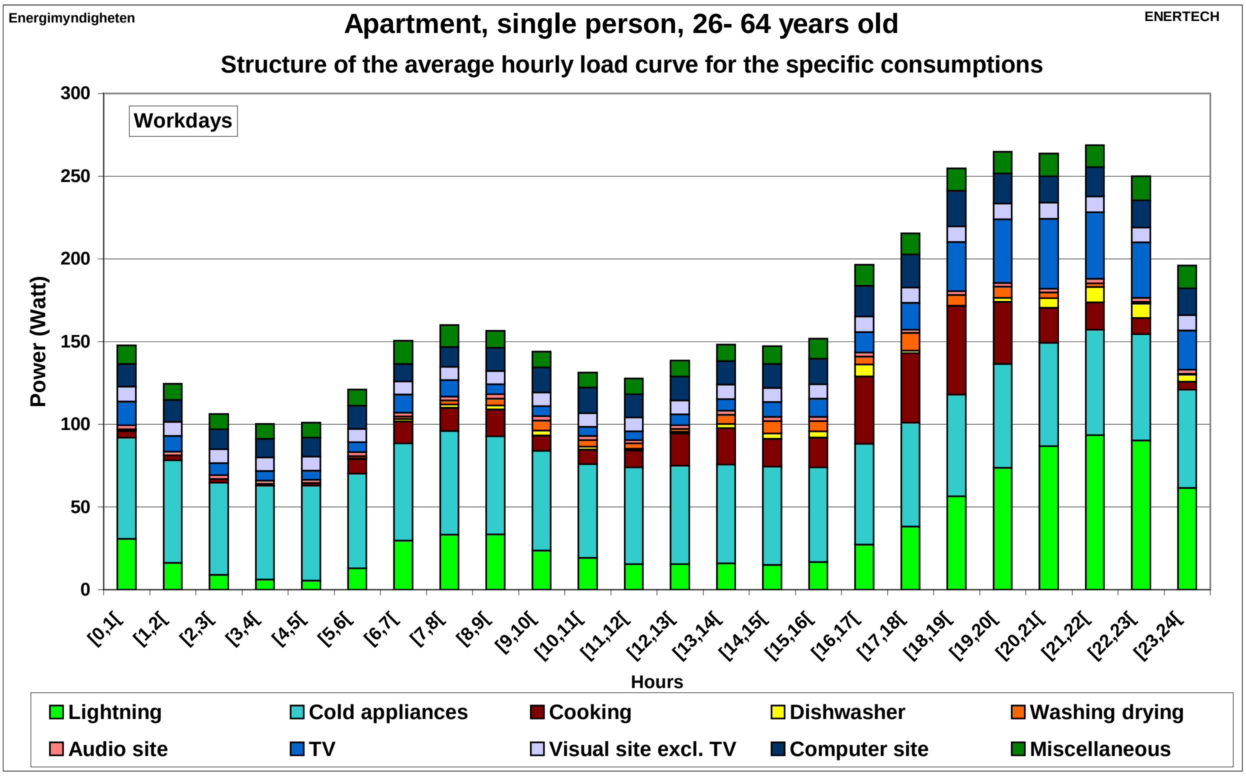


Figure 2.115: Structure of the average hourly load curve for the specific consumption– Apartments – Workdays

Single person, 64 years old and above

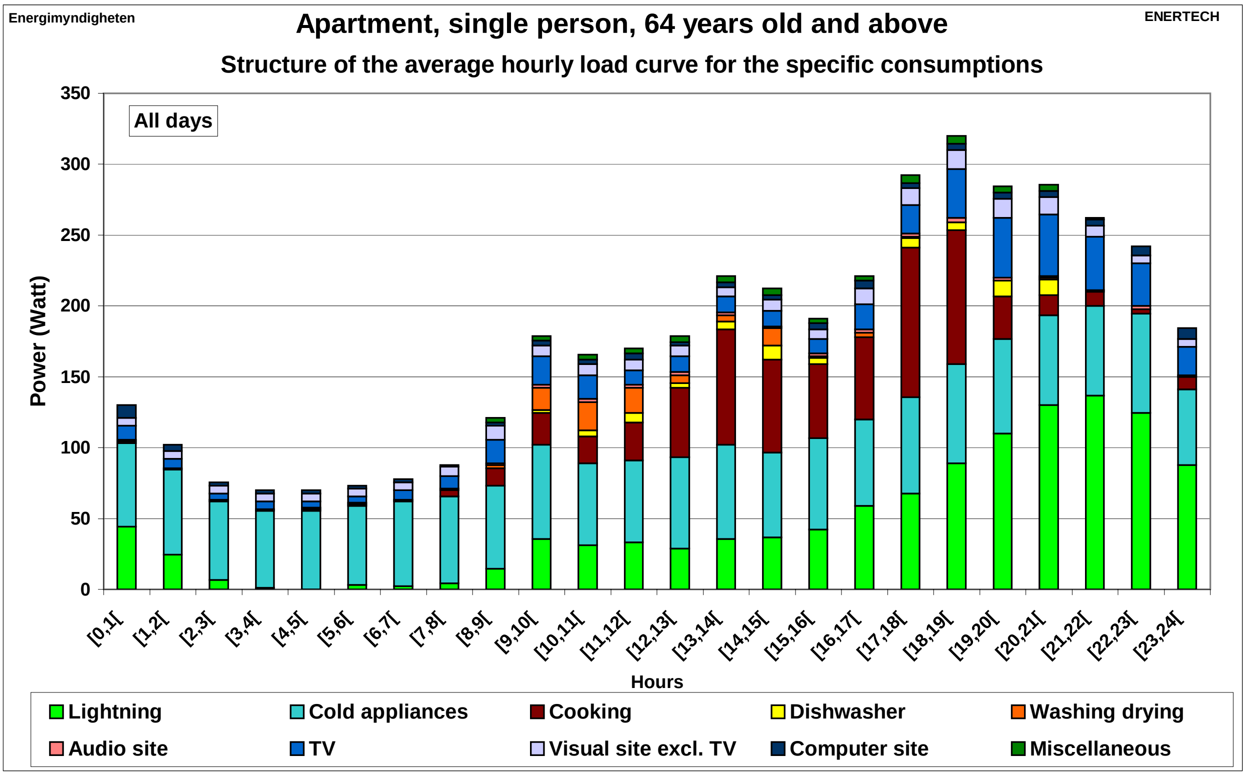


Figure 2.119: Structure of the average hourly load curve for the specific consumption– Apartments – All days

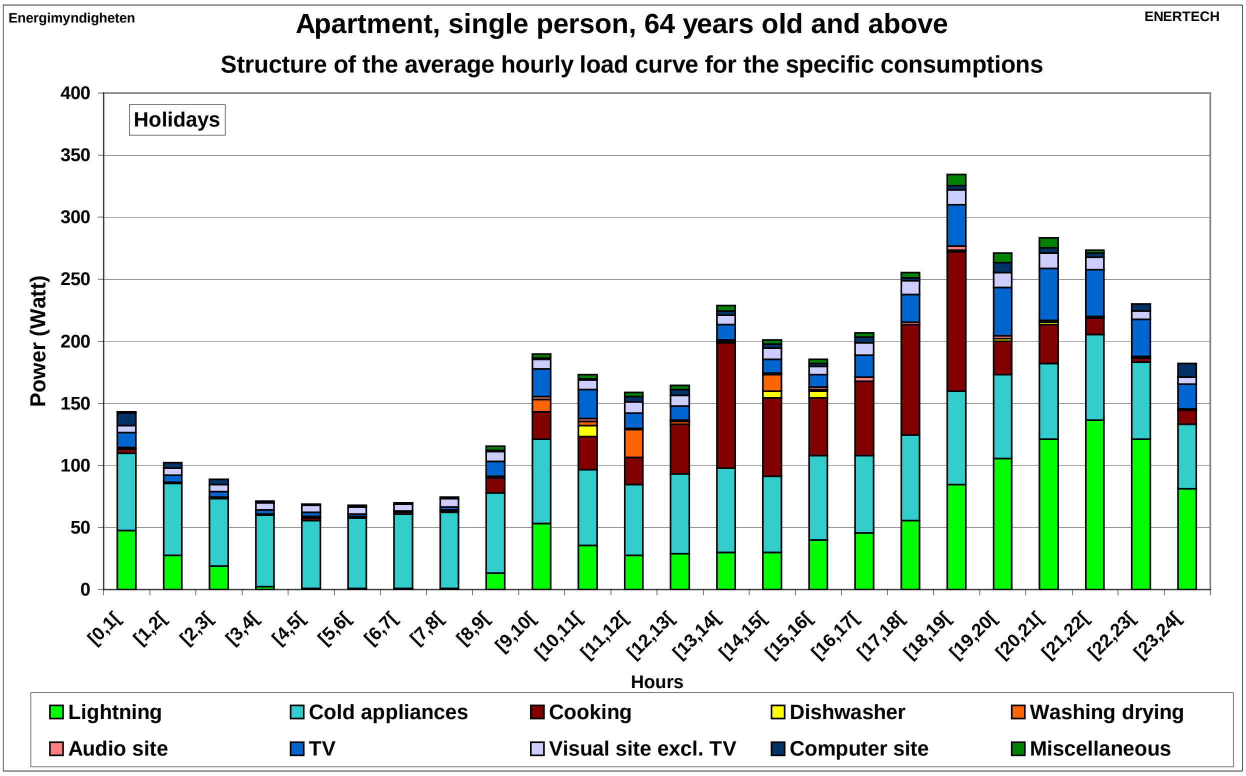


Figure 2.120: Structure of the average hourly load curve for the specific consumption– Apartments – Holidays

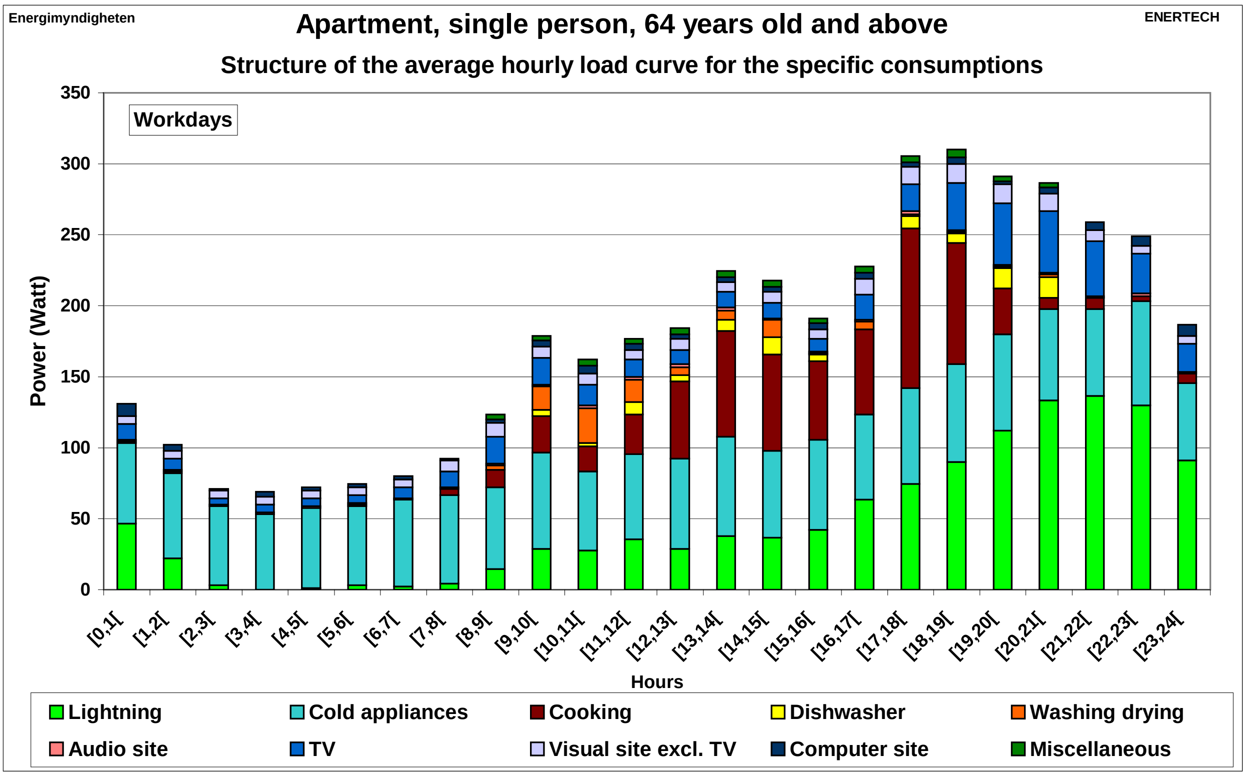


Figure 2.121: Structure of the average hourly load curve for the specific consumption– Apartments – Workdays

Relative contribution from the different loads

Figures 2.122 to 2.187 shows for type of household, the split between holidays (Saturday and Sunday) workdays (Monday-Friday) and the sum of the two, the relative contribution from the different loads. These figures were calculated by averaging the individual consumption for each household. The individual monitored devices were merged per type of appliances (cold appliances, lighting, audiovisual sites, computer sites, cooking, washing, heating etc.).

The graphs are split in two: a first set with all the different consumptions including heating and water heating, a second set displaying only the specific consumptions.

Family, 26-64 years old

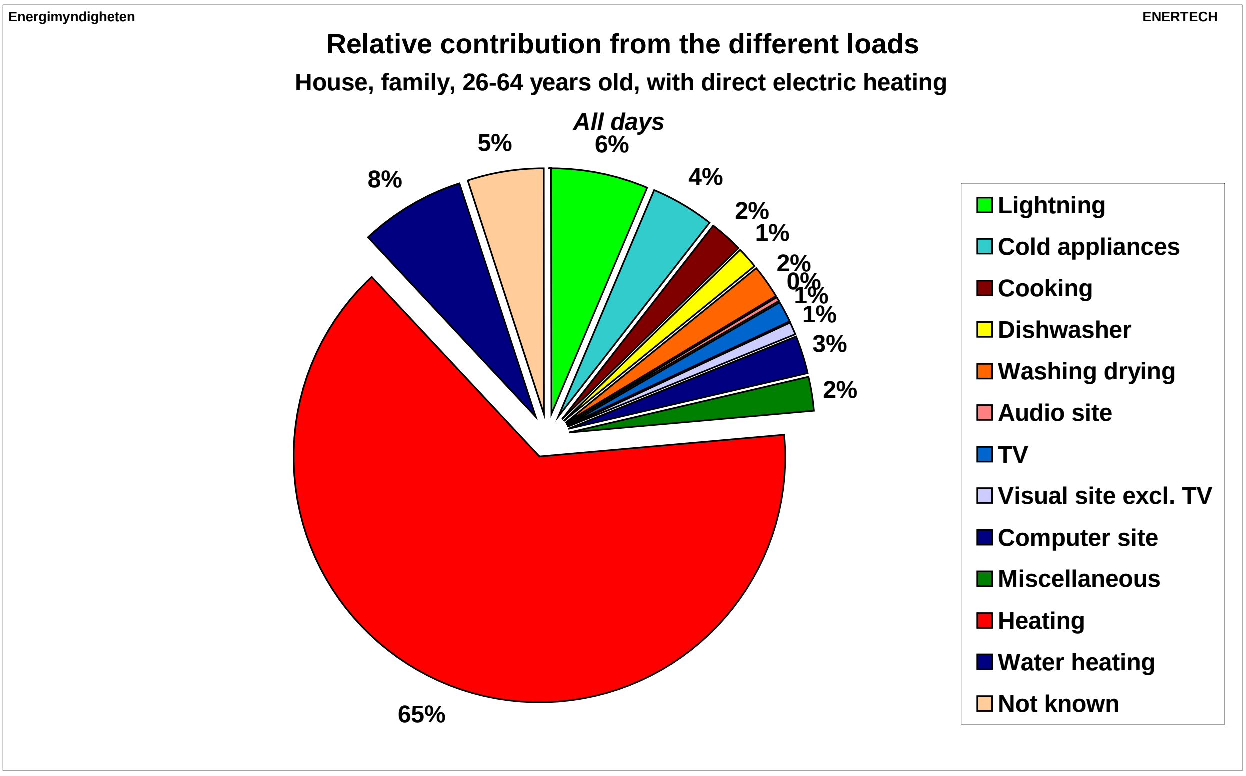


Figure 2.122: Relative contribution from the different loads – Houses with direct electric heating - All days

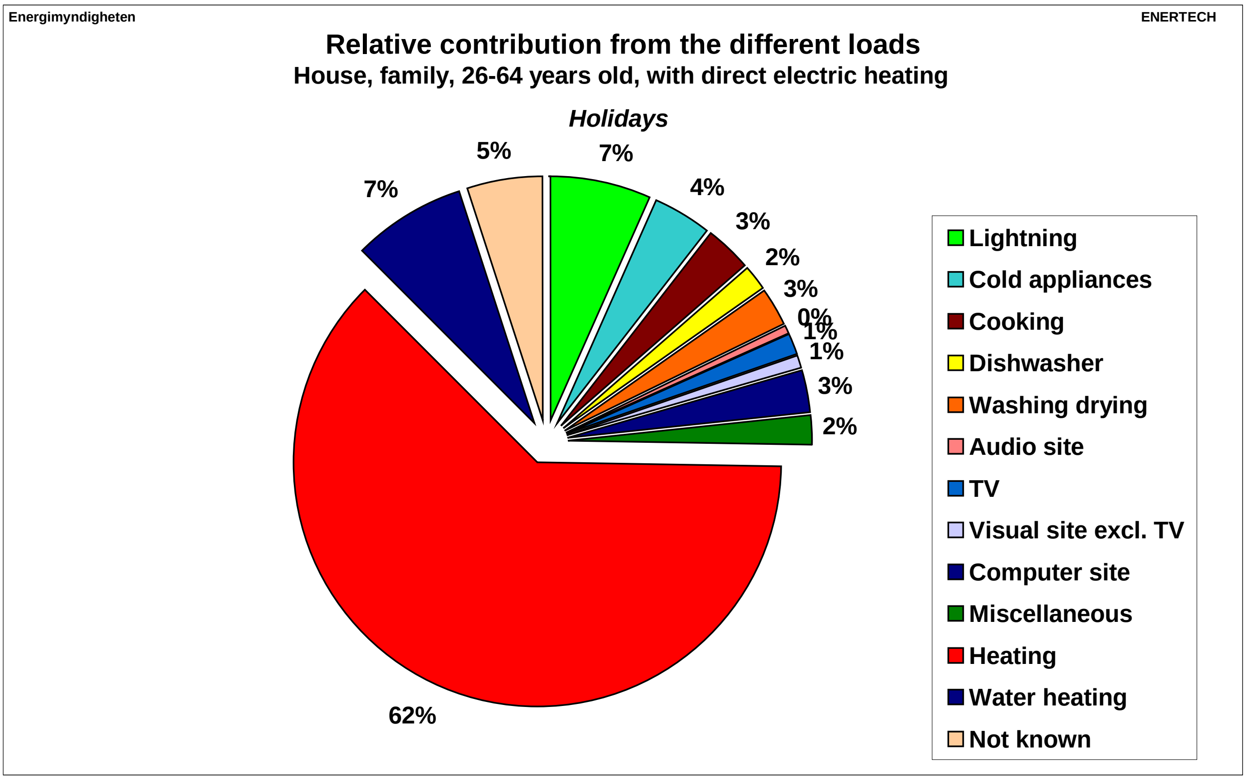


Figure 2.123: Relative contribution from the different loads – Houses with direct electric heating - Holidays

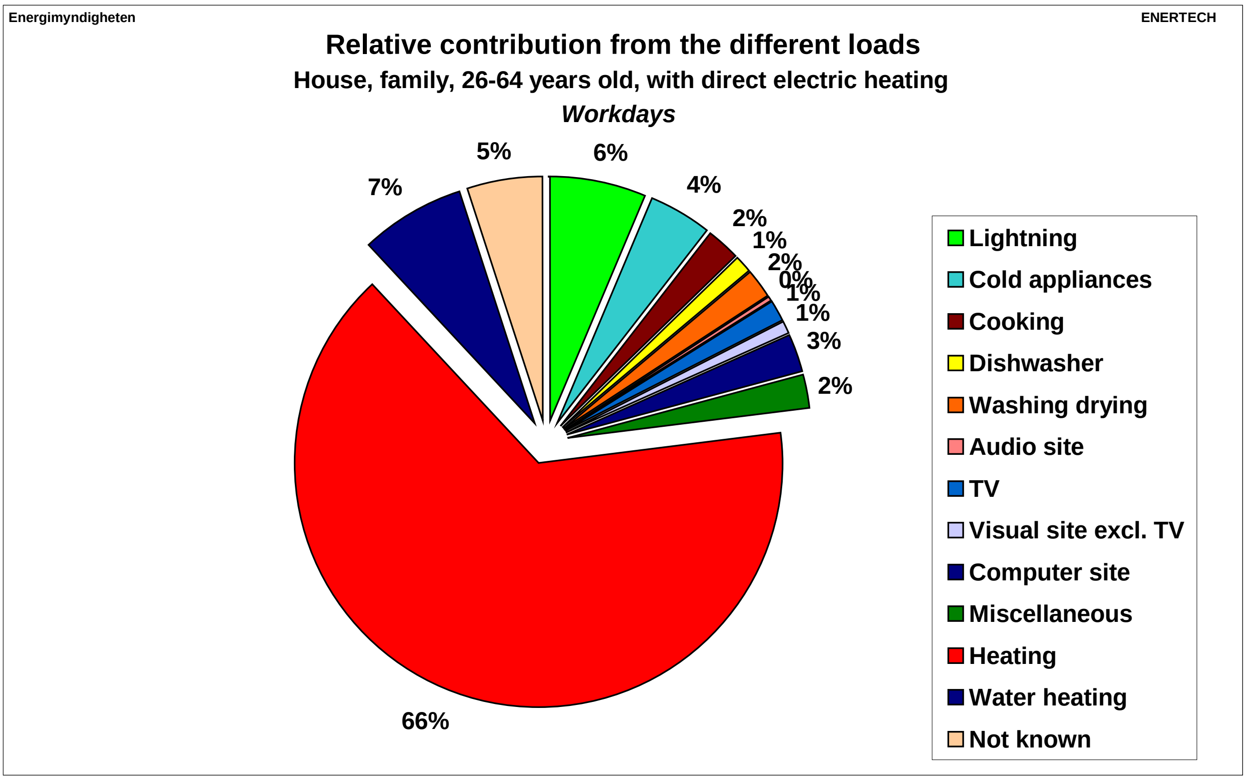


Figure 2.124: Relative contribution from the different loads – Houses with direct electric heating – Workdays

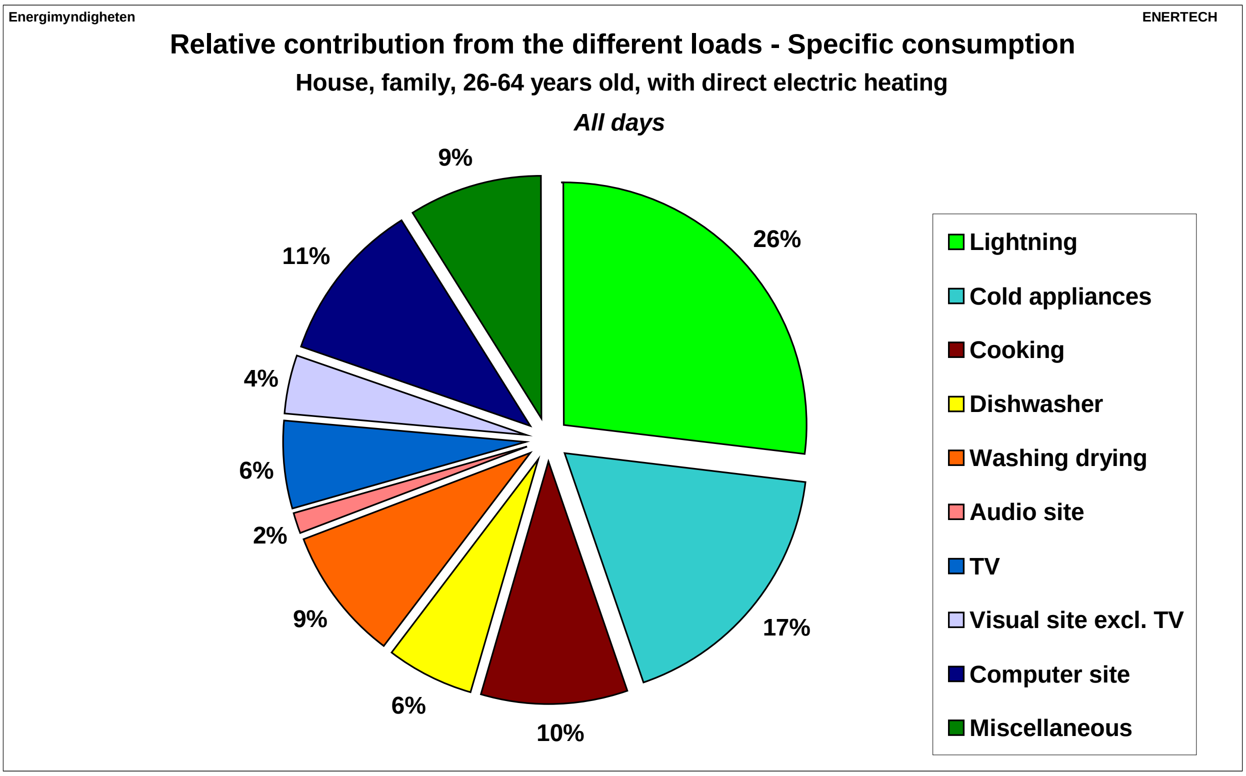


Figure 2.125: Relative contribution from the different loads for the specific consumption– Houses with direct electric heating - All days

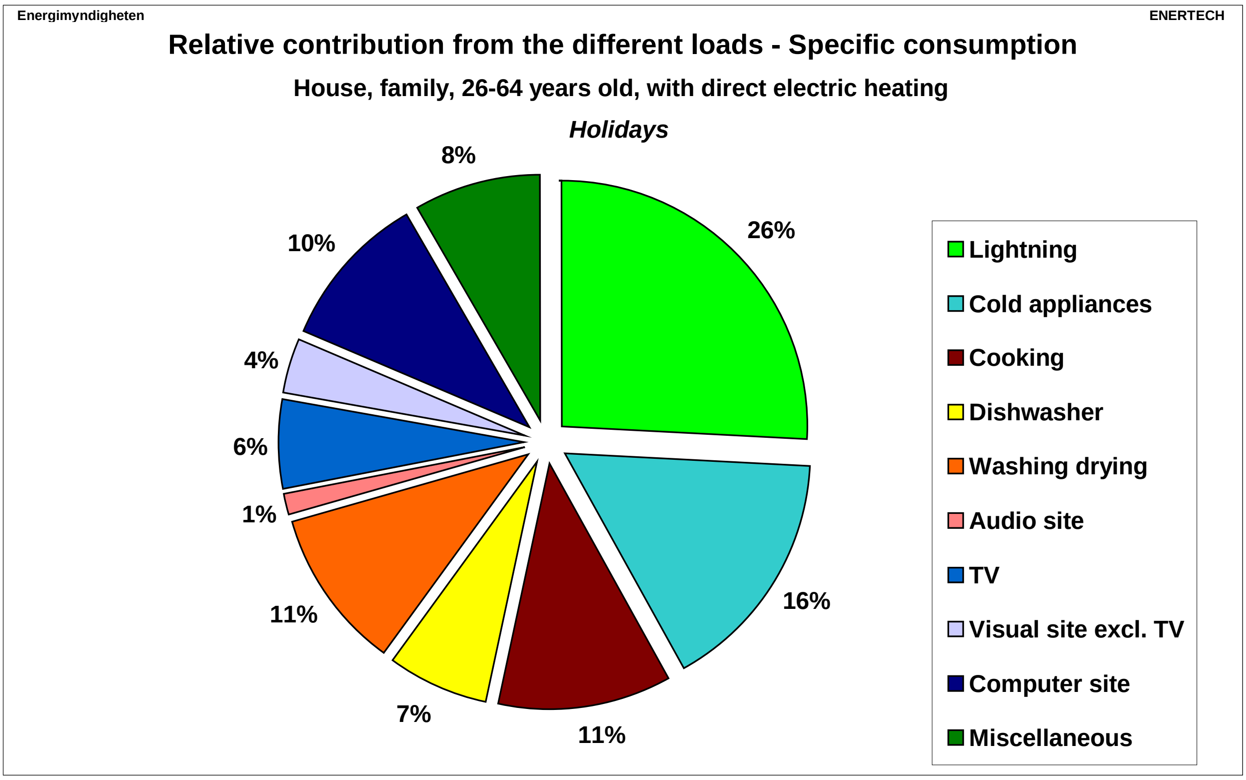


Figure 2.126: Relative contribution from the different loads for the specific consumption– Houses with direct electric heating - Holidays

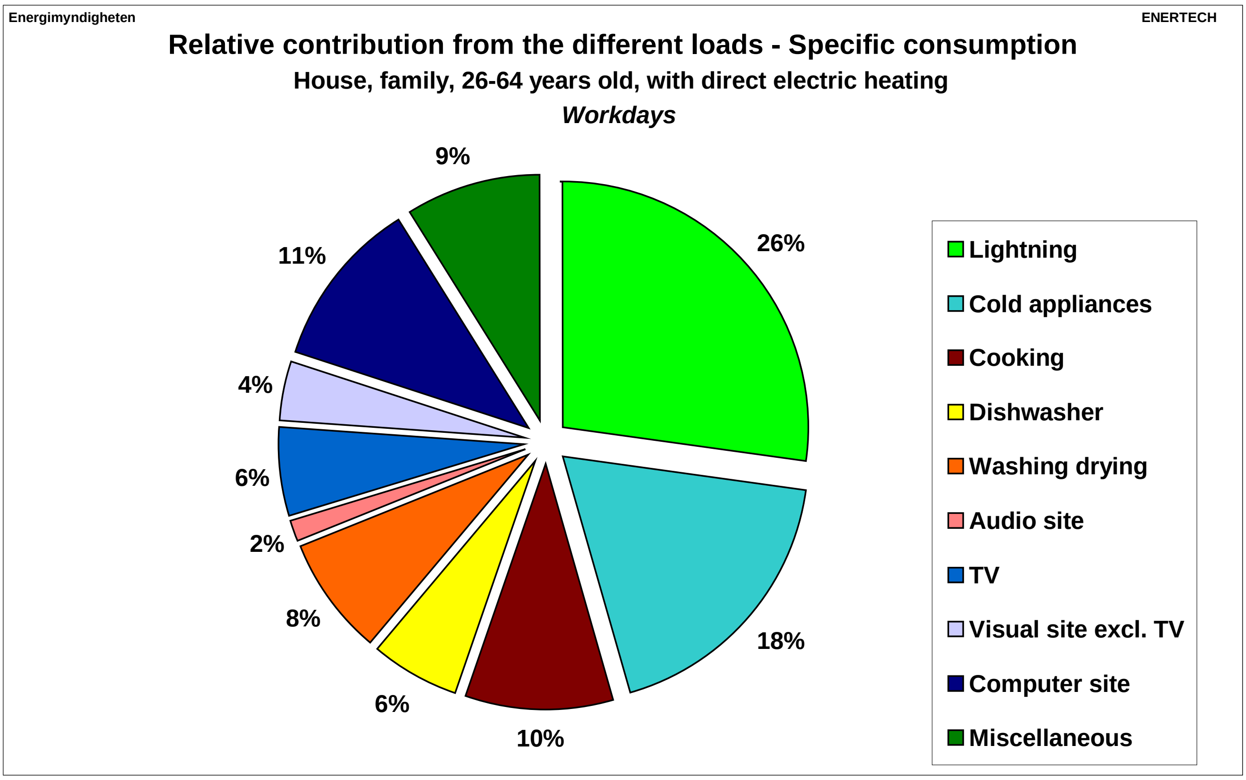


Figure 2.127: Relative contribution from the different loads for the specific consumption– Houses with direct electric heating – Workdays

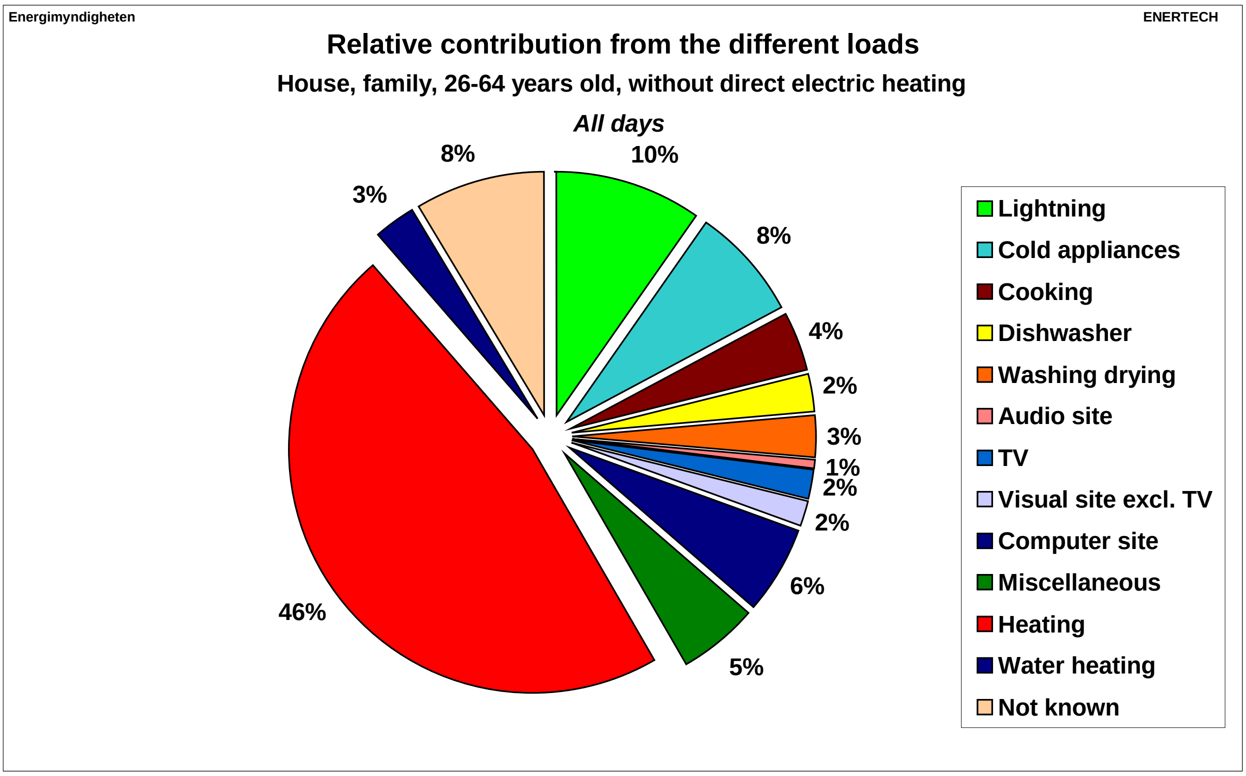


Figure 2.128: Relative contribution from the different loads – Houses without direct electric heating - All days

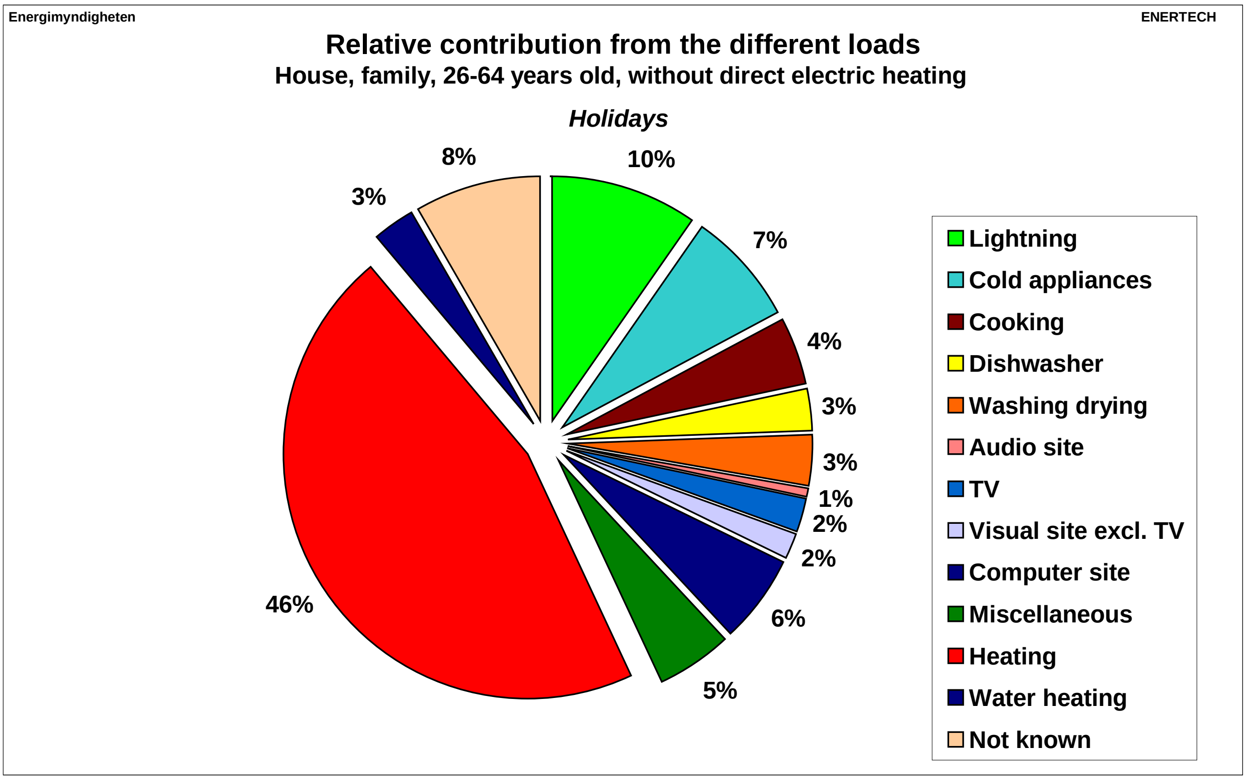


Figure 2.129: Relative contribution from the different loads – Houses without direct electric heating - Holidays

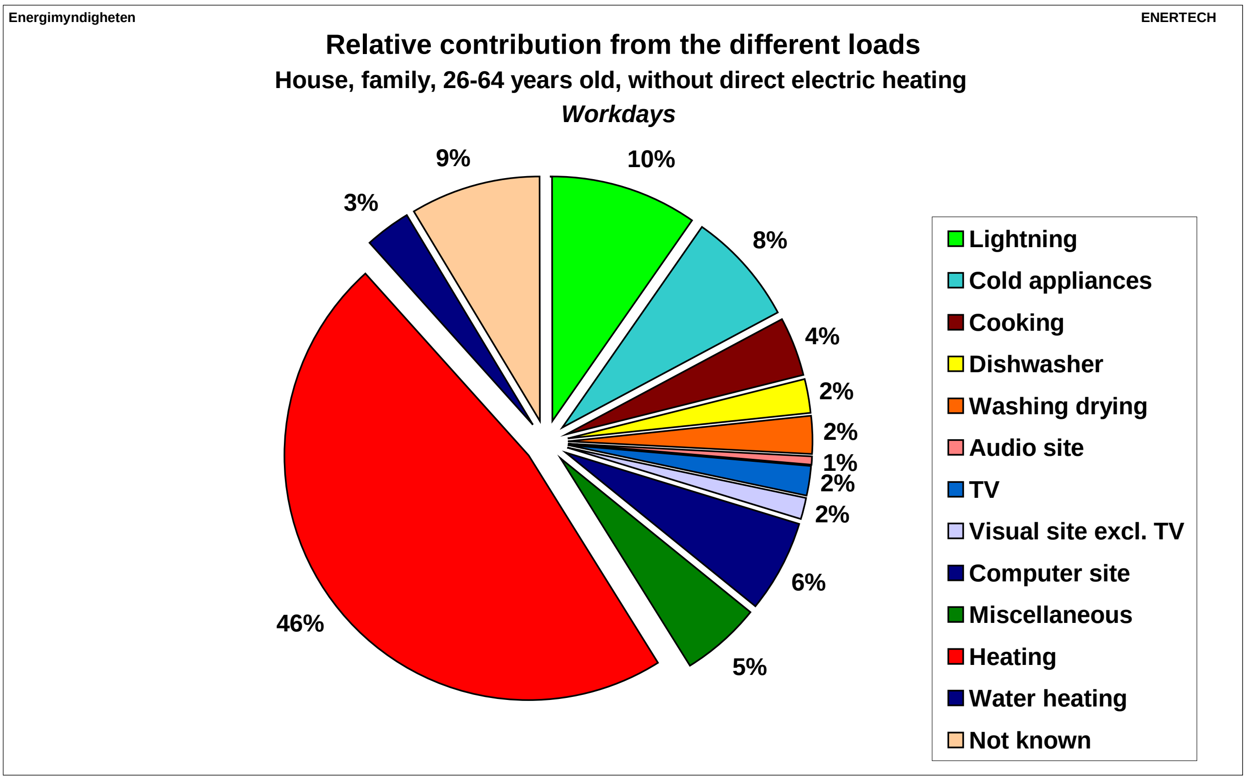


Figure 2.130: Relative contribution from the different loads – Houses without direct electric heating – Workdays

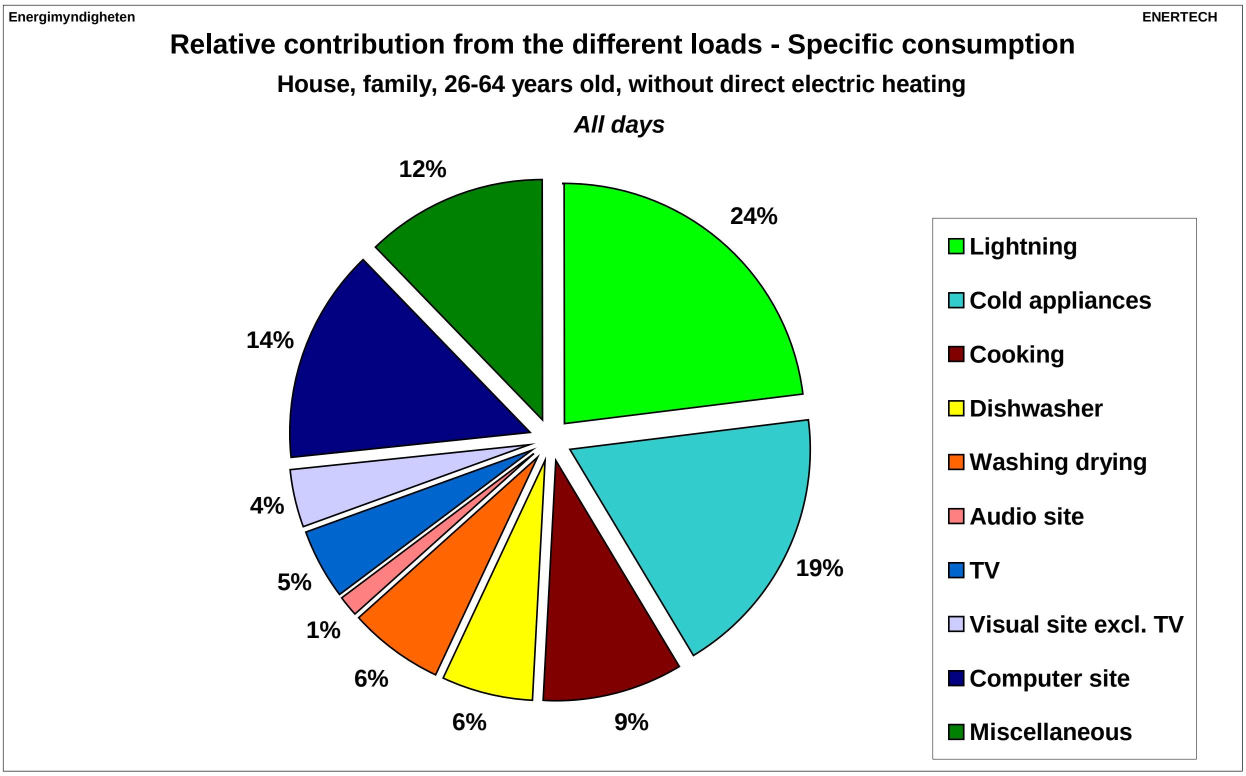


Figure 2.131: Relative contribution from the different loads for the specific consumption– Houses without direct electric heating - All days

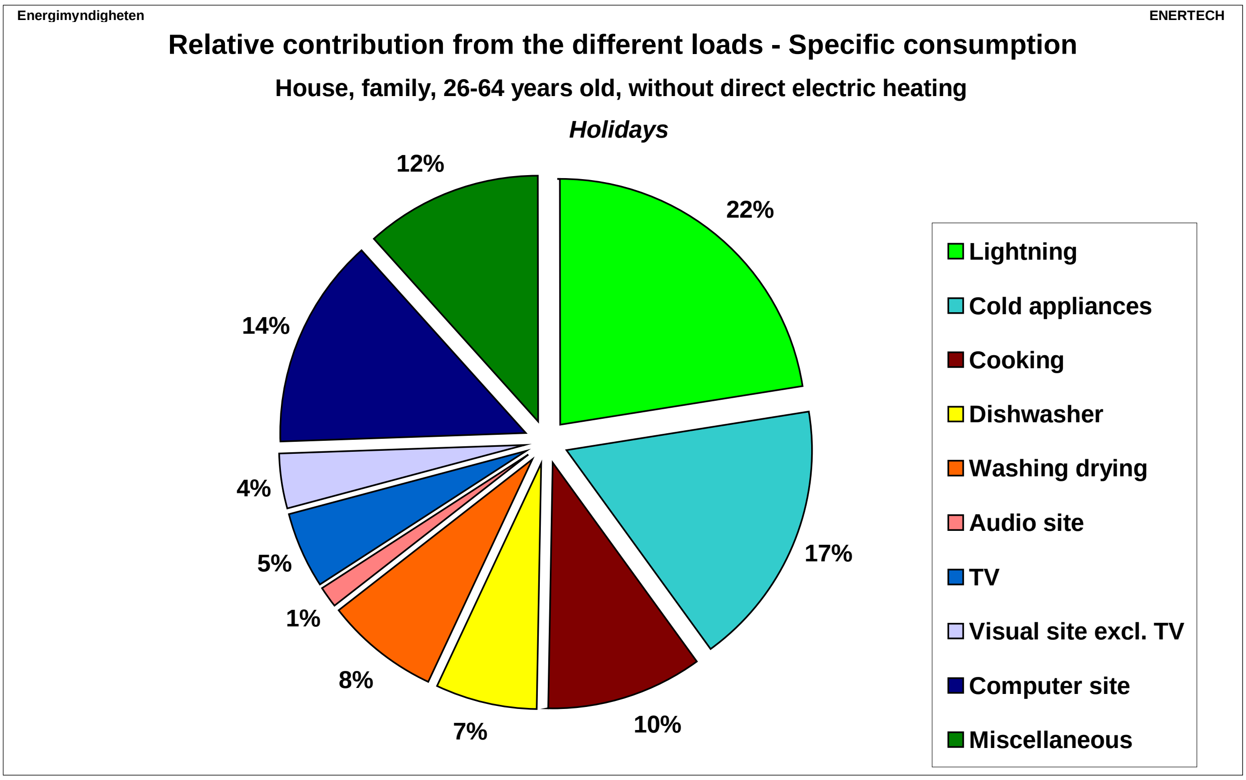


Figure 2.132: Relative contribution from the different loads for the specific consumption– Houses without direct electric heating - Holidays

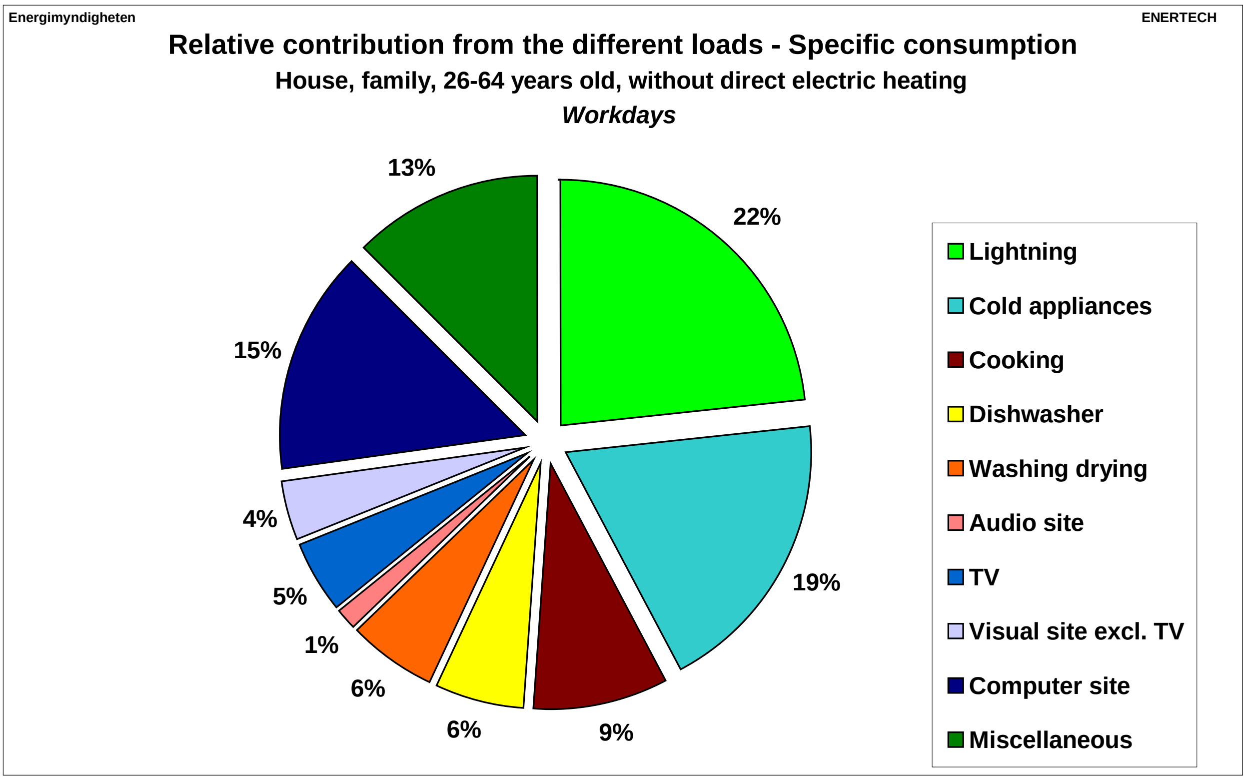


Figure 2.133: Relative contribution from the different loads for the specific consumption– Houses without direct electric heating – Workdays

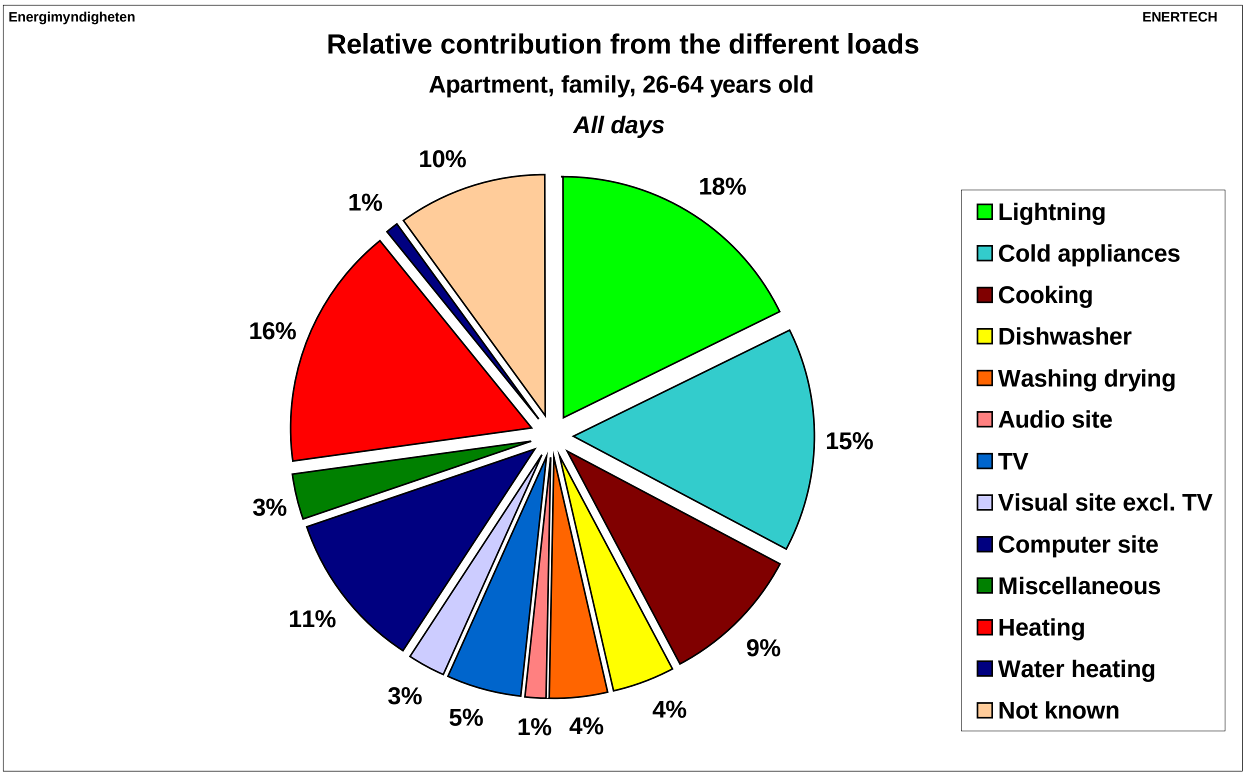


Figure 2.134: Relative contribution from the different loads – Apartments - All days

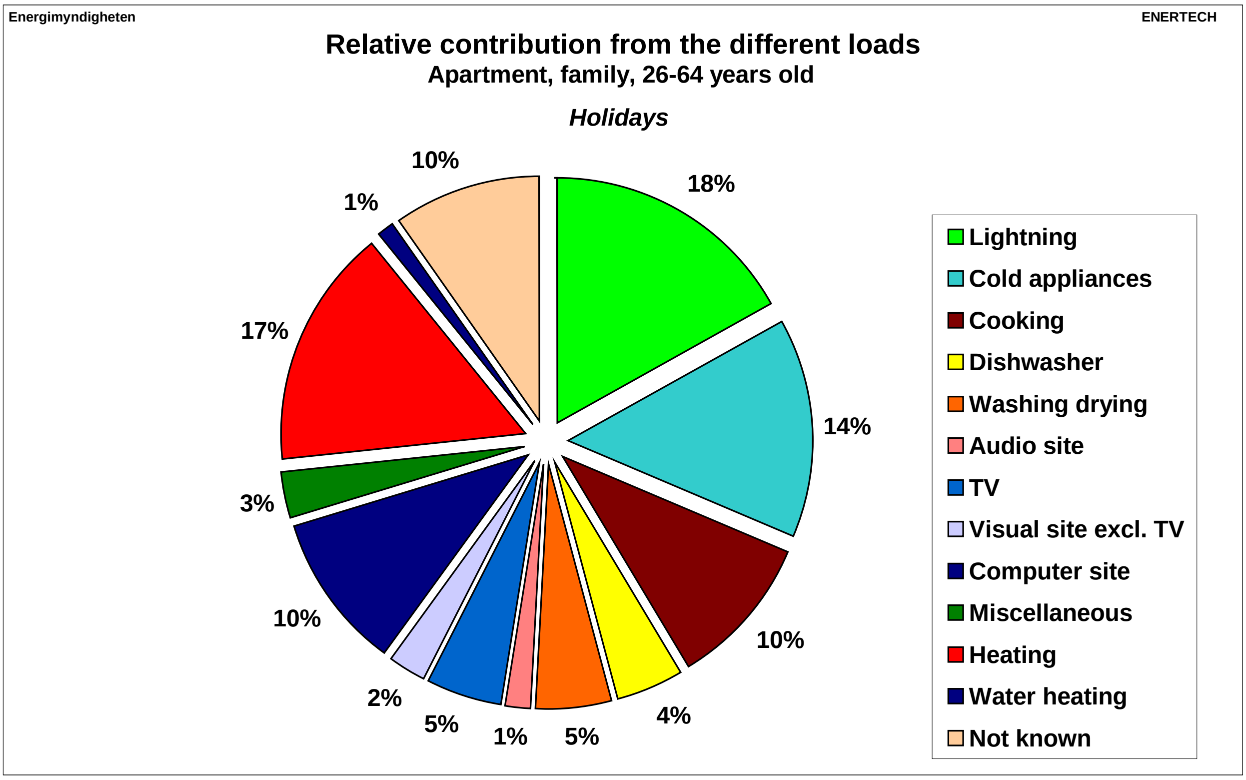


Figure 2.135: Relative contribution from the different loads – Apartments - Holidays

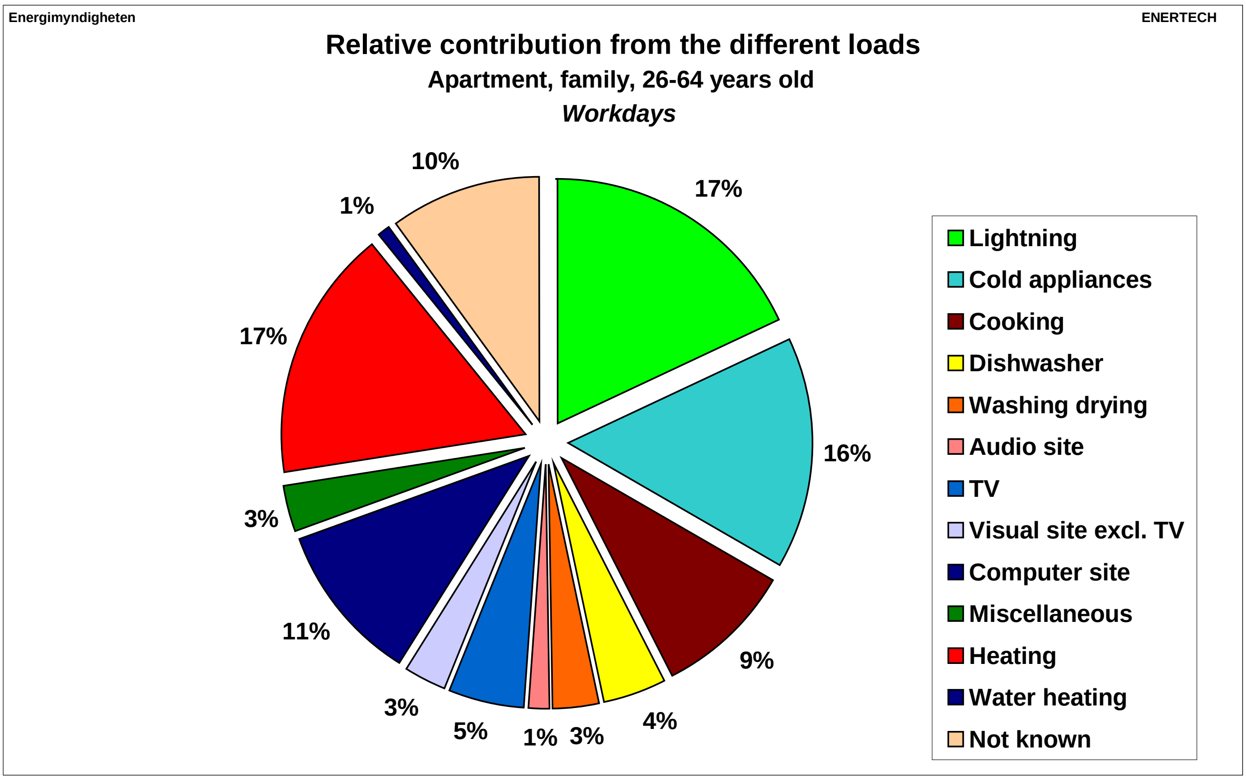


Figure 2.136: Relative contribution from the different loads – Apartments - Workdays

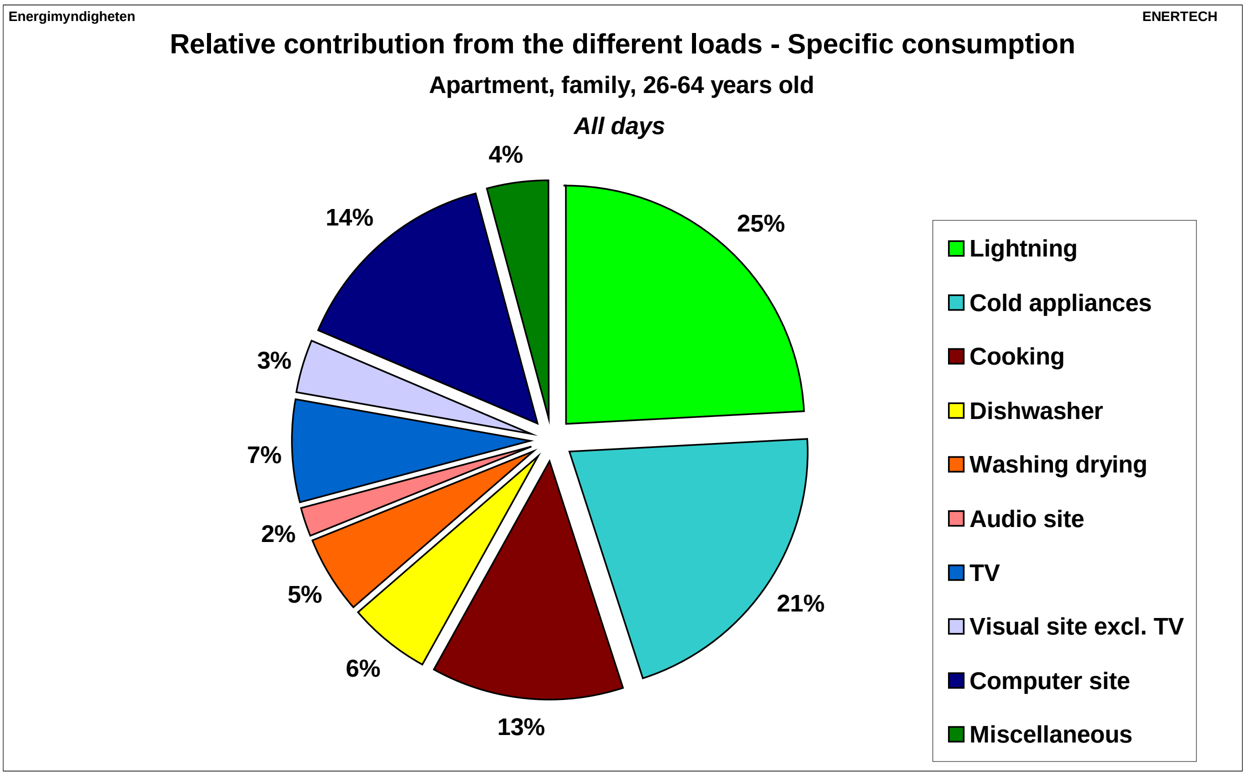


Figure 2.137: Relative contribution from the different loads for the specific consumption– Apartments - All days

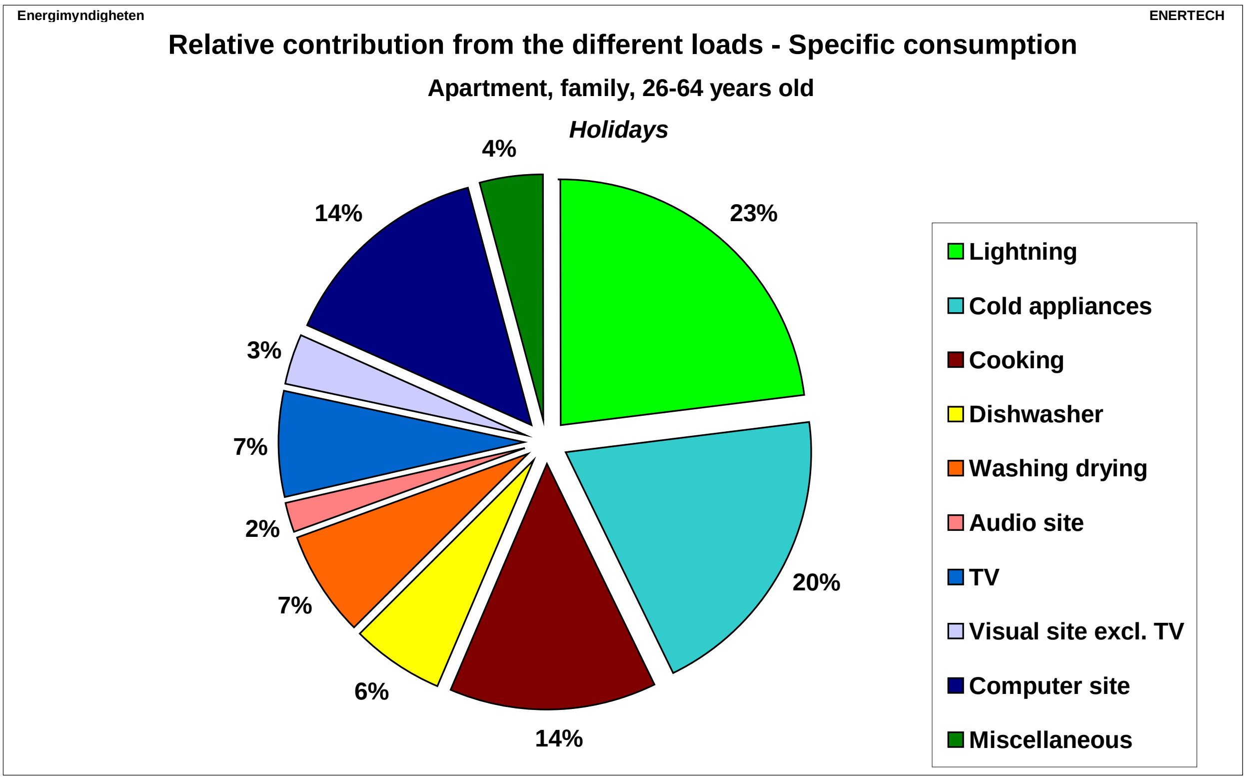


Figure 2.138: Relative contribution from the different loads for the specific consumption– Apartments - Holidays

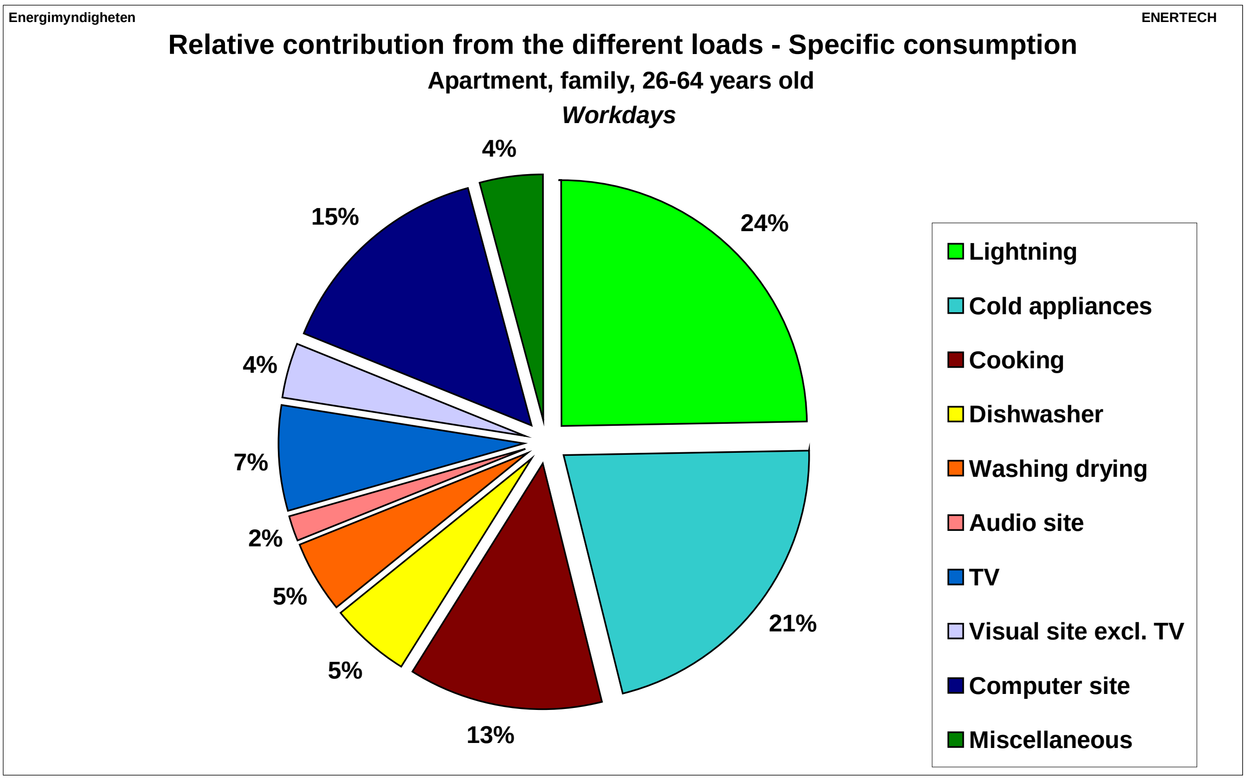


Figure 2.139: Relative contribution from the different loads for the specific consumption– Apartments - Workdays

Couples without children, 26-64 years old

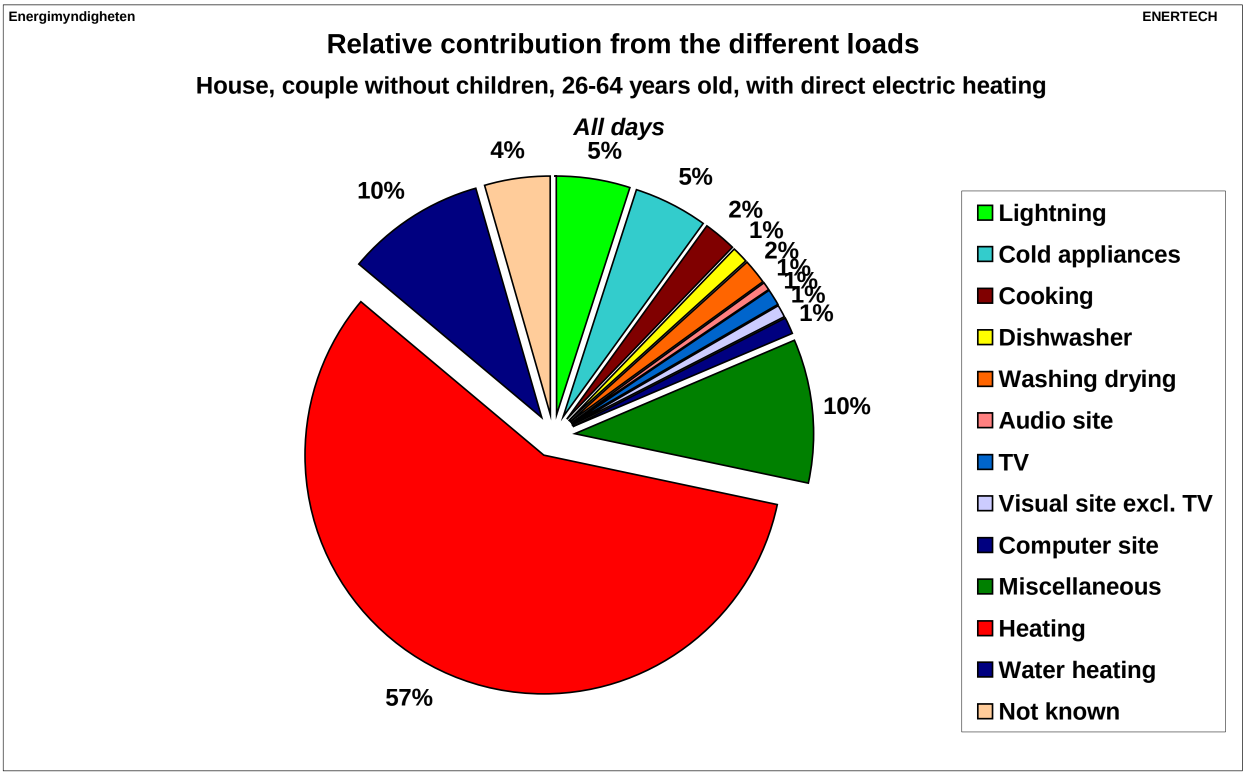


Figure 2.140: Relative contribution from the different loads – Houses with direct electric heating – All days

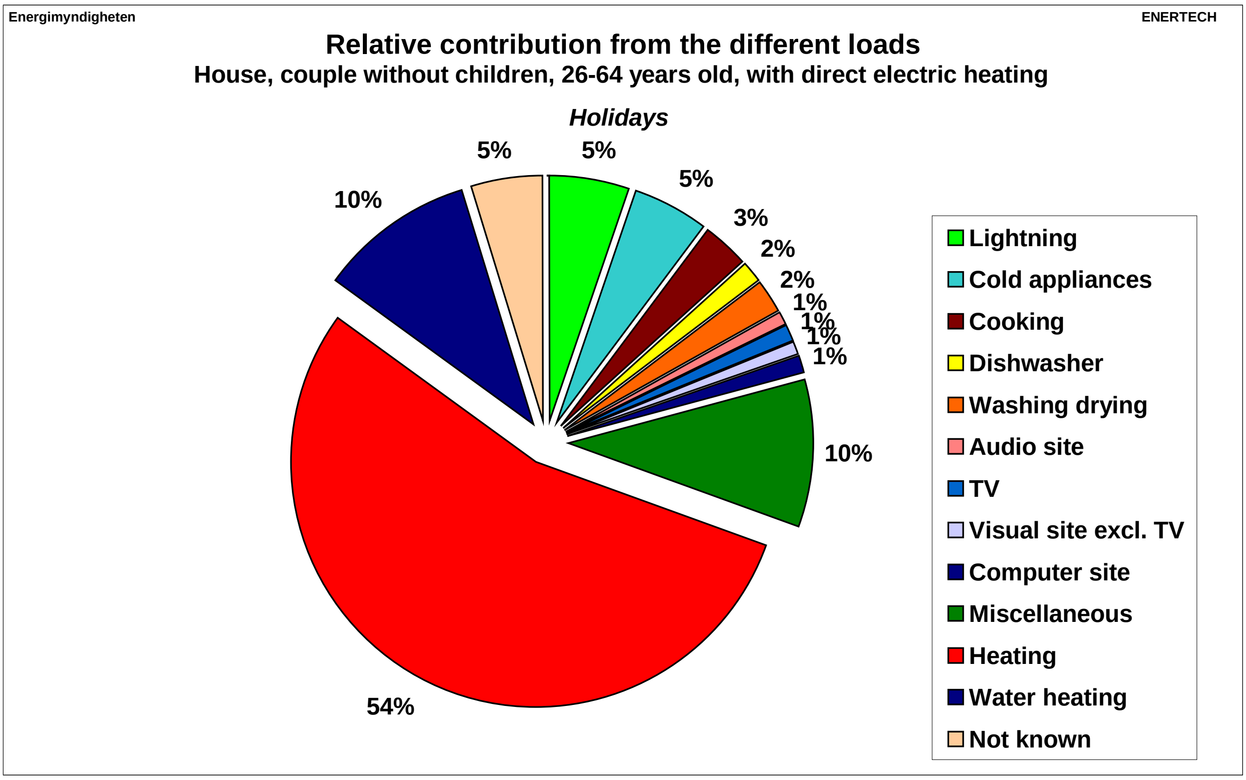


Figure 2.141: Relative contribution from the different loads – Houses with direct electric heating – Holidays

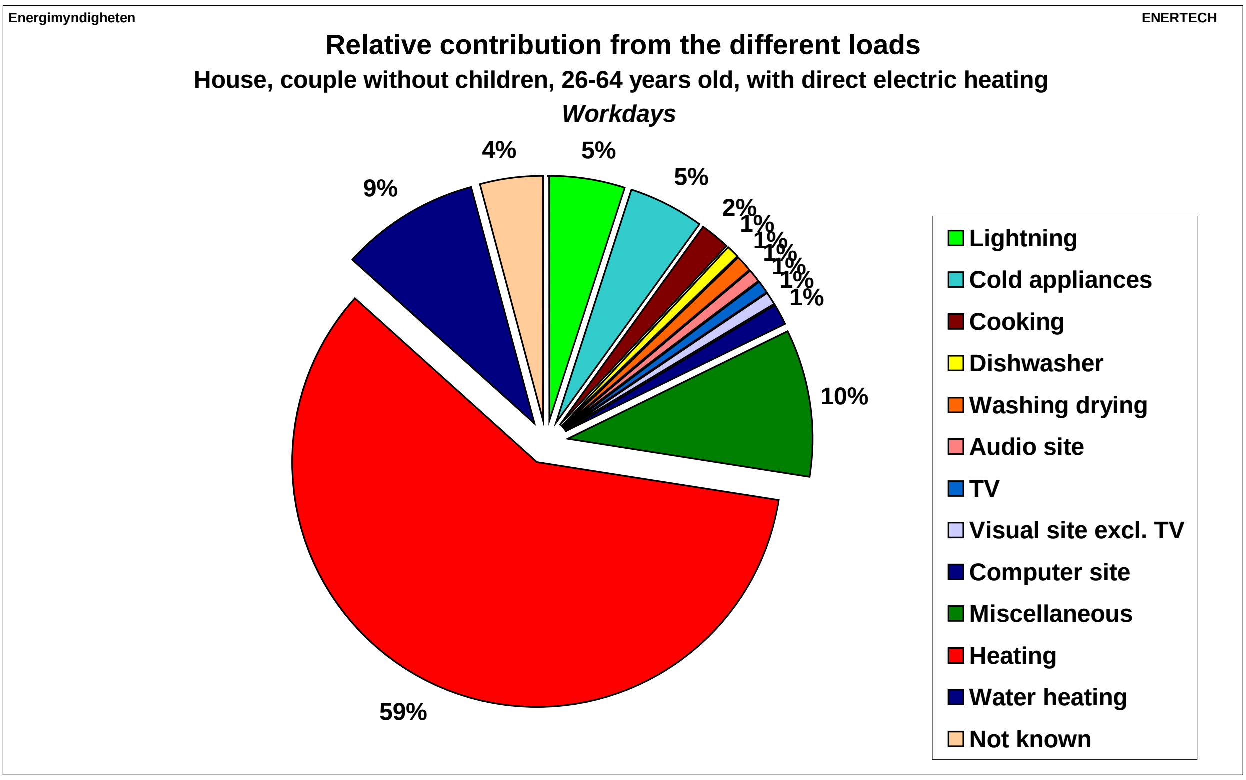


Figure 2.142: Relative contribution from the different loads – Houses with direct electric heating – Workdays

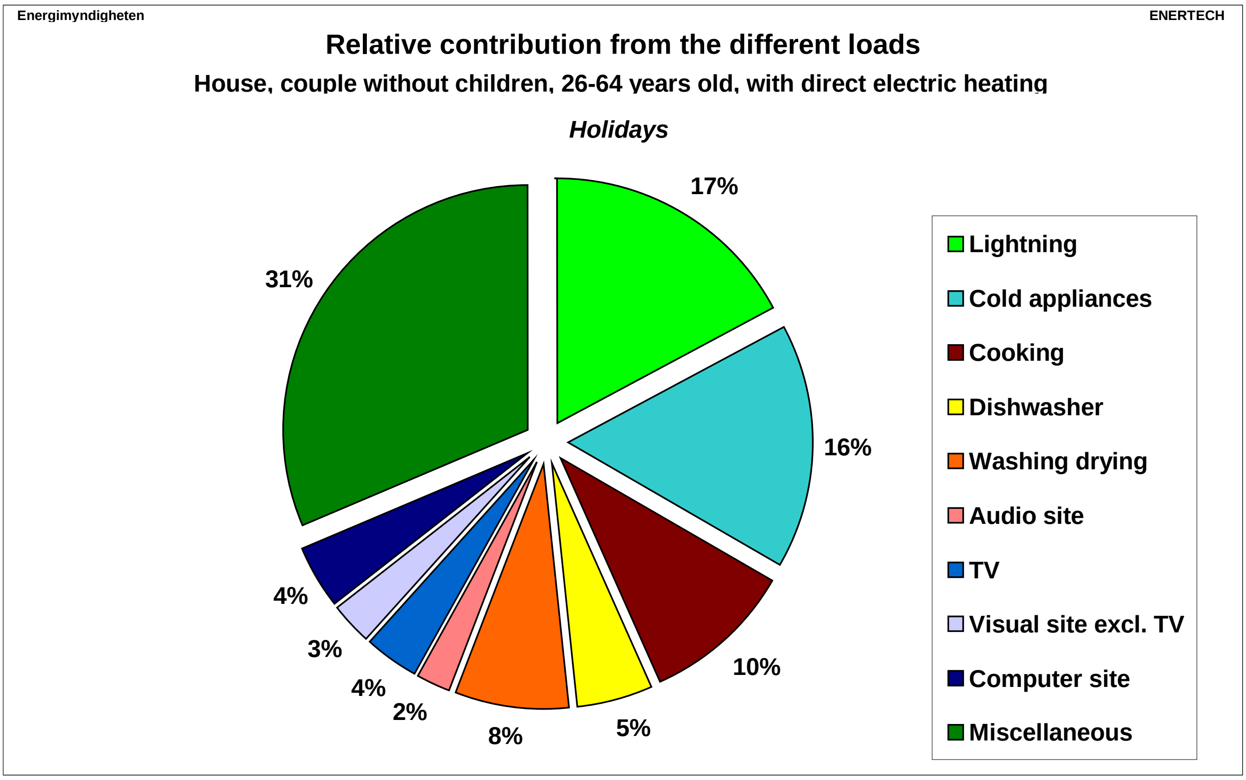


Figure 2.143: Relative contribution from the different loads for the specific consumption– Houses with direct electric heating – All days

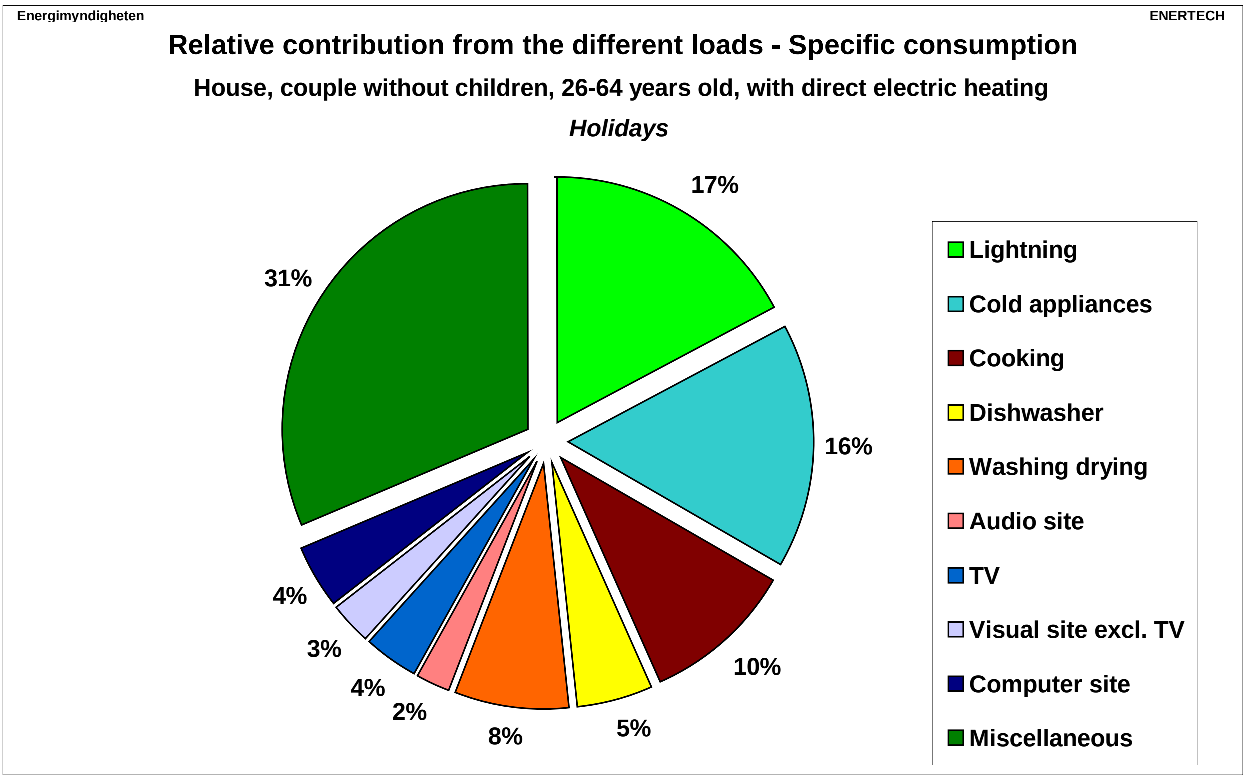


Figure 2.144: Relative contribution from the different loads for the specific consumption– Houses with direct electric heating – Holidays

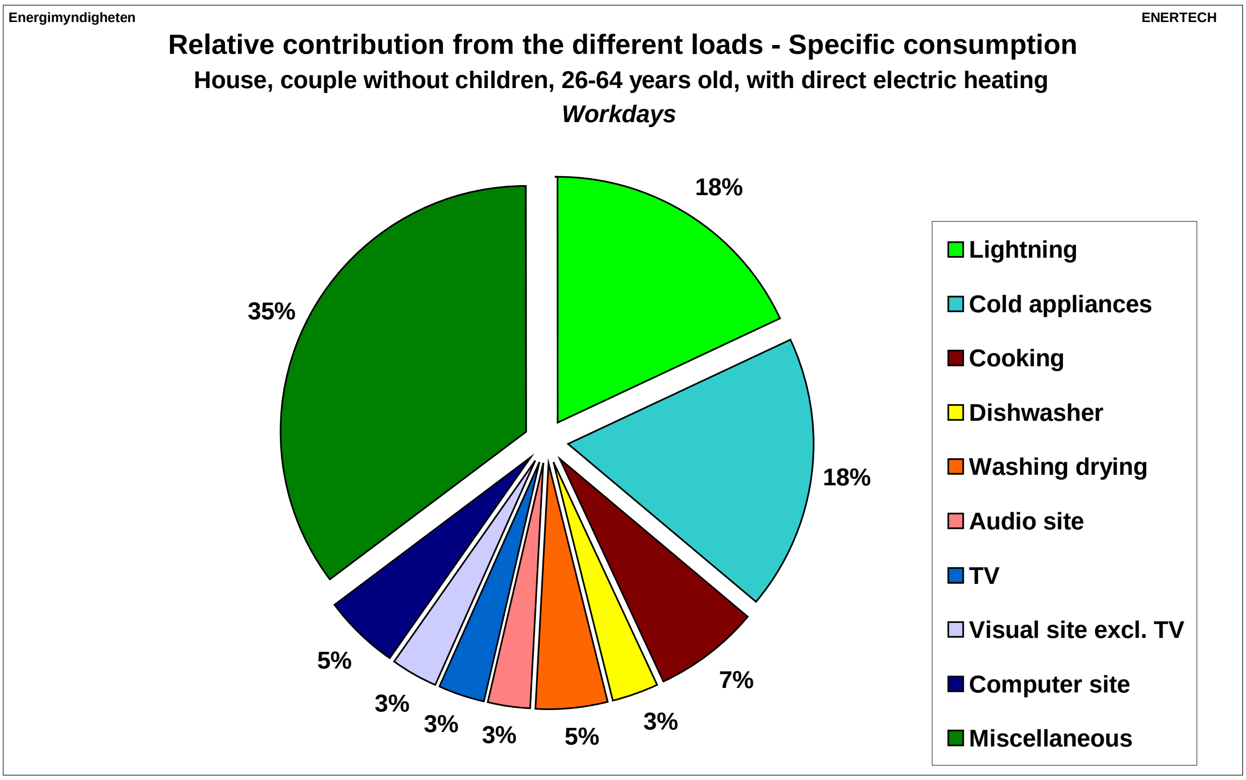


Figure 2.145: Relative contribution from the different loads for the specific consumption– Houses with direct electric heating – Workdays

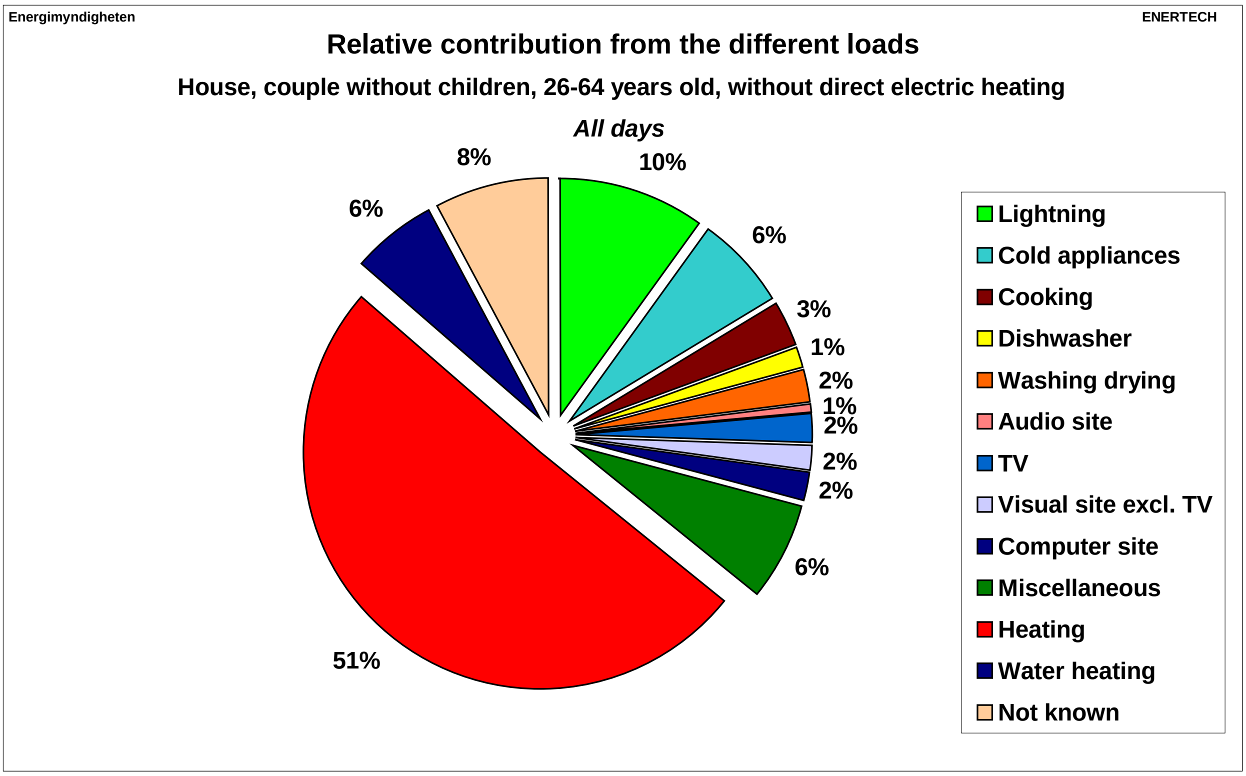


Figure 2.146: Relative contribution from the different loads – Houses without direct electric heating – All days

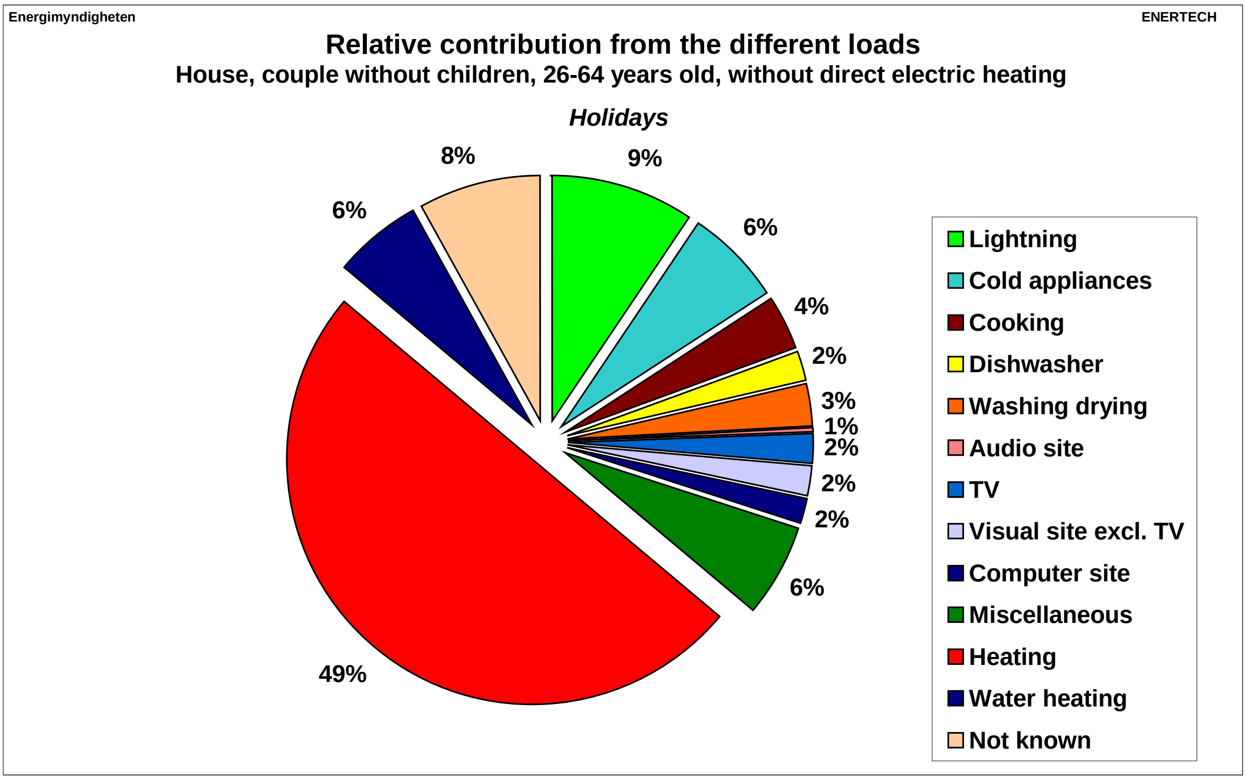


Figure 2.147: Relative contribution from the different loads – Houses without direct electric heating – Holidays

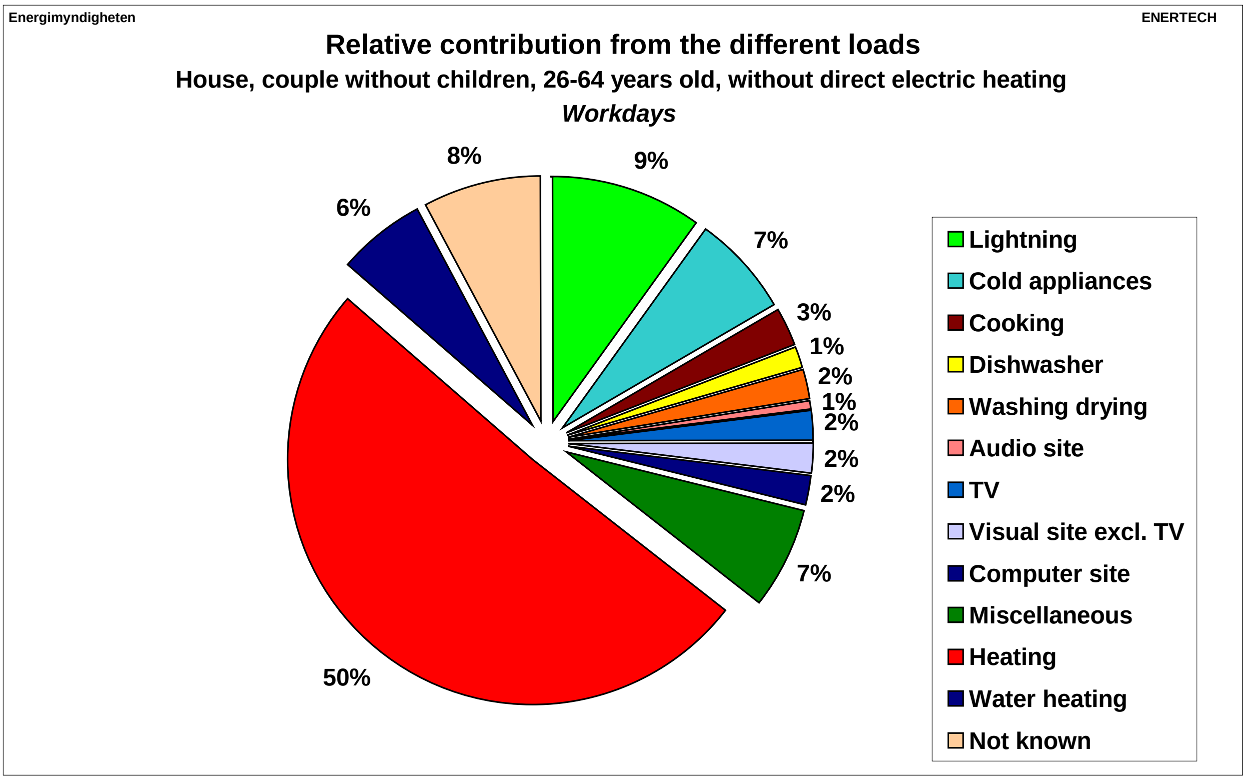


Figure 2.148: Relative contribution from the different loads – Houses without direct electric heating – Workdays

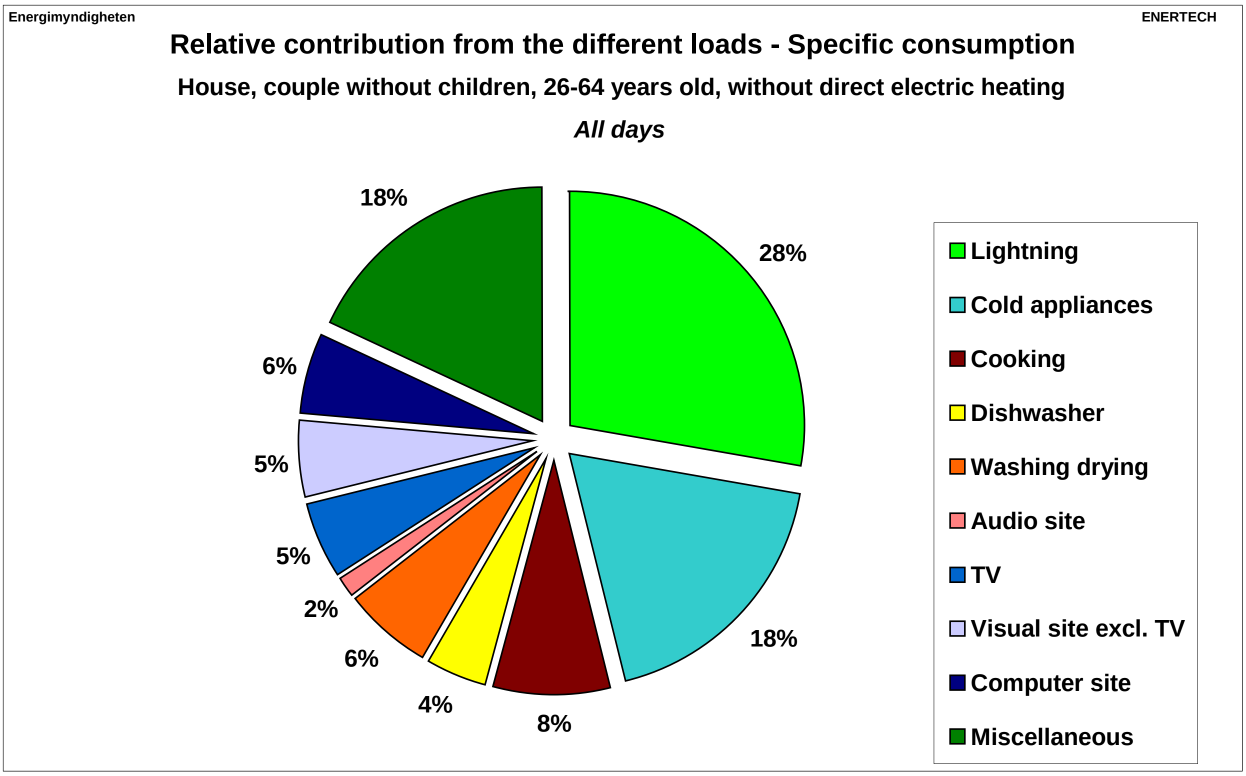


Figure 2.149: Relative contribution from the different loads for the specific consumption– Houses without direct electric heating – All days

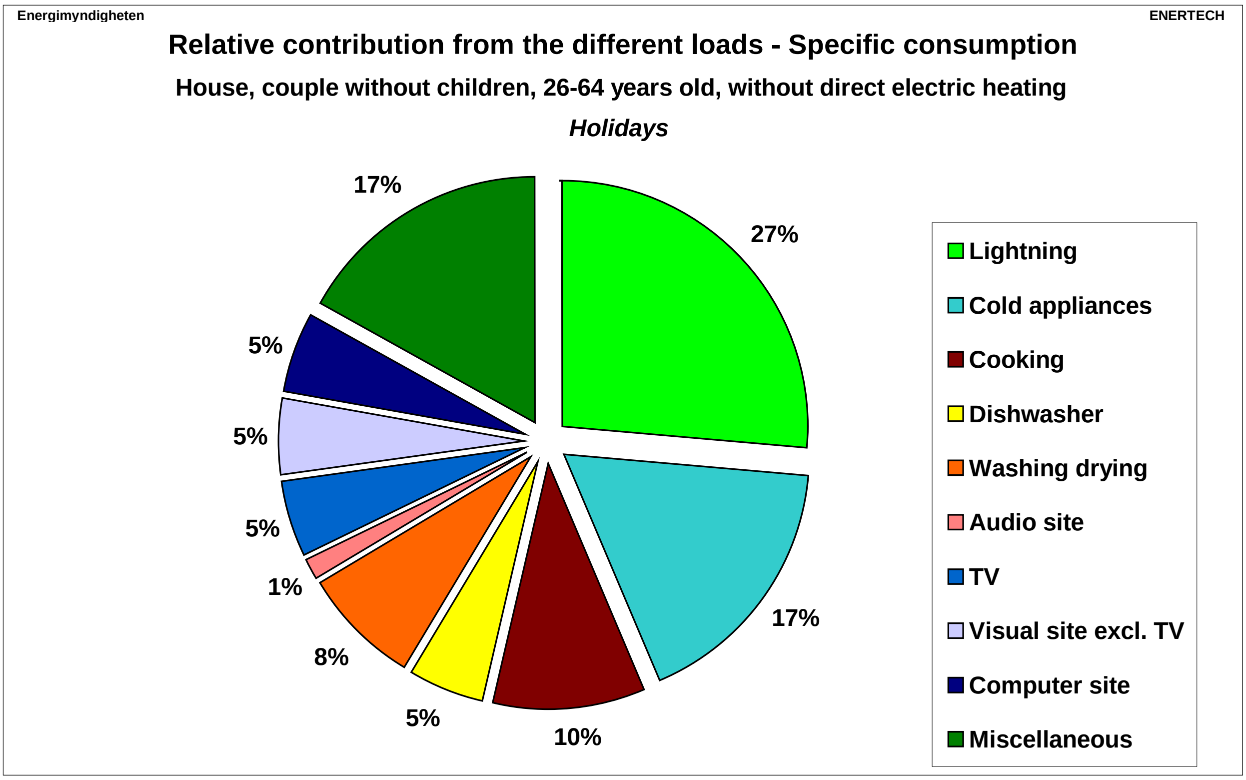


Figure 2.150: Relative contribution from the different loads for the specific consumption– Houses without direct electric heating – Holidays

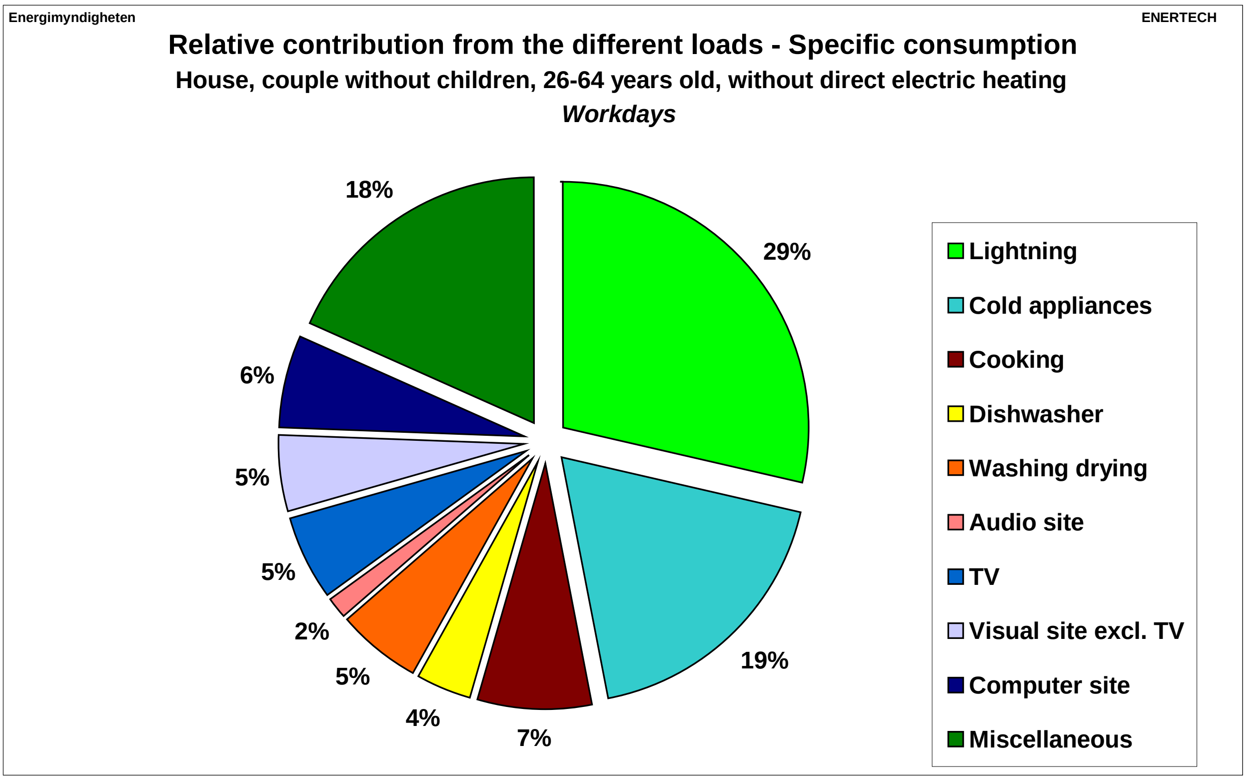


Figure 2.151: Relative contribution from the different loads for the specific consumption– Houses without direct electric heating – Workdays

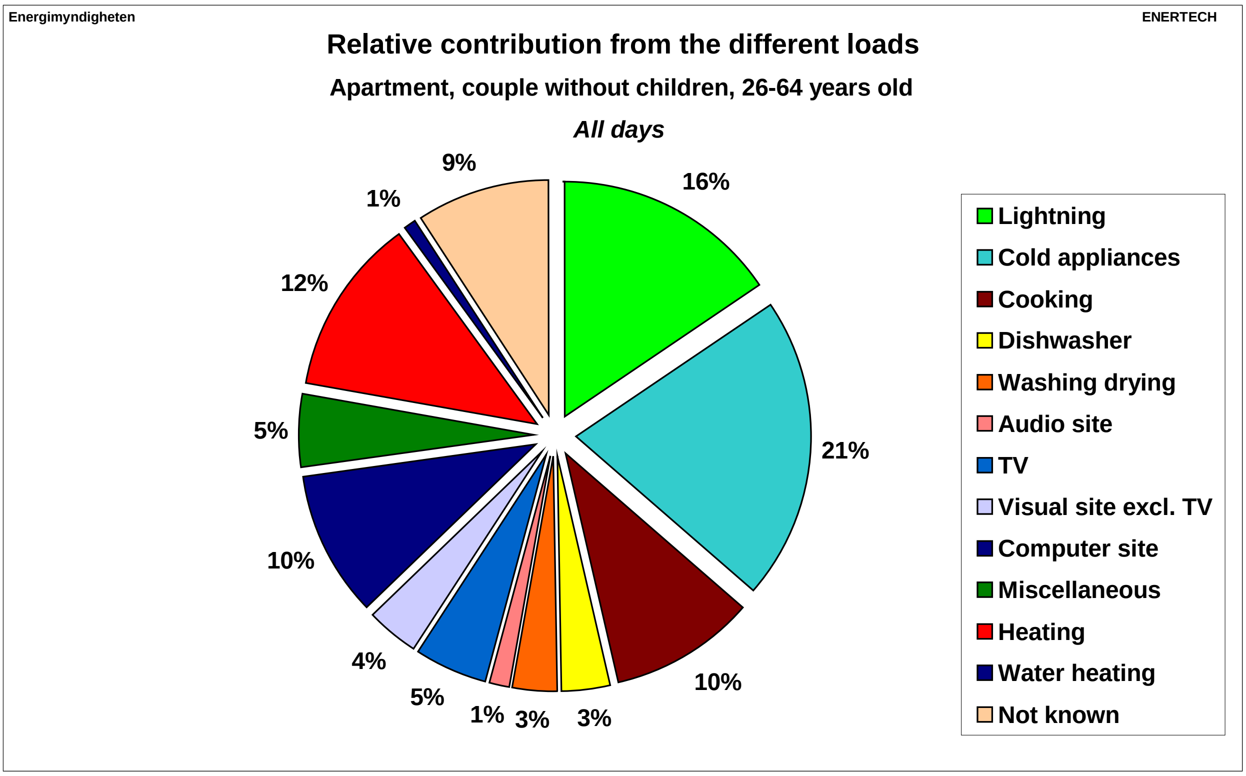


Figure 2.152: Relative contribution from the different loads – Apartments – All days

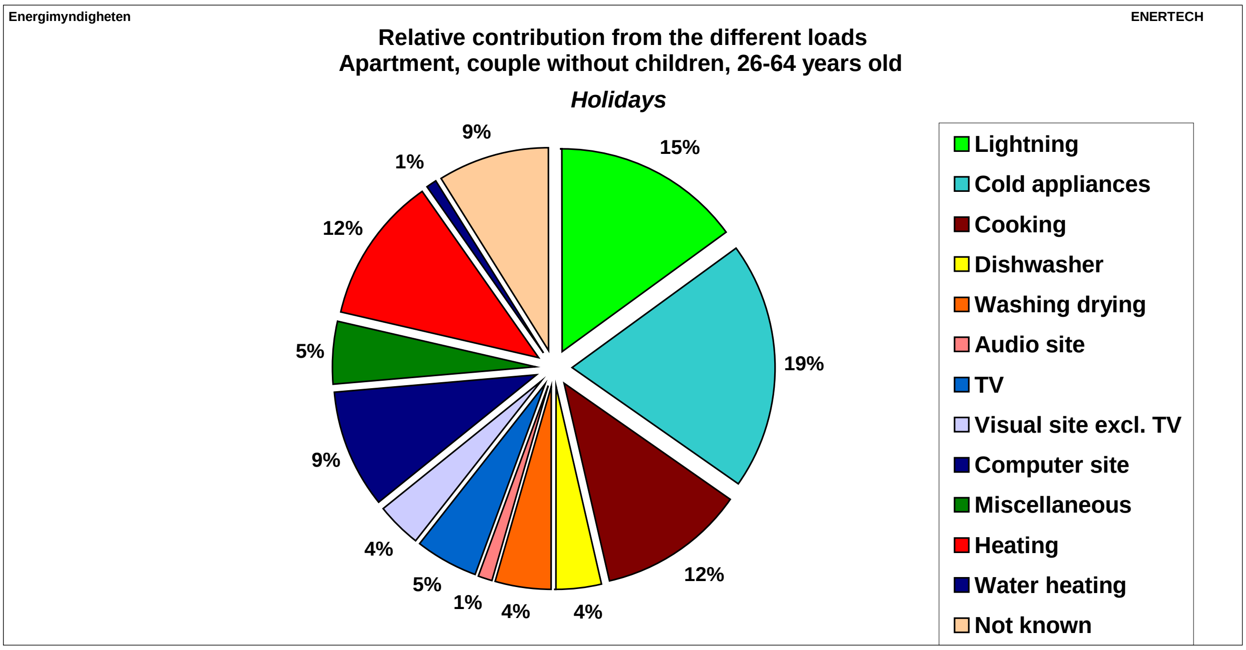


Figure 2.153: Relative contribution from the different loads – Apartments – Holidays

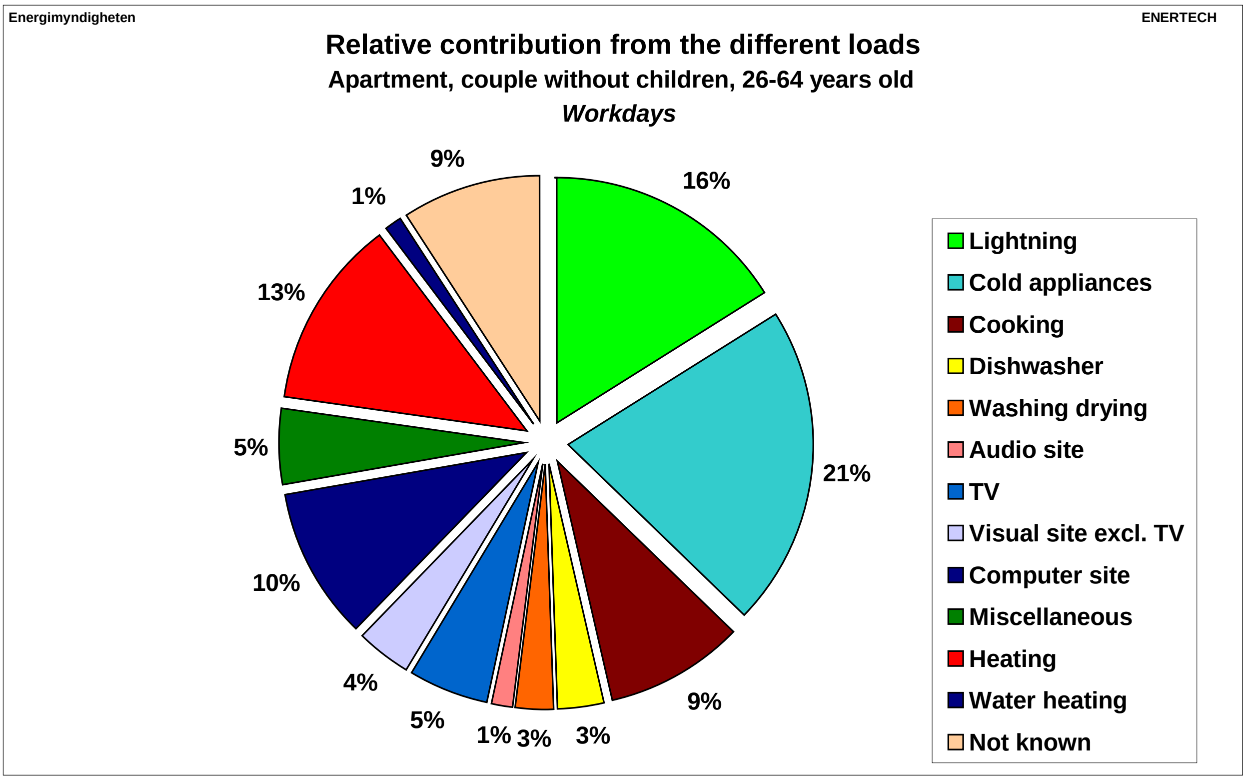


Figure 2.154: Relative contribution from the different loads – Apartments – Workdays

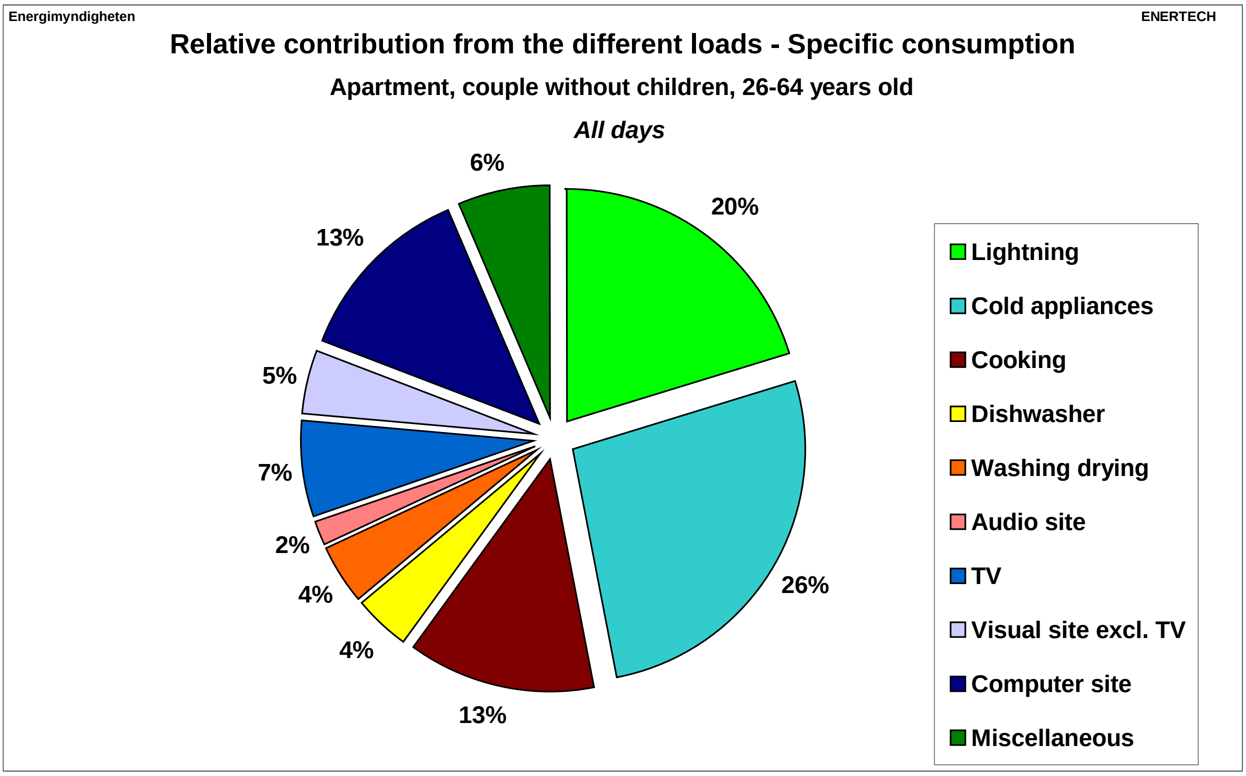


Figure 2.155: Relative contribution from the different loads for the specific consumption– Apartments – All days

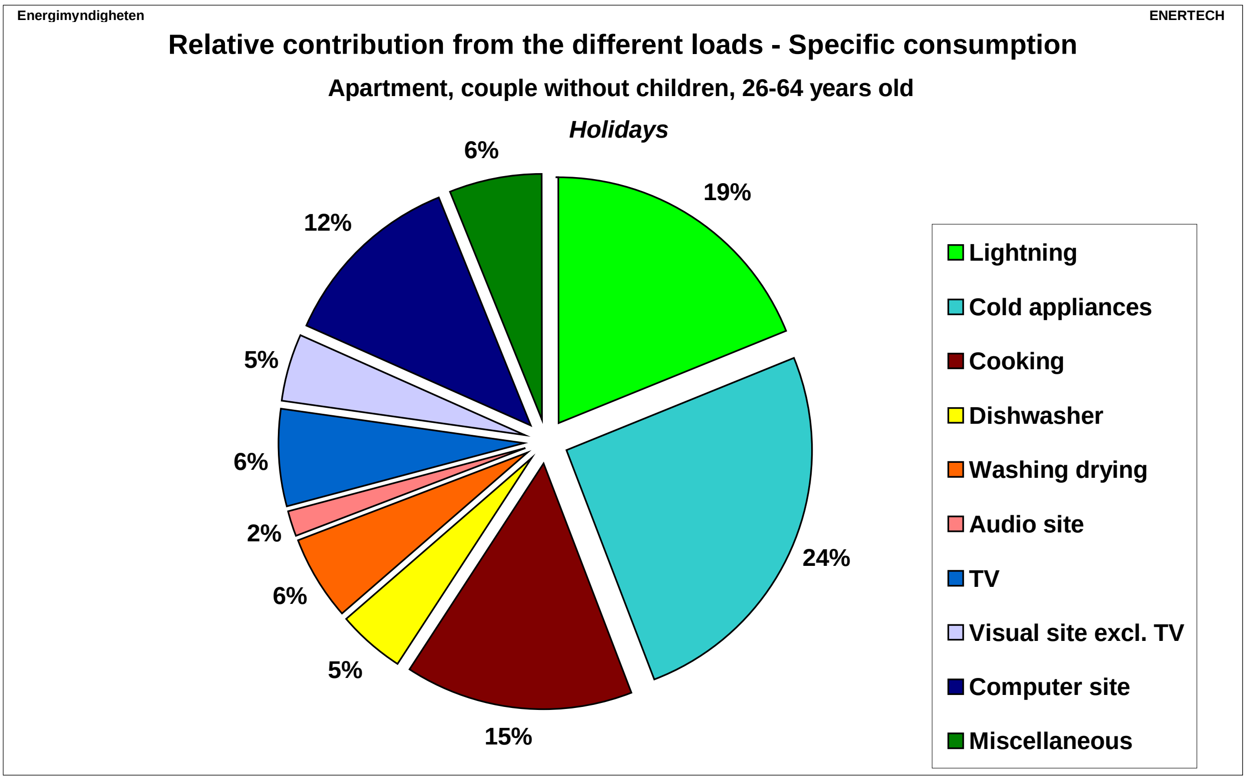


Figure 2.156: Relative contribution from the different loads for the specific consumption– Apartments – Holidays

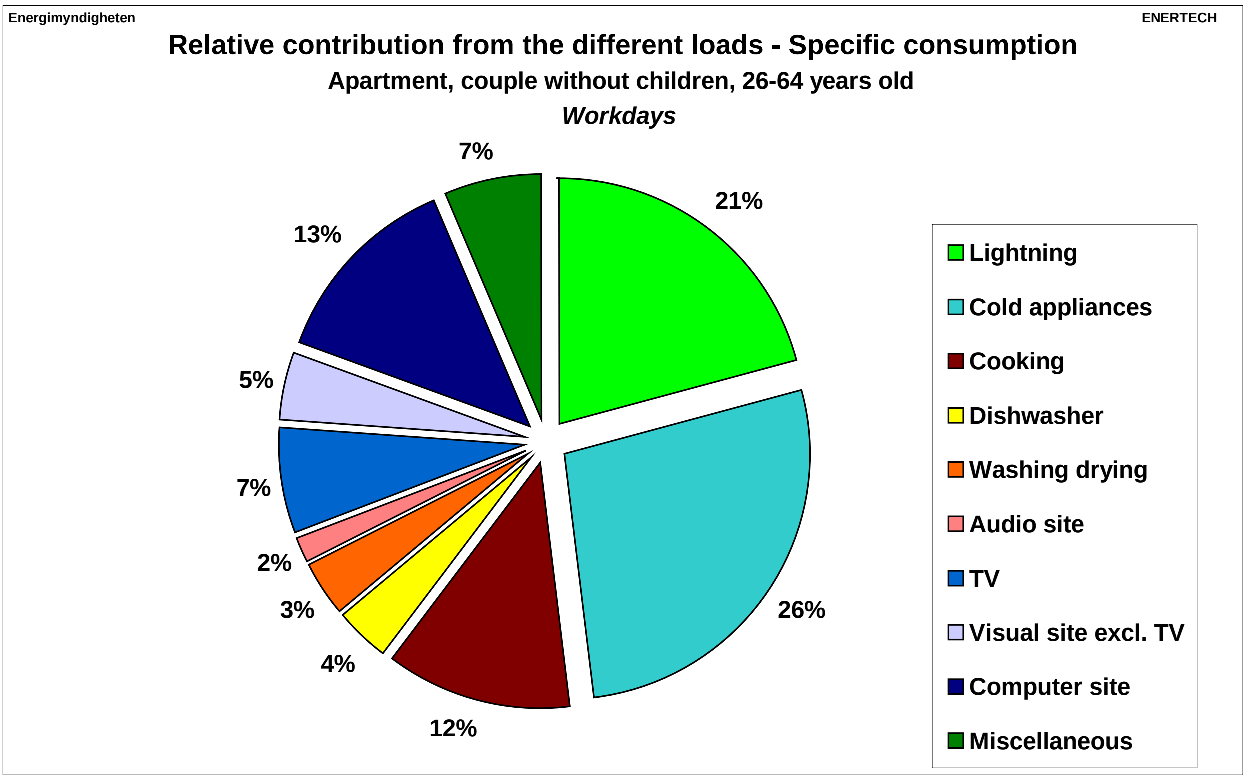


Figure 2.157: Relative contribution from the different loads for the specific consumption– Apartments – Workdays

Couples without children, 64 years old and above

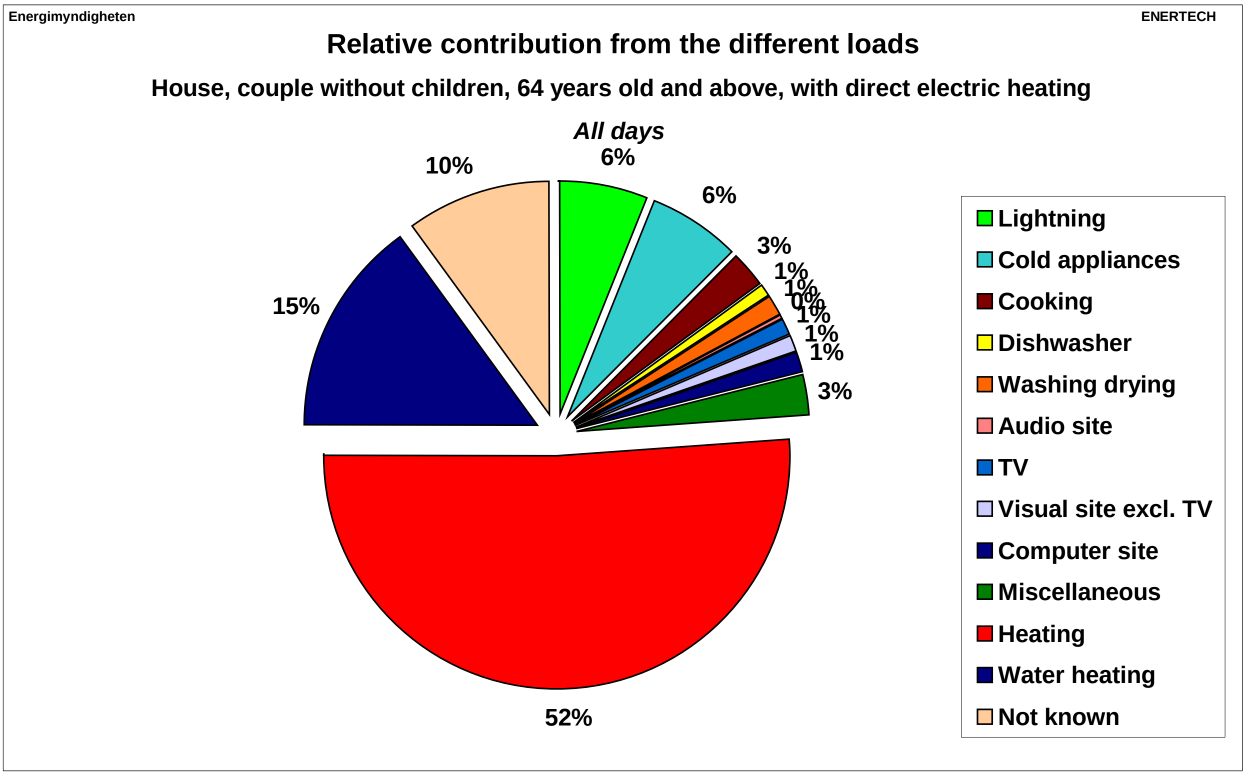


Figure 2.158: Relative contribution from the different loads – Houses with direct electric heating – All days

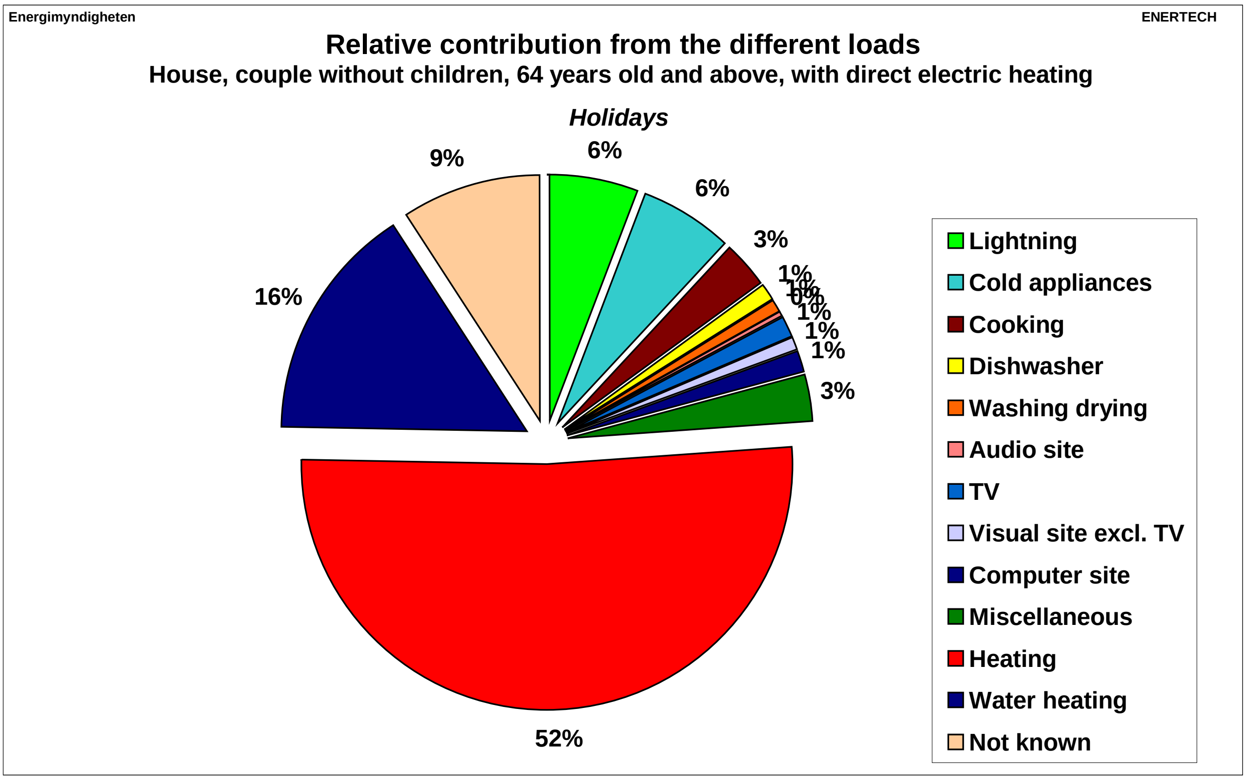


Figure 2.159: Relative contribution from the different loads – Houses with direct electric heating – Holidays

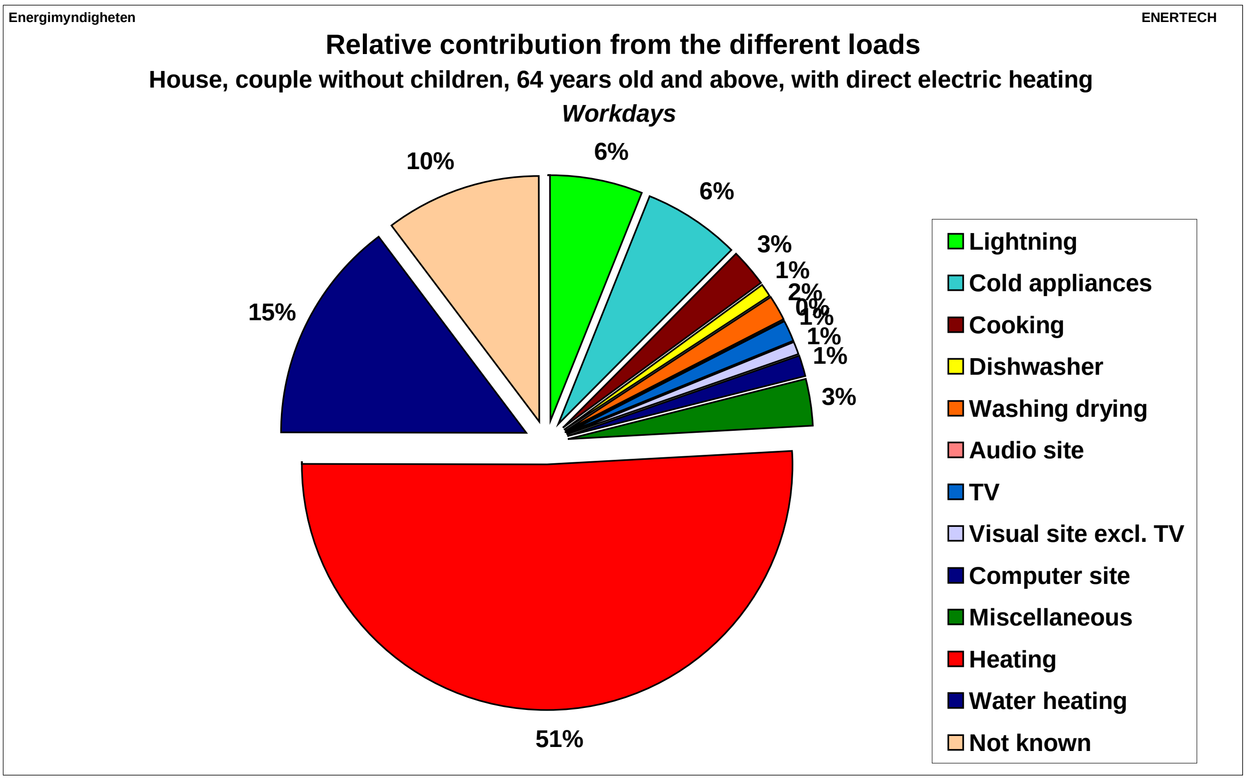


Figure 2.160: Relative contribution from the different loads – Houses with direct electric heating – Workdays

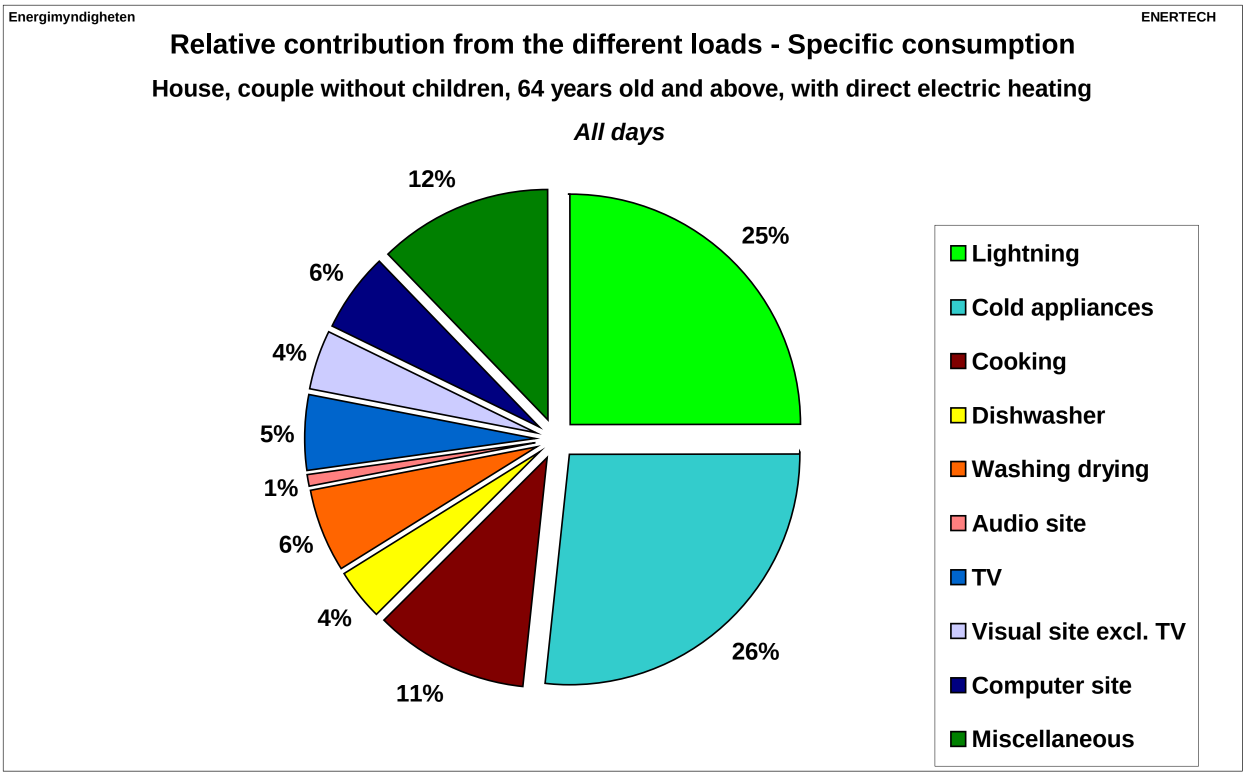


Figure 2.161: Relative contribution from the different loads for the specific consumption– Houses with direct electric heating – All days

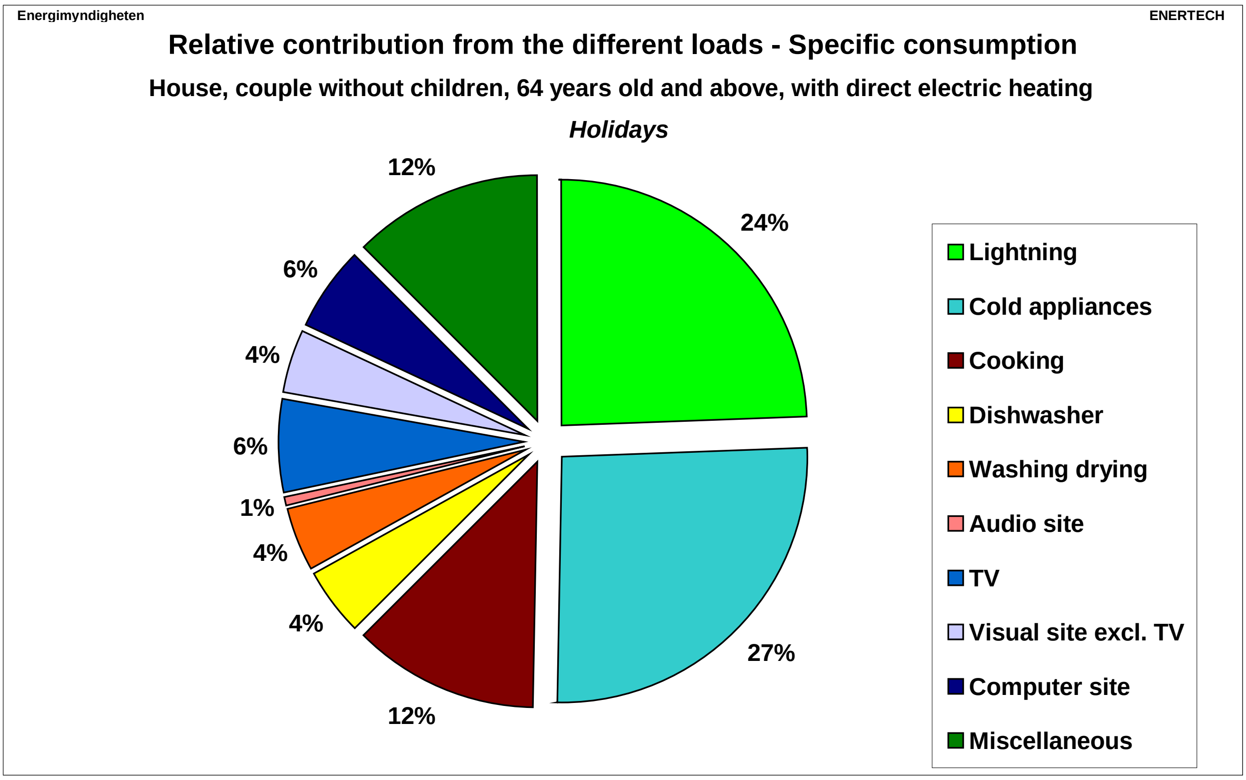


Figure 2.162: Relative contribution from the different loads for the specific consumption– Houses with direct electric heating – Holidays

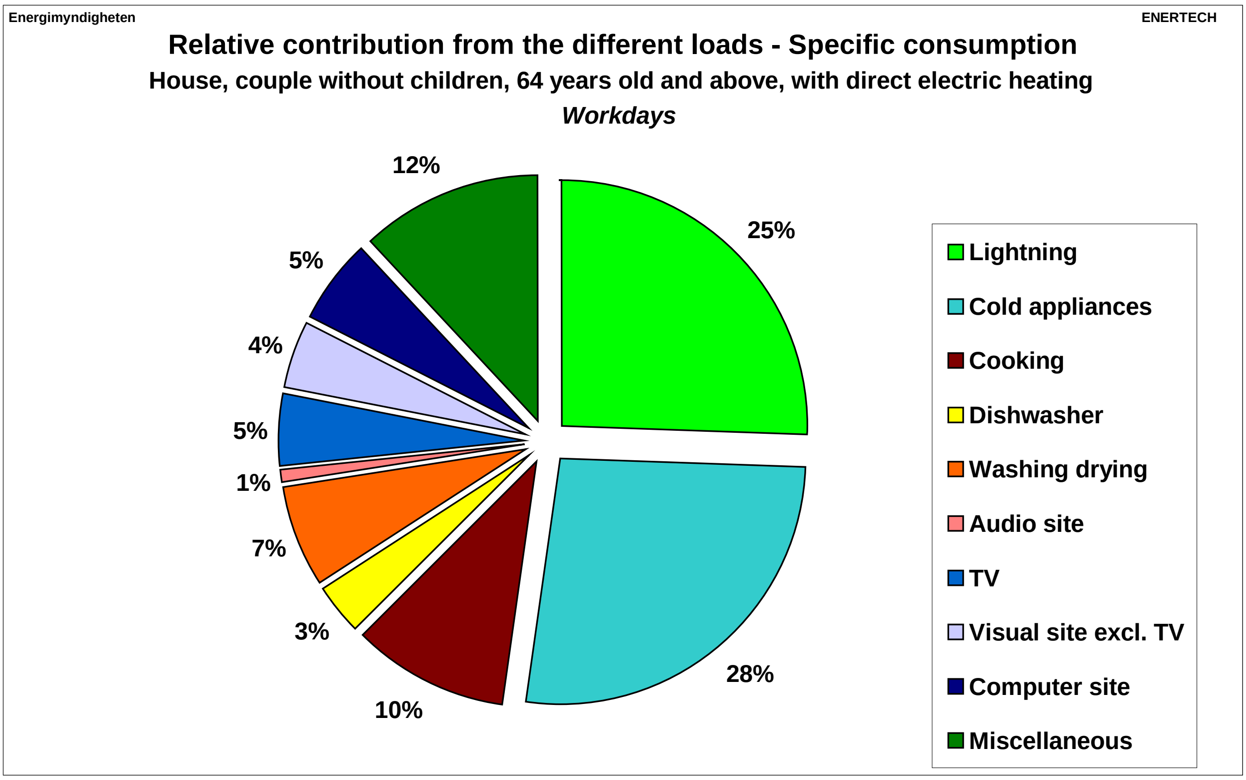


Figure 2.163: Relative contribution from the different loads for the specific consumption– Houses with direct electric heating – Workdays

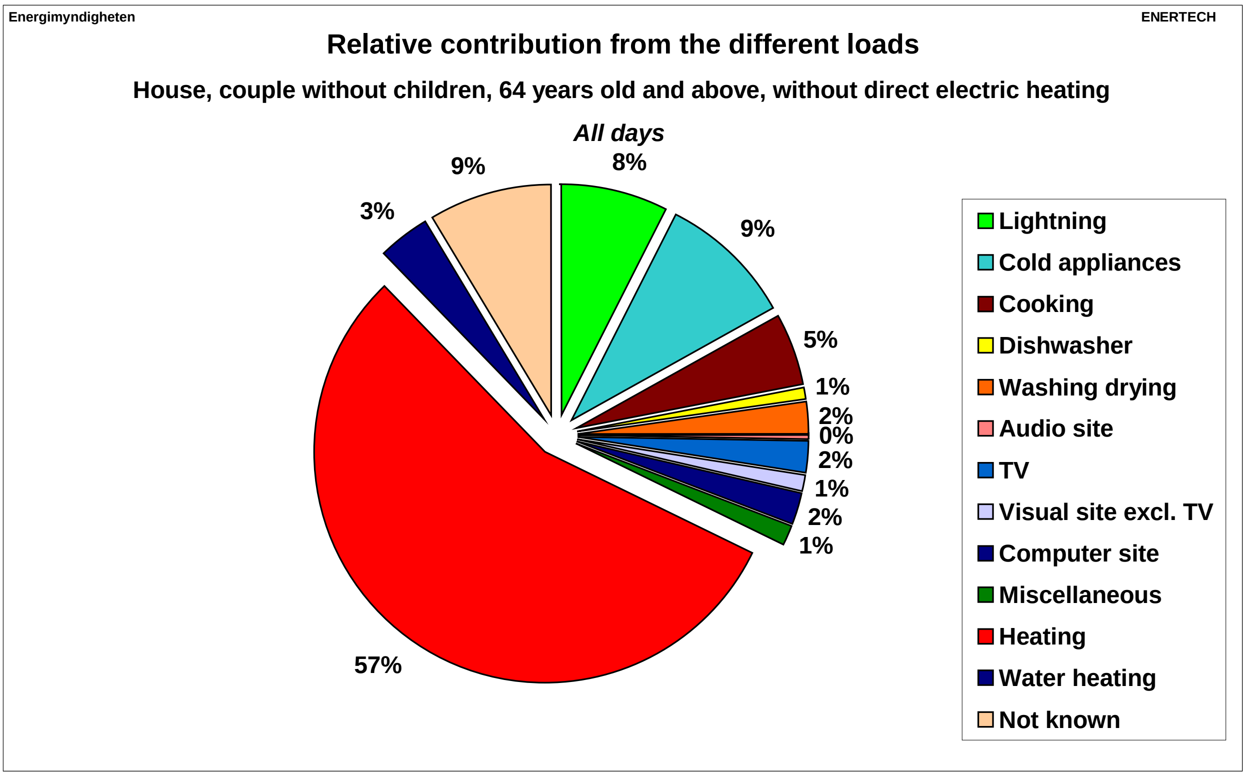


Figure 2.164: Relative contribution from the different loads – Houses without direct electric heating – All days

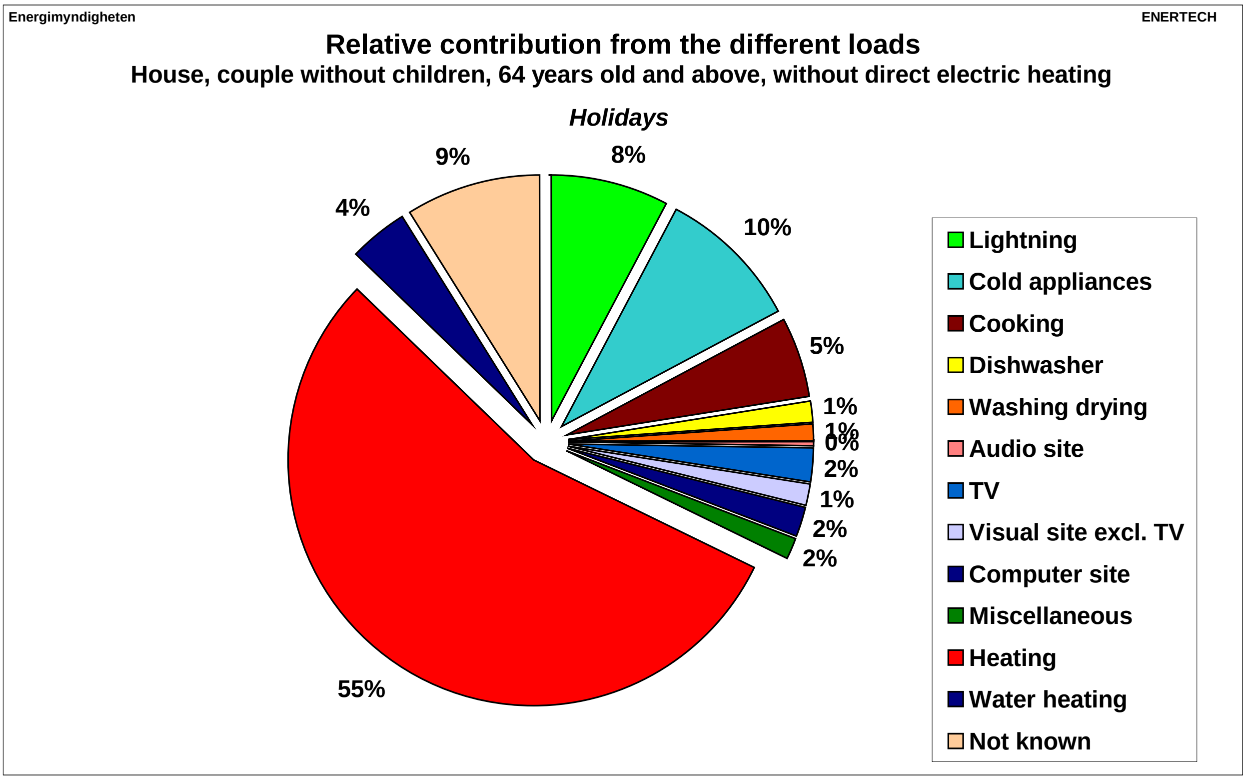


Figure 2.165: Relative contribution from the different loads – Houses without direct electric heating – Holidays

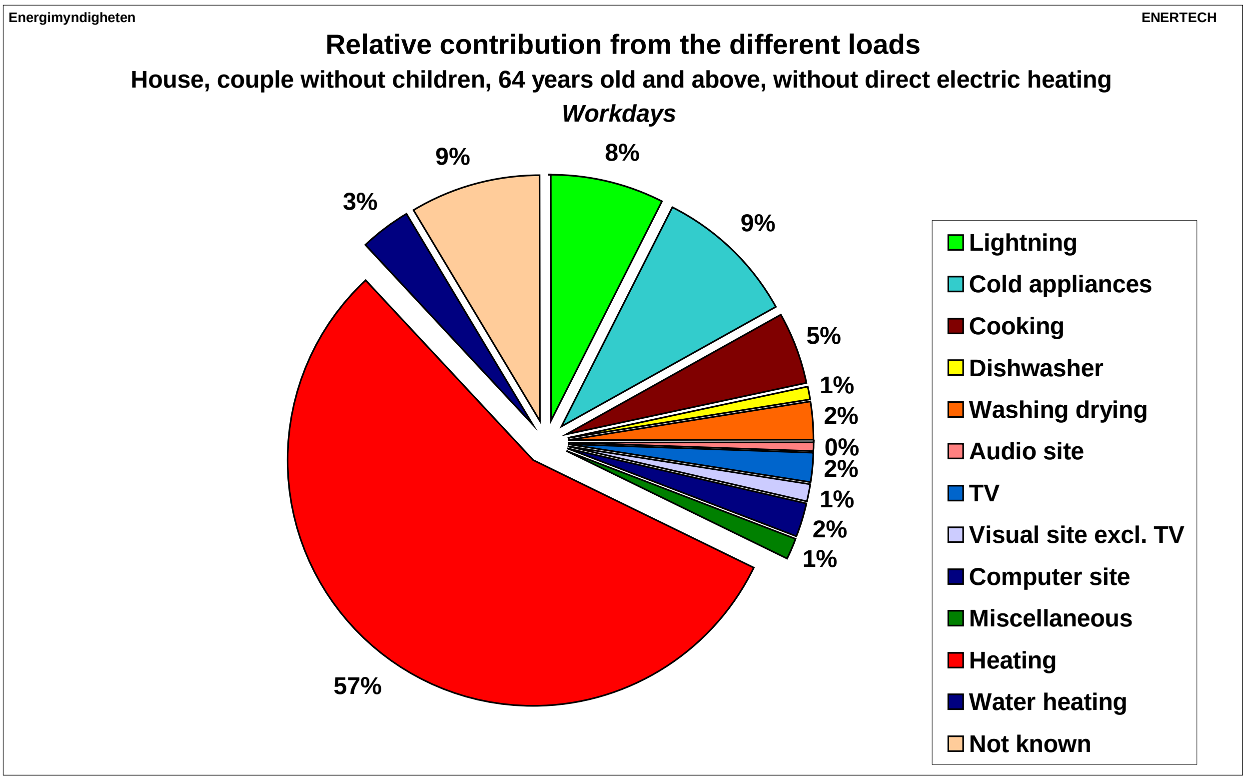


Figure 2.166: Relative contribution from the different loads – Houses without direct electric heating – Workdays

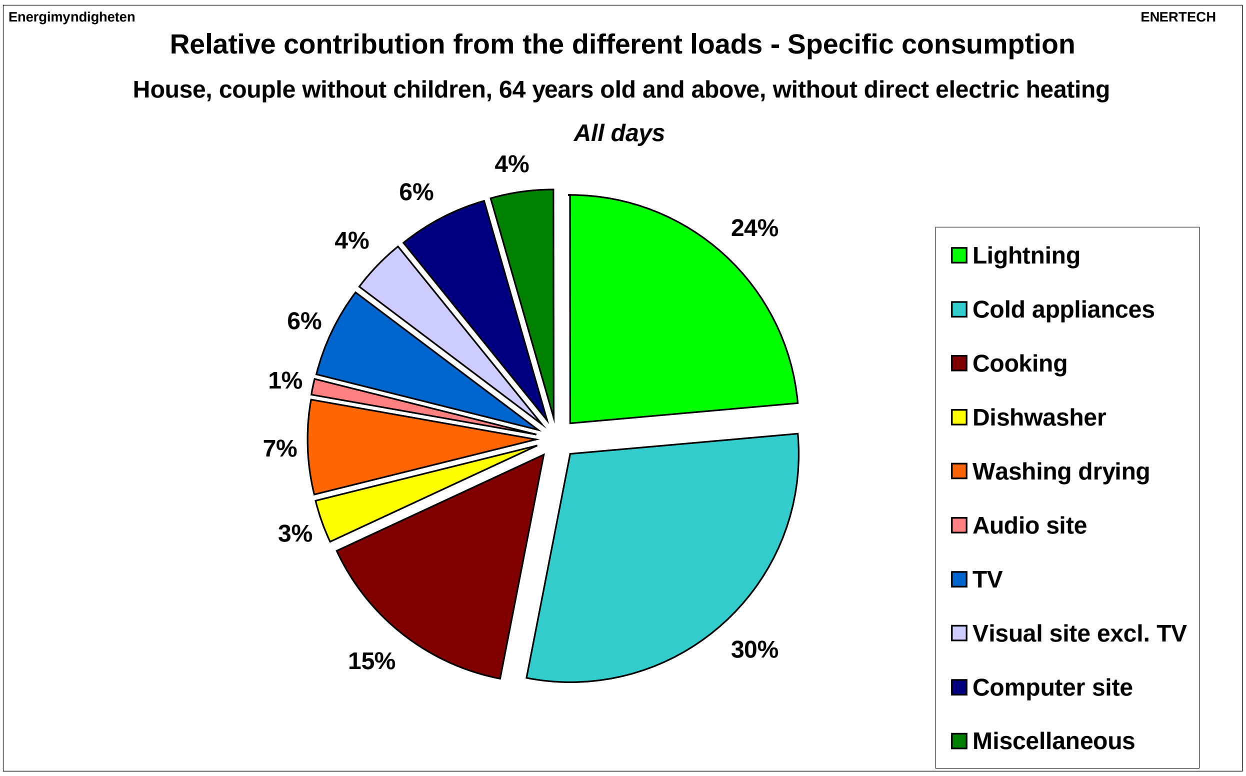


Figure 2.167: Relative contribution from the different loads for the specific consumption– Houses without direct electric heating – All days

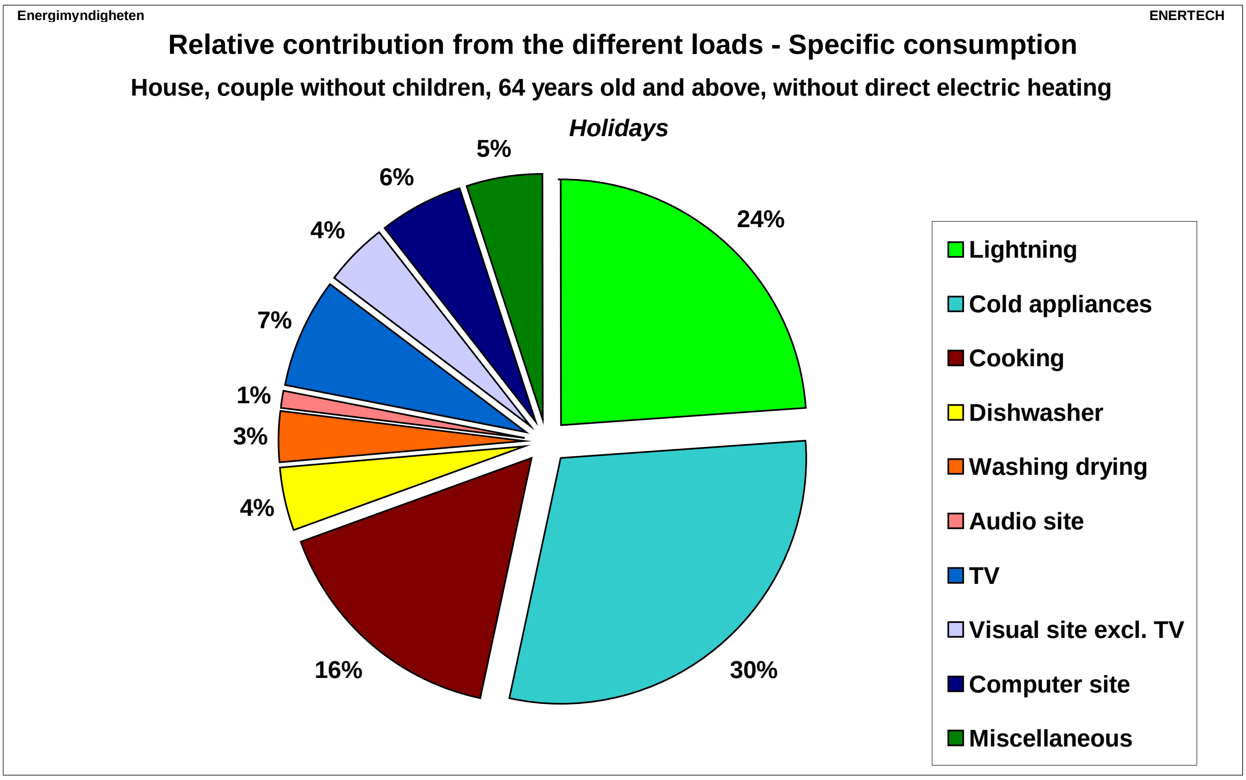


Figure 2.168: Relative contribution from the different loads for the specific consumption– Houses without direct electric heating – Holidays

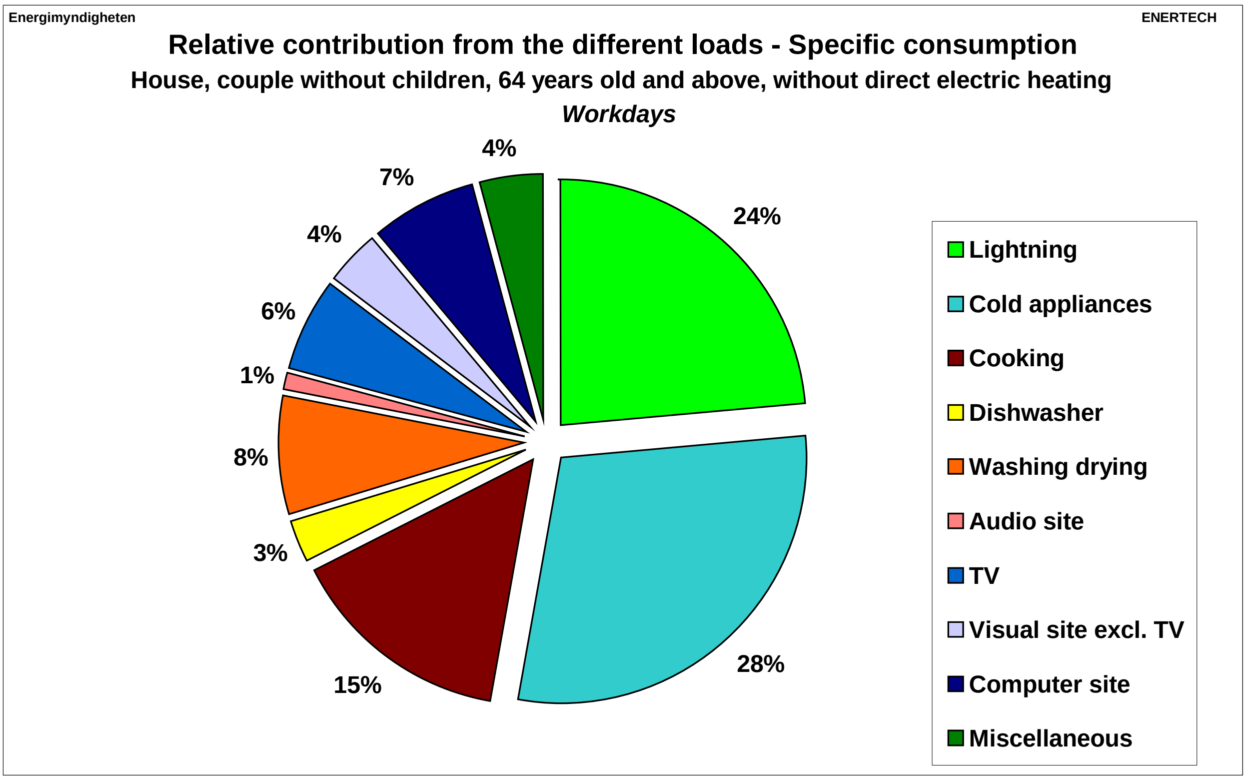


Figure 2.169: Relative contribution from the different loads for the specific consumption– Houses without direct electric heating – Workdays

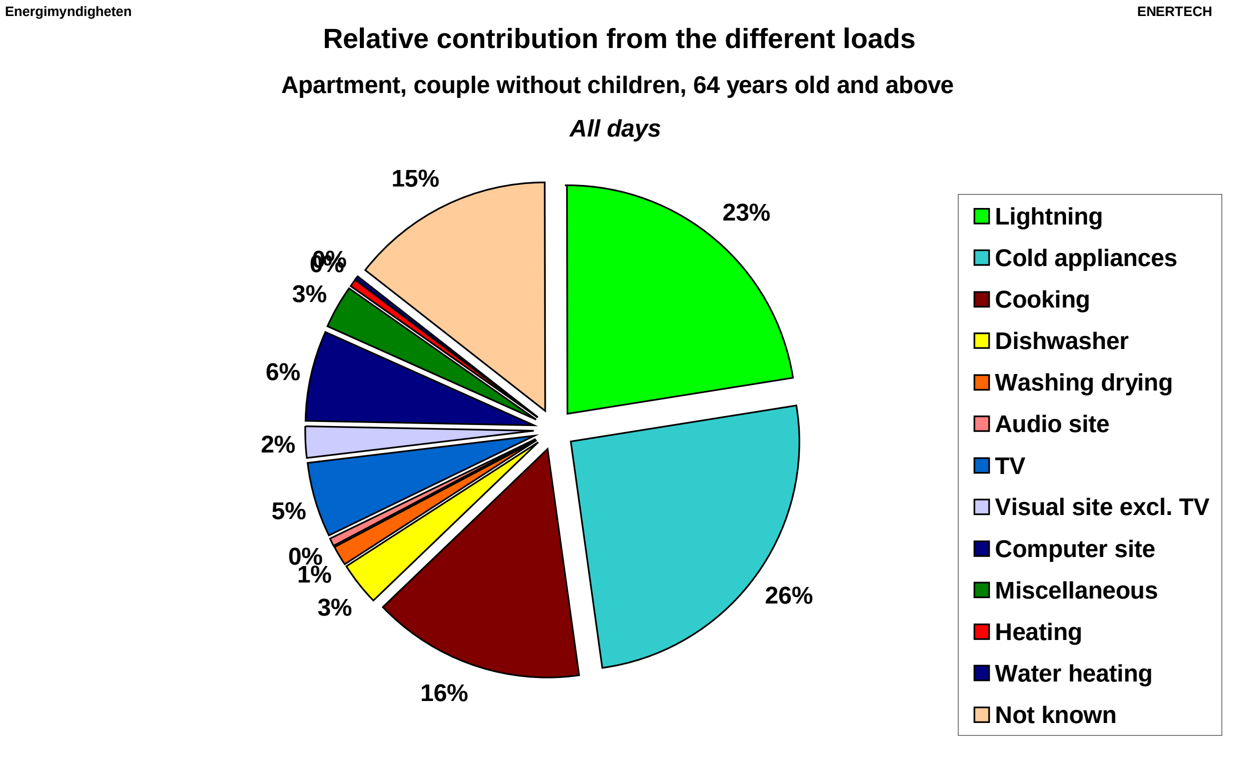


Figure 2.170: Relative contribution from the different loads – Apartments – All days

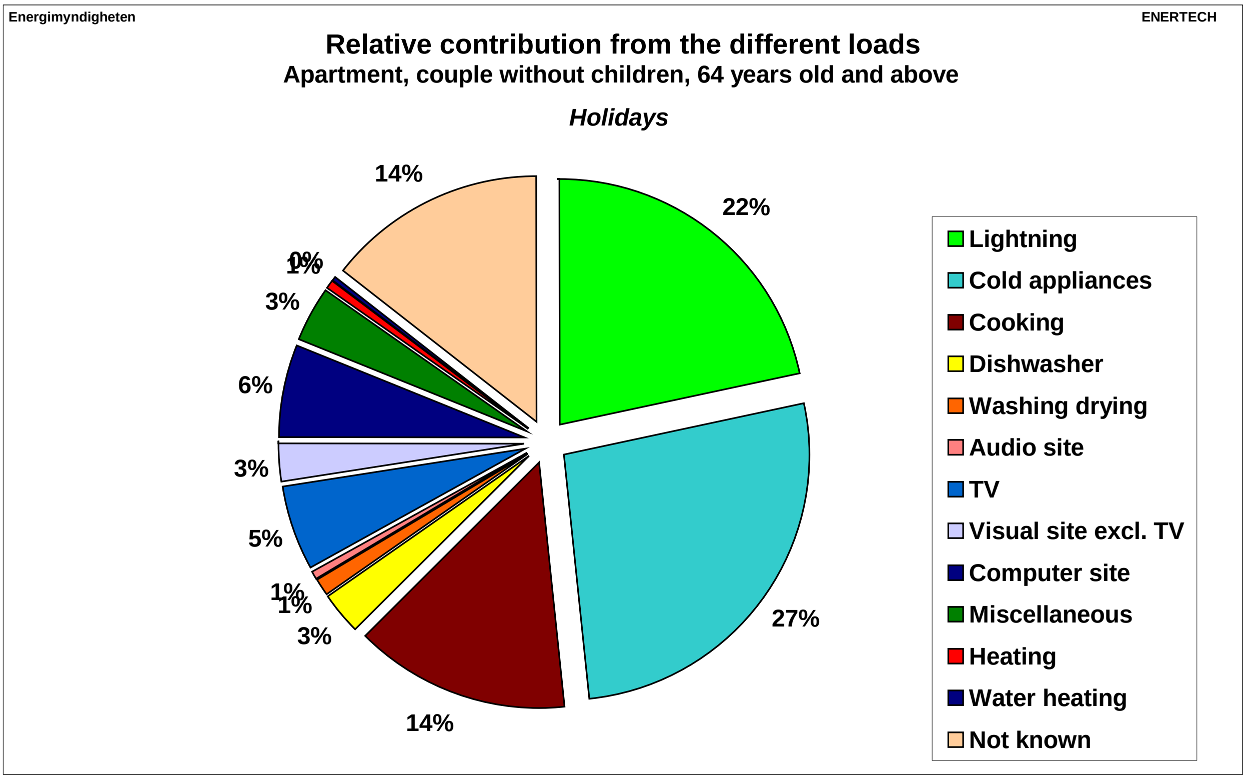


Figure 2.171: Relative contribution from the different loads – Apartments – Holidays

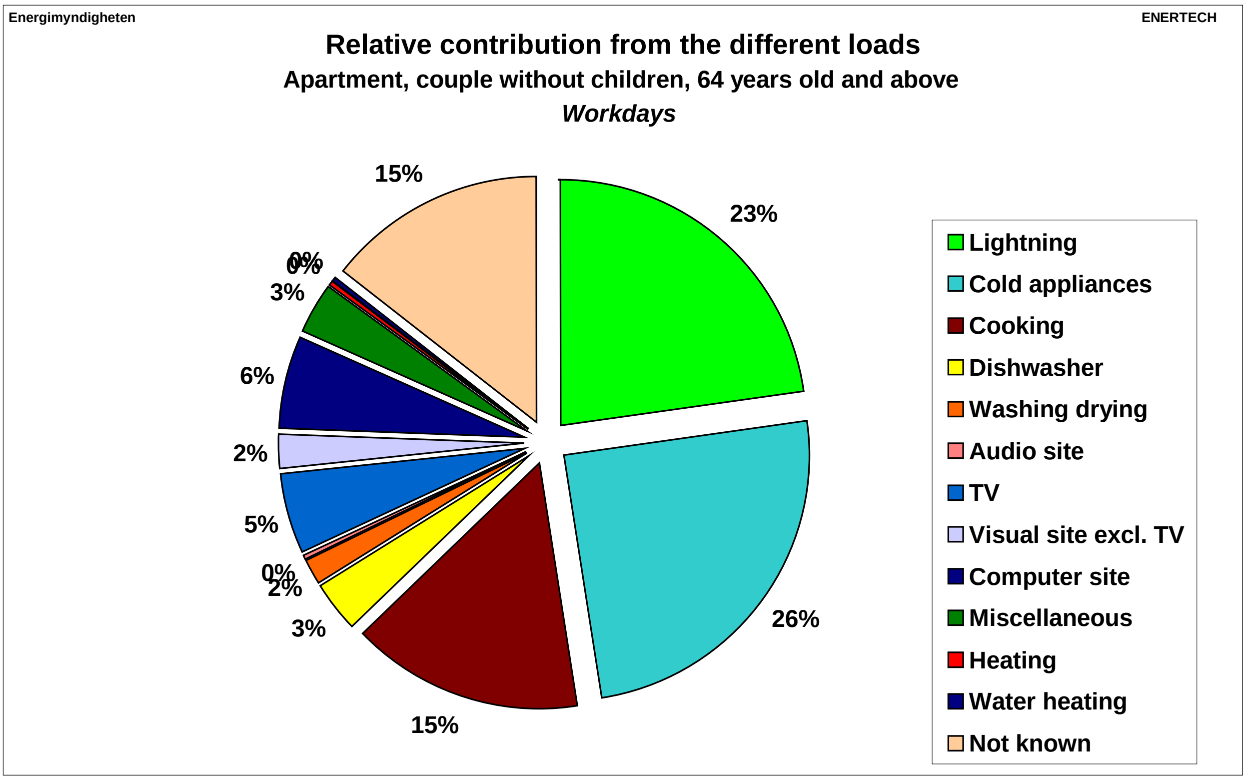


Figure 2.172: Relative contribution from the different loads – Apartments – Workdays

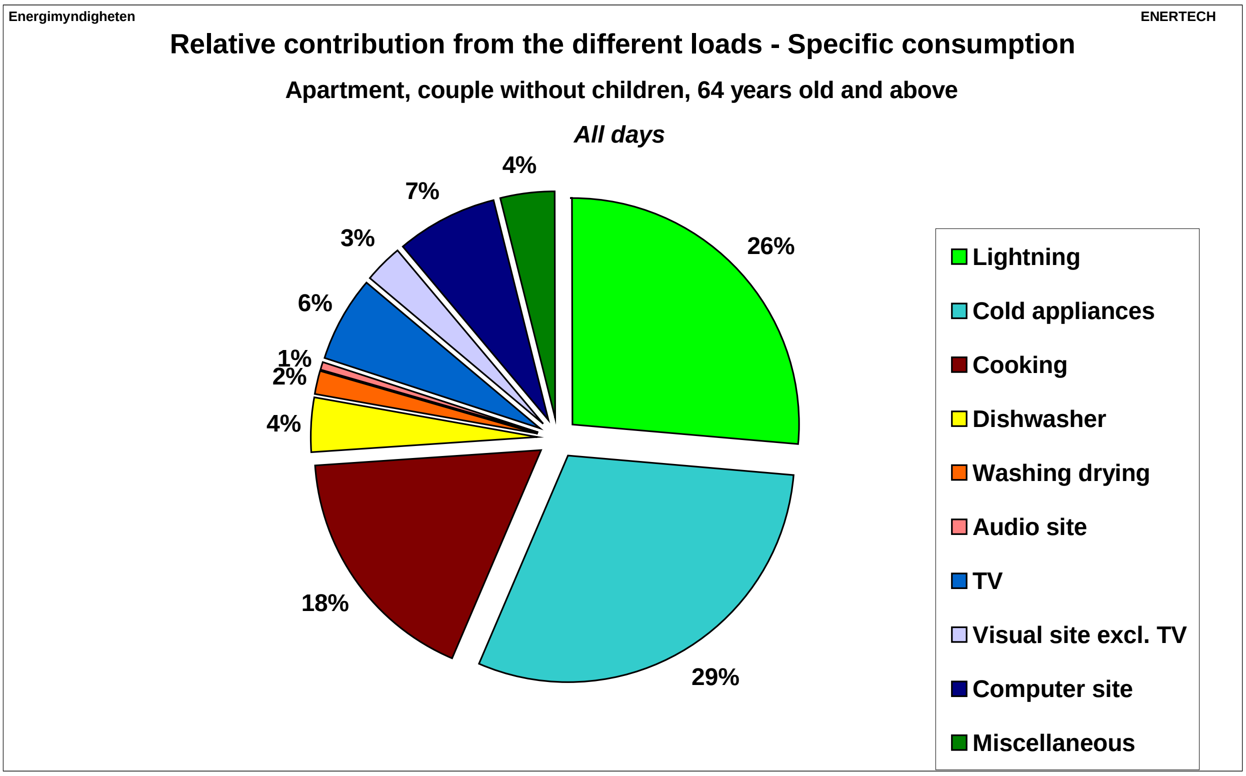


Figure 2.173: Relative contribution from the different loads for the specific consumption– Apartments – All days

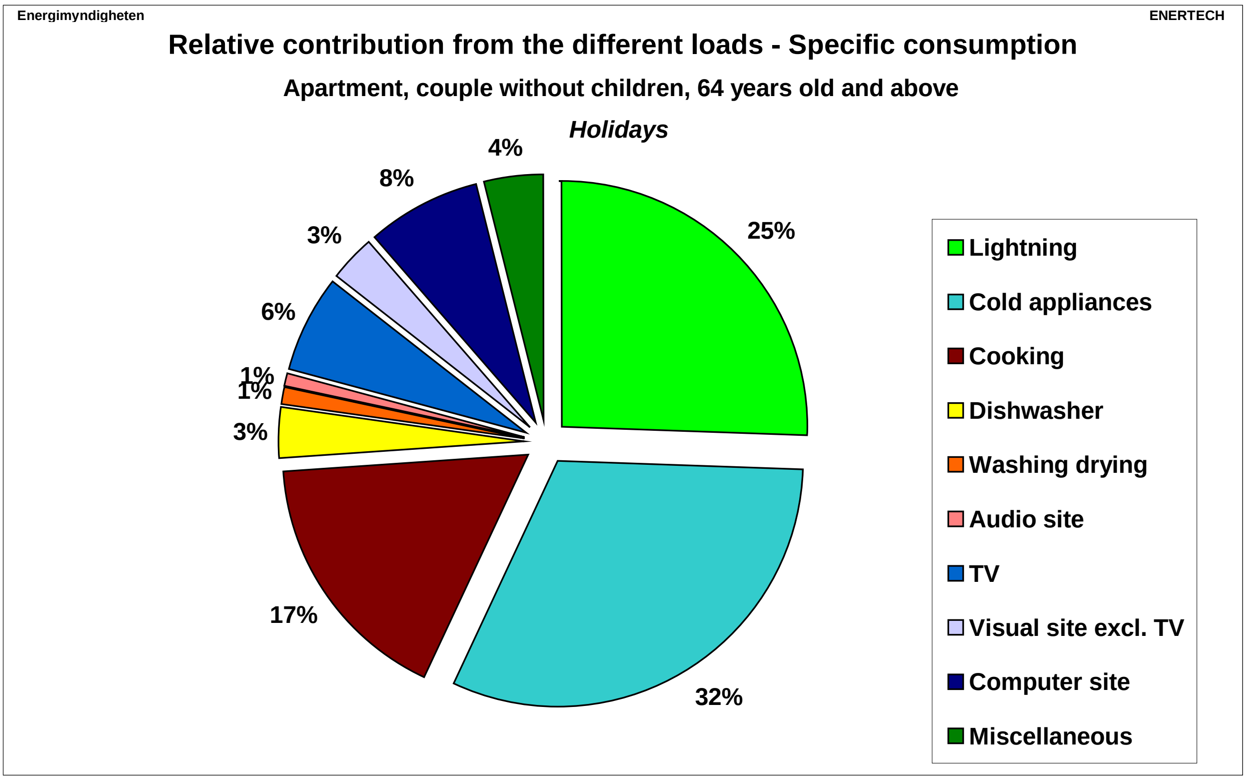


Figure 2.174: Relative contribution from the different loads for the specific consumption– Apartments – Holidays

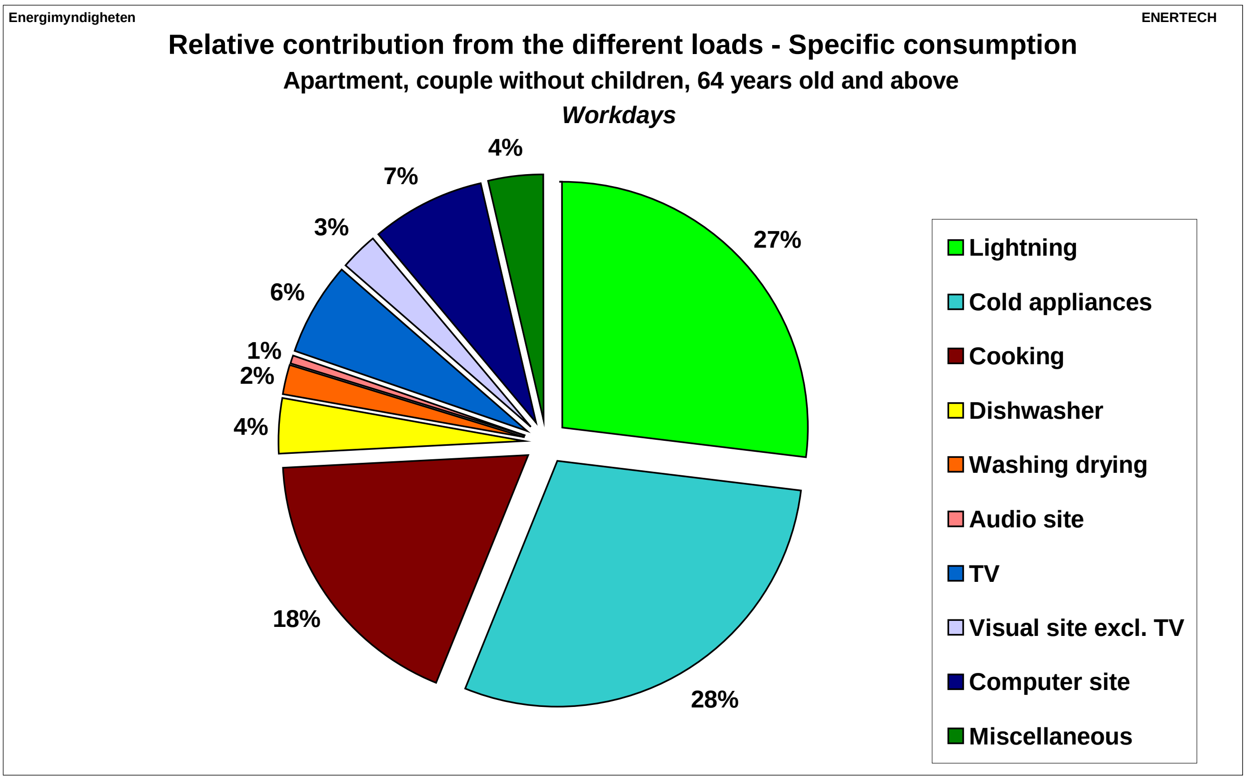


Figure 2.175: Relative contribution from the different loads for the specific consumption– Apartments – Workdays

Single person, 26-64 years old

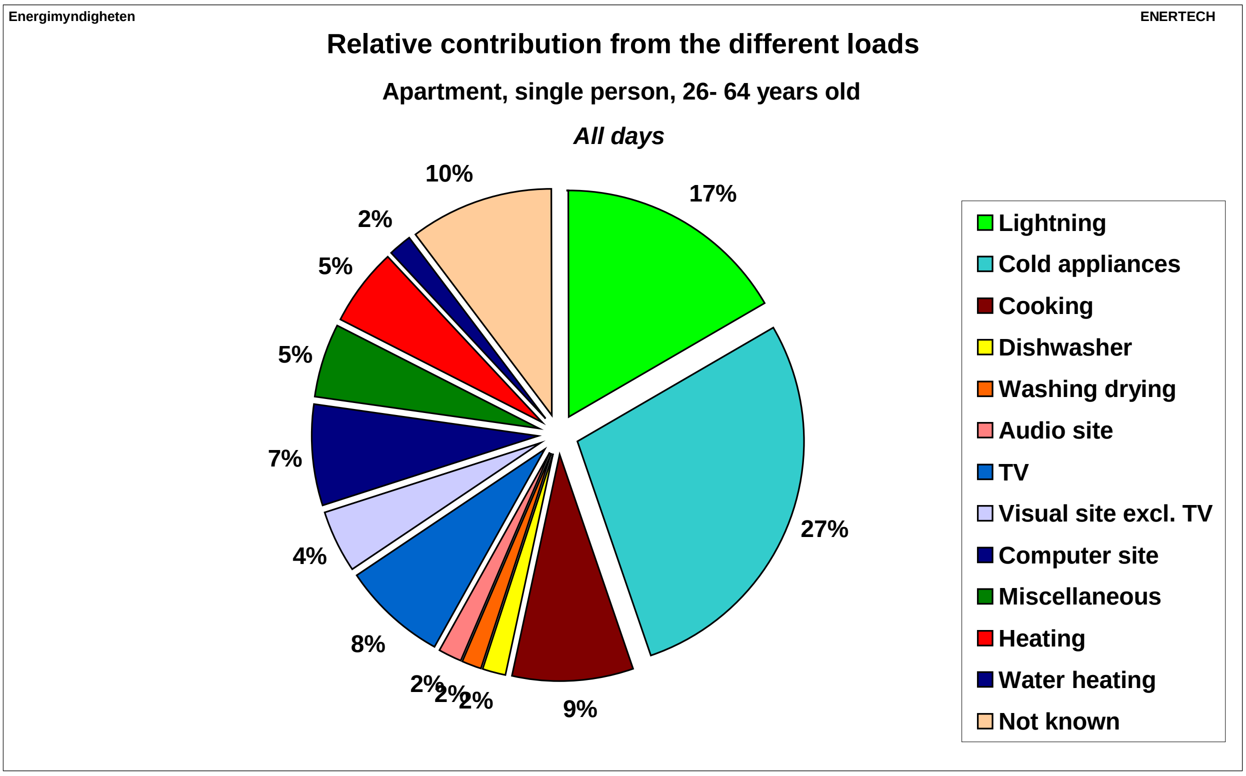


Figure 2.176: Relative contribution from the different loads – Apartments – All days

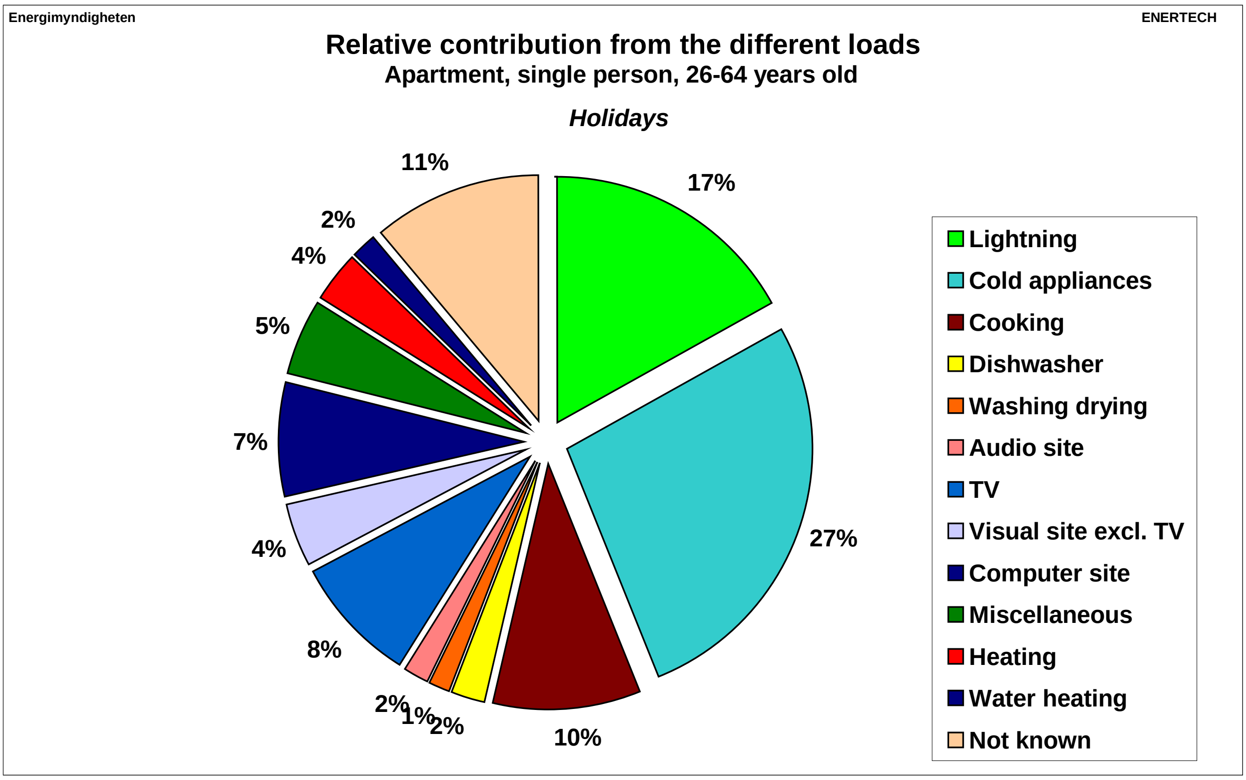


Figure 2.177: Relative contribution from the different loads – Apartments – Holidays

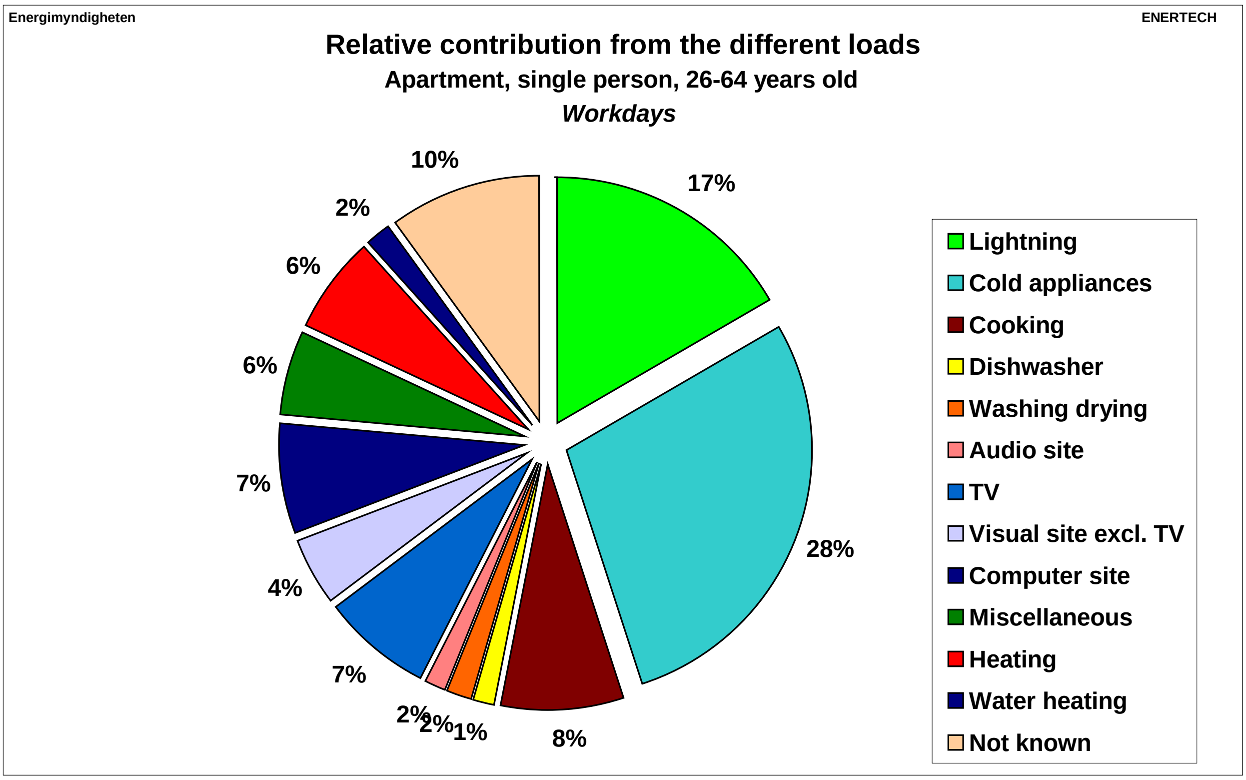


Figure 2.178: Relative contribution from the different loads – Apartments – Workdays

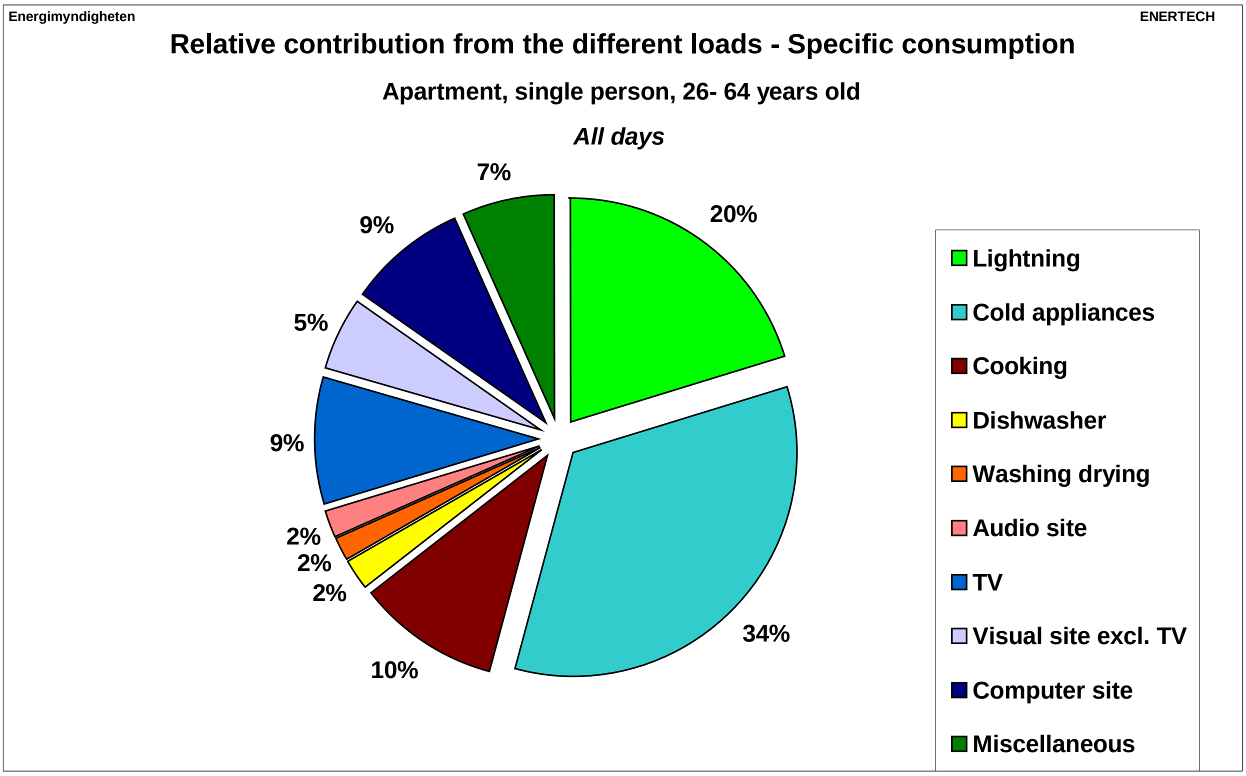


Figure 2.179: Relative contribution from the different loads for the specific consumption– Apartments – All days

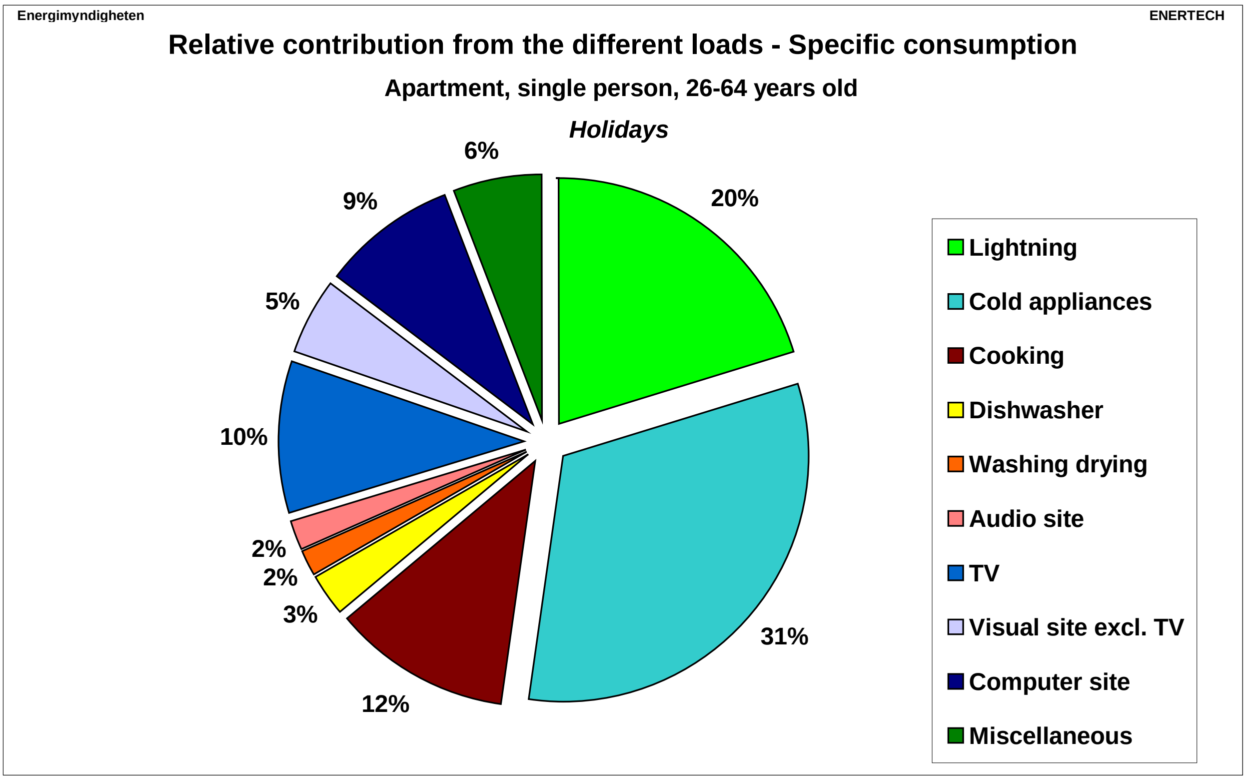


Figure 2.180: Relative contribution from the different loads for the specific consumption– Apartments – Holidays

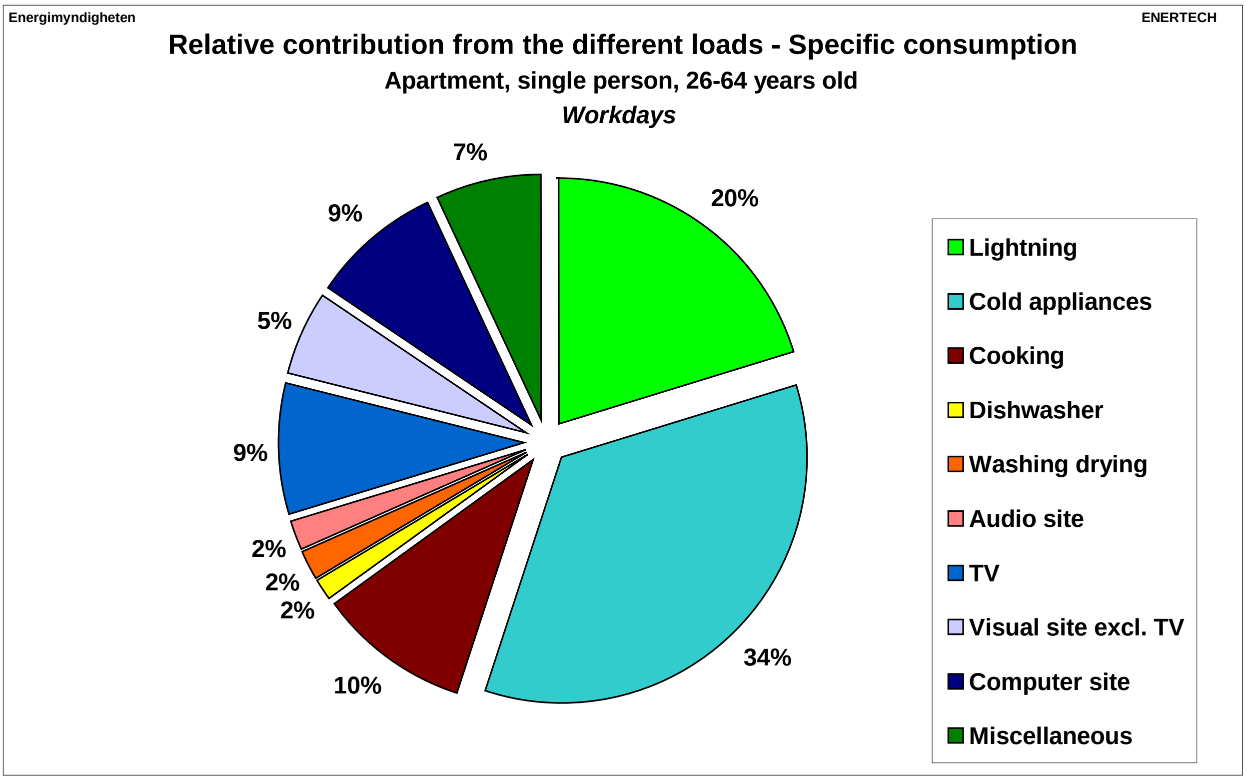


Figure 2.181: Relative contribution from the different loads for the specific consumption– Apartments – Workdays

Single person, 64 years old and above

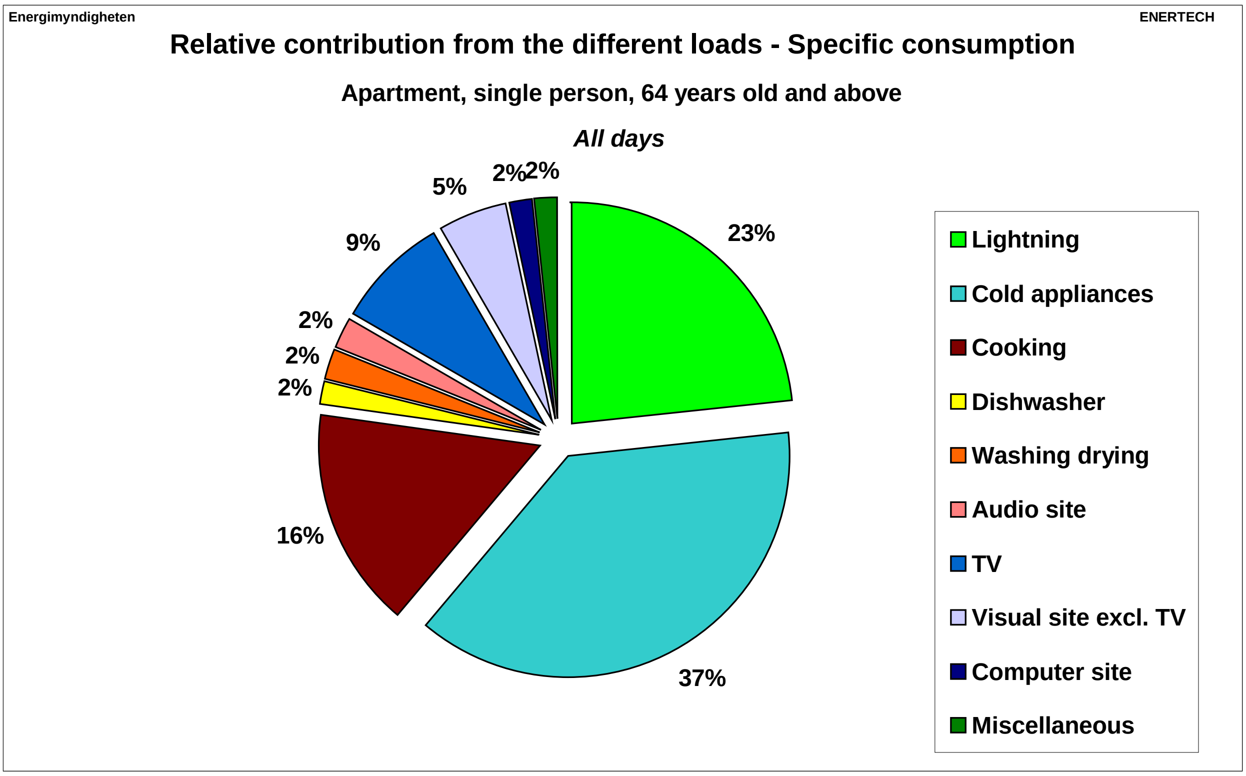


Figure 2.185: Relative contribution from the different loads for the specific consumption– Apartments – All days

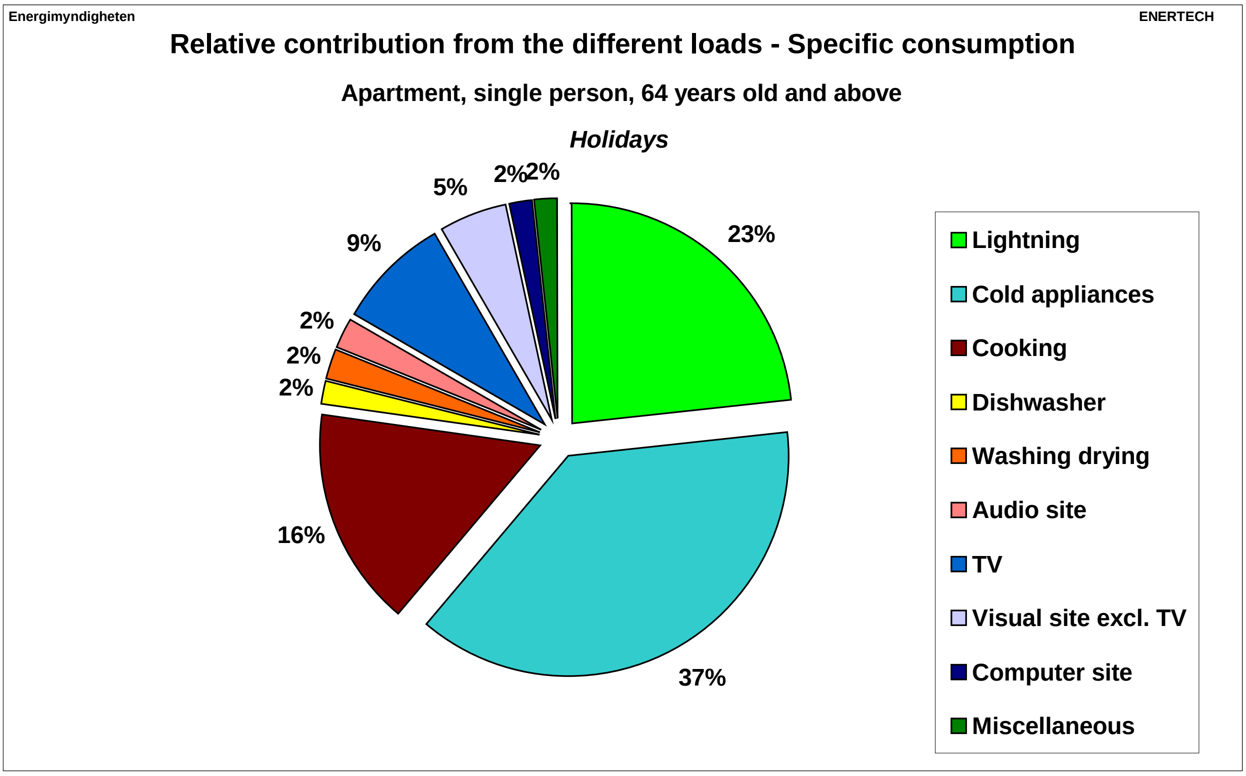


Figure 2.186: Relative contribution from the different loads for the specific consumption– Apartments – Holidays

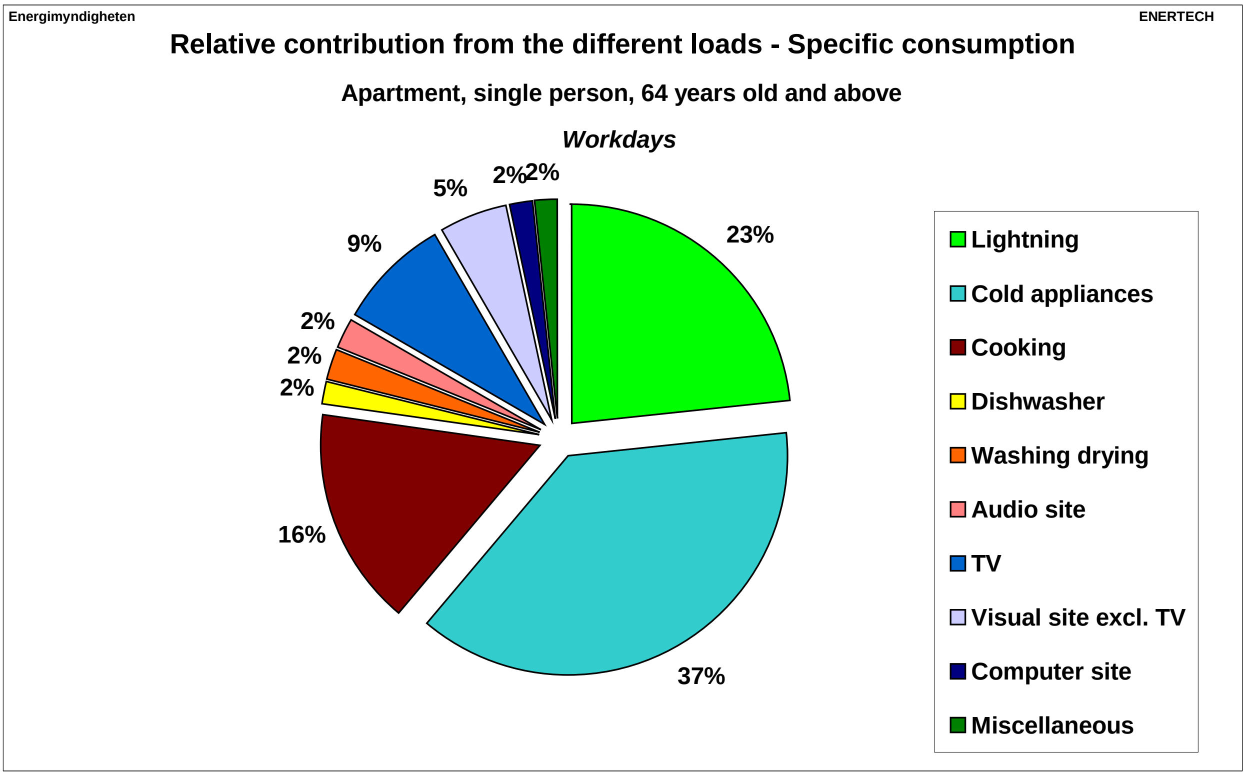


Figure 2.187: Relative contribution from the different loads for the specific consumption– Apartments – Workdays

COLD DOMESTIC APPLIANCES

Average possession of appliances

Figure 2.188-A and 2.188-B show the average number of cold appliances for houses and apartments. There are more cold appliances in the houses than in apartments: 1,89 and 1,33 respectively. Fridges and vertical freezers are most installed in the houses, fridge-freezers are more present in apartments.

The table from figure 2.188-C show the same type of results but per type of household. The number between brackets indicates the number of households used to calculate the average possession so the results for the last two categories has to be treated with care as only 3 and 4 households were analysed.

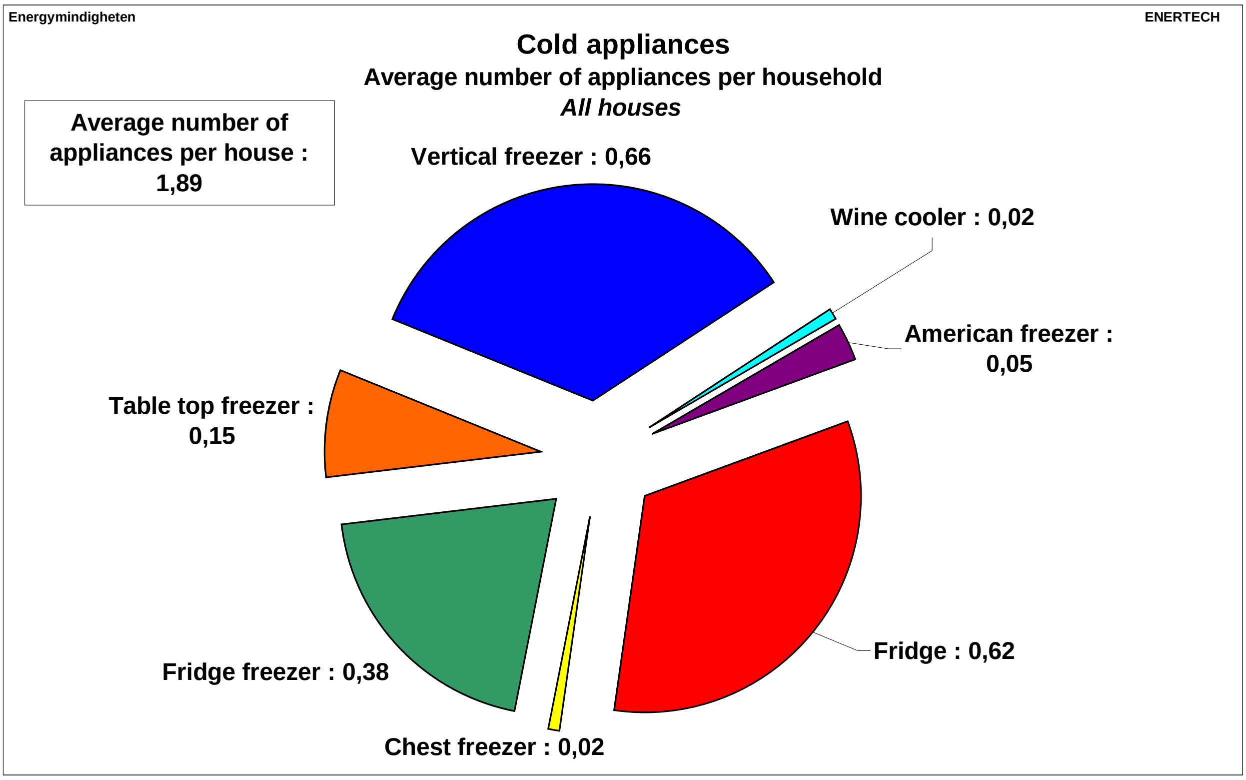


Figure 2.188-A: Average number of cold appliances – All houses

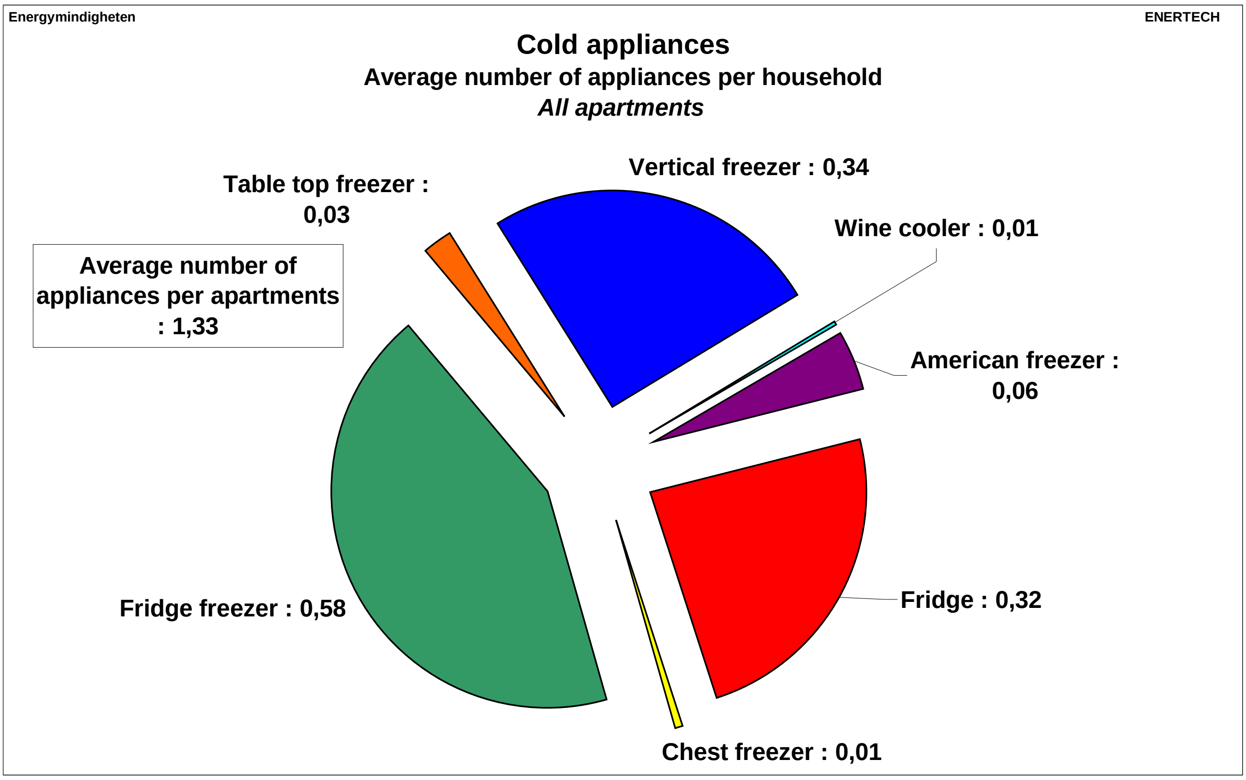


Figure 2.188-B: Average number of cold appliances – All apartments

	American freezer	Fridge	Chest freezer	Fridge freezer	Table top freezer	Vertical freezer	Wine cooler	Average number of appliances
Apartment, couples without children, 26-64 years old (41)	0,00	0,34	0,02	0,61	0,02	0,34	0,00	***1,3***
Apartment, couples without children, 64 years old and above (14)	0,00	0,43	0,00	0,57	0,07	0,50	0,00	***1,6***
Apartment, family, 26-64 years old (81)	0,05	0,35	0,00	0,54	0,04	0,42	0,01	***1,4***
Apartment, single person, 26-64 years old (41)	0,12	0,22	0,00	0,63	0,00	0,15	0,00	***1,1***
Apartment, single person, 64 years old and above (10)	0,20	0,20	0,00	0,60	0,00	0,20	0,00	***1,2***
House, couples without children, 26-64 years old (46)	0,04	0,74	0,04	0,33	0,11	0,74	0,02	***2,0***
House, couples without children, 64 years old and above (21)	0,05	0,48	0,05	0,57	0,14	0,52	0,00	***1,8***
House, family, 26-64 years old (125)	0,06	0,62	0,00	0,37	0,18	0,66	0,02	***1,9***
House, single person, 26-64 years old (3)	0,00	0,67	0,00	0,33	0,00	1,00	0,00	***2,0***
House, single person, 64 years old and above (4)	0,00	0,25	0,00	0,50	0,00	0,25	0,00	***1,0***

Figure 2.188-C: Average number of cold appliances – Per type of household

** The number between brackets represents the number of households*

Seasonality effect

The consumption of cold appliances is strongly seasonal, but most of the households were only monitored for one month. The seasonality effect was calculated using the 40 households monitored for one year. For each household, we calculated the weekly consumption by adding all the data per week. The result output consists of 52 values per household corresponding to the number of weeks in one year. This set of values were then normalized to 1 (the average value gives one for each set). An average value per week was then calculated using all the data sets. Figure 2.188 represents the seasonality curve calculated by this method. This curve was used to calculate the annual consumption for the appliances monitored for less than six month.

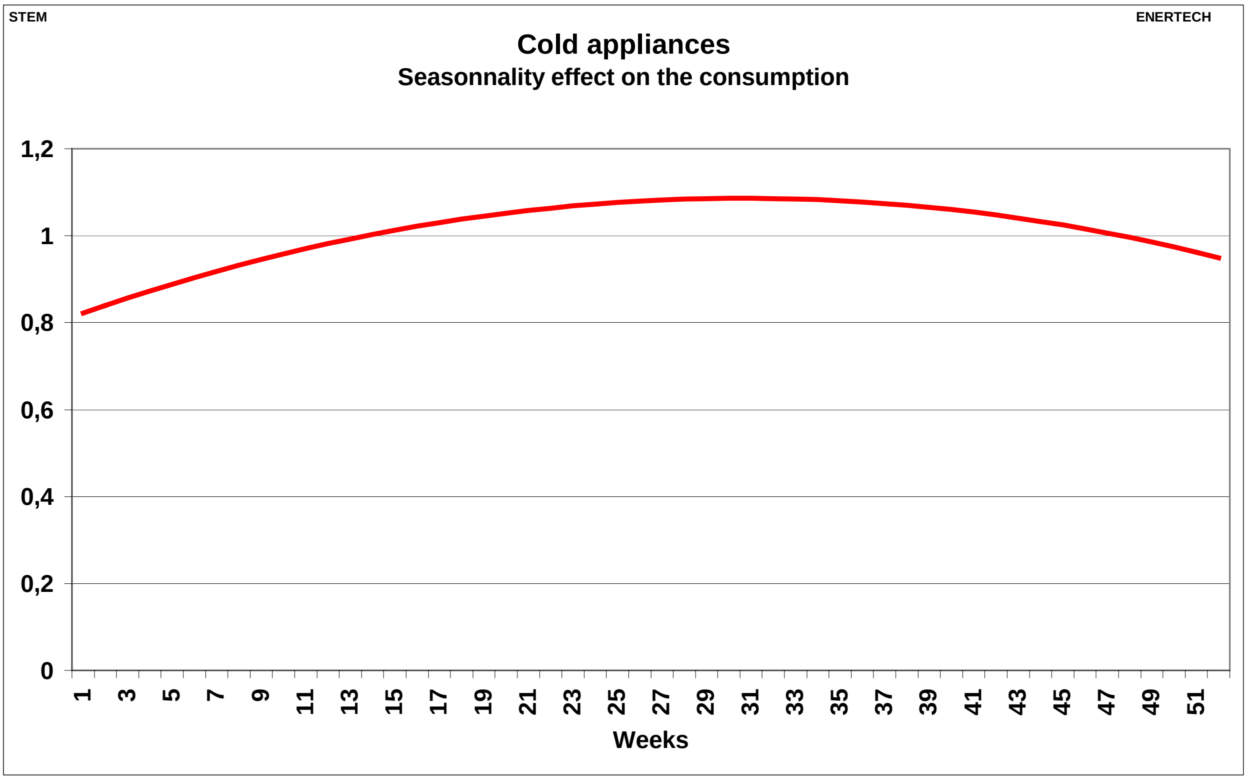


Figure 2.188: Cold appliances: seasonality effect

REFRIGERATORS

Annualized consumption

Figures 2.189 and 2.190 shows the annual consumption per type of household. The consumption goes from 196 to 231 kWh/year for the houses and from 135 to 260 kWh for the apartments. The value of 135 kWh/year can be explained by the small number of appliances (5) used to calculated the mean value. In France, the *Remodece+* monitoring campaign (100 household monitored during one year in 2007) gives us an annual consumption of 253 kWh/year. In Sweden we are near this value in the apartments for families and "couples without children between 26-64 years old" but below in the other types of household. One of the most significant parameters that can explain this difference is the inside temperature of the different cold appliances but this parameter wasn't measured during the monitoring campaign.

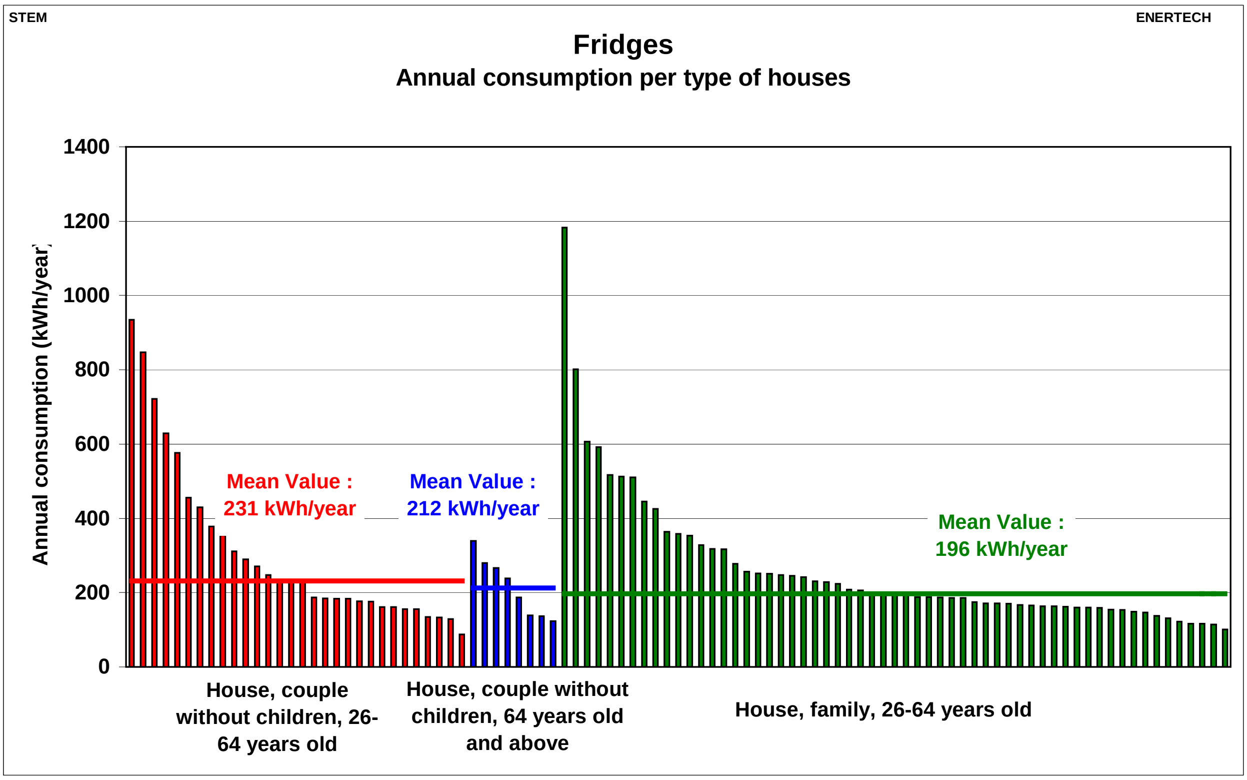


Figure 2.189: Fridges: annual consumption for houses

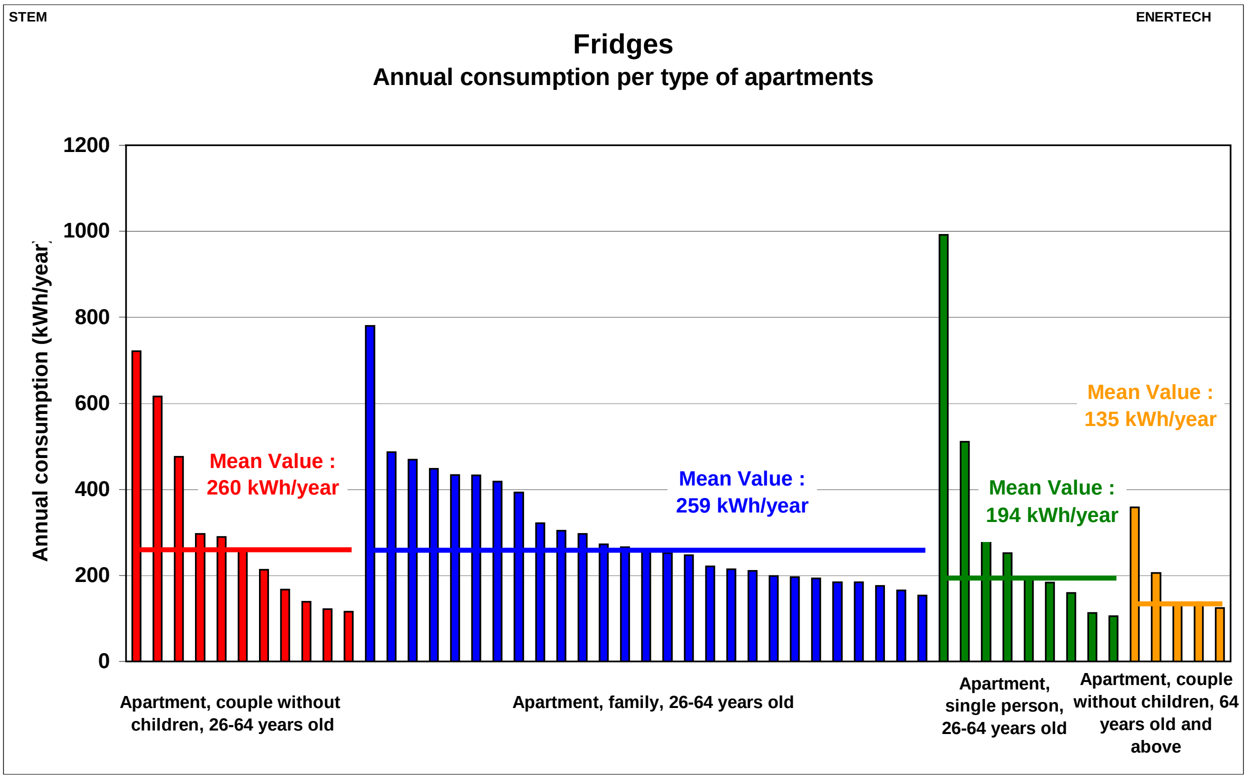


Figure 2.190: Fridges: annual consumption for apartments

Hourly load curve

Figures 2.191 and 2.192 shows the average hourly load curve for houses and apartments. This type of representation allows, for that type of appliance, to determine when it is mostly used over the day by searching for the peak value. The maximum peak is between 18:00 and 20:00 corresponding to the meal time and the presence of the persons in the household.

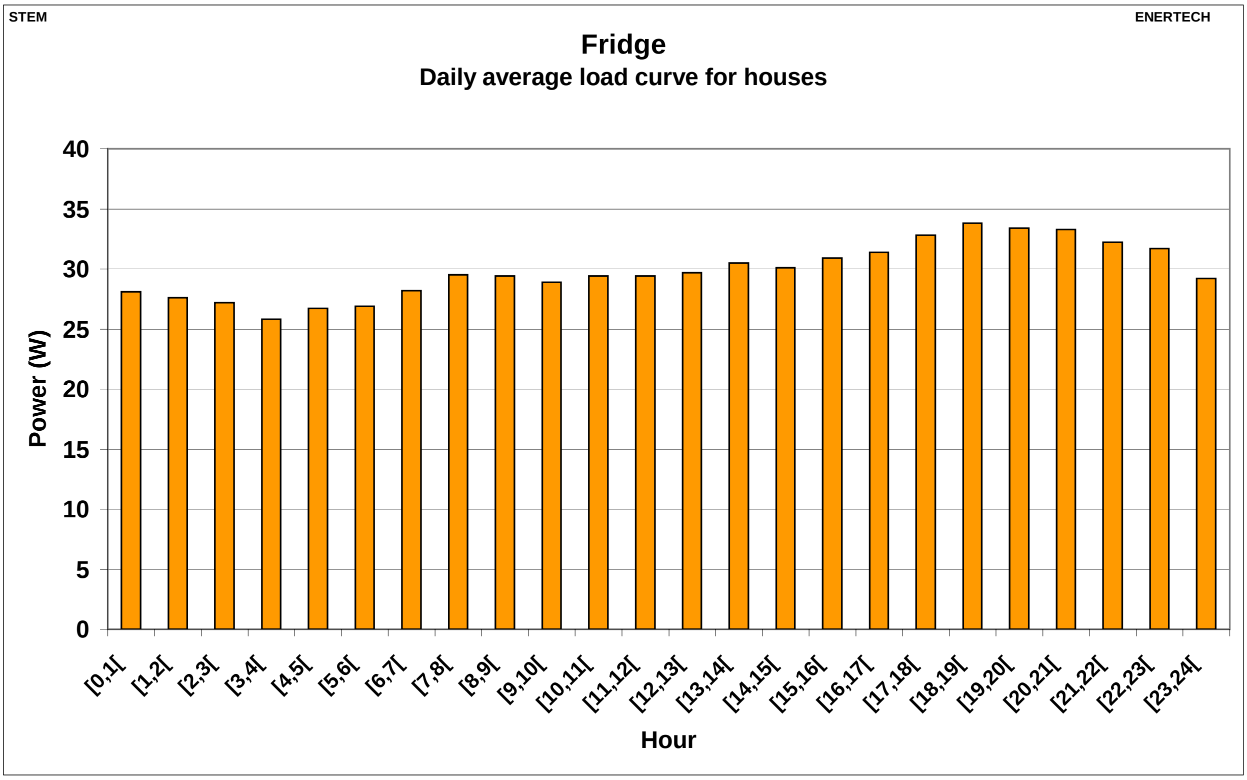


Figure 2.191: Fridges: daily average load curve for houses

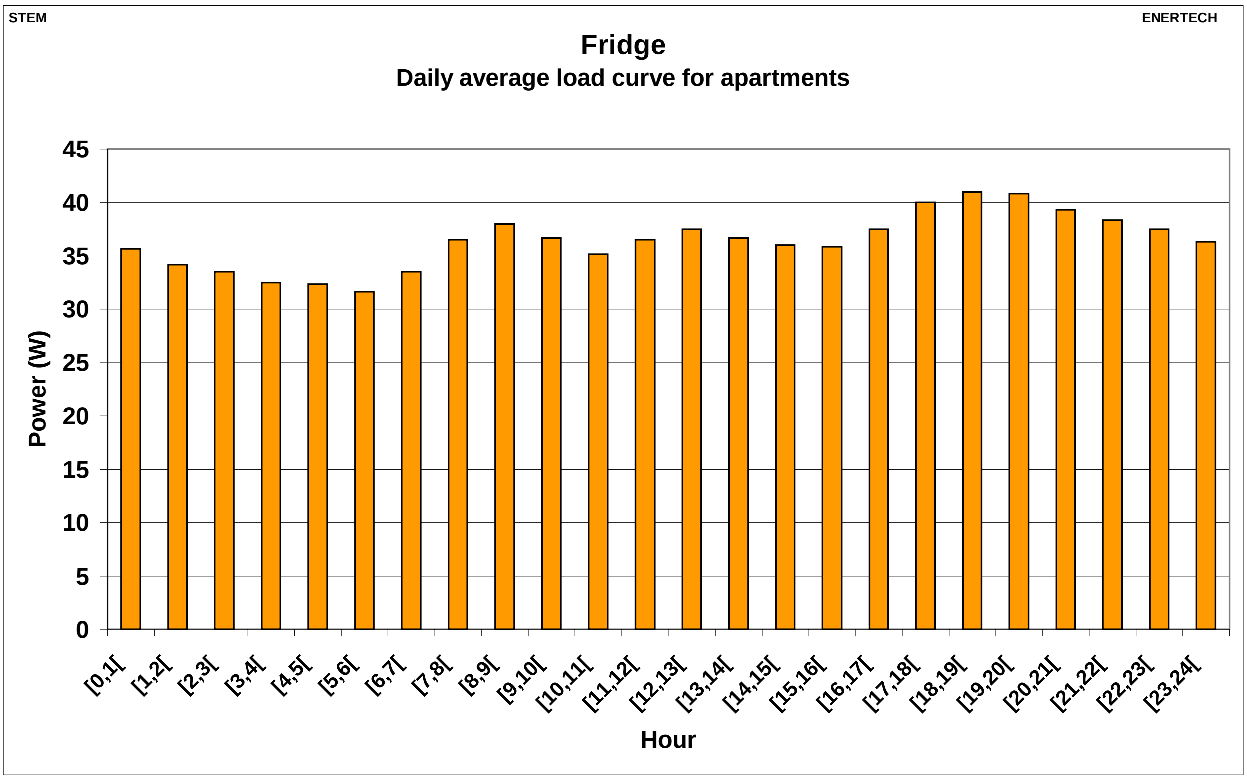


Figure 2.192: Fridges: daily average load curves for apartments

REFRIGERATOR-FREEZERS

Annualized consumption

Figures 2.193 and 2.194 shows the annual consumption per type of household for the fridge-freezers. The consumption goes from 413 to 525 kWh/year for the houses and from 447 to 497 kWh for the apartments. For France, in the Remodece+ project, the annual consumption was 460 kWh/year. This value is in the average of what we calculated for Sweden.

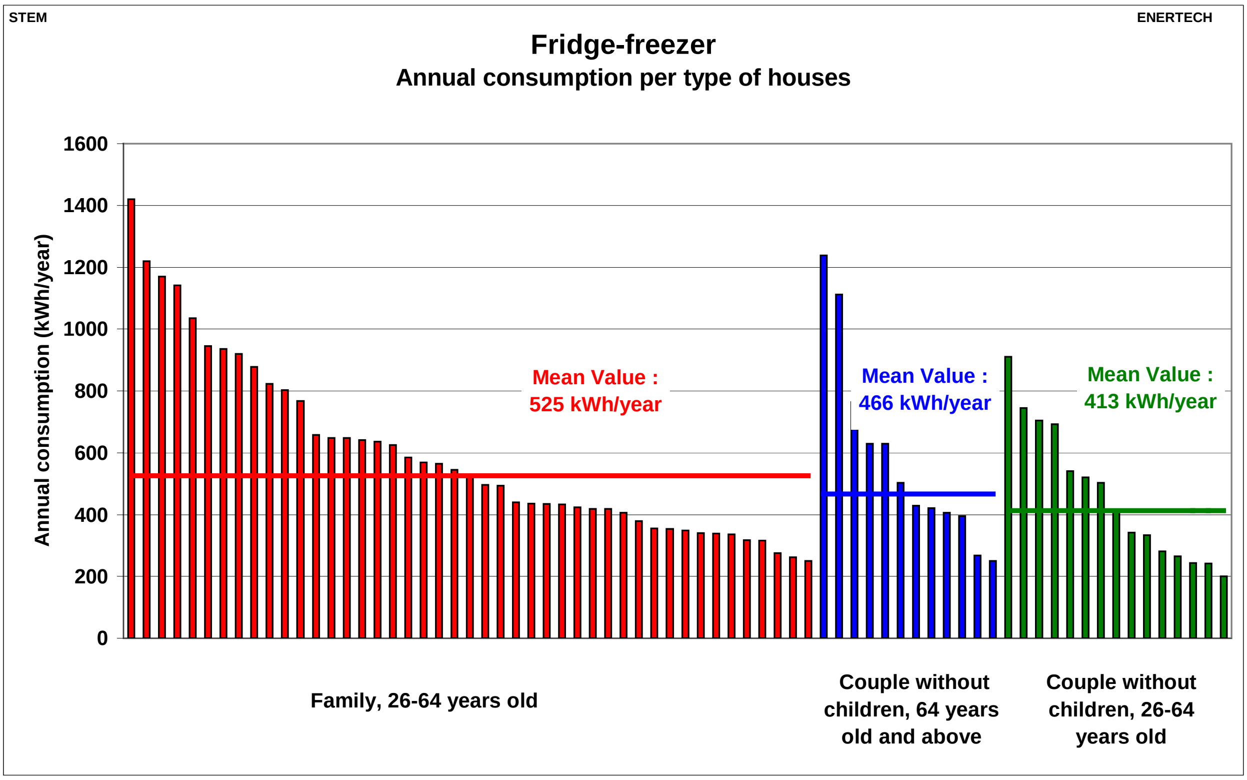


Figure 2.193: Fridge-freezer: annual consumption for houses

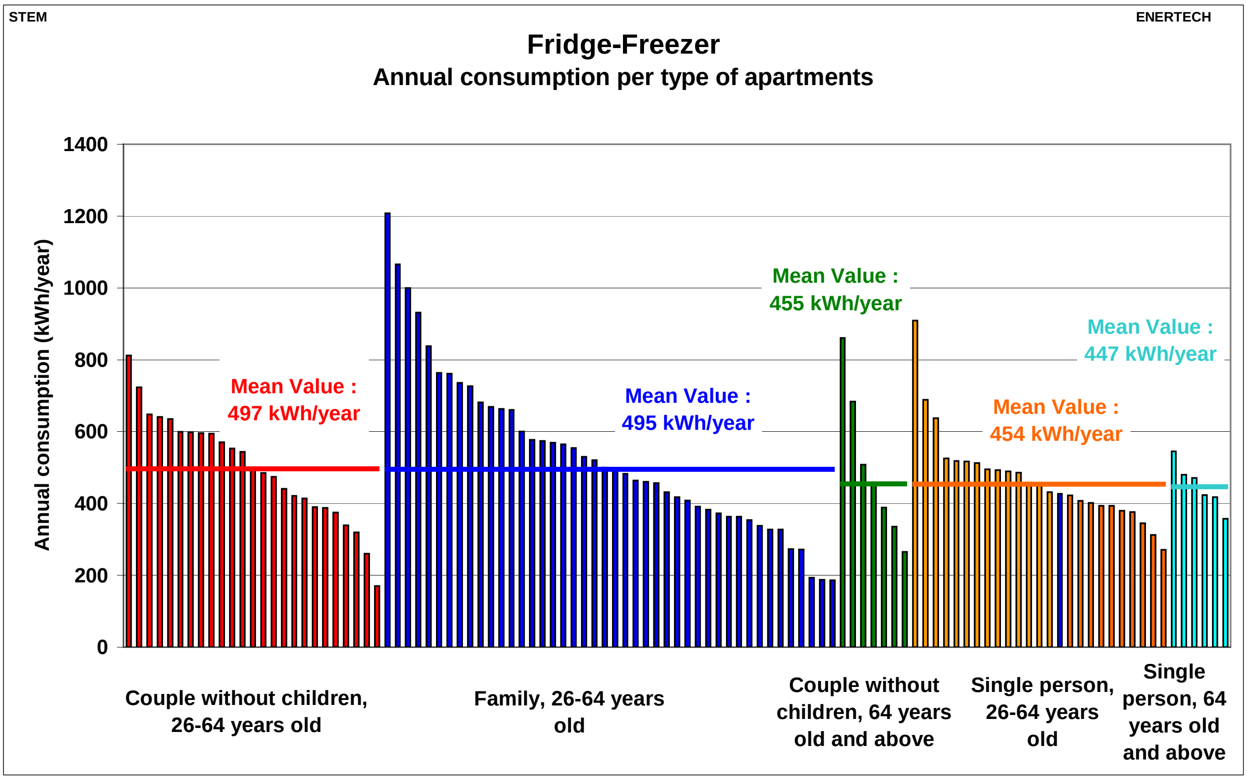


Figure 2.194: Fridge-freezer: annual consumption for apartments

Hourly load curve

Figures 2.195 and 2.196 shows the average hourly load curve for houses and apartments for the fridge freezers. The maximum peak can be found in the evening but is less visible than for refrigerators as the consumption during the day is more stable.

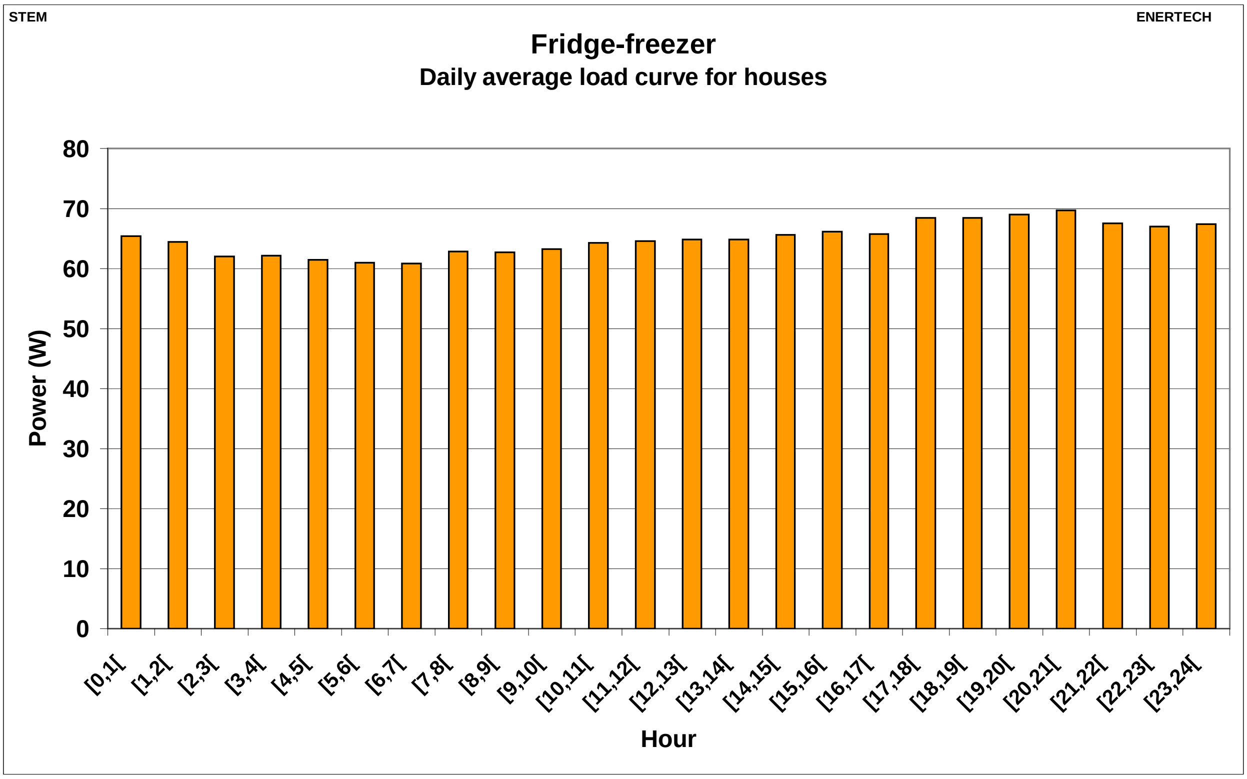


Figure 2.195: Fridge-freezer: daily average load curves for houses

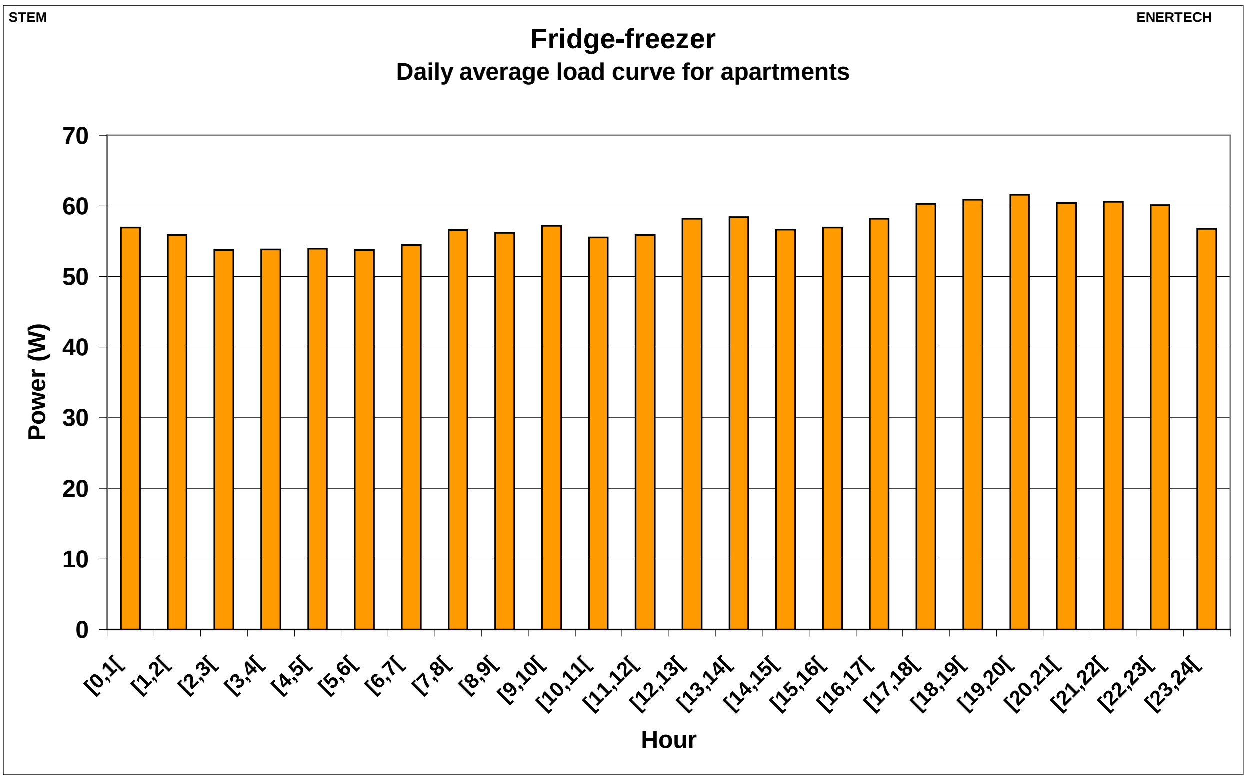


Figure 2.196: Fridge-freezer: daily average load curves for apartments

VERTICAL FREEZERS

Annualized consumption

Figures 2.193 and 2.194 shows the annual consumption per type of household for the fridge-freezers. The consumption goes from 372 to 585 kWh/year for the houses and from 326 to 438 kWh for the apartments. For France, in the Remodece+ project, the annual consumption was 556 kWh/year. The consumption in Sweden is lower (except for the "houses - couples without children, 64 years old and above" which represents only a small part of the monitored appliances).

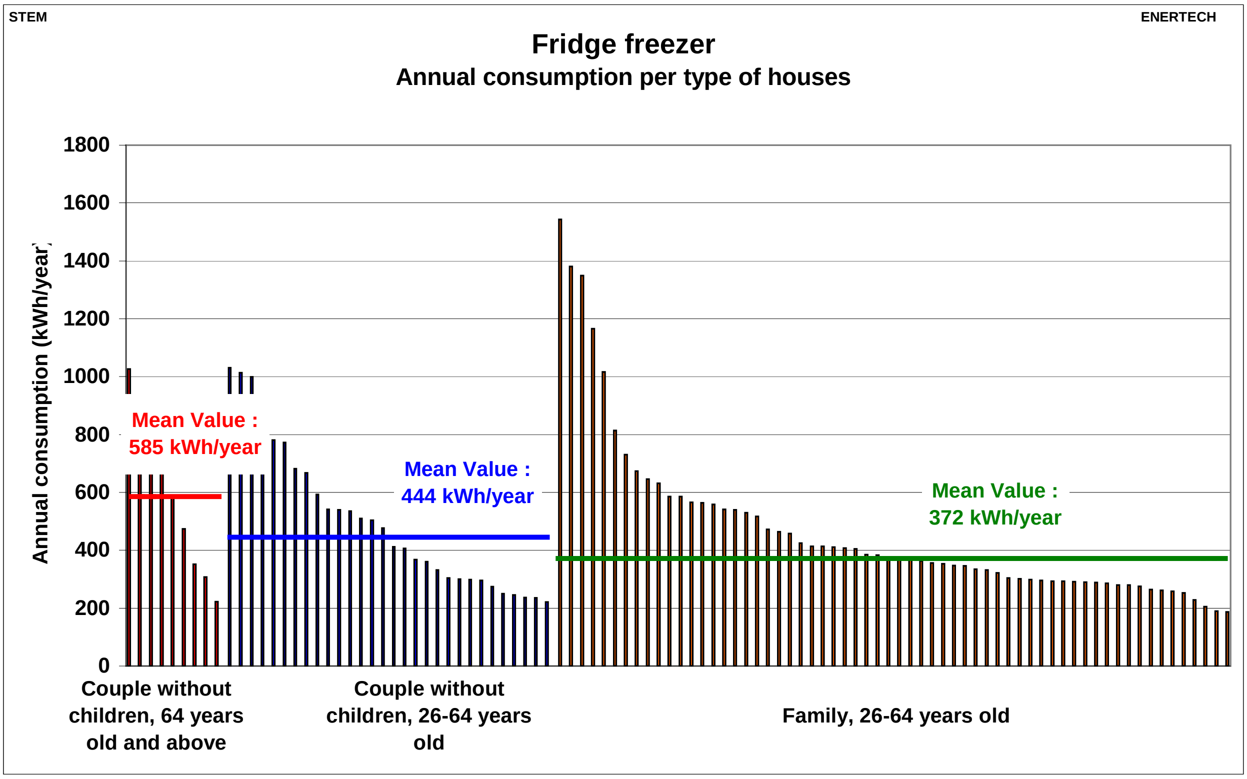


Figure 2.197: Vertical freezer: annual consumption for houses

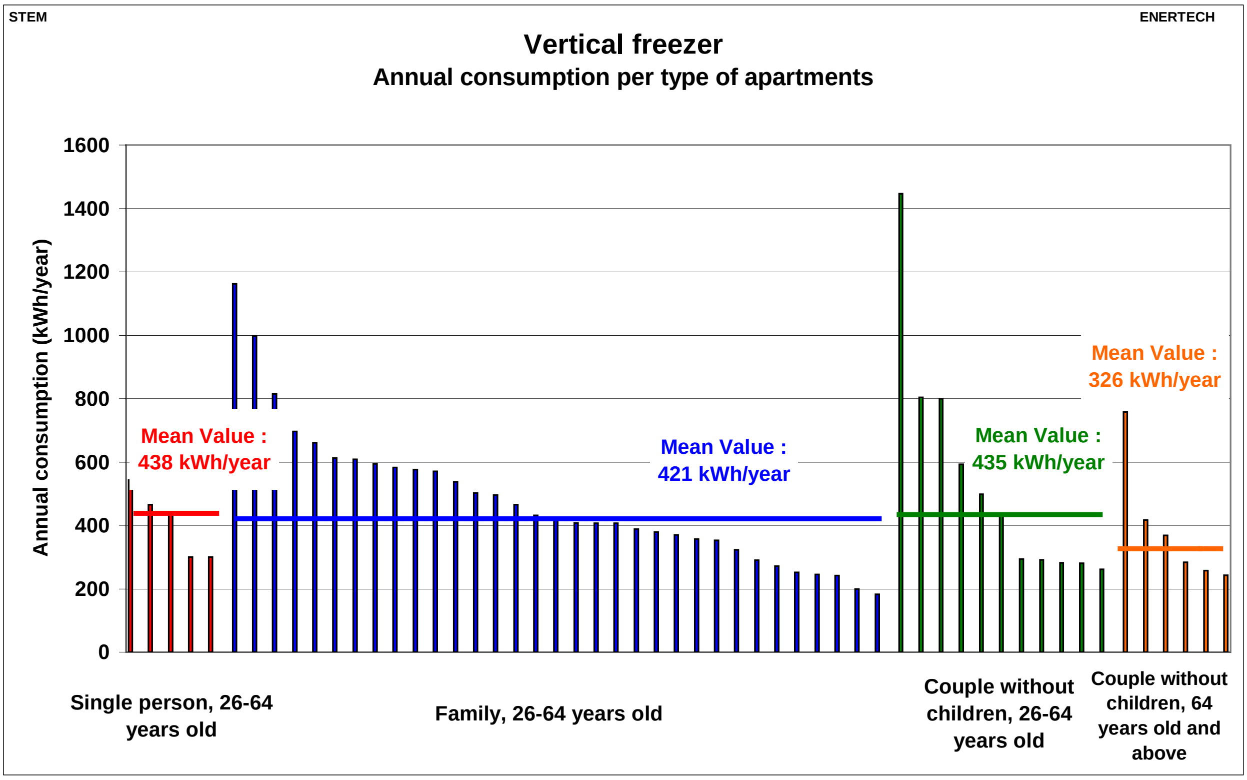


Figure 2.198: Vertical freezer: annual consumption for apartments

Hourly load curve

Figures 2.199 and 2.200 shows the average hourly load curve for houses and apartments for the vertical freezers. The consumption during the day is very stable.

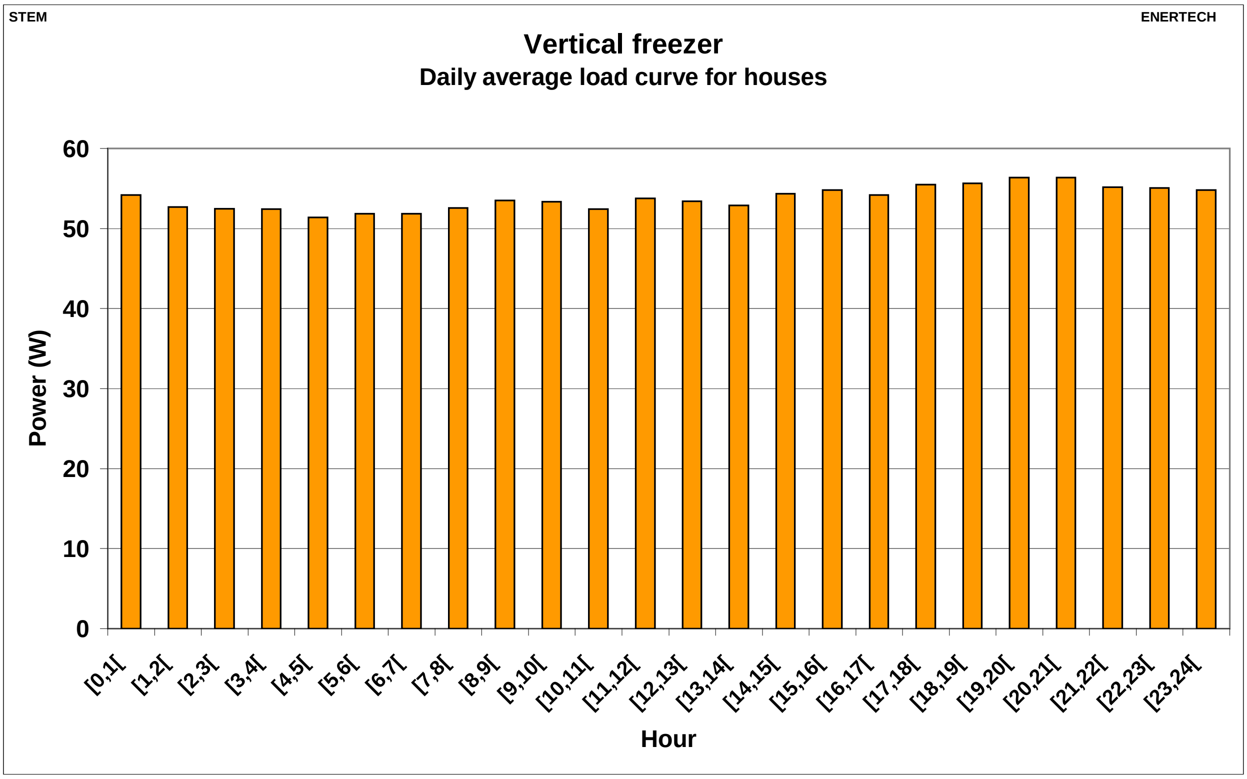


Figure 2.199: Vertical freezer: daily average load curves for houses

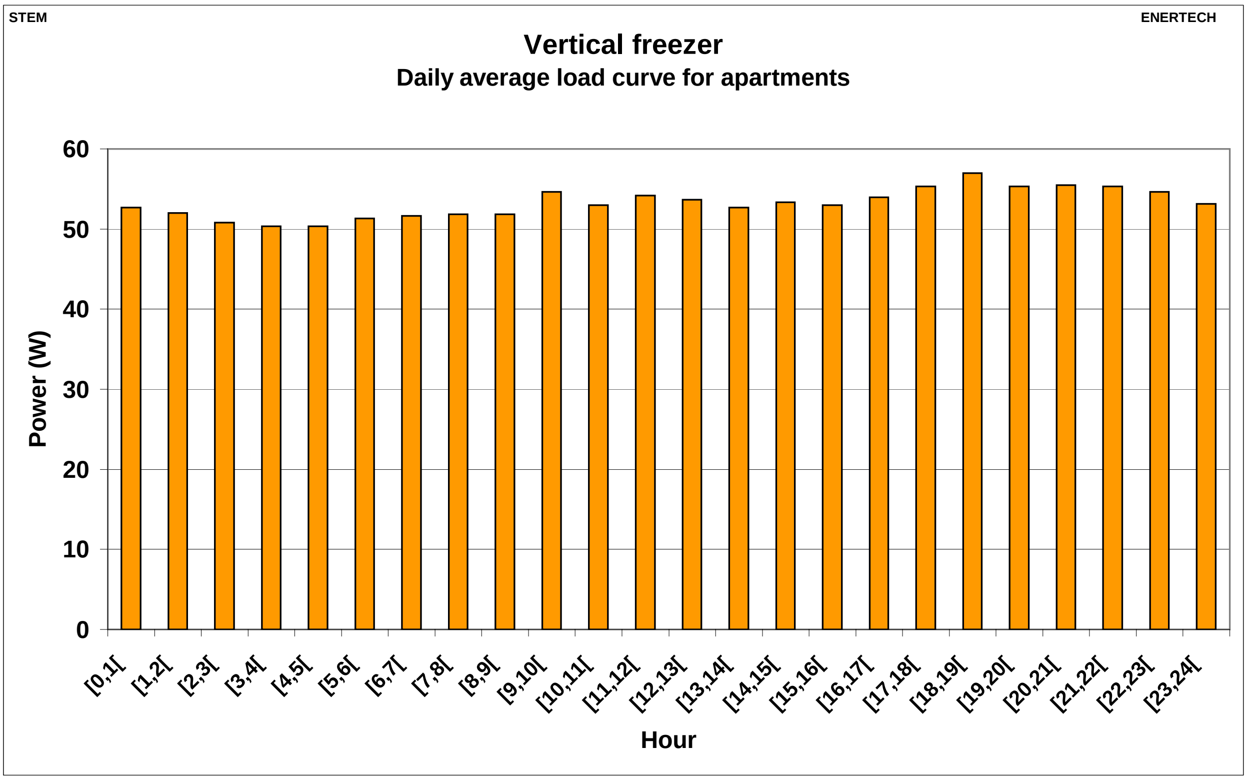


Figure 2.200: Vertical freezer: daily average load curves for apartments

OTHER COLD APPLIANCES

In this chapter, we will list all the other cold appliances that were monitored during the campaign but for which the size of the panel was less important.

Table Top Freezer

Table top freezers are vertical freezers that can be installed under kitchen work plans. There is only a difference in height between a standard vertical freezer and a table top.

Annualized consumption

Figure 2.201 shows the annual consumption for the table top freezers. It seems that the average consumption is in the same range as for the standard vertical freeers.

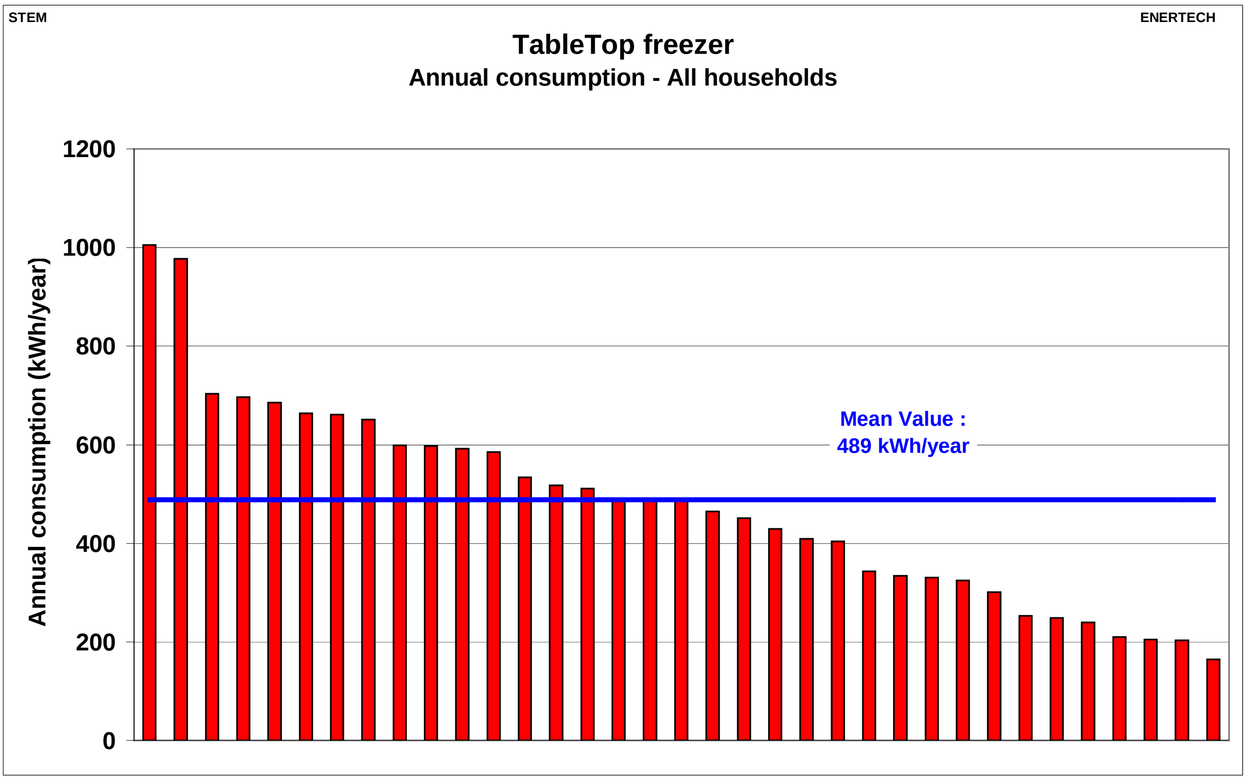


Figure 2.201: TableTop freezer: annual consumption – all households

Hourly load curve

The average hourly load curve from figure 2.202 shows us a power demand of 55 Watt that is very near to the one for vertical freezers (52 Watt).

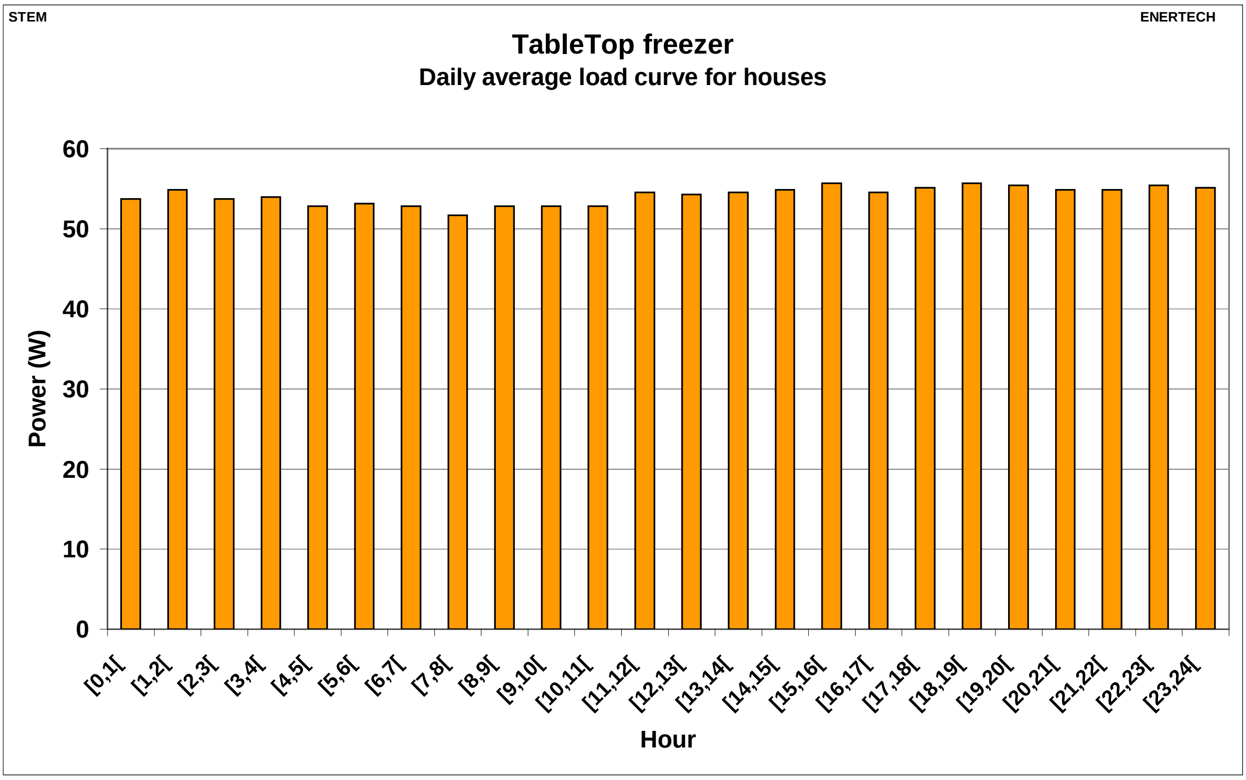


Figure 2.202: TableTop freezer: daily average load curves – all households

American Freezer

American freezers are two doors cold appliances with a fridge and a freezer part. The volume for each part is rather large with the freezer part having a cold water and ice disposer.

Annualized consumption

Figure 2.203 shows us the average annual consumption for the american freezers monitored during the campaign. This value of 454 kWh/year can be compared to the 796 kWh/year measured in the french Remodece+ campaign. One more time we see that the consumption for the Swedish appliances are smaller.

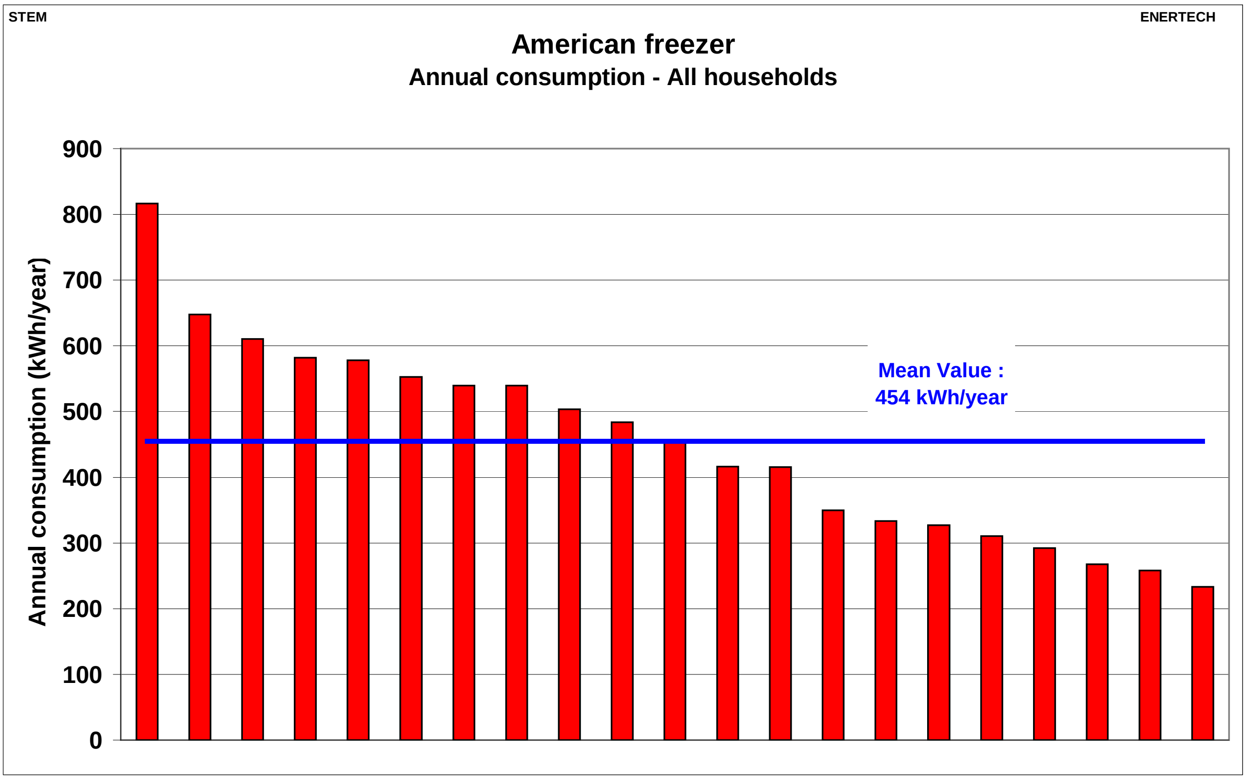


Figure 2.203: American freezer: annual consumption – all households

Hourly load curve

Figure 2.204 shows us the daily average load curve for the american freezers.

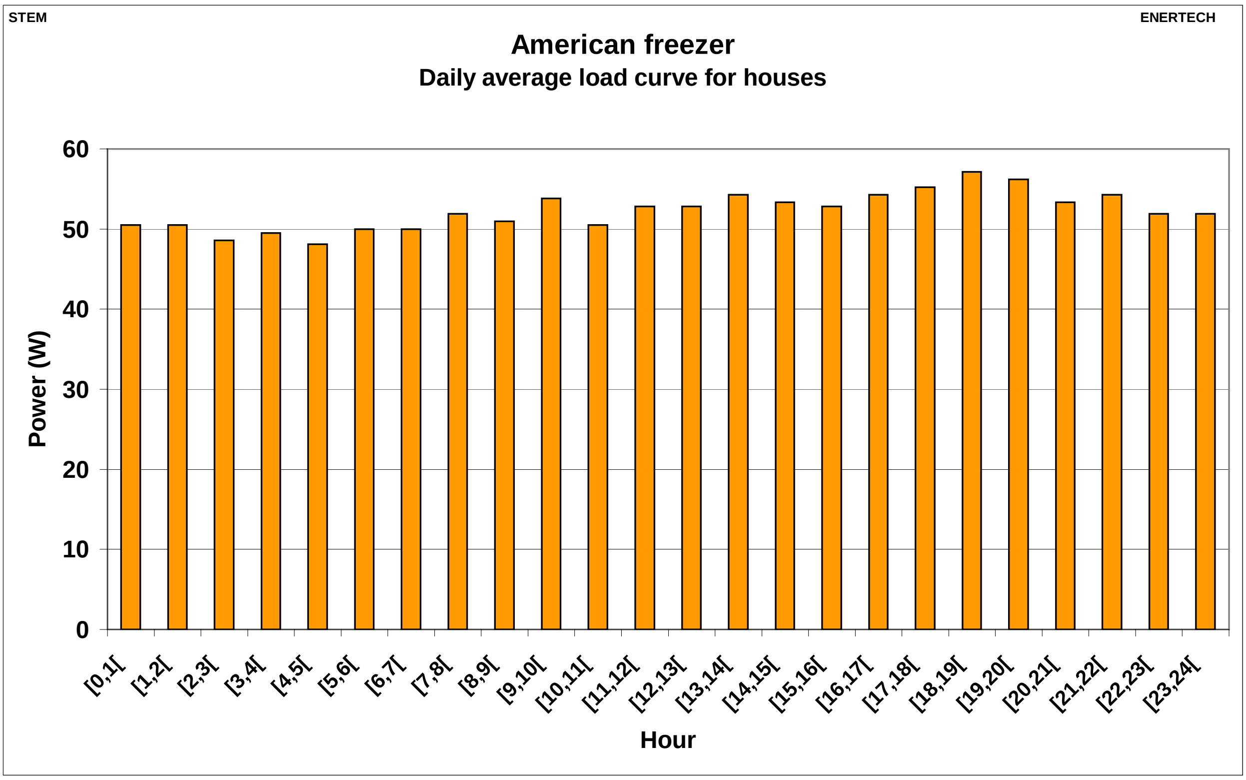


Figure 2.204: American freezer: daily average load curves – all households

Chest Freezer

Chest freezer are horizontal freezers. They are less common in the Swedish households than the vertical one's: only 4 chest freezers were monitored. The kitchens always have a specific place for fridge / fridge-freezer and/or vertical freezer so there's no need for that type of equipment.

Annualized consumption

Figure 2.205 shows the annual consumption for the chest freezers. With an average annual consumption of 242 kWh/year they are consumming half the energy than a vertical freezer. This value has to be confirmed with a larger panel.

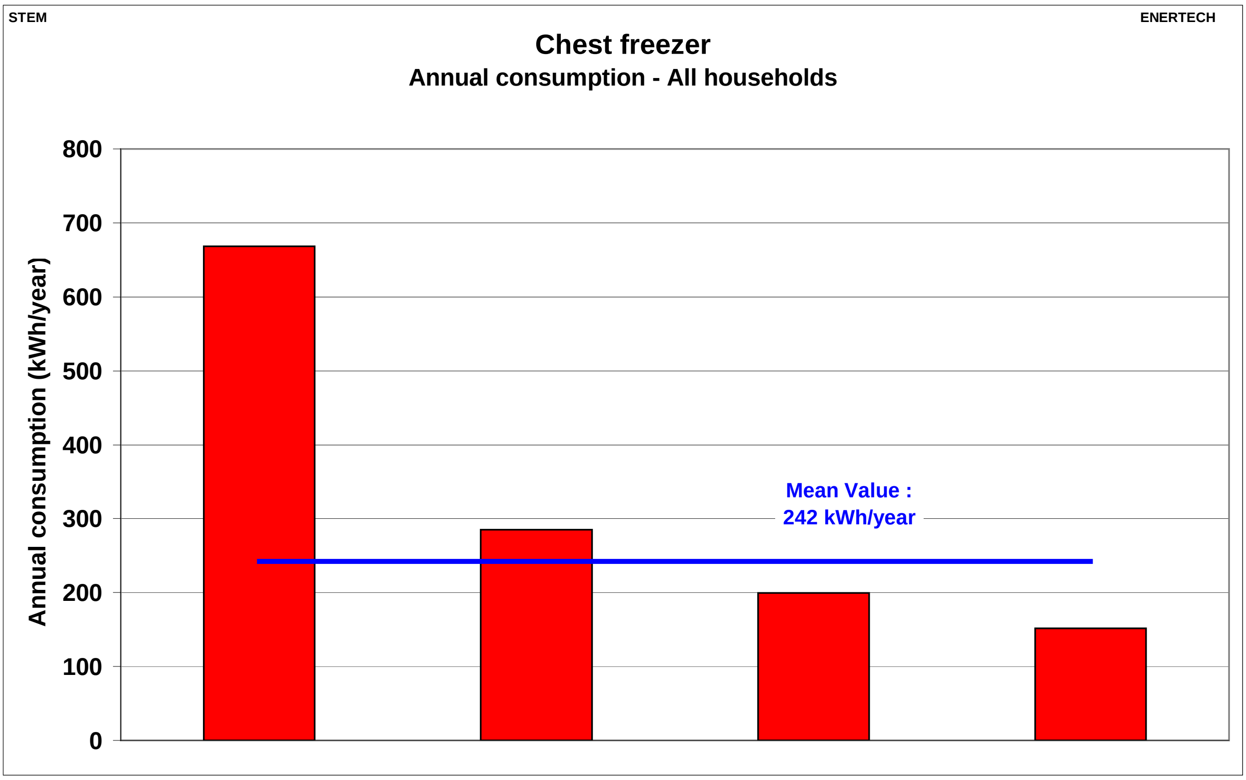


Figure 2.205: Chest freezer: annual consumption – all households

Hourly load curve

Figures 2.206 shows us the daily average load curve. The average power is 36 Watt instead of 52 Watt for the vertical freezers. Based on the fact that the power demand for the compressors is normally very similar for the two types of appliances, it indicates that the ON time is shorter for the chest freezers than for the vertical ones and that their consumption will be lower. This was measured in several campaign: for example, in the Eureco project for Denmark, vertical freezers are at 456 kWh/year and chest freezers are at 380 kWh/year.

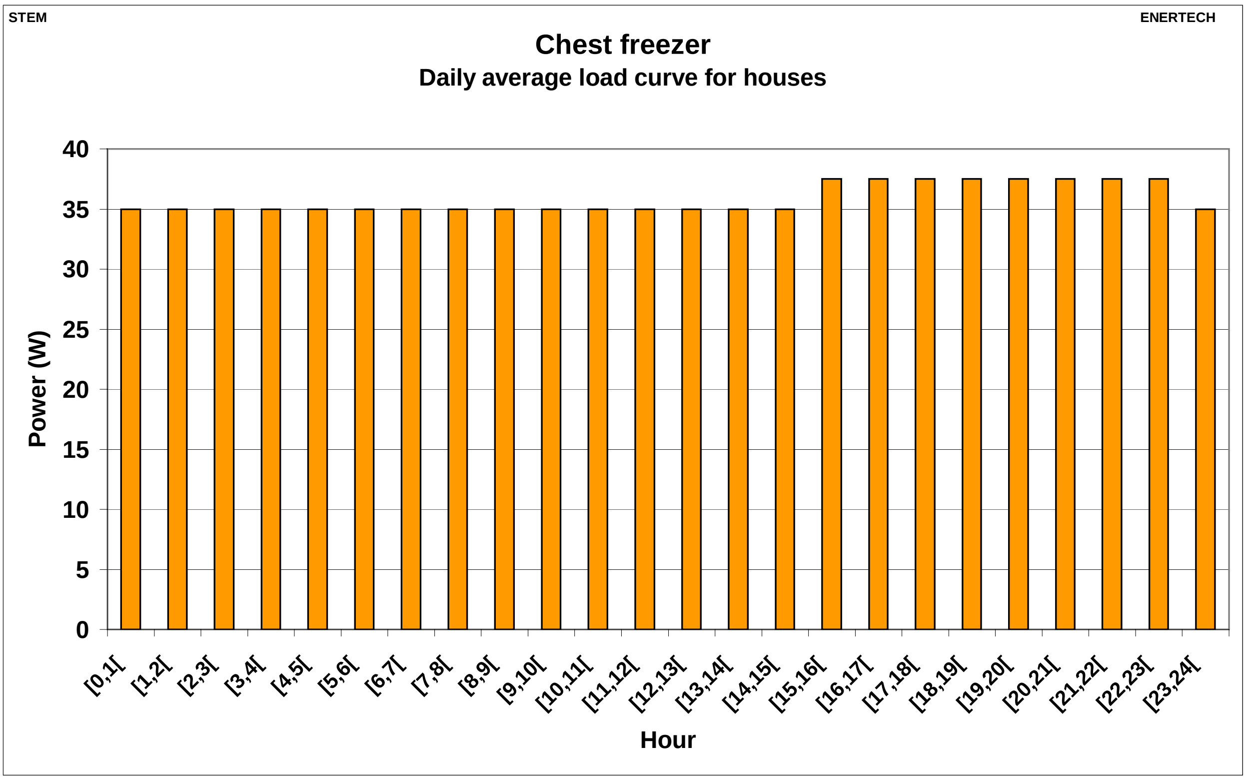


Figure 2.206: Chest freezer: daily average load curves – all households

LAUNDRY, DISH-WASHING AND CLEANING APPLIANCES

Average possession of appliances

The table from figure 2.207-A indicates the average number of appliances per type of household. The number between brackets indicates the number of households used to calculate the average possession so the results for the last two categories has to be treated with care as only 3 and 4 households were analysed. For all the three appliances, the average number is always higher for houses than for apartments. It is common to find a common laundry in the residential buildings so the need for a washing-machine and a clothe-dryer is minor for the apartments.

	Washing machine	Clothes dryer	Dish washer
Apartment, couples without children, 26-64 years old (41)	0,49	0,15	0,46
Apartment, couples without children, 64 years old and above (14)	0,43	0,00	0,50
Apartment, family, 26-64 years old (81)	0,63	0,21	0,64
Apartment, single person, 26-64 years old (41)	0,39	0,10	0,34
Apartment, single person, 64 years old and above (10)	0,40	0,00	0,30
All apartments	0,52	0,15	0,51
House, couples without children, 26-64 years old (46)	1,00	0,57	0,91
House, couples without children, 64 years old and above (21)	1,05	0,48	0,76
House, family, 26-64 years old (125)	1,01	0,64	0,93
House, single person, 26-64 years old (3)	0,67	0,33	1,00
House, single person, 64 years old and above (4)	1,00	0,25	0,75
All houses	1,01	0,59	0,90

Figure 2.207-A: Average number of appliances per type of household

CLOTHES-WASHERS

This appliance will be called clothes-washer or washing machine in the rest of the paragraph and figures.

Annualized consumptions

Figures 2.207 to 2.212 shows the histogram of clothes-washer annualized consumption for the different types of households. The analysis of the one year households didn't show a seasonality effect.

There are some significant differences from one type to the other, which can be explained by different practices (wash-cycle frequency, predominance of very hot cycles over 40°C wash-cycle, etc.). Consumption is higher in the houses (from 107 kWh/year to 213 kWh/year) than in the apartments (from 62 kWh/year to 167 kWh/year) and vary a lot from one type of household to another. As we will see in the next chapter, the annual consumption is very dependant of the number of persons in the household.

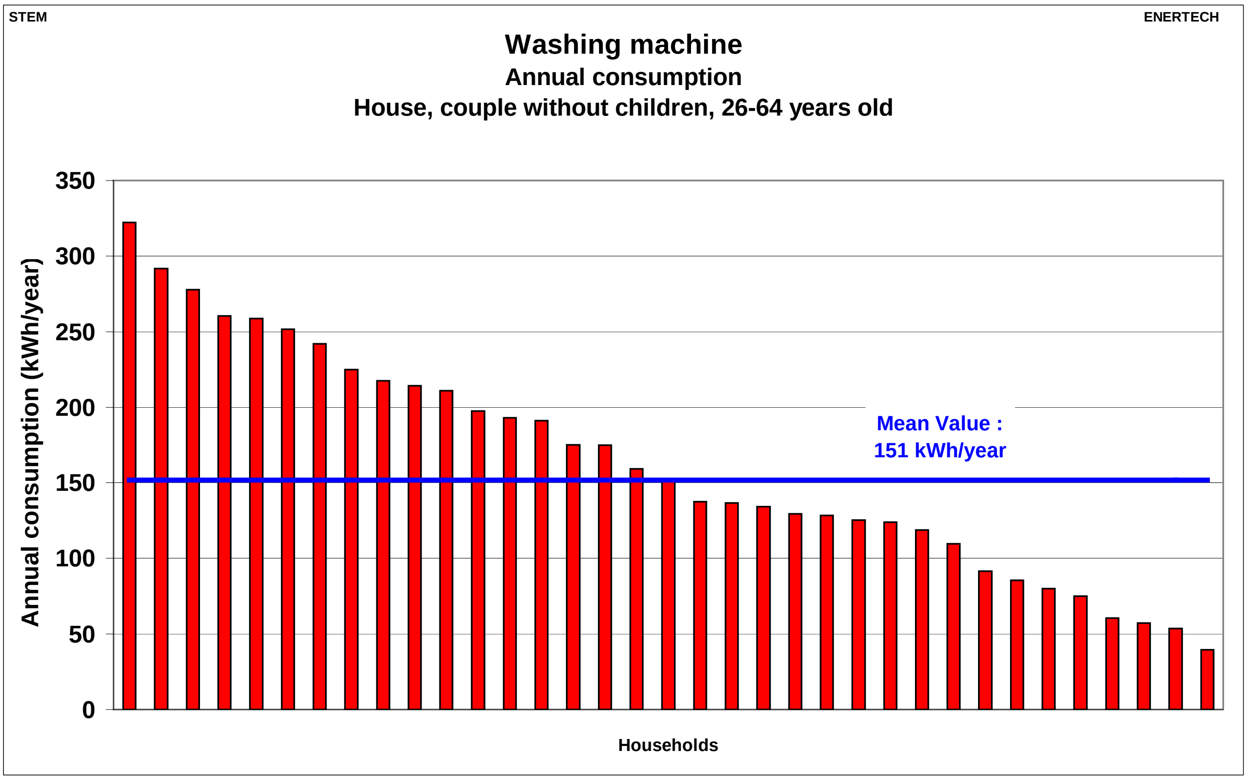


Figure 2.207: Washing machine: annual consumption – House, couples without children,26-64 years old

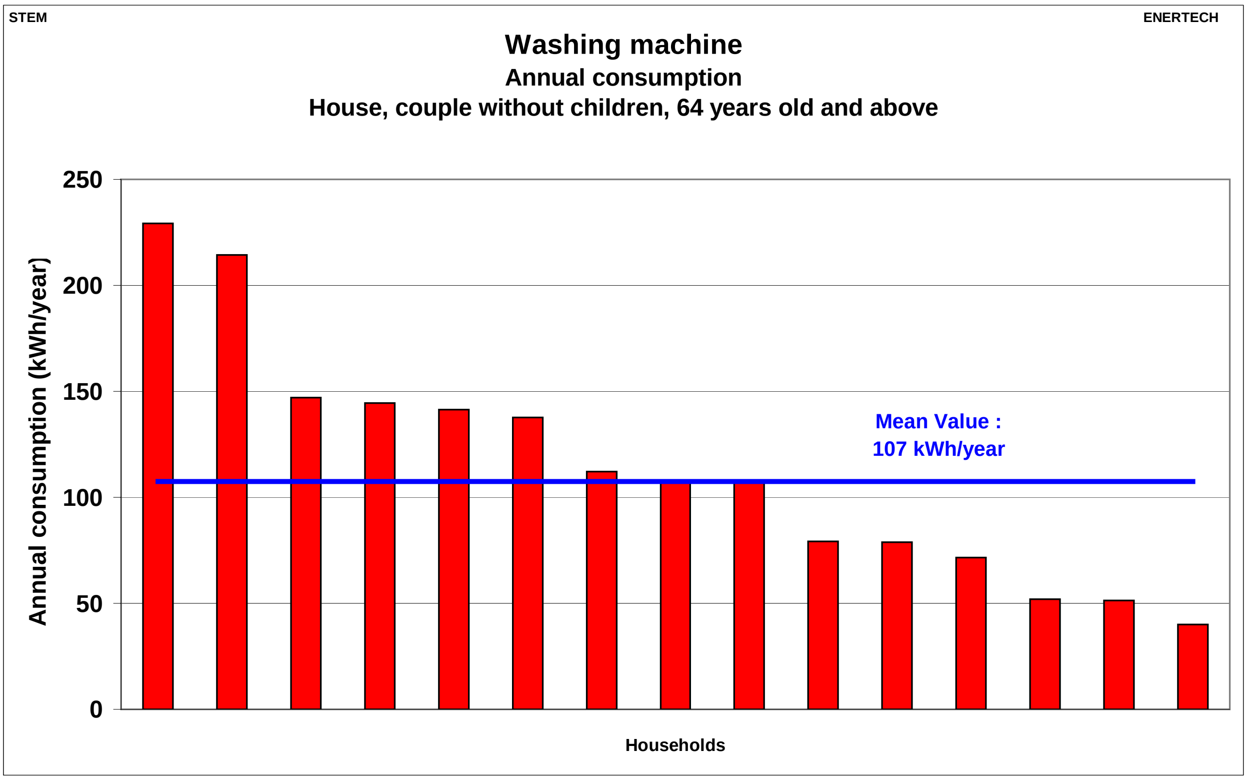


Figure 2.208: Washing machine: annual consumption – House, couples without children, 64 years old and above

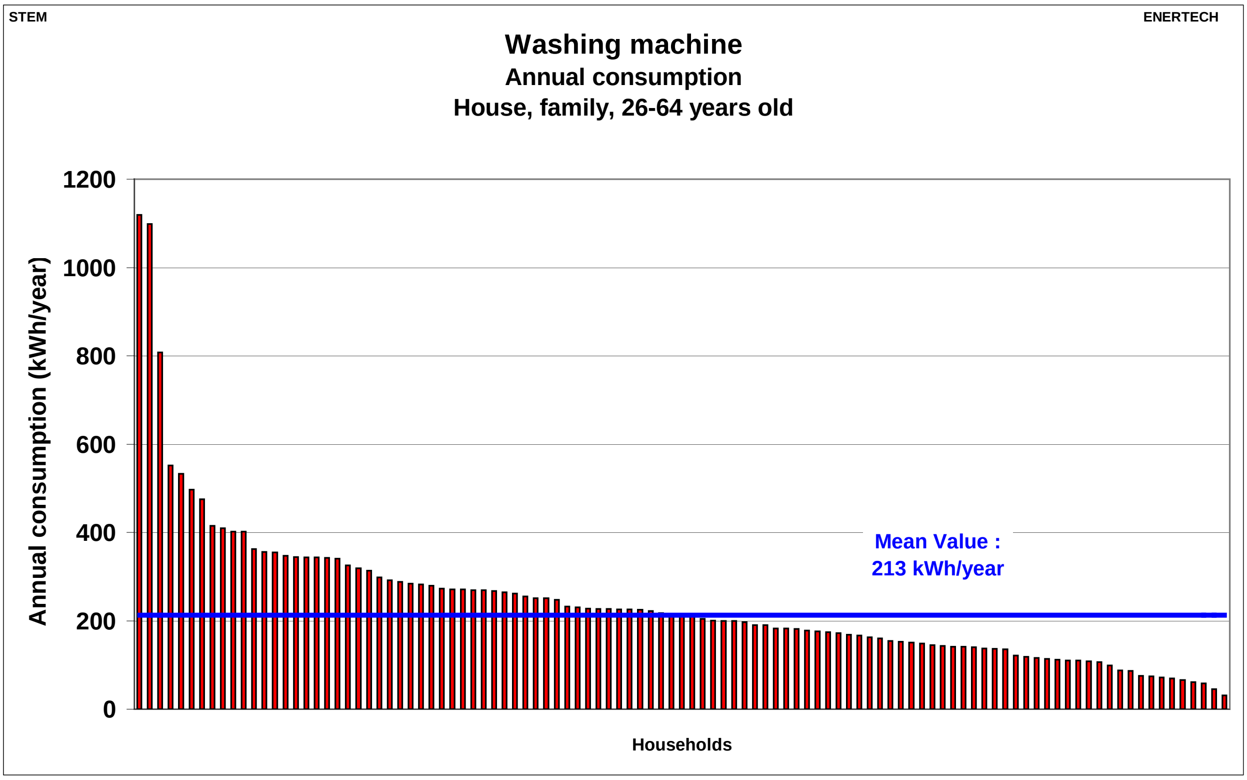
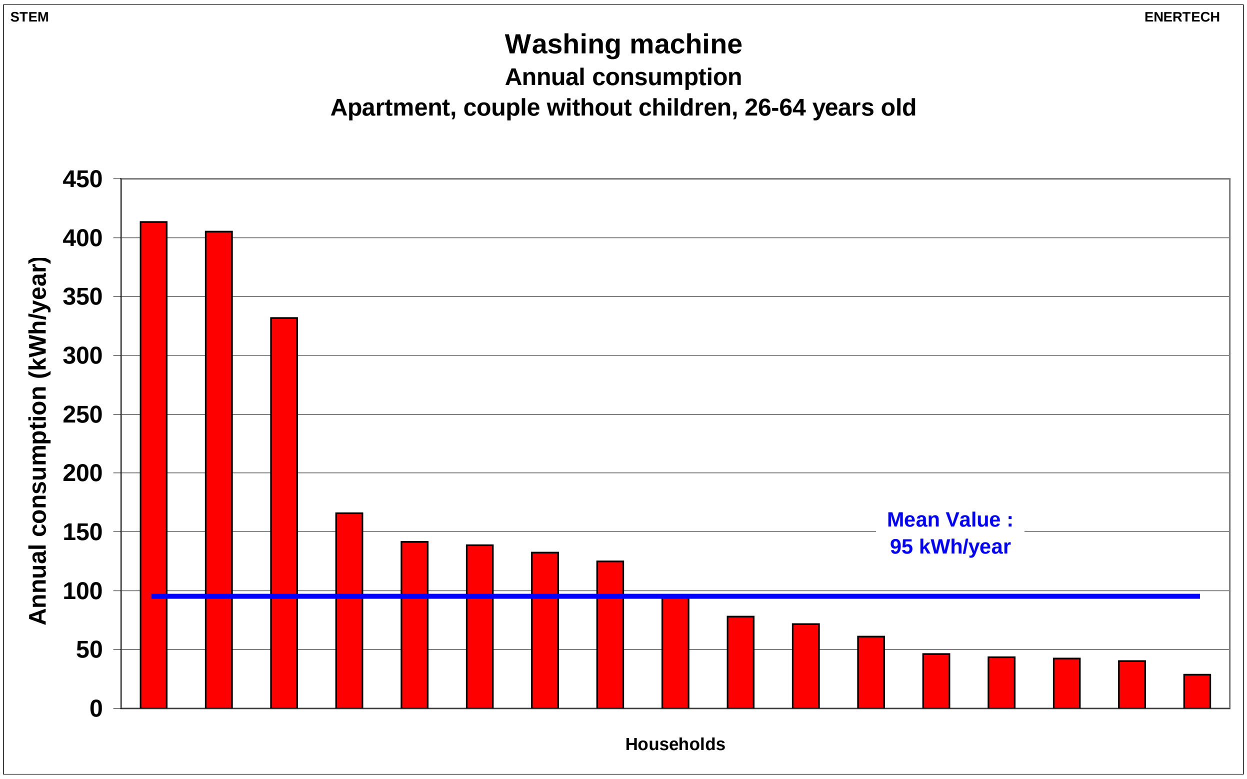


Figure 2.209: Washing machine: annual consumption – House, family,26-64 years old

Figure 2.210: Washing machine: annual consumption – Apartment, couples without children, 26-64 years old



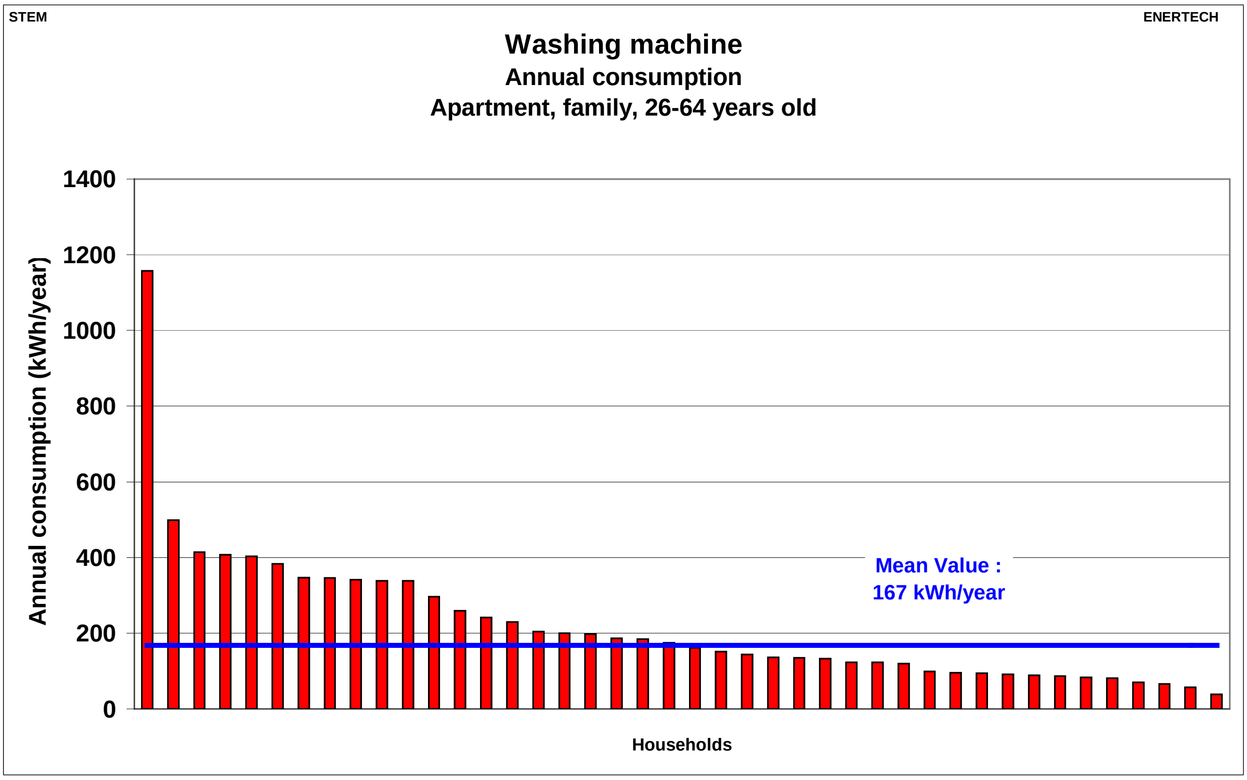


Figure 2.211: Washing machine: annual consumption – Apartment, family, 26-64 years old

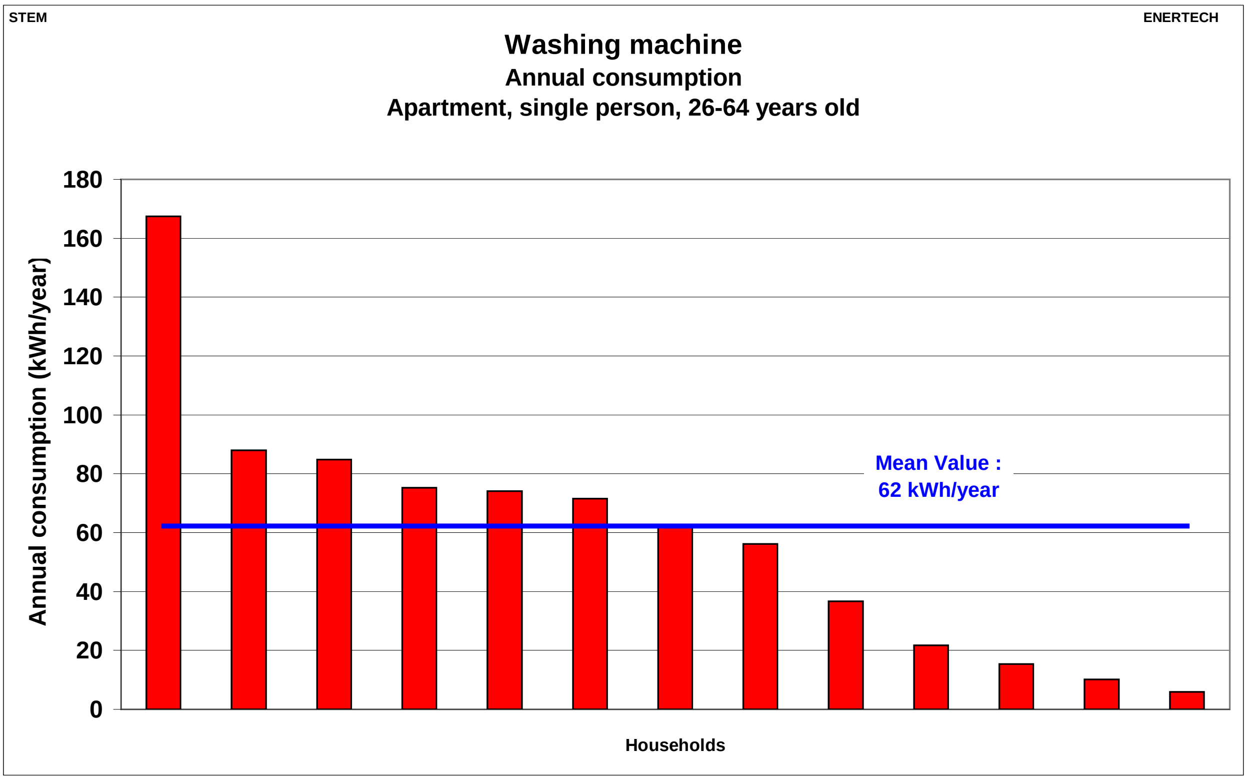


Figure 2.212: Washing machine: annual consumption – Apartment, single person, 26-64 years old

Annualized consumption per person

Figure 2.213 shows us the annual consumption per person per family size. The values per person should be treated with some care, since the family structure has to be taken into account as well. The consumption per person for households from 1 to 4 persons doesn't vary a lot and is always between 60 and 70 kWh/person/year. It is only for families with more than 5 members that we can see a decrease in the annual consumption per person. The washing machine consumption seems to be very dependent of the number of persons in the household.

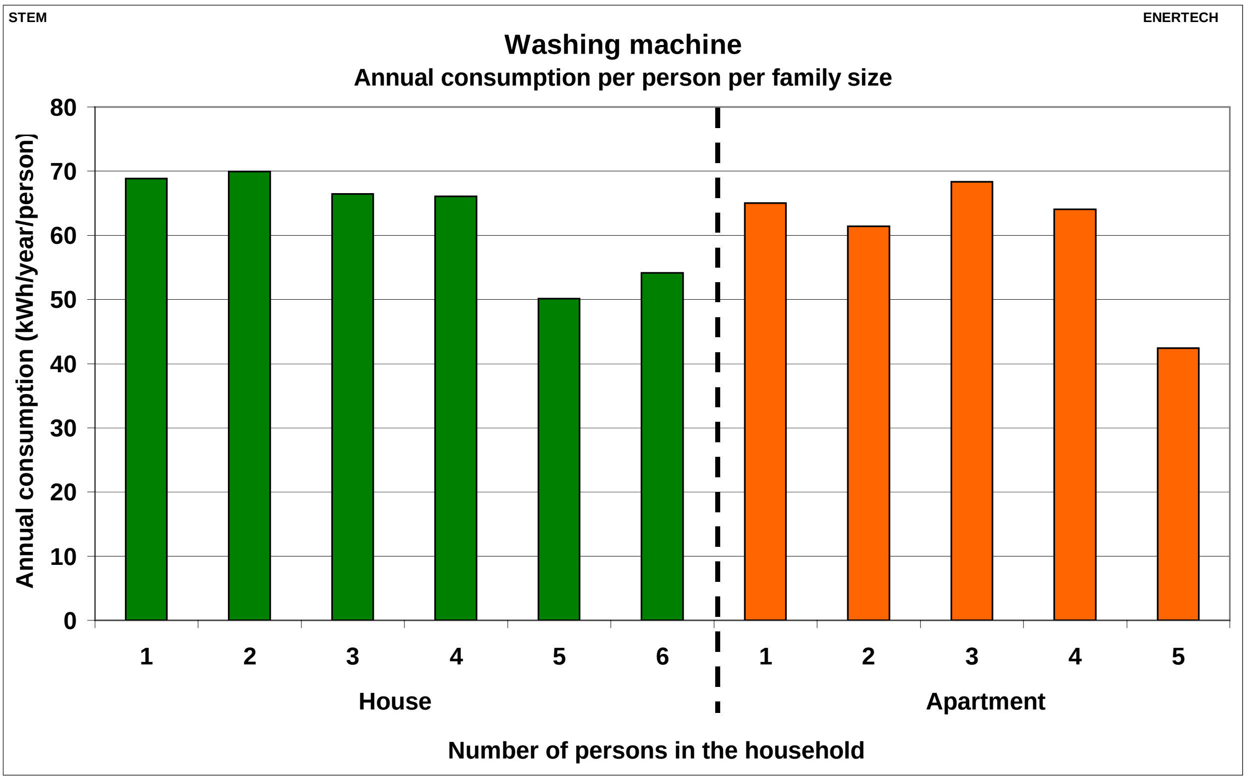


Figure 2.213: Washing machine: annual consumption per person per household size

Hourly load curve

Figures 2.214 to 2.225 shows the daily average load curve for each type of household split between holidays and workdays. The consumption occurs mainly during the day between 08:00 and 20:00 and during the holidays.

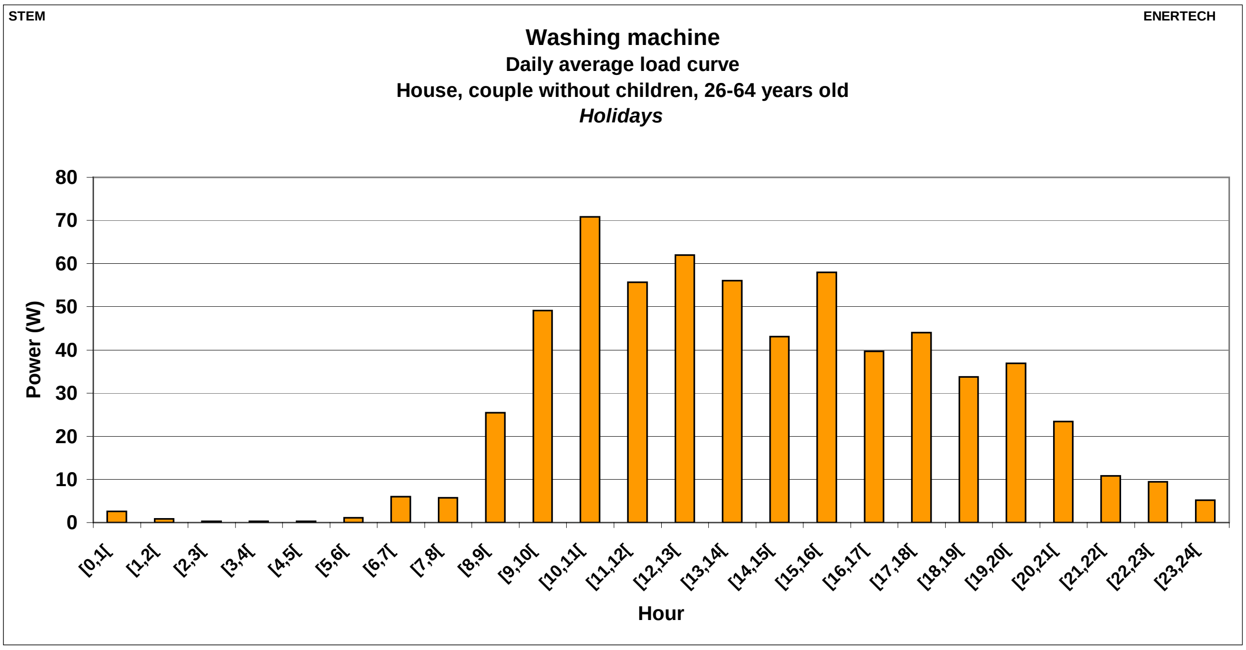


Figure 2.214: Washing machine – Daily average load curve – House, couples without children, 26-64 years old – Holidays

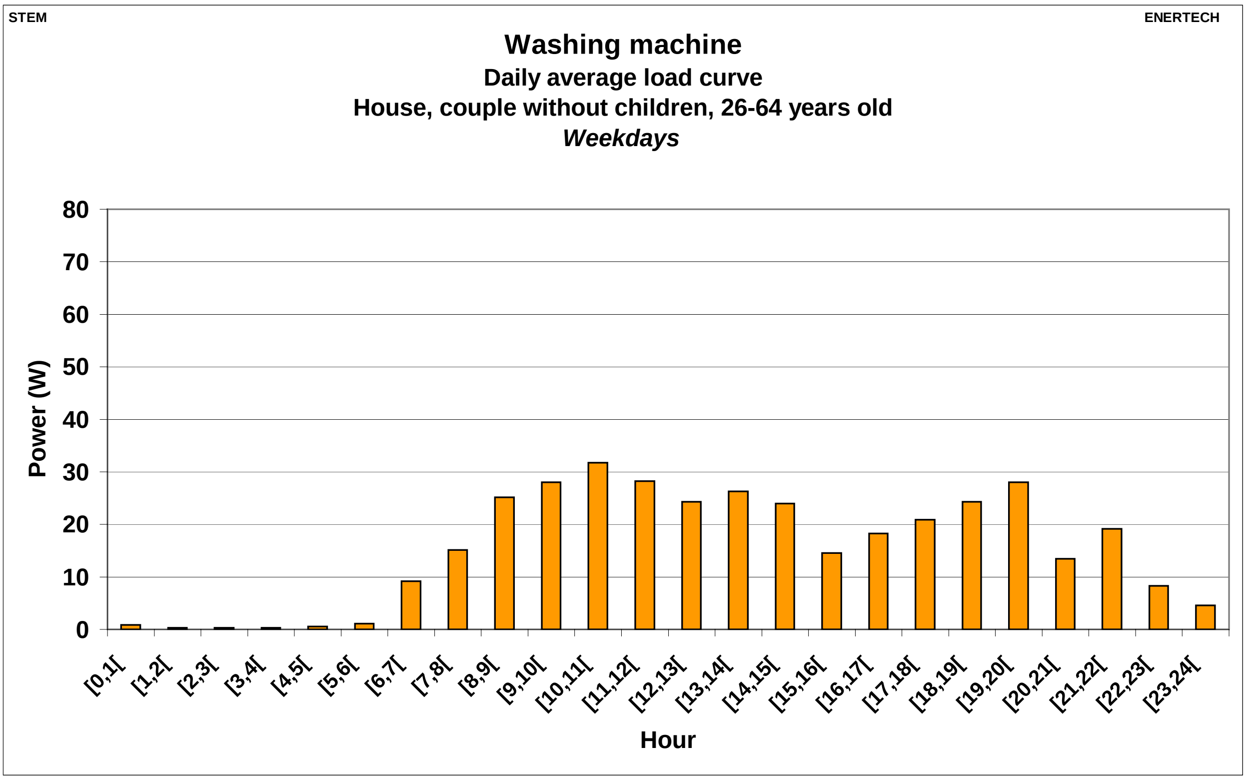


Figure 2.215: Washing machine – Daily average load curve – House, couples without children, 26-64 years old – Weekdays

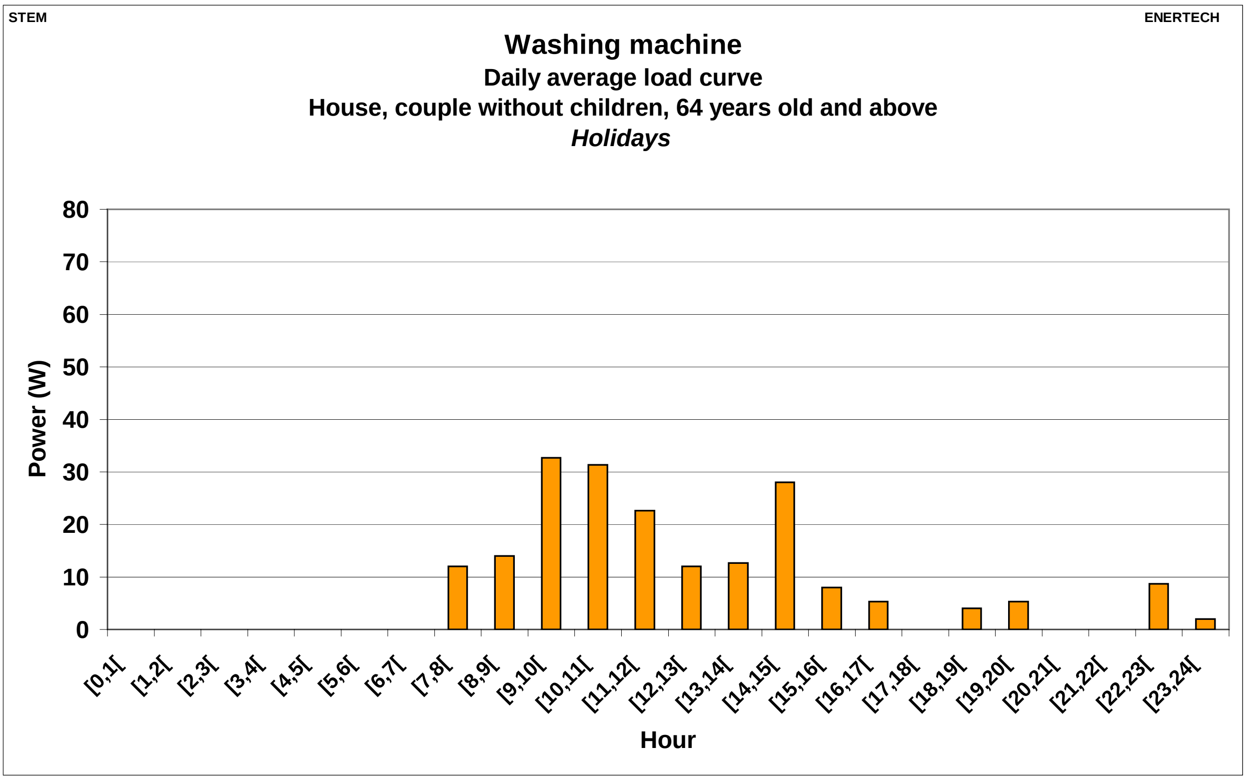


Figure 2.216: Washing machine – Daily average load curve – House, couples without children, 64 years old and above – Holidays

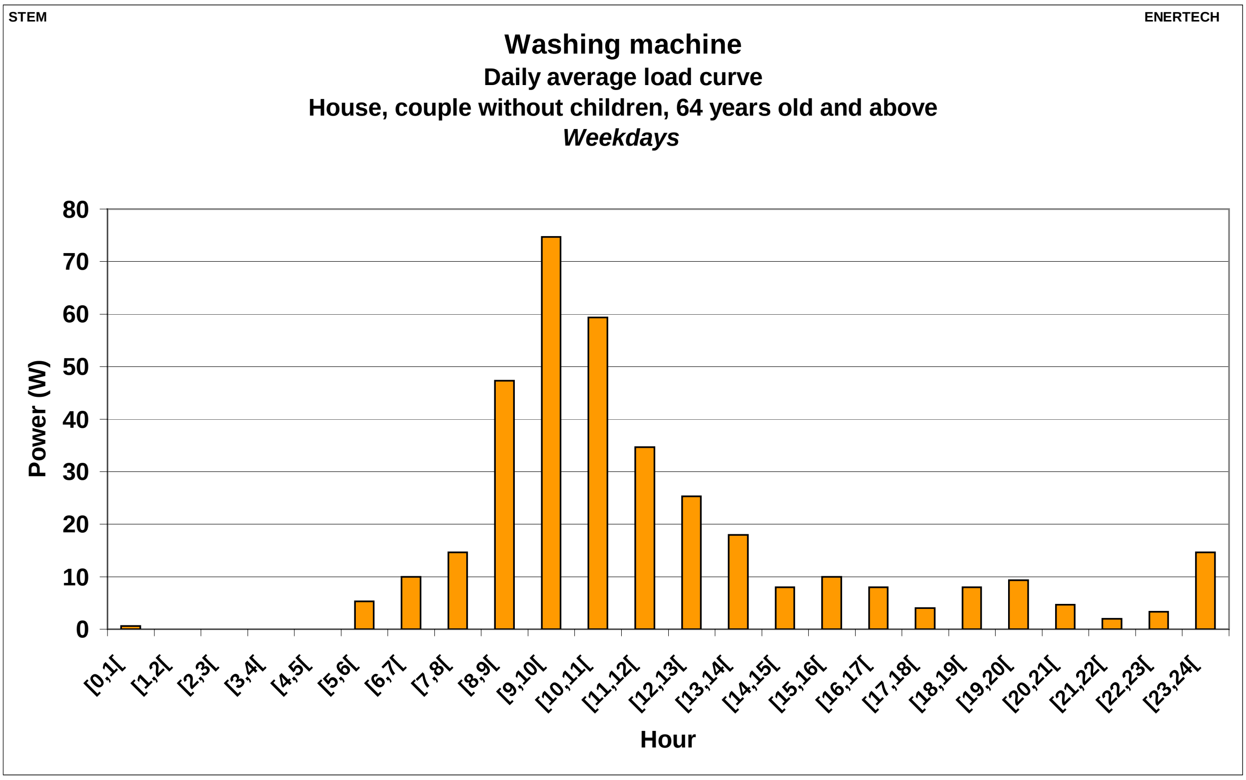


Figure 2.217: Washing machine – Daily average load curve – House, couples without children, 64 years old and above – Weekdays

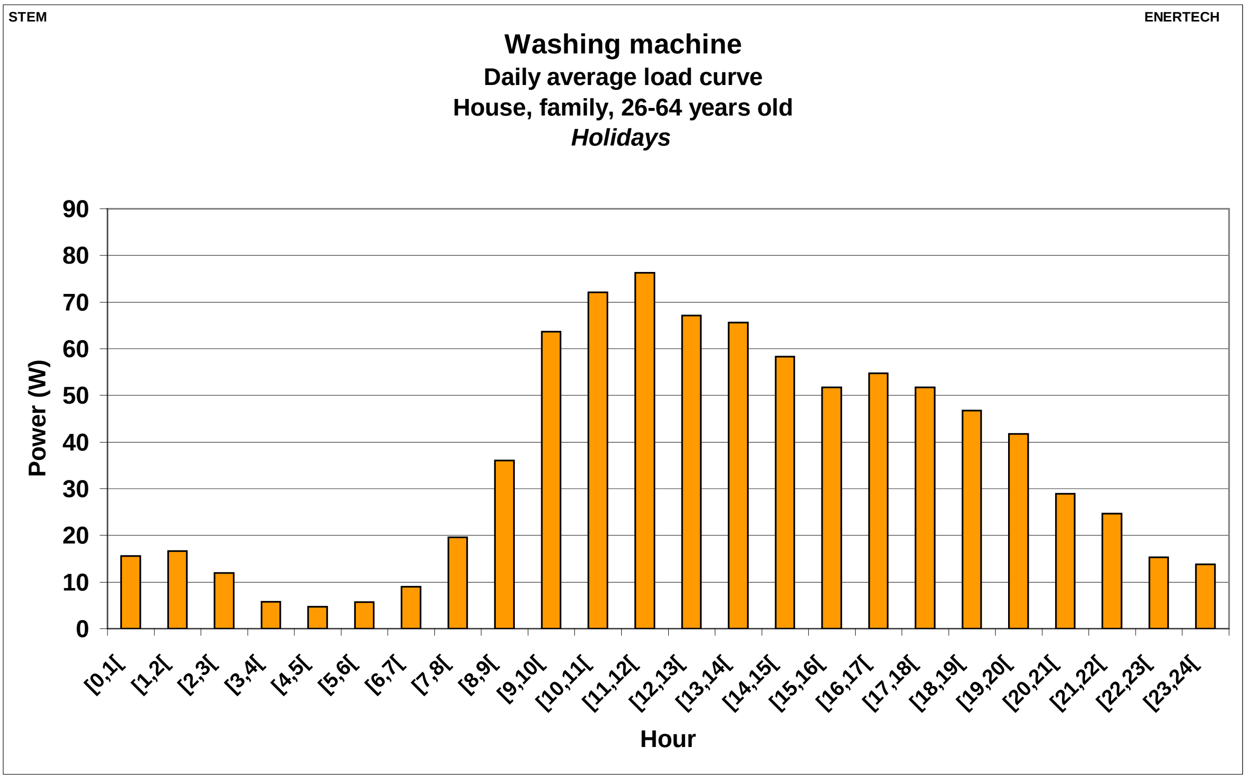


Figure 2.218: Washing machine – Daily average load curve – House, family, 26-64 years old – Holidays

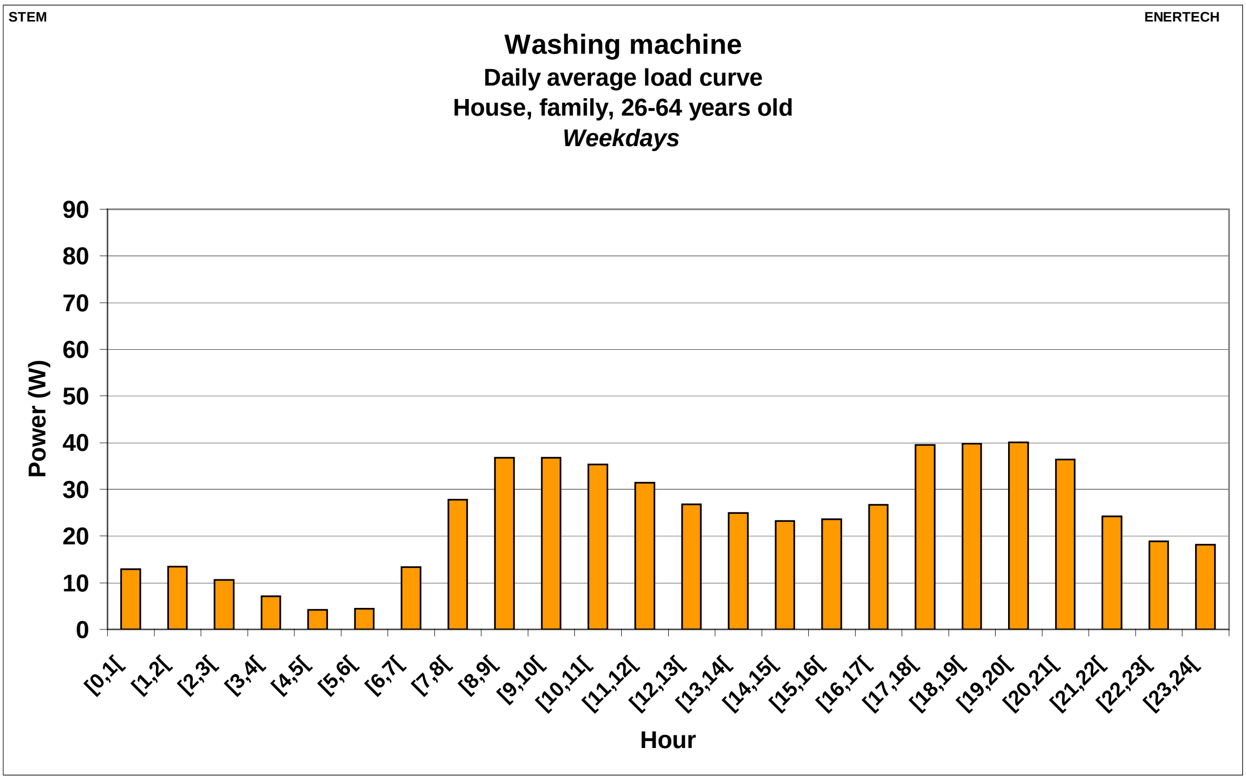


Figure 2.219: Washing machine – Daily average load curve – House, family, 26-64 years old – Weekdays

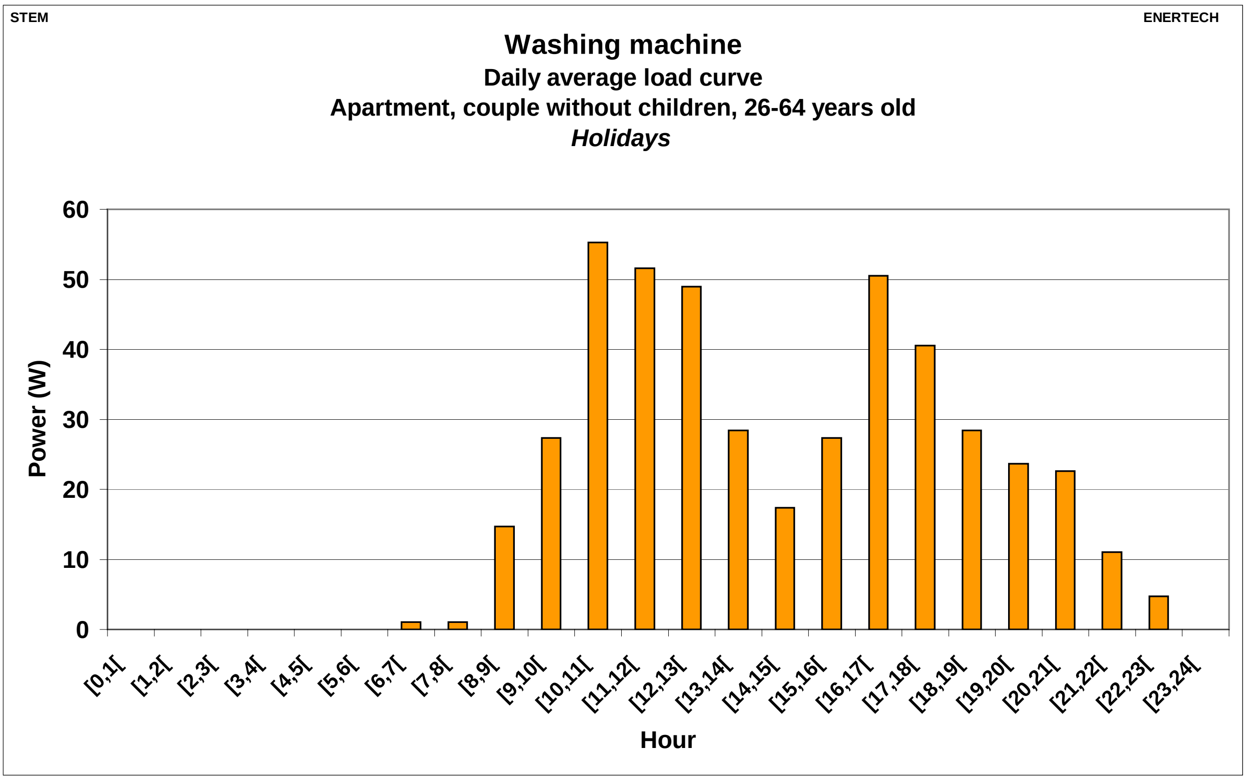


Figure 2.220: Washing machine – Daily average load curve – Apartment, couples without children, 26-64 years old – Holidays

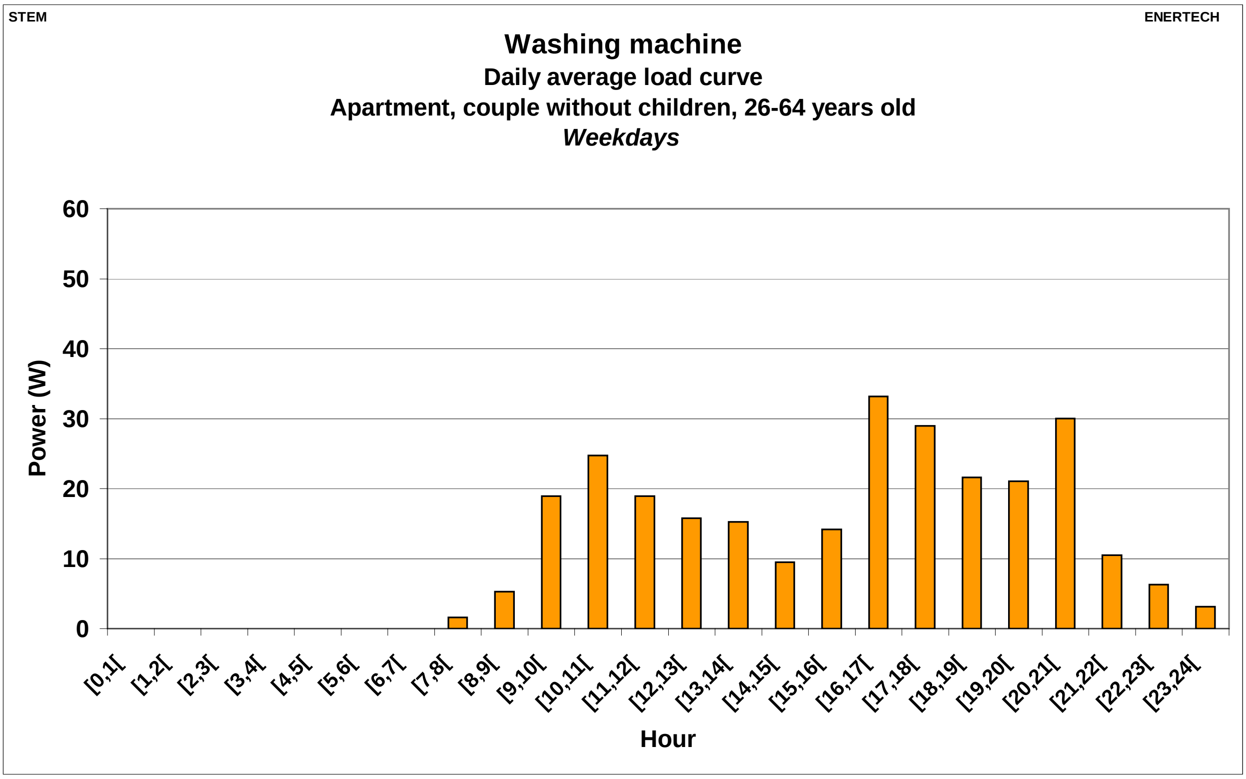


Figure 2.221: Washing machine – Daily average load curve – Apartment, couples without children, 26-64 years old – Weekdays

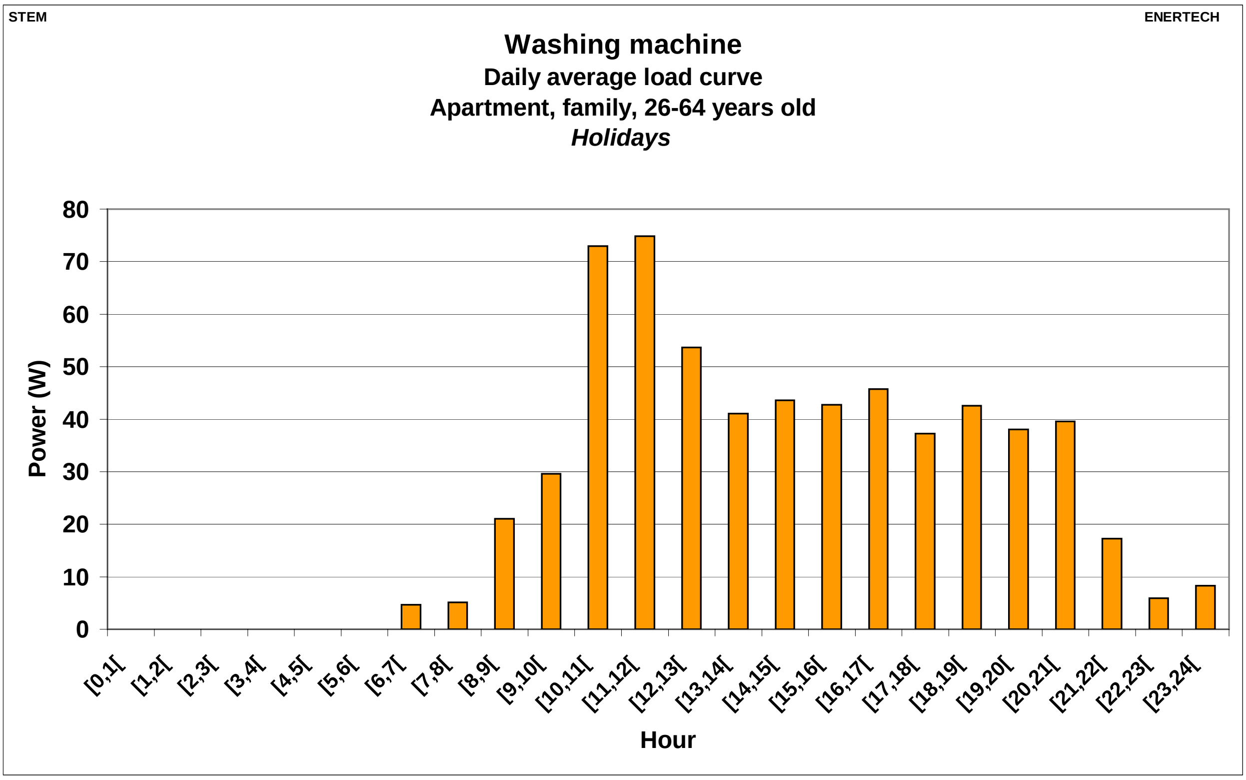


Figure 2.222: Washing machine – Daily average load curve – Apartment, family, 26-64 years old – Holidays

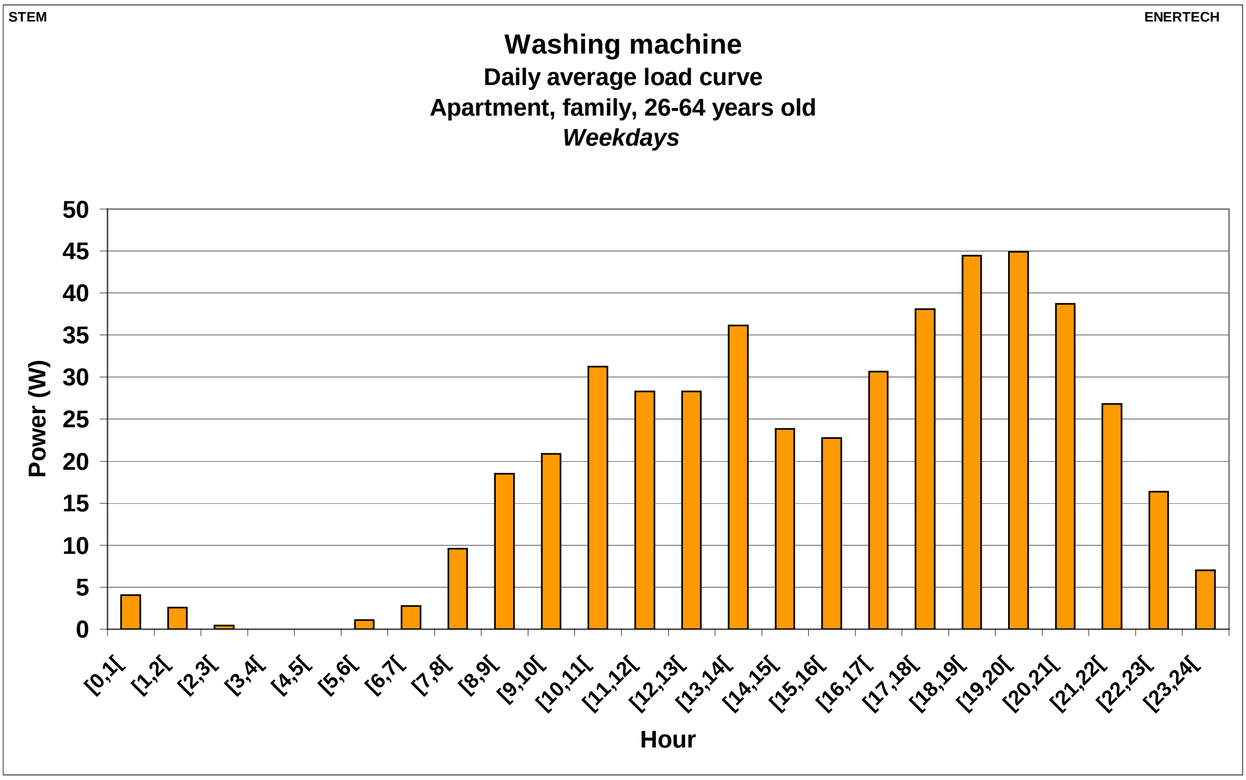


Figure 2.223: Washing machine – Daily average load curve – Apartment, family, 26-64 years old – Weekdays

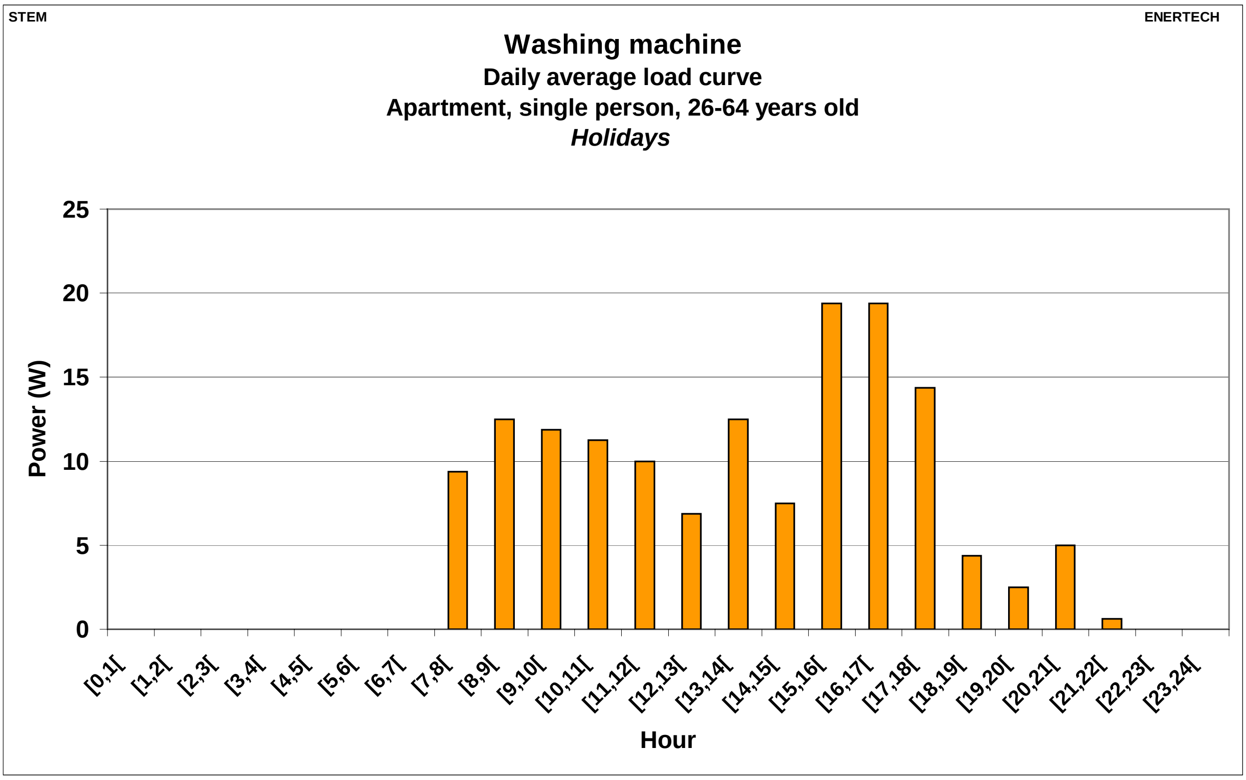


Figure 2.224: Washing machine – Daily average load curve – Apartment, single person, 26-64 years old – Holidays

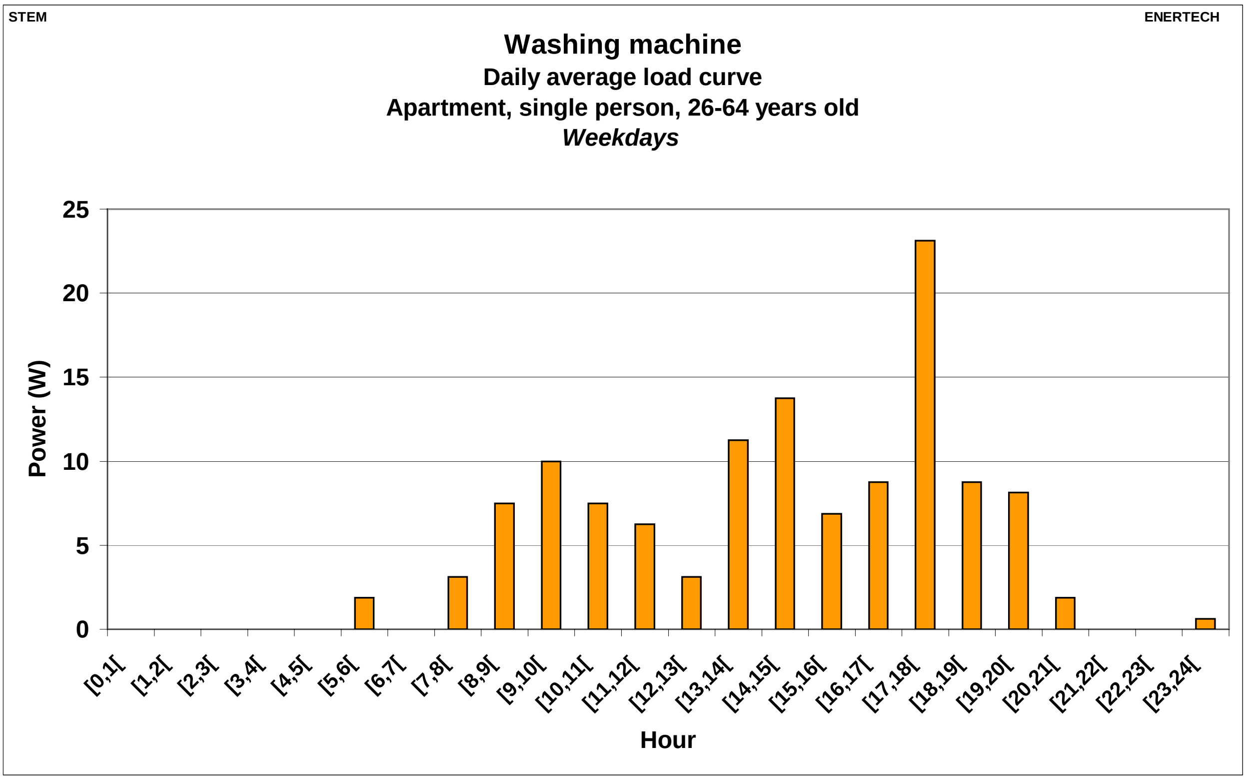


Figure 2.225: Washing machine – Daily average load curve – Apartment, single person, 26-64 years old – Weekdays

Analysis of the wash-cycles

Cycle consumption

Figures 2.226 and 2.227 tries to give us indications about the cycle consumptions. Figure 2.226 shows the cumulative frequency of the cycle consumption. All the cycles for all the washing machines were individually listed and sorted in descending order: 80 % of the washing cycles consume less than 900 Wh, 20% less than 380 Wh and only 12 % more than 1 kWh. Figure 2.227 shows the distribution of the cycles in order to determine the different washing cycles at 40°C, 60°C and 90°C. What we can see is that it is impossible to sort the washing cycles by temperature using the cycles consumption. The actual electronic regulation adapt the consumption using different parameters like the quantity of clothes, the water temperature etc.

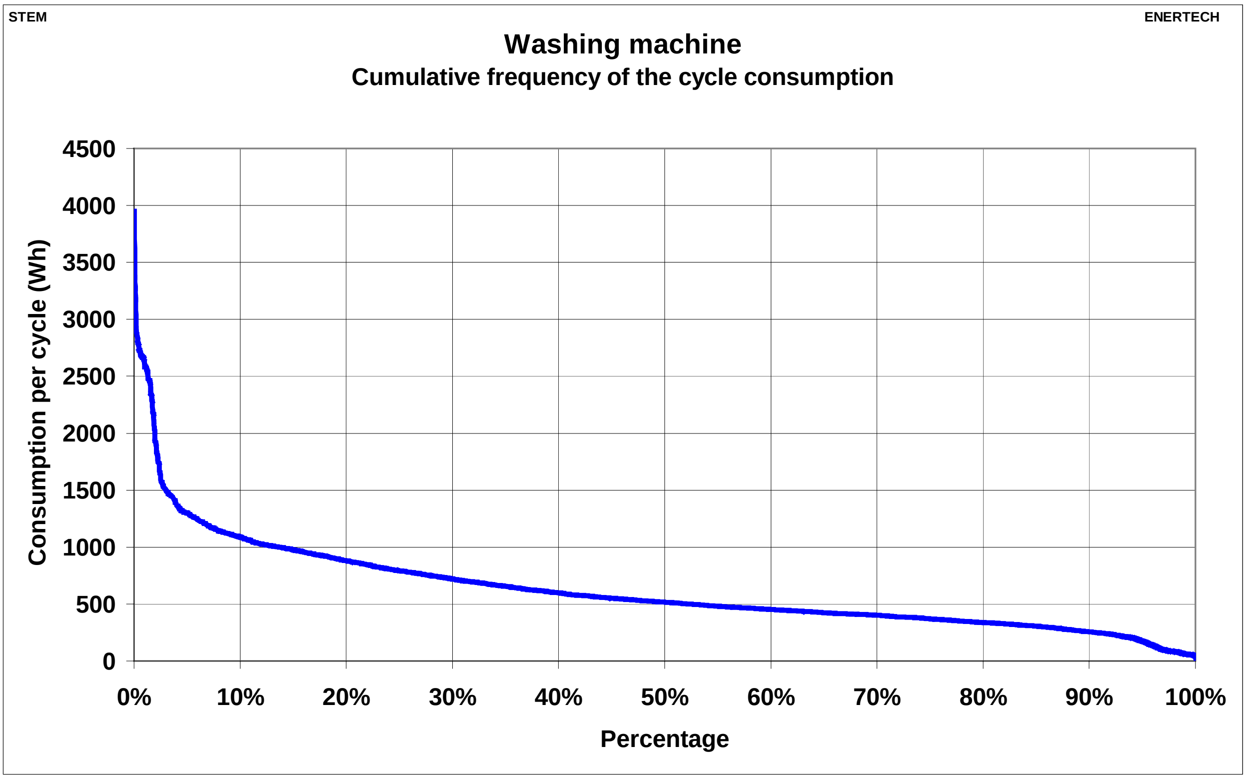


Figure 2.226: Washing machine – Cumulative frequency of the washing cycle consumptions

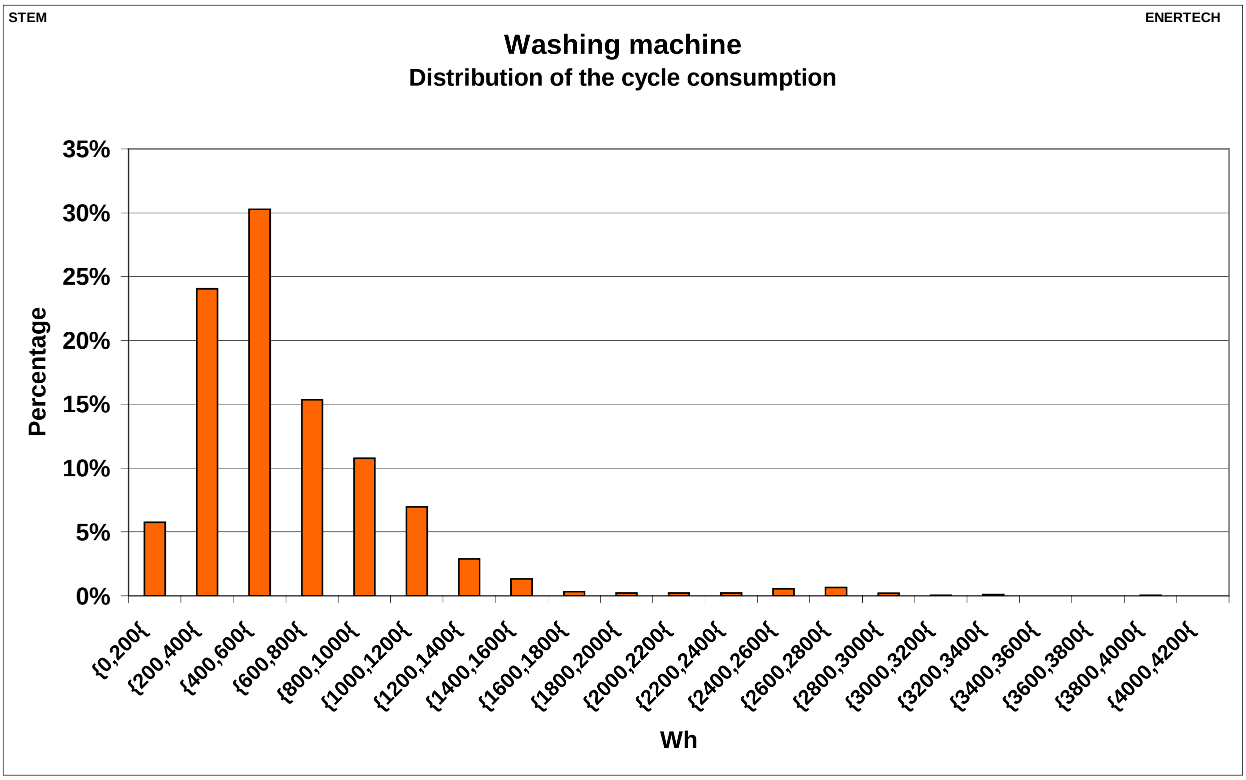


Figure 2.227: Washing machine – Distribution of the washing cycle consumption

Number of annual cycles

Figure 2.227-B and 2.227-C represent the number of annual cycles per washing machine. The mean value is higher for houses than for apartments: 250 against 150. This difference could be explained by the average number of persons per household: 3,1 persons per house and 2,5 persons/apartment for the sample used to create the graphs.

Figure 2.227-D and 2.227-E show the annual number of cycles per person. The mean value is a little bit higher for houses: 73 cycles/person against 65 cycles/person.

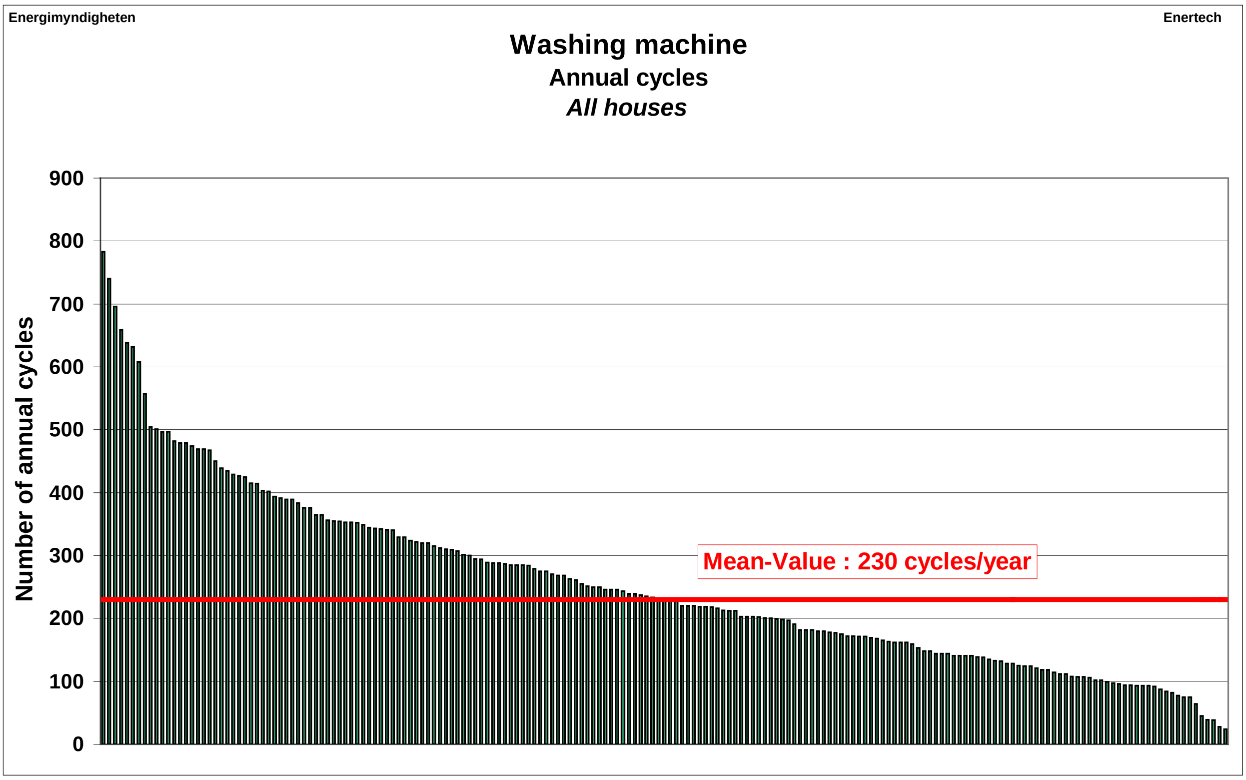


Figure 2.227-B: Washing machine – Number of annual cycles – All houses

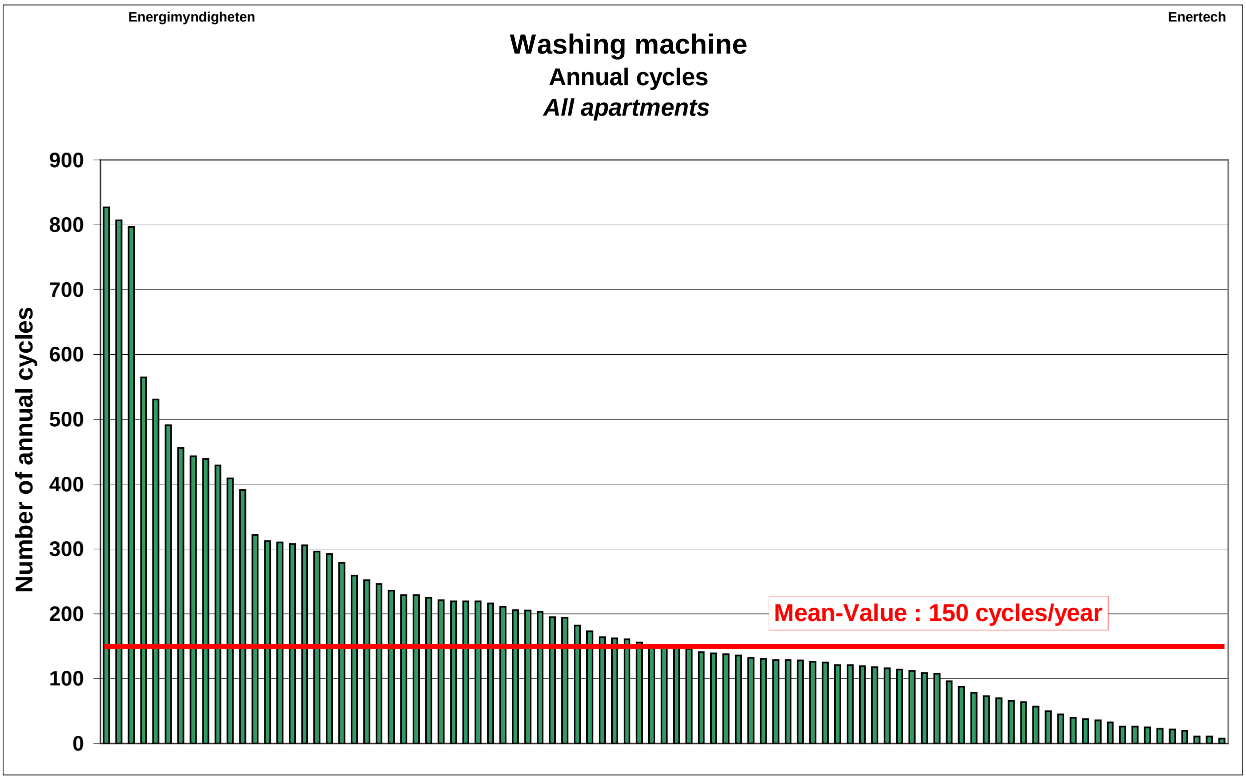


Figure 2.227-C: Washing machine – Number of annual cycles – All apartments

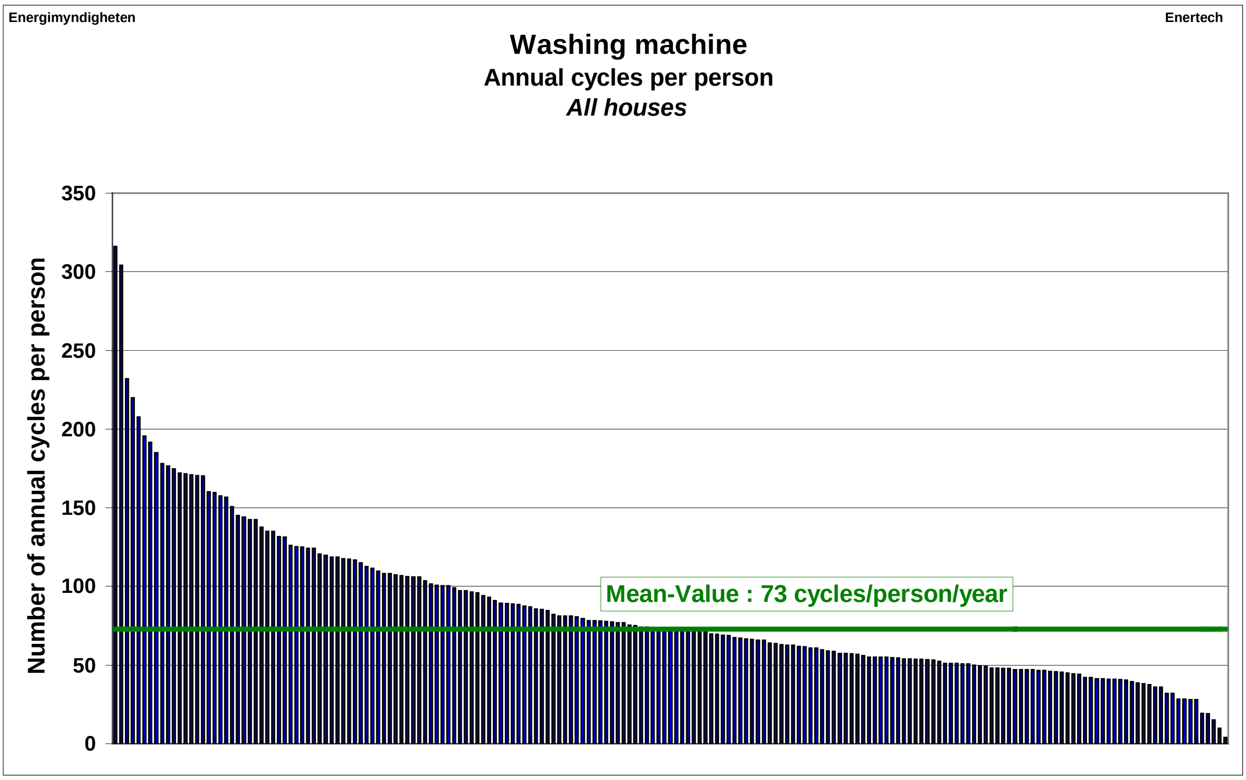


Figure 2.227-D: Washing machine – Number of annual cycles per person – All houses

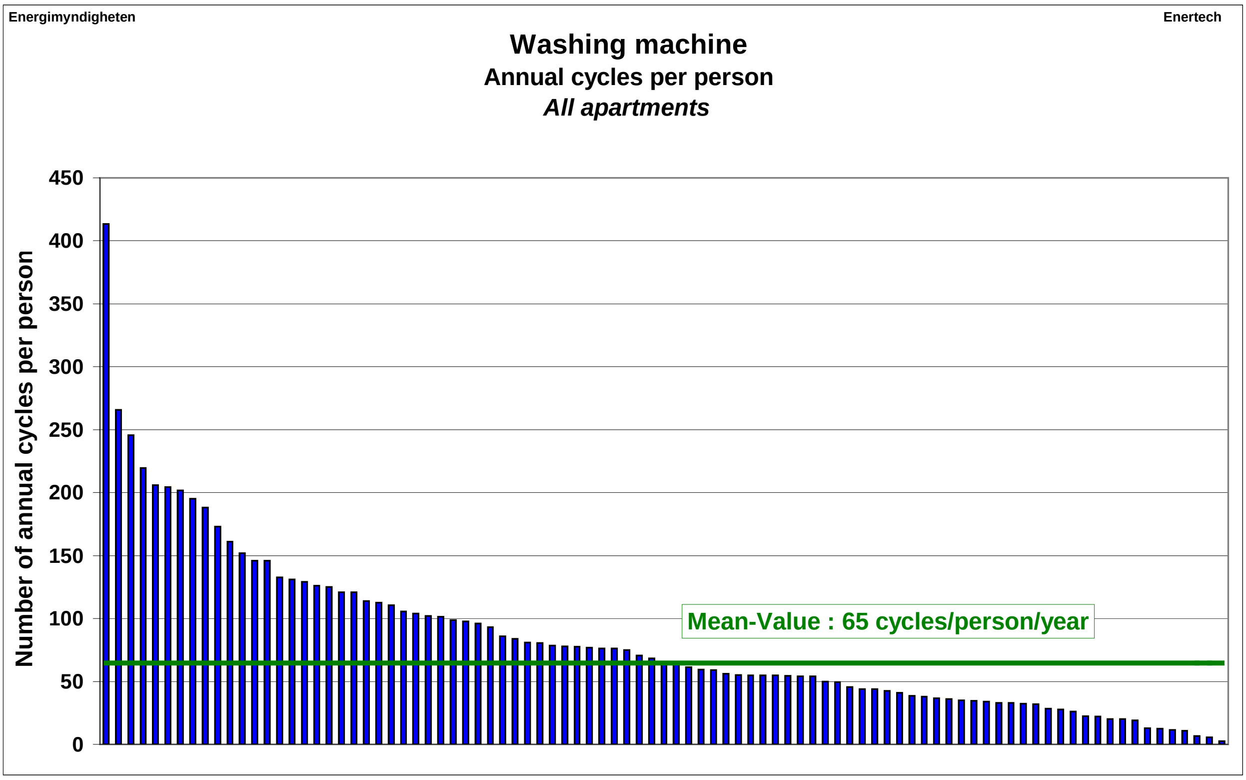


Figure 2.227-E: Washing machine – Number of annual cycles per person – All apartments

CLOTHES-DRYERS

Annualized consumptions

Figures 2.228 to 2.230 shows the histogram of clothes-dryer annualized consumption for the different types of households. The analysis of the one year households didn't show a seasonality effect.

There are some significant differences from one type to the other, which can be explained by different practices. Consumption is higher in the apartments (243 kWh/year to 315 kWh/year) than in the houses (from 95 kWh/year to 131 kWh/year). For houses, it is possible to dry the clothes outside in summer and use the clothes dryer only in winter which is not the case for apartments: this behaviour can explain the big difference in consumption between the two.

Figure 2.228: Clothes dryer: annual consumption – House, family, 26-64 years old

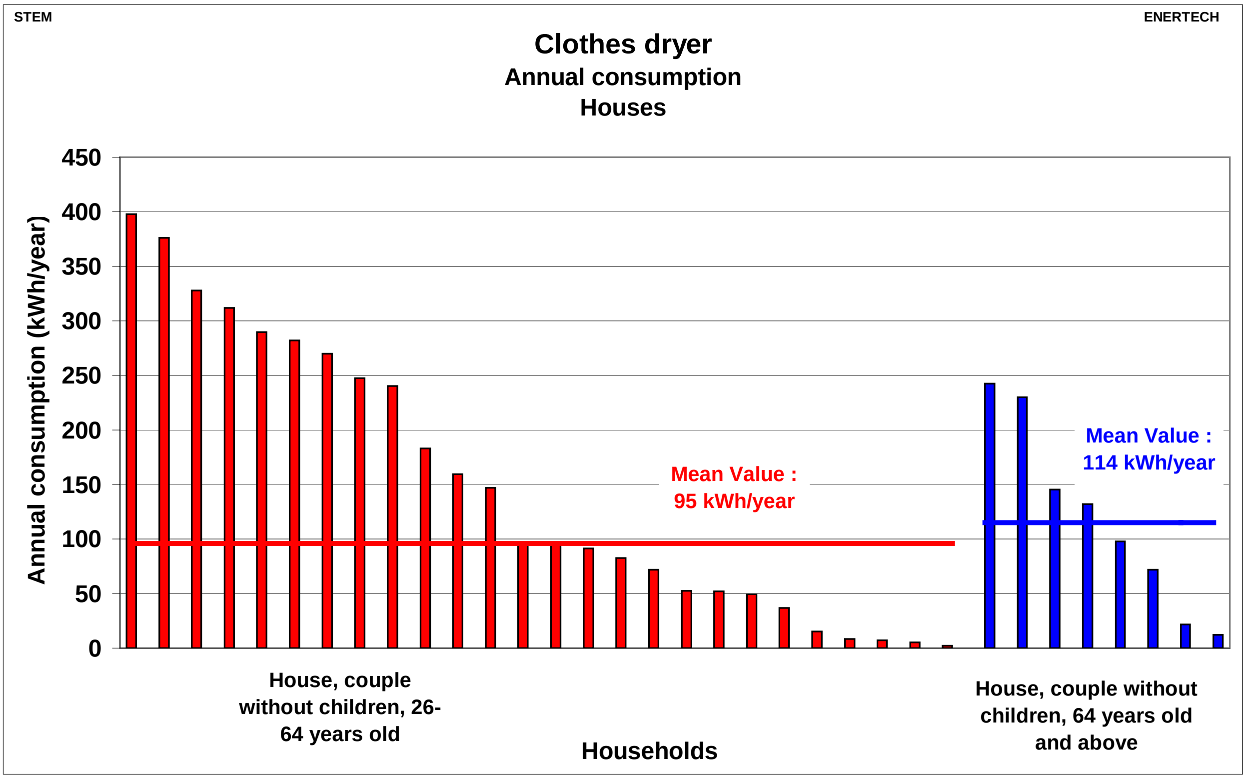


Figure 2.229: Clothes dryer: annual consumption – Houses

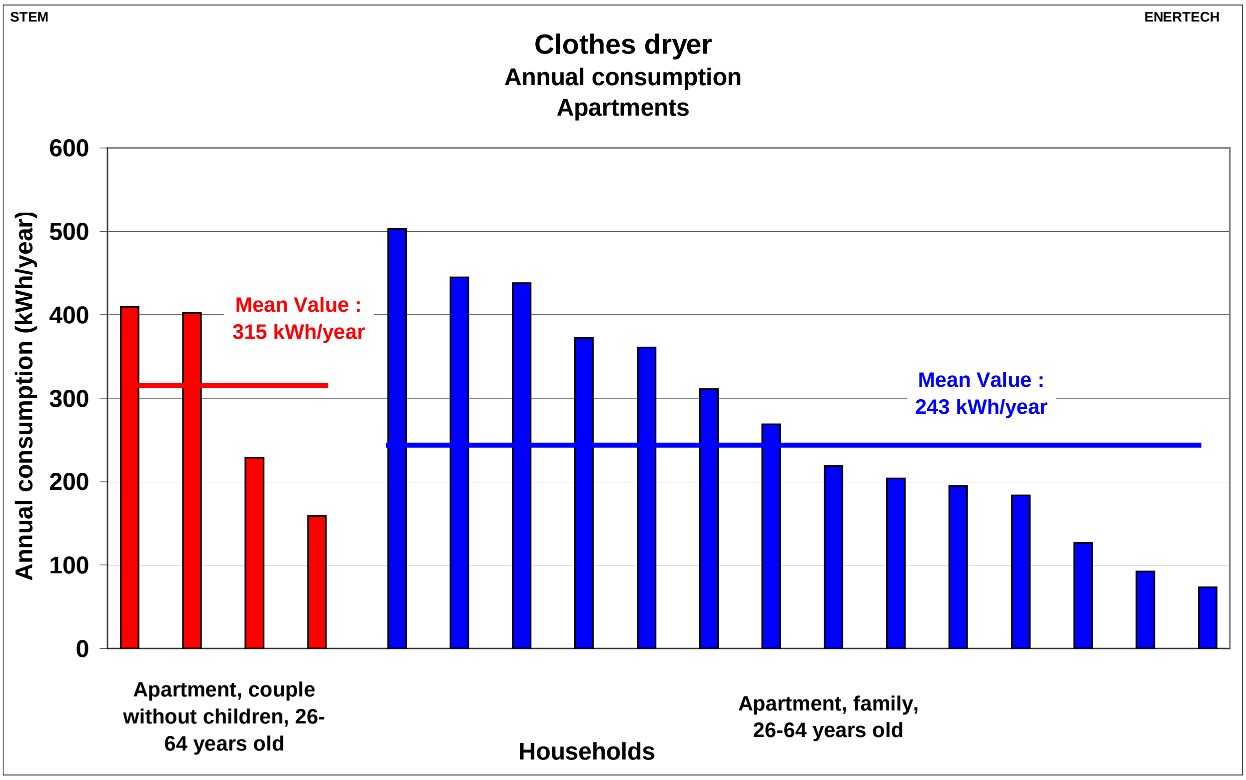


Figure 2.230: Clothes dryer: annual consumption – Apartments

Figure 2.231 shows us the annual consumption per person per family size. The values per persons should be treated with some care, since the family structure has to be taken into account as well. The consumption per person for houses from 2 to 6 persons is between 40 and 70 kWh/person/year. For houses with one person, the small number of household analyzed can explain the difference between this result and the rest. For apartments the consumption per person is maximum for 1 or 2 persons and decreases to around 80 kWh/person/year for 3,4 or 5 persons.

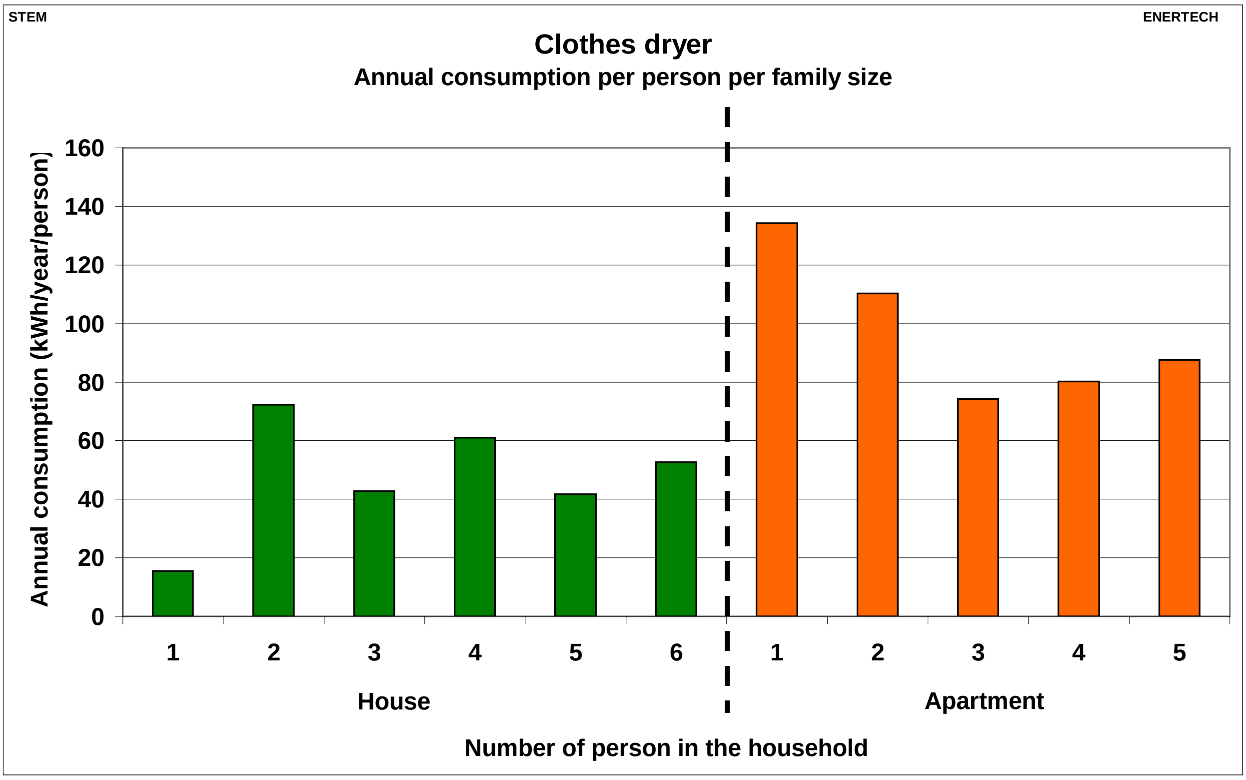


Figure 2.231: Clothes dryer: annual consumption per person per household size

Hourly load curve

Figures 2.232 to 2.241 shows the daily average load curve for each type of household split between holidays and workdays. The consumption occurs mainly during the holidays.

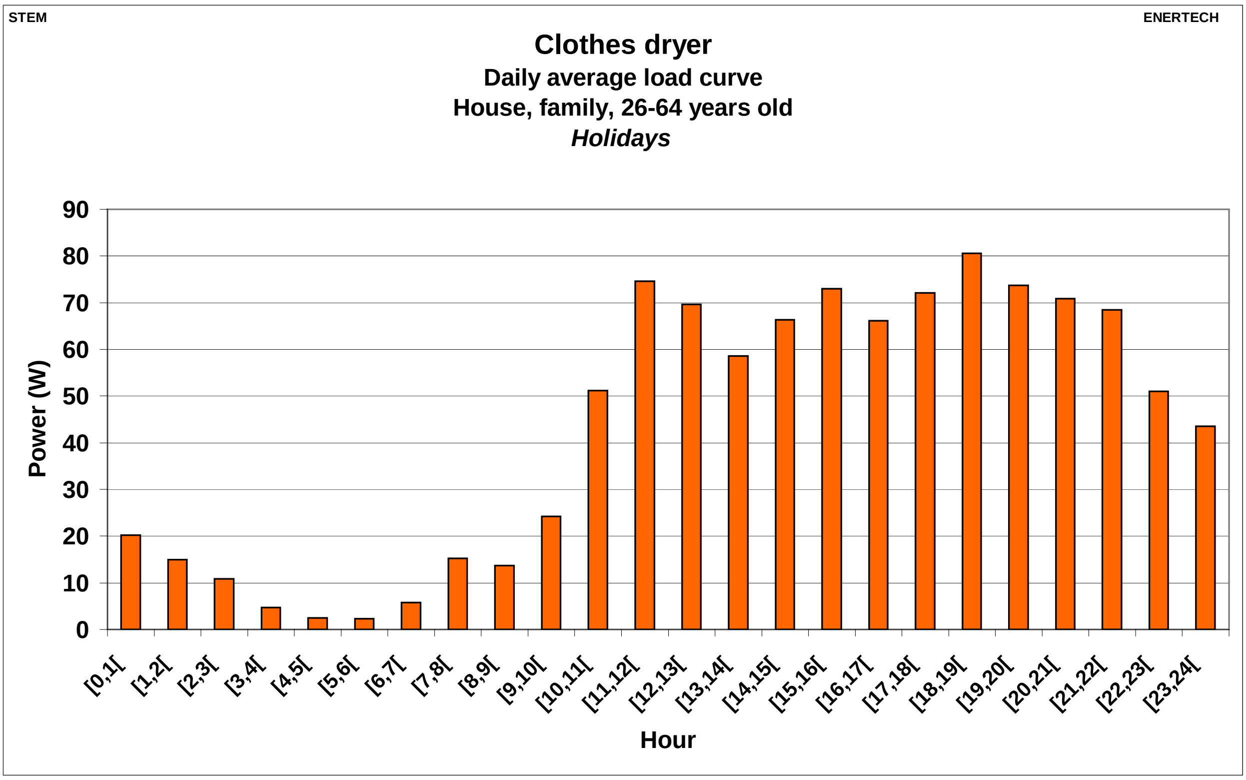


Figure 2.232: Clothes dryer – Daily average load curve – House, family, 26-64 years old – Holidays

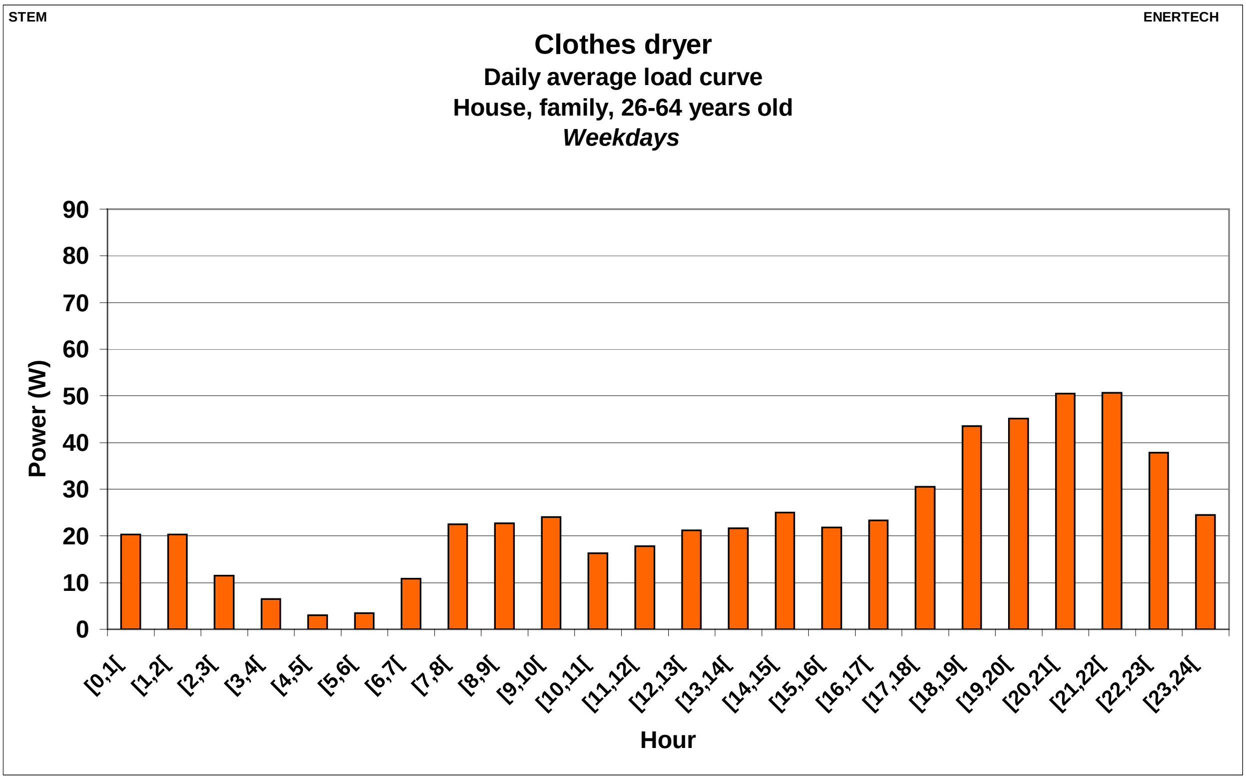


Figure 2.233: Clothes dryer – Daily average load curve – House, family, 26-64 years old – Weekdays

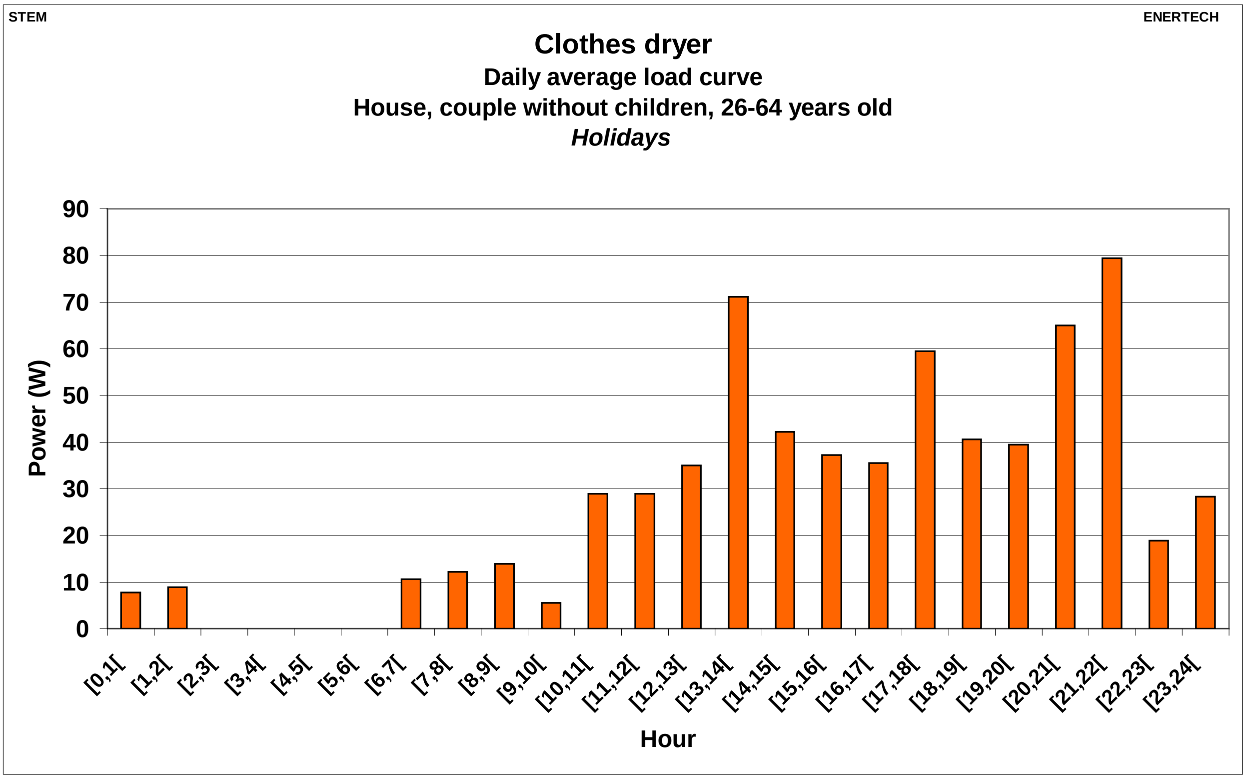


Figure 2.234: Clothes dryer – Daily average load curve – House, couples without children, 26-64 years old – Holidays

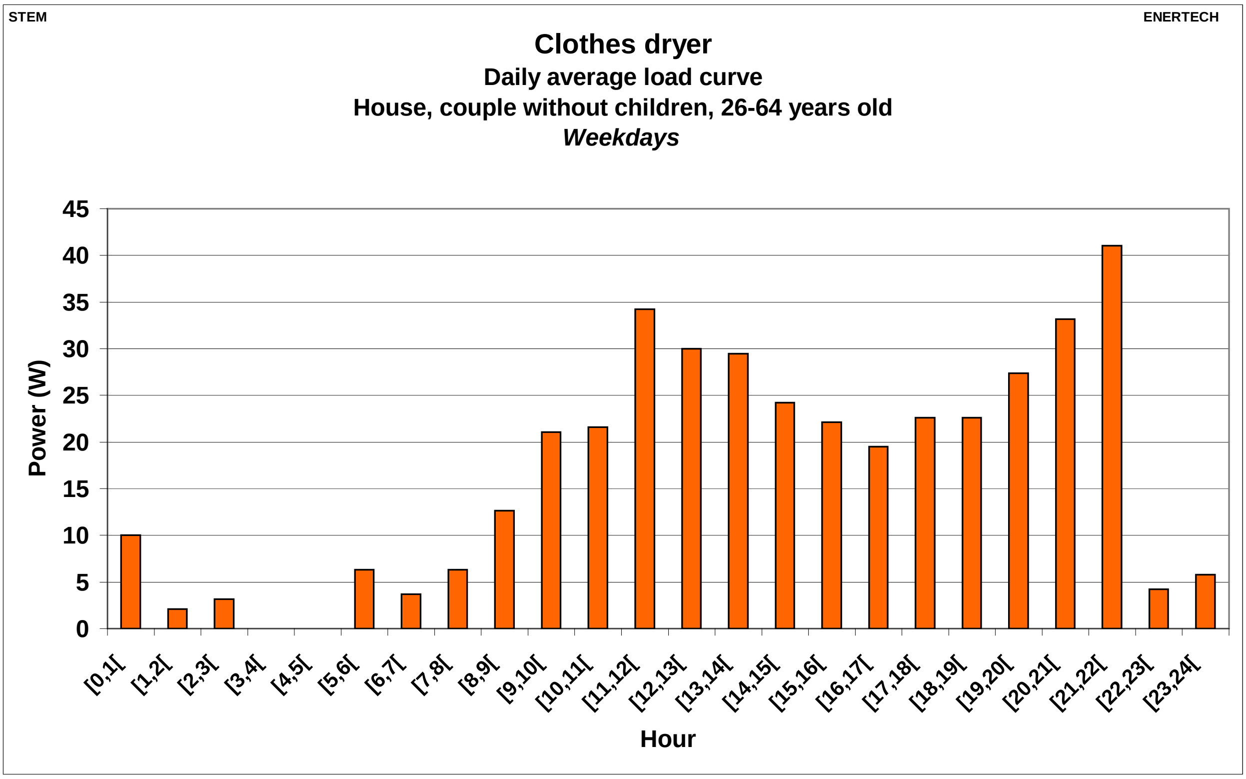


Figure 2.235: Clothes dryer – Daily average load curve – House, couples without children, 26-64 years old – Weekdays

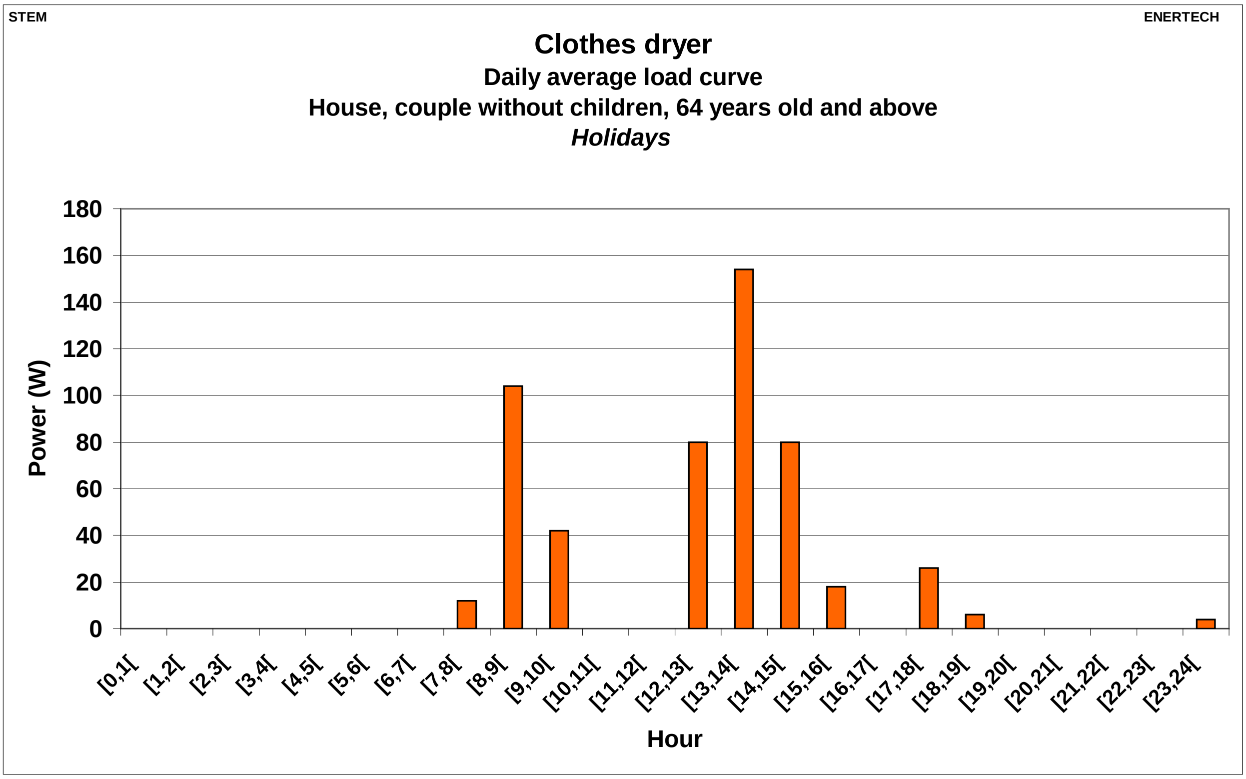


Figure 2.236: Clothes dryer – Daily average load curve – House, couples without children, 64 years old and above – Holidays

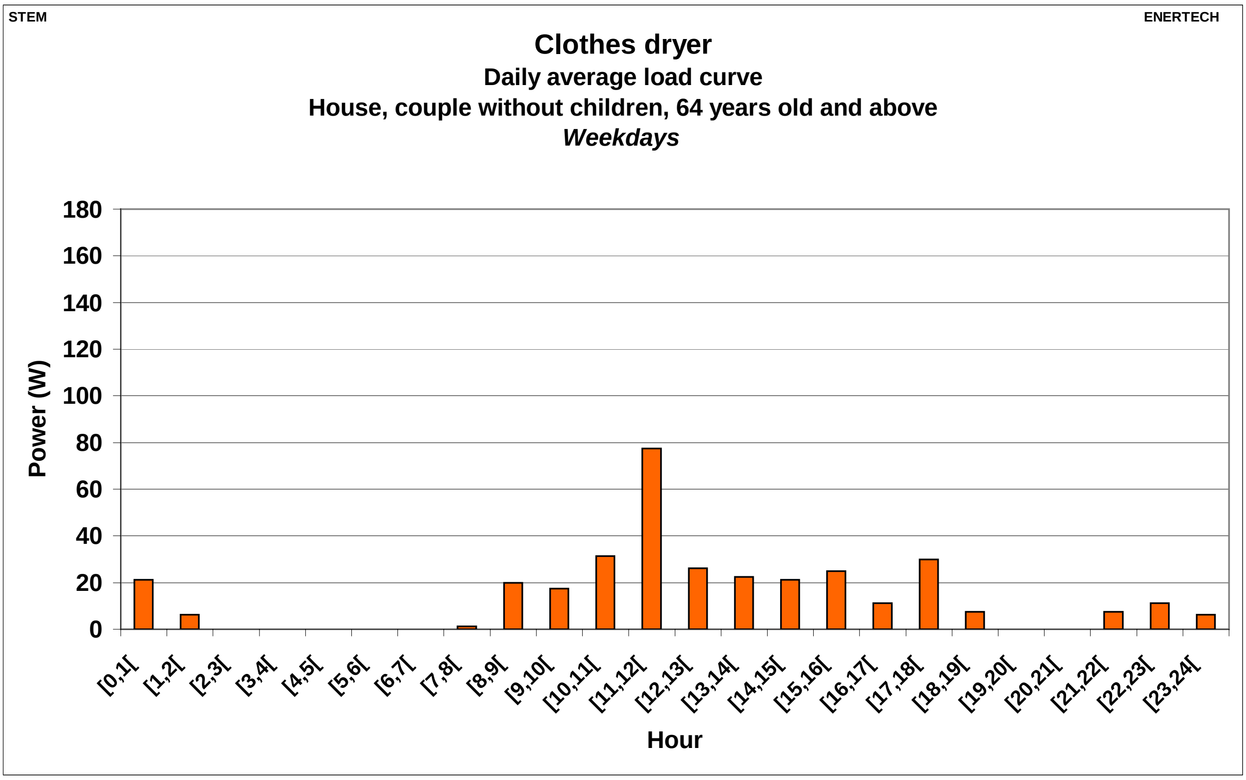


Figure 2.237: Clothes dryer – Daily average load curve – House, couples without children, 64 years old and above – Weekdays

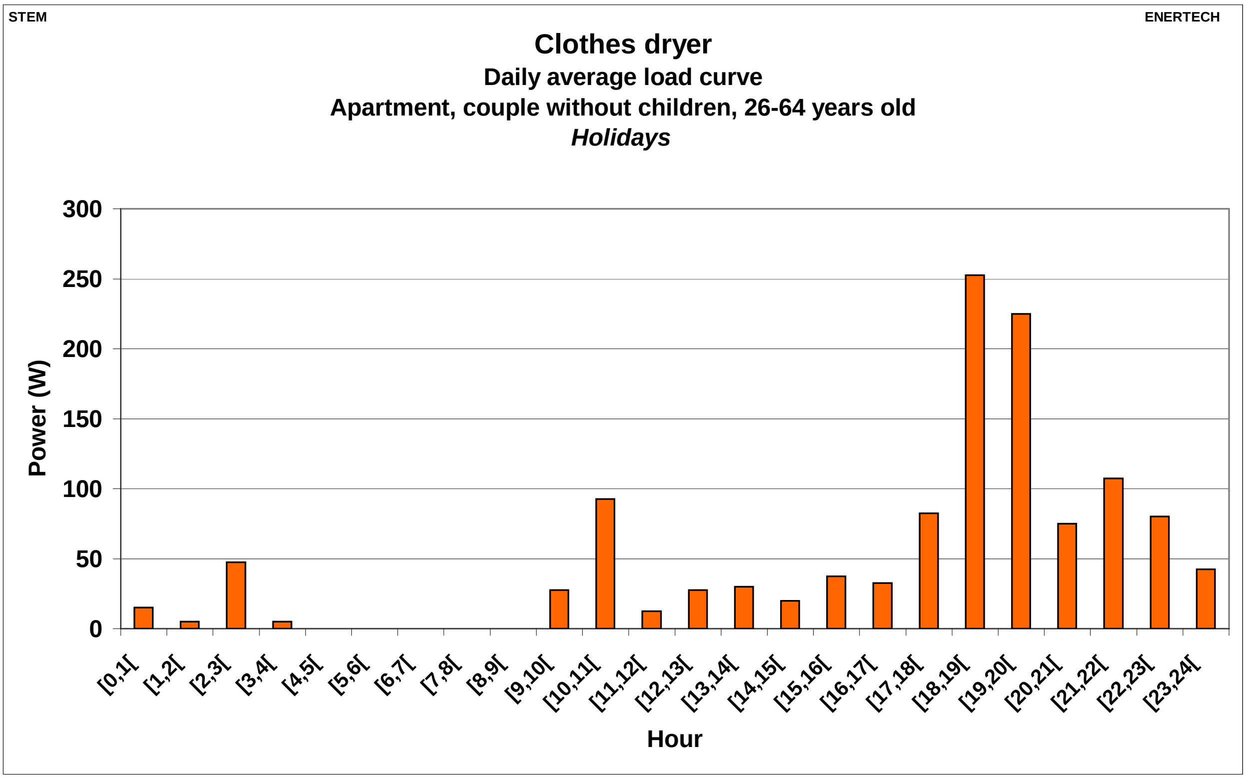


Figure 2.238: Clothes dryer – Daily average load curve – Apartment, couples without children, 26-64 years old – Holidays

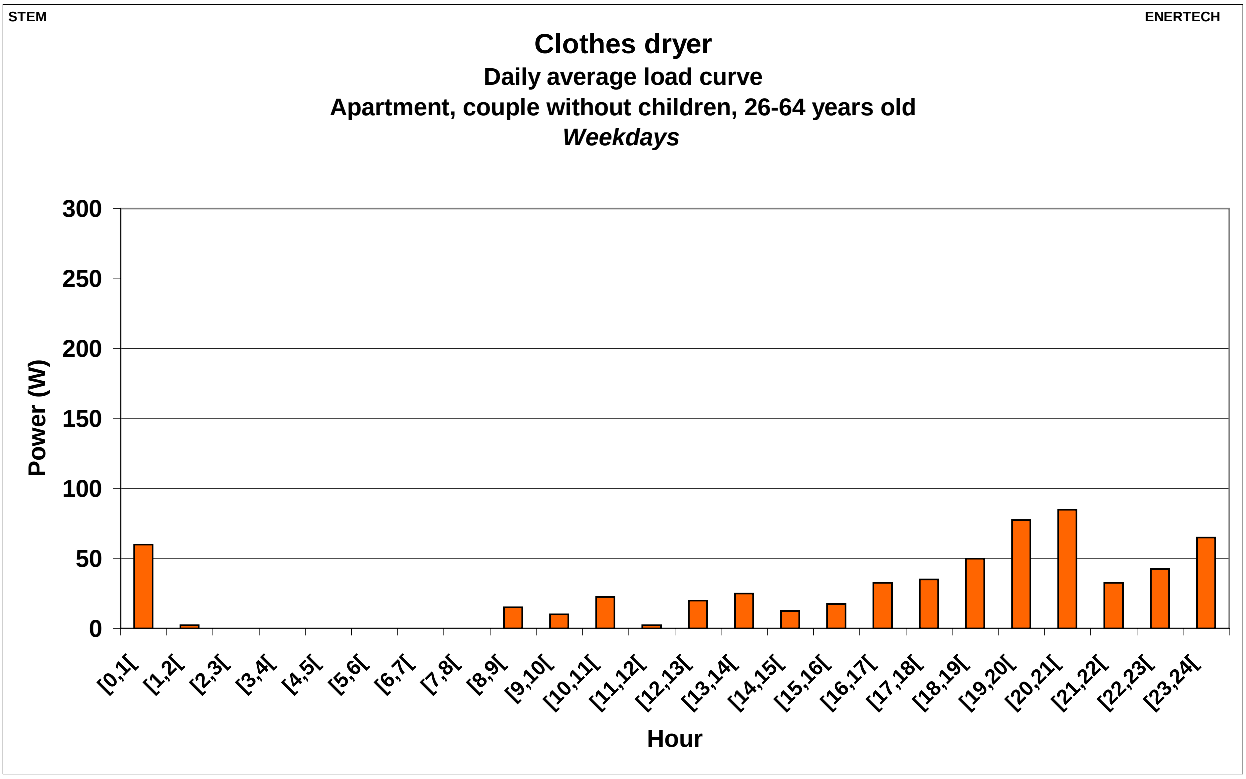


Figure 2.239: Clothes dryer – Daily average load curve – Apartment, couples without children, 26-64 years old – Weekdays

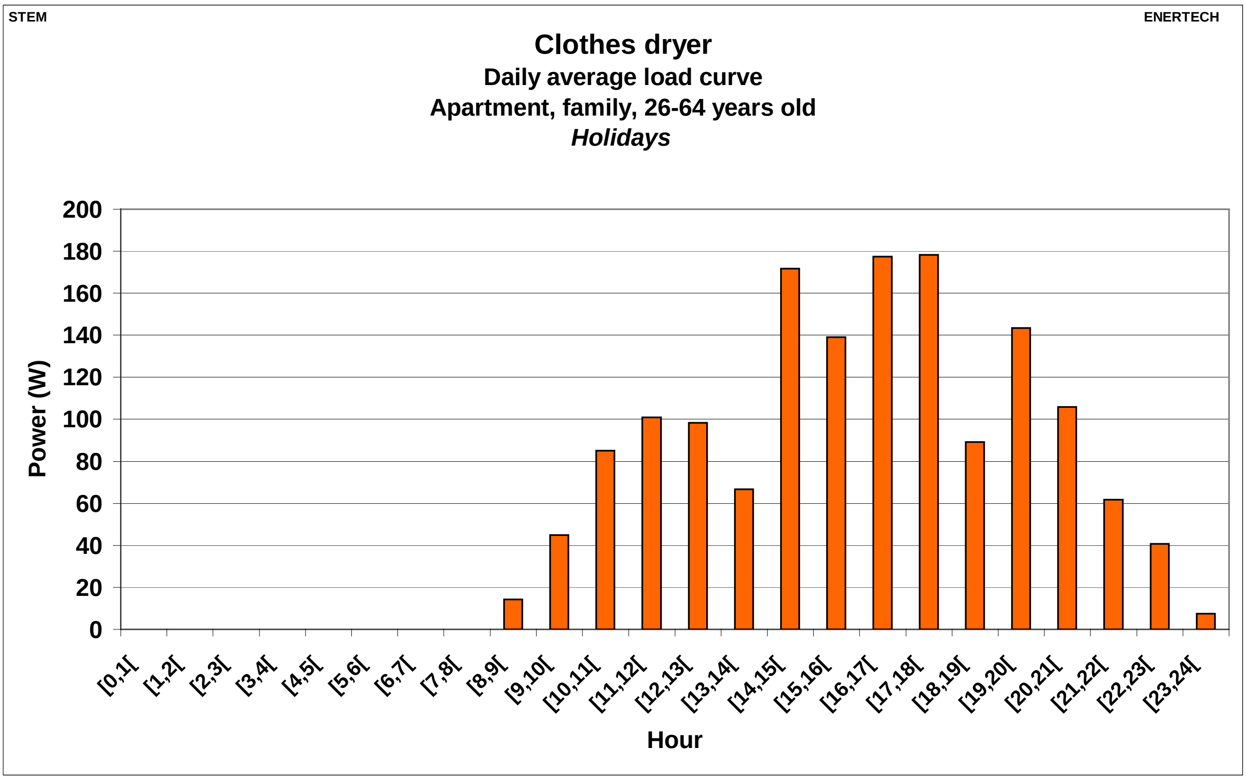


Figure 2.240: Clothes dryer – Daily average load curve – Apartment, family, 26-64 years old – Holidays

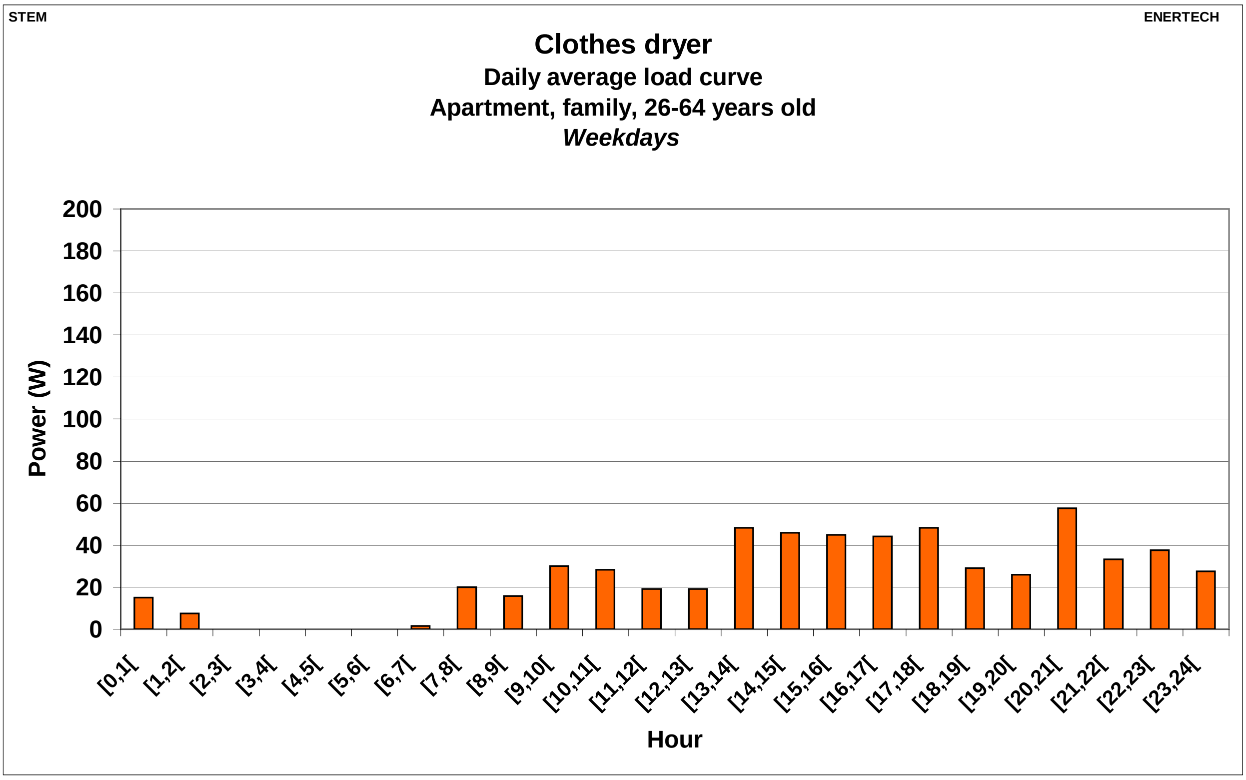


Figure 2.241: Clothes dryer – Daily average load curve – Apartment, family, 26-64 years old – Weekdays

Analysis of the drying-cycles

Cycle consumption

Figures 2.242 and 2.243 tries to give us indications about the cycle consumptions. Figure 2.242 shows the cumulative frequency of the cycle consumptions. All the cycles for all the washing machines were individually listed and sorted in descending order: 80 % of the washing cycles consume less than 2000 Wh, 20% less than 500 Wh and only 7 % more than 3 kWh. Figure 2.243 shows the distribution of the cycles.

Figure 2.242: Clothes dryer – Cumulative frequency of the washing cycle consumption

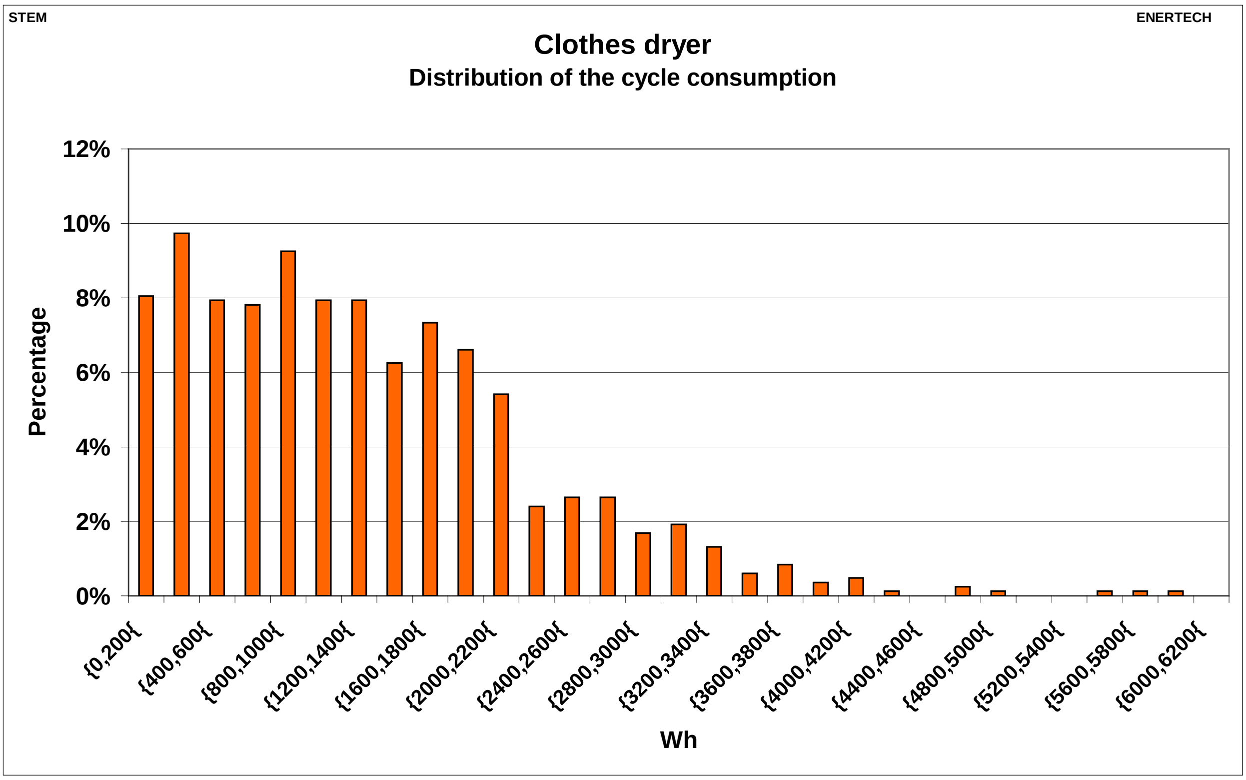


Figure 2.243: Clothes dryer – Distribution of the drying cycle consumption

Number of cycles

Figure 2.243-B and 2.243-C show the number of annual cycles for houses and apartments respectively. Figure 2.243-D and 2.243-E show the number of annual cycles per person. The clothes dryers are more used in the apartments than in the houses: 53 cycles/person for apartments against 31 cycles/person for houses. This can be certainly explained by the possibility to dry the washings outside or in a specific room for houses.

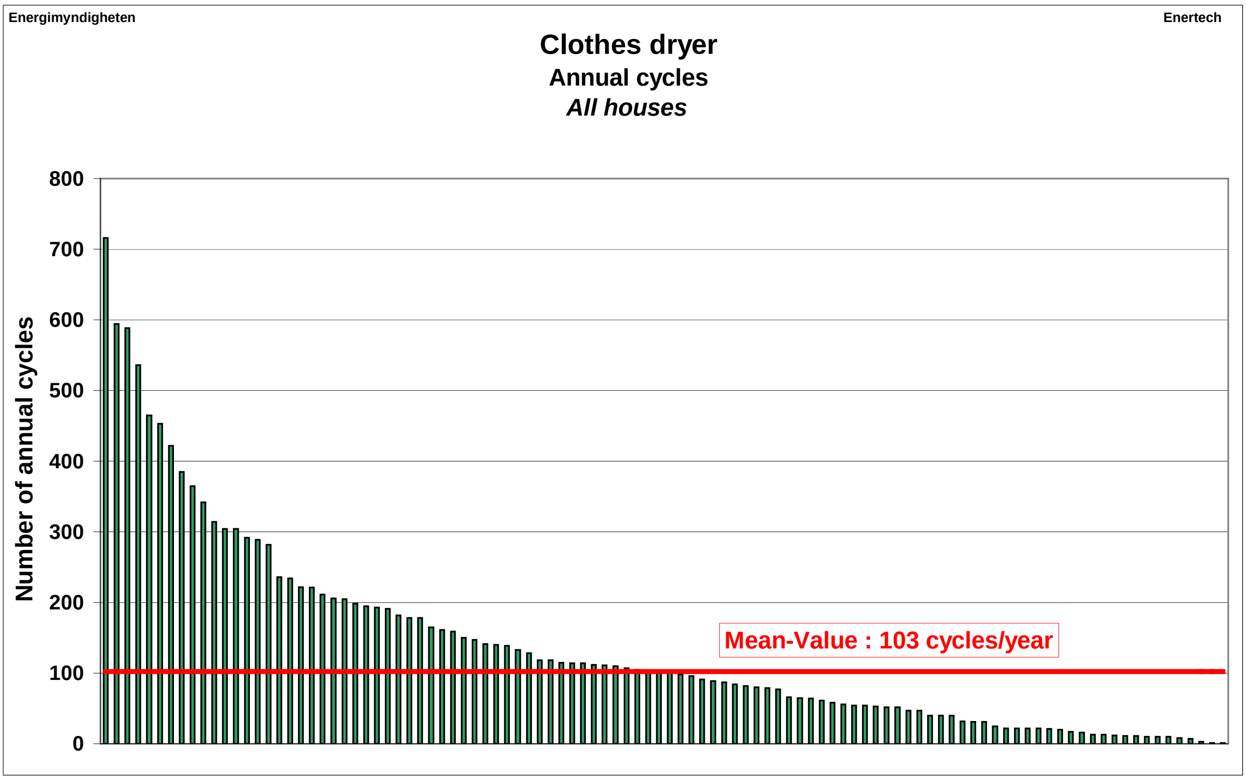


Figure 2.243-B: Clothes dryer – Number of annual cycles – All houses

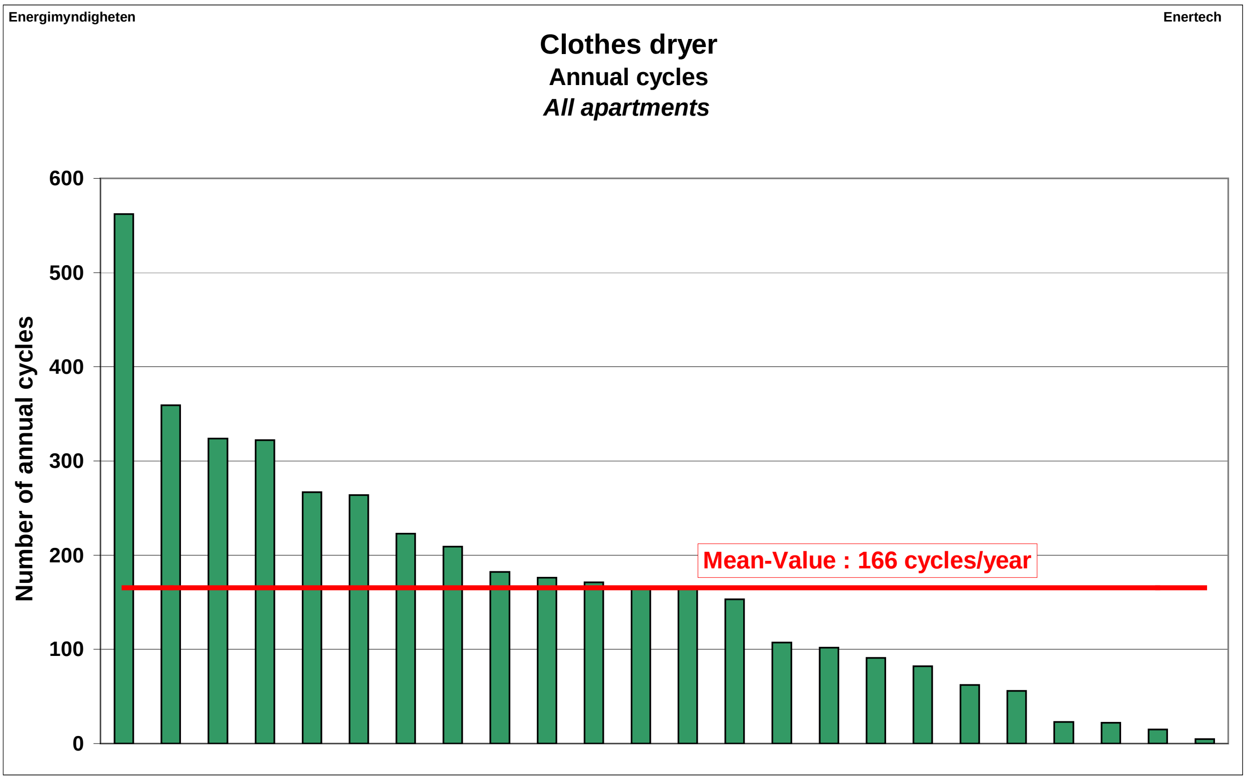


Figure 2.243-C: Clothes dryer – Number of annual cycles – All apartments

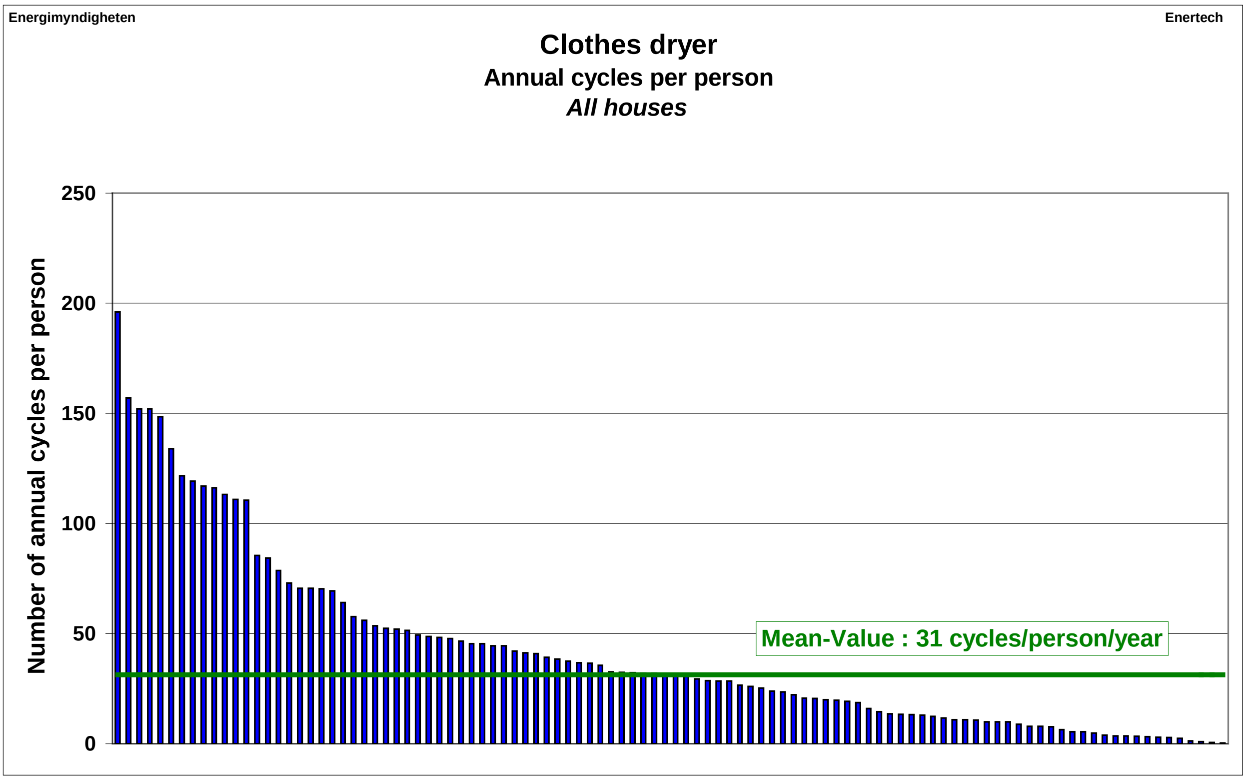


Figure 2.243-D: Clothes dryer – Number of annual cycles per person – All houses

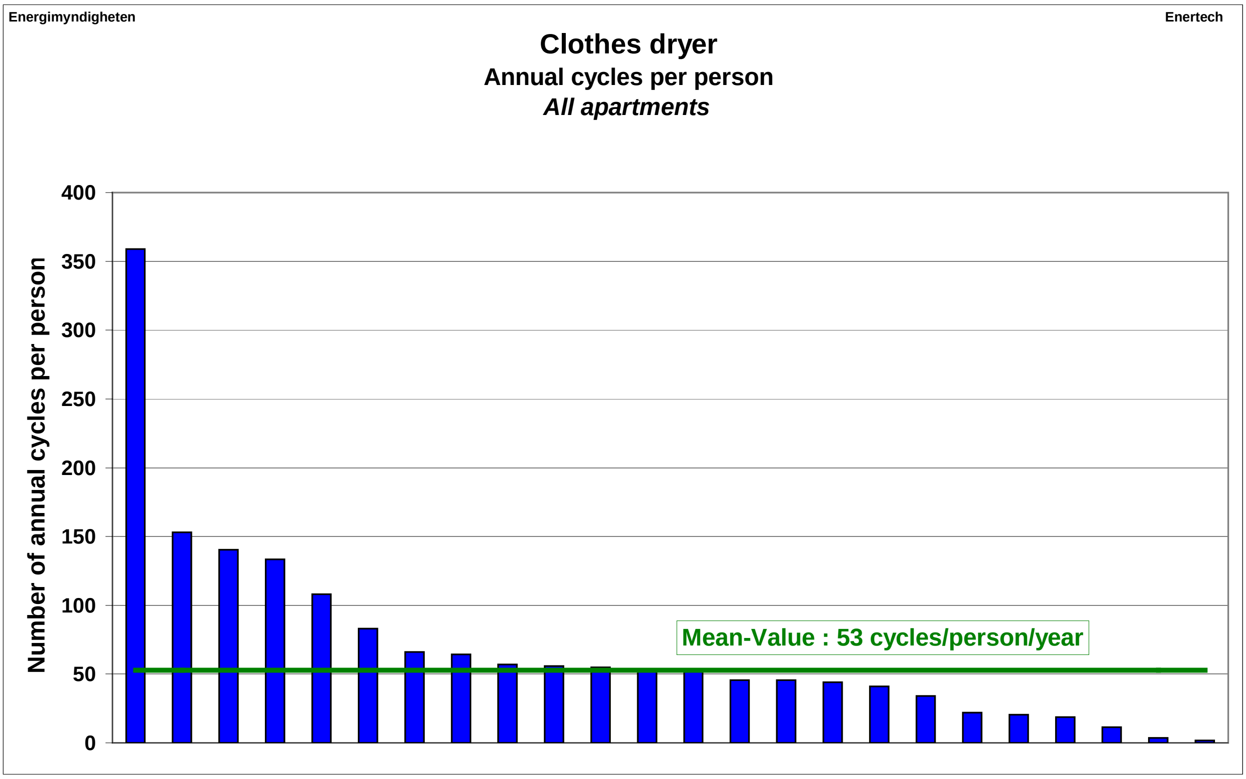


Figure 2.243-E: Clothes dryer – Number of annual cycles per person – All apartments

DISHWASHERS

Annualized consumptions

Figures 2.244 to 2.247 shows the histogram of dishwashers annualized consumption for different types of households. The analysis of the one year households didn't show a seasonality effect.

There are some significant differences from one type to another. Consumption for houses are between 143 and 236 kWh/year and between 74 and 214 kWh/year for apartments. In France, the Remodece+ project shows an average consumption of 273 kWh/year. As for the cold appliances, the annual consumption seems lower in Sweden.

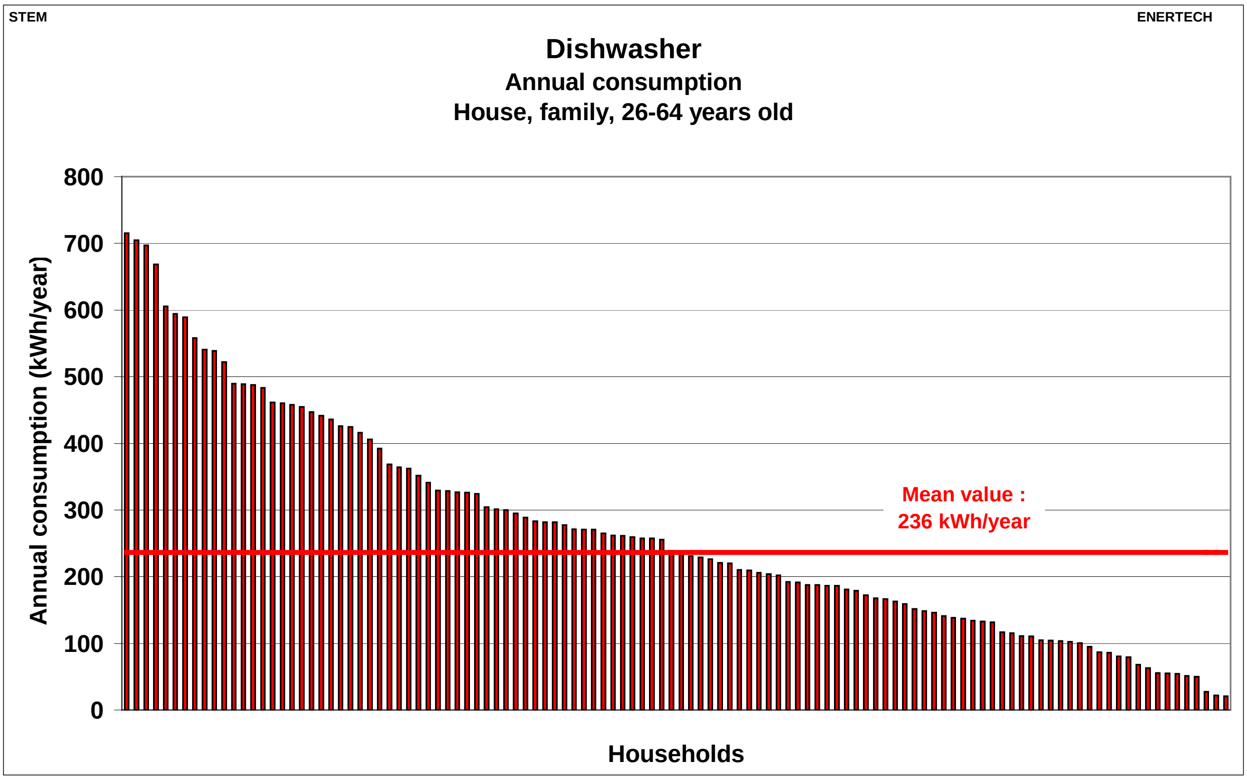


Figure 2.244: Dishwasher: annual consumption – House, family, 26-64 years old

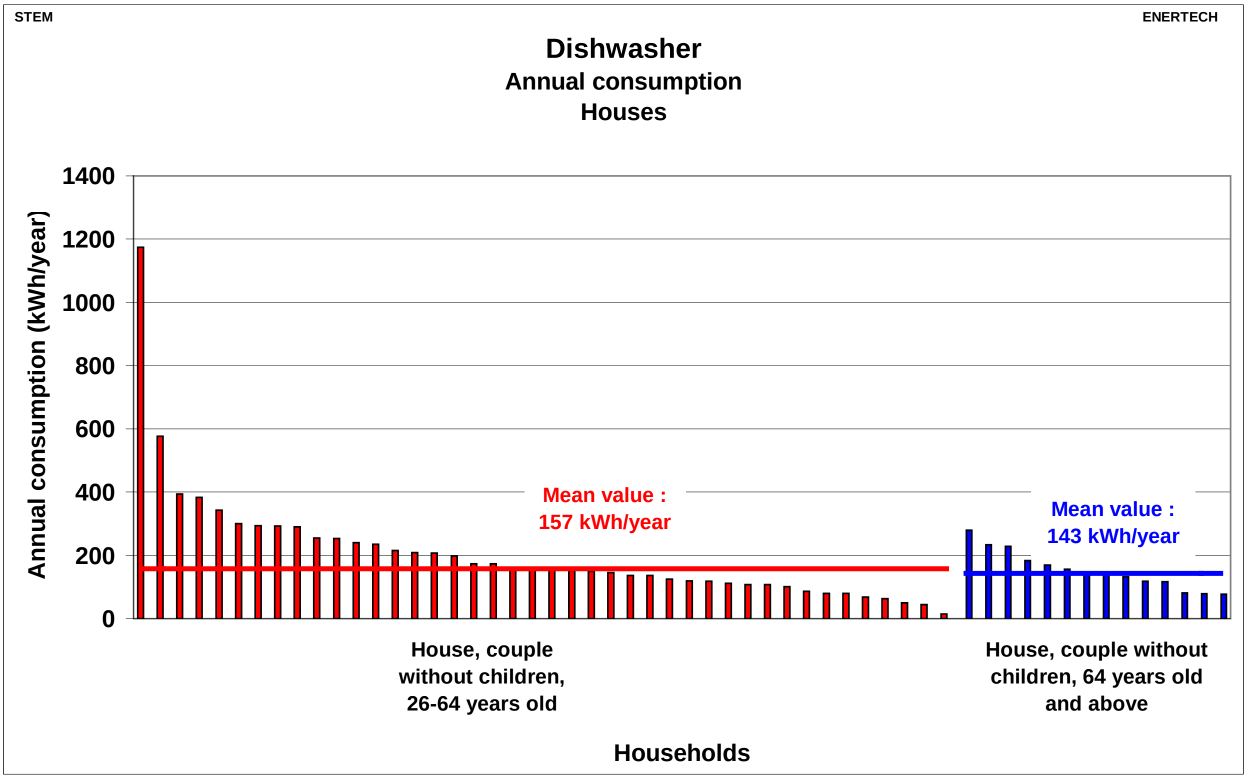


Figure 2.245: Dishwasher: annual consumption – Houses

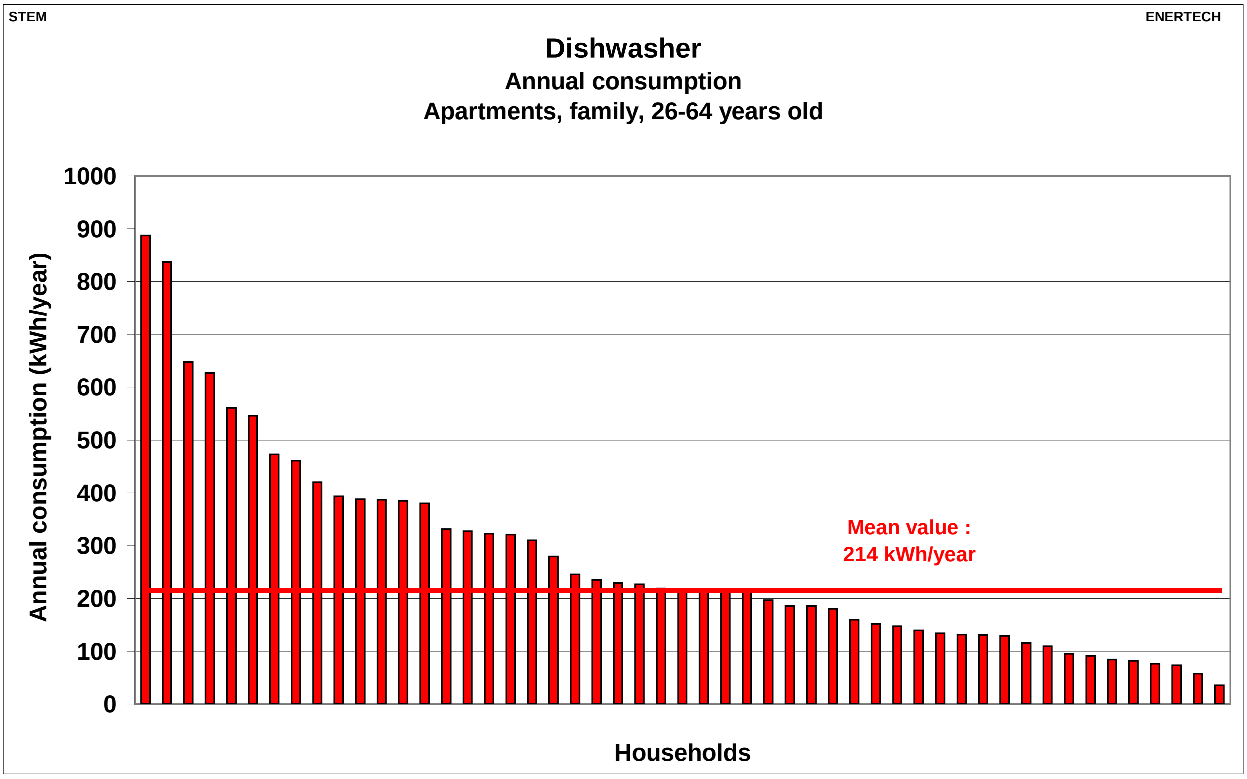


Figure 2.246: Dishwasher: annual consumption – Apartments, family, 26-64 years old

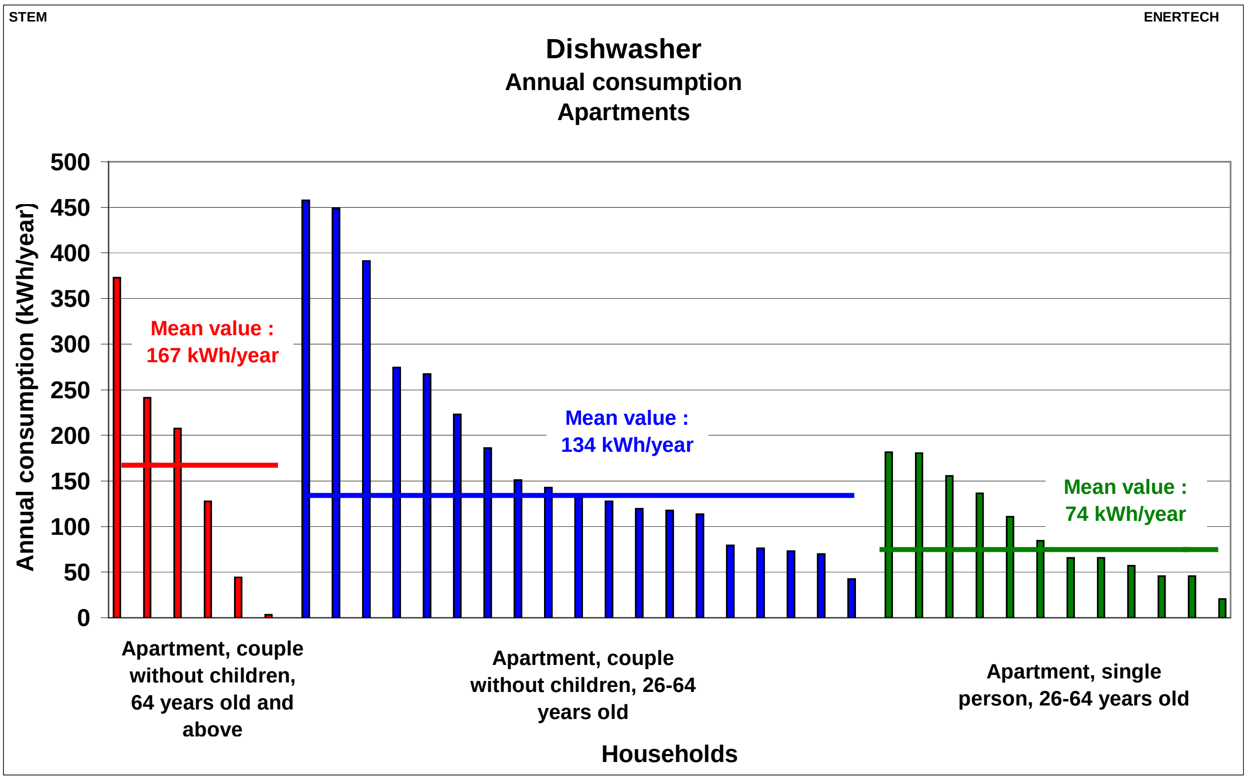


Figure 2.247: Dishwasher: annual consumption – Apartments

Figure 2.248 shows the annual consumption per person per family size. The values per persons should be treated with some care, since the family structure has to be taken into account as well. The consumption per person for houses from 1 to 6 persons is between 50 and 90 kWh/person/year with an average at 70 kWh/person/year. For apartments the consumption per person are maximum between 1 and 3 persons with an average consumption of 82 kWh/person/year.

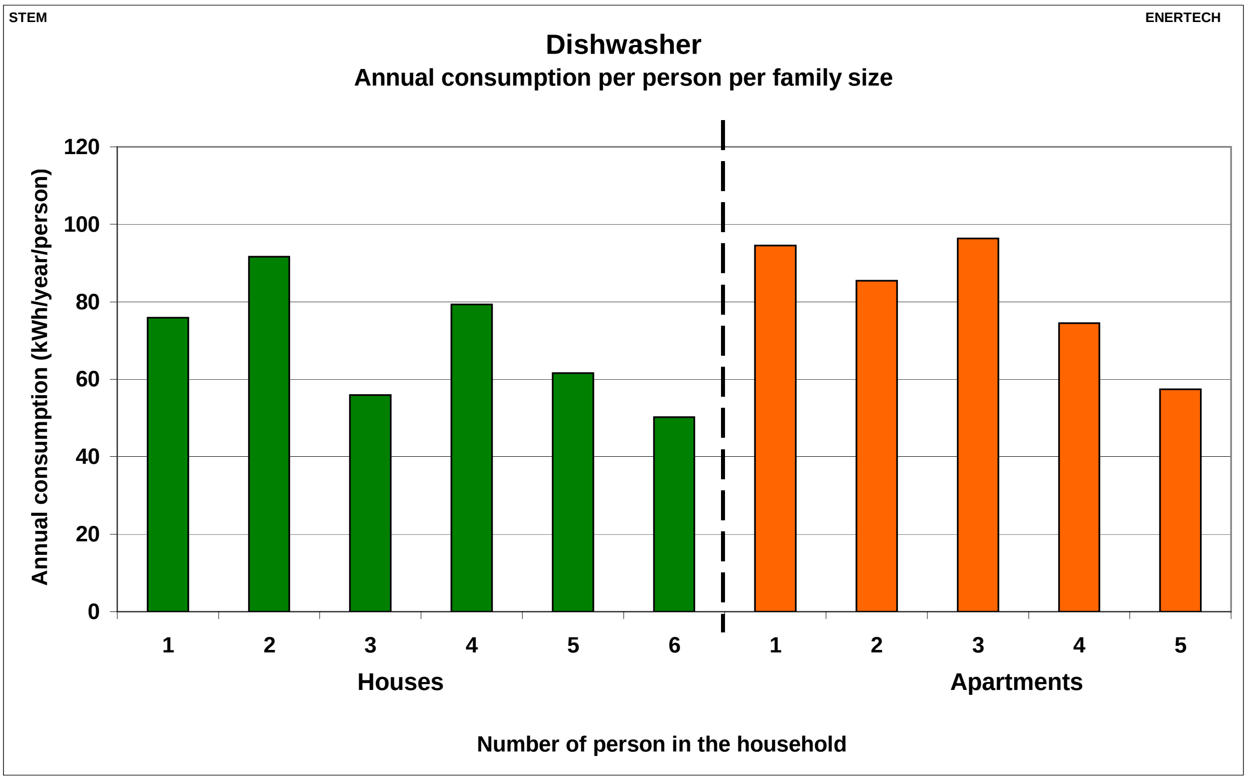


Figure 2.248: Dishwasher: annual consumption per person per household size

Hourly load curve

Figures 2.249 to 2.241 shows the daily average load curve for each type of household split between holidays and workdays.

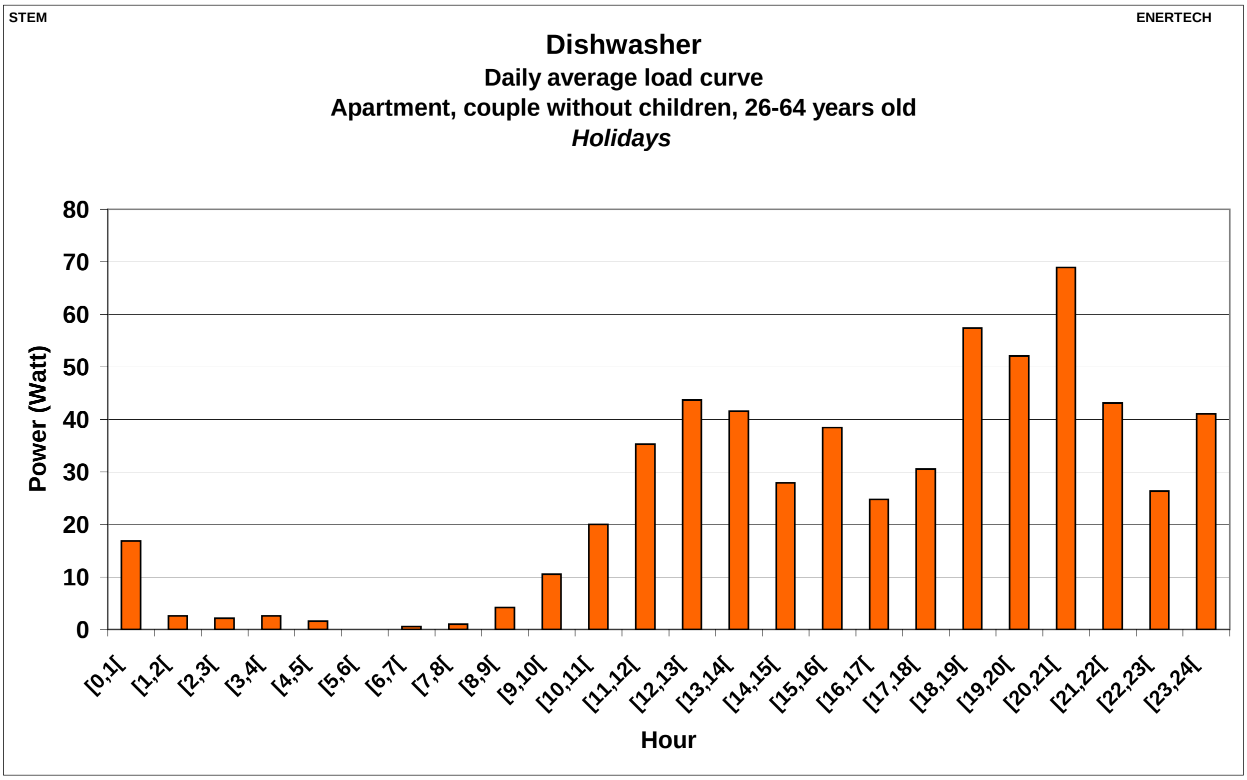


Figure 2.249: Dishwasher – Daily average load curve – Apartment, couples without children, 26-64 years old – Holidays

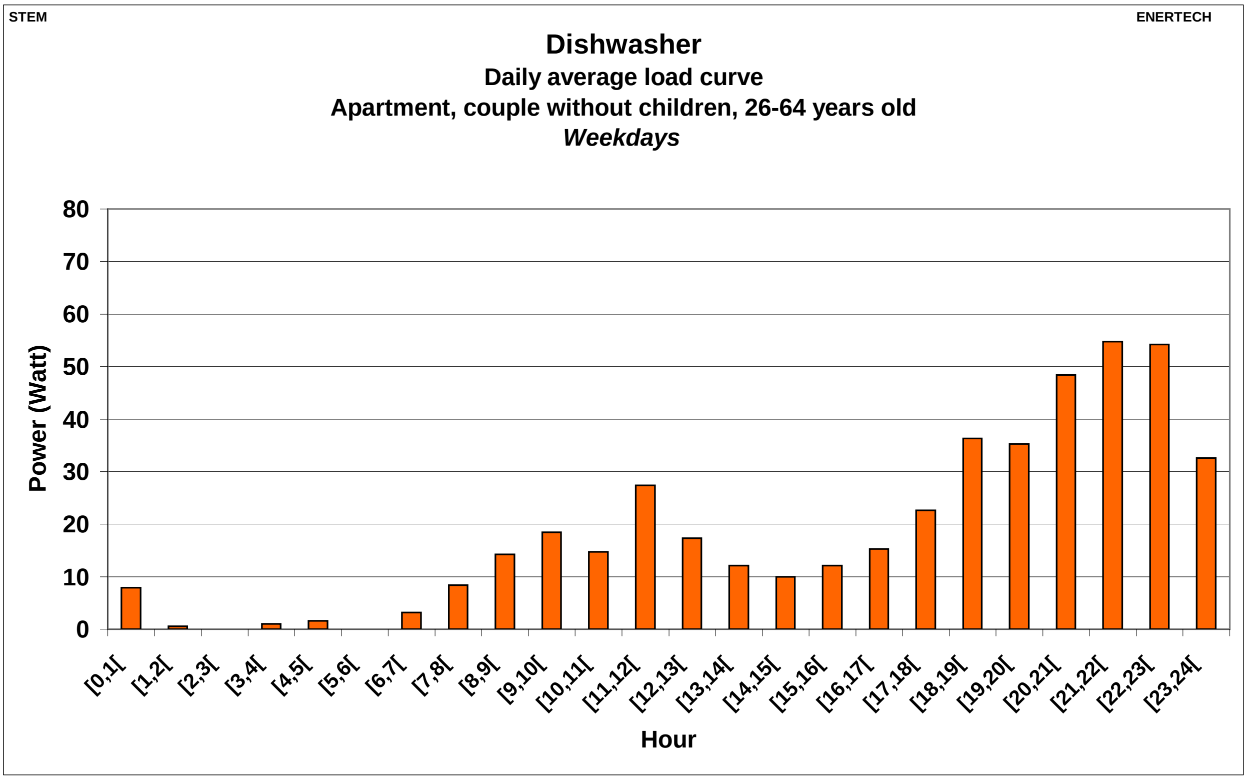


Figure 2.250: Dishwasher – Daily average load curve – Apartment, couples without children, 26-64 years old – Weekdays

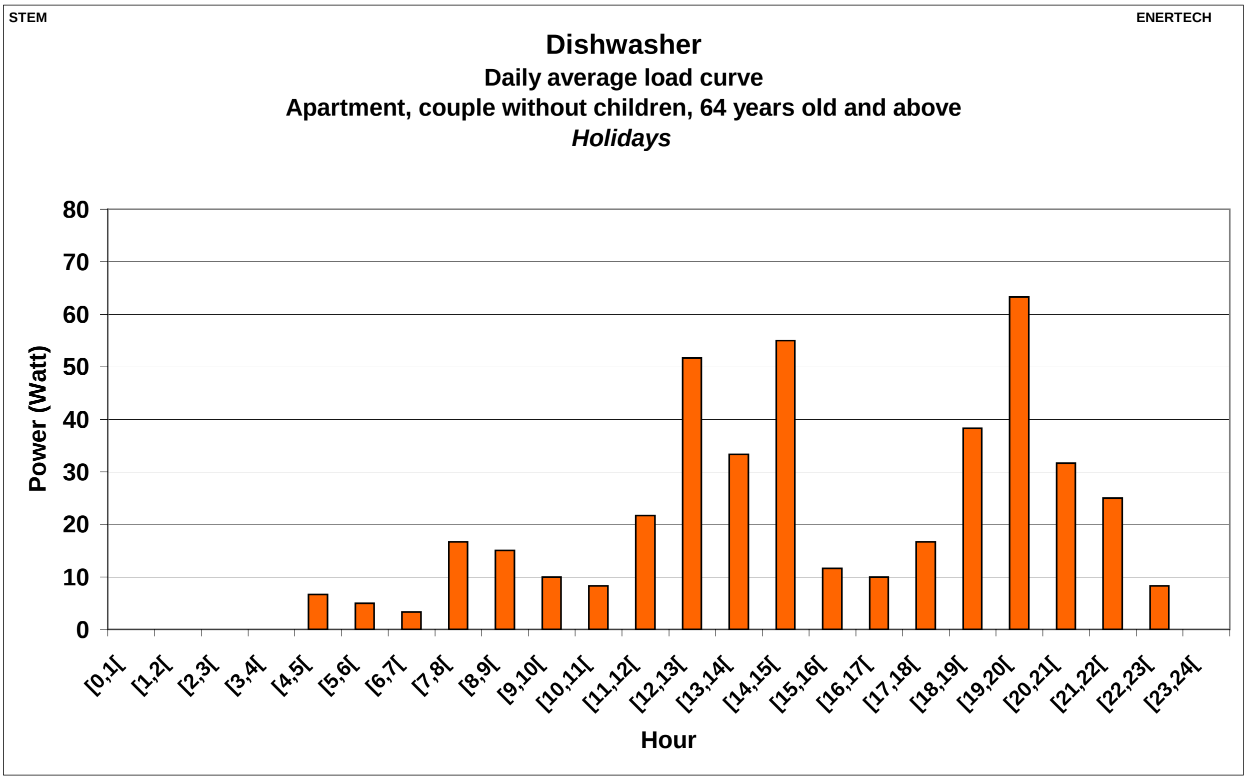


Figure 2.251: Dishwasher – Daily average load curve – Apartment, couples without children, 64 years old and above– Holidays

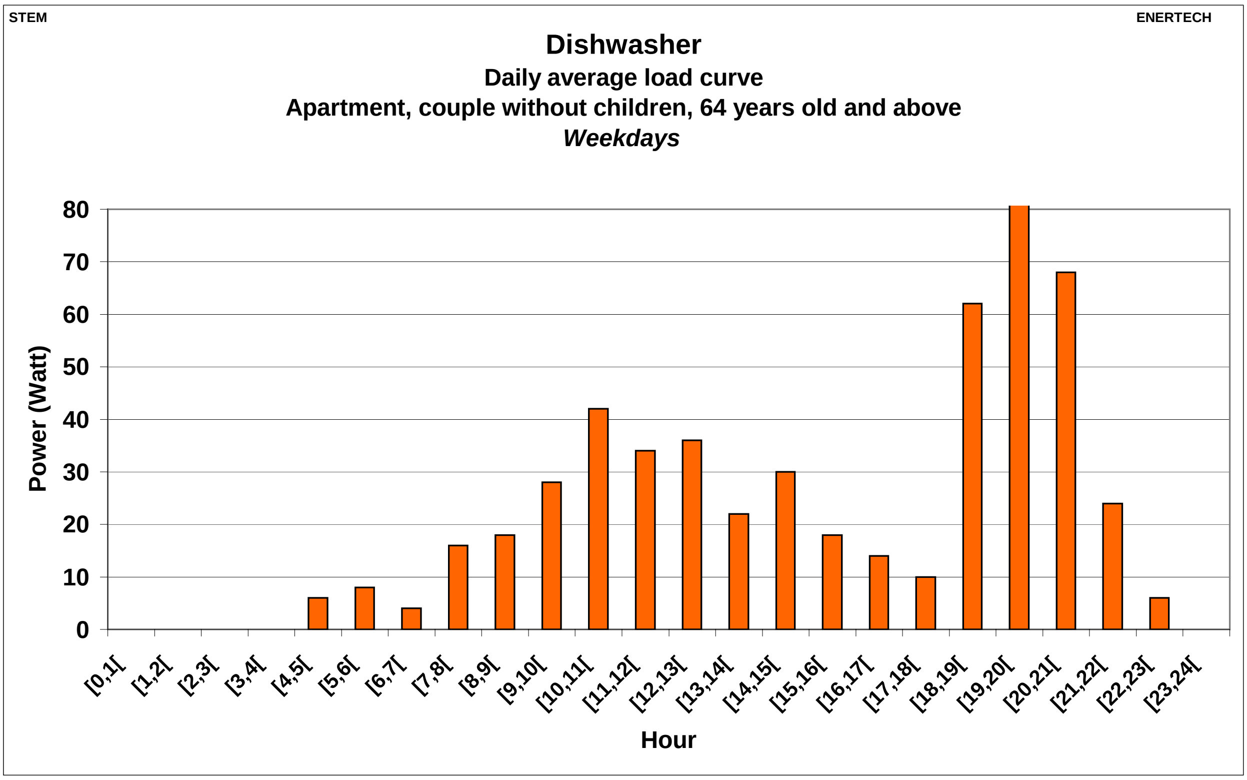


Figure 2.252: Dishwasher – Daily average load curve – Apartment, couples without children, 64 years old and above– Weekdays

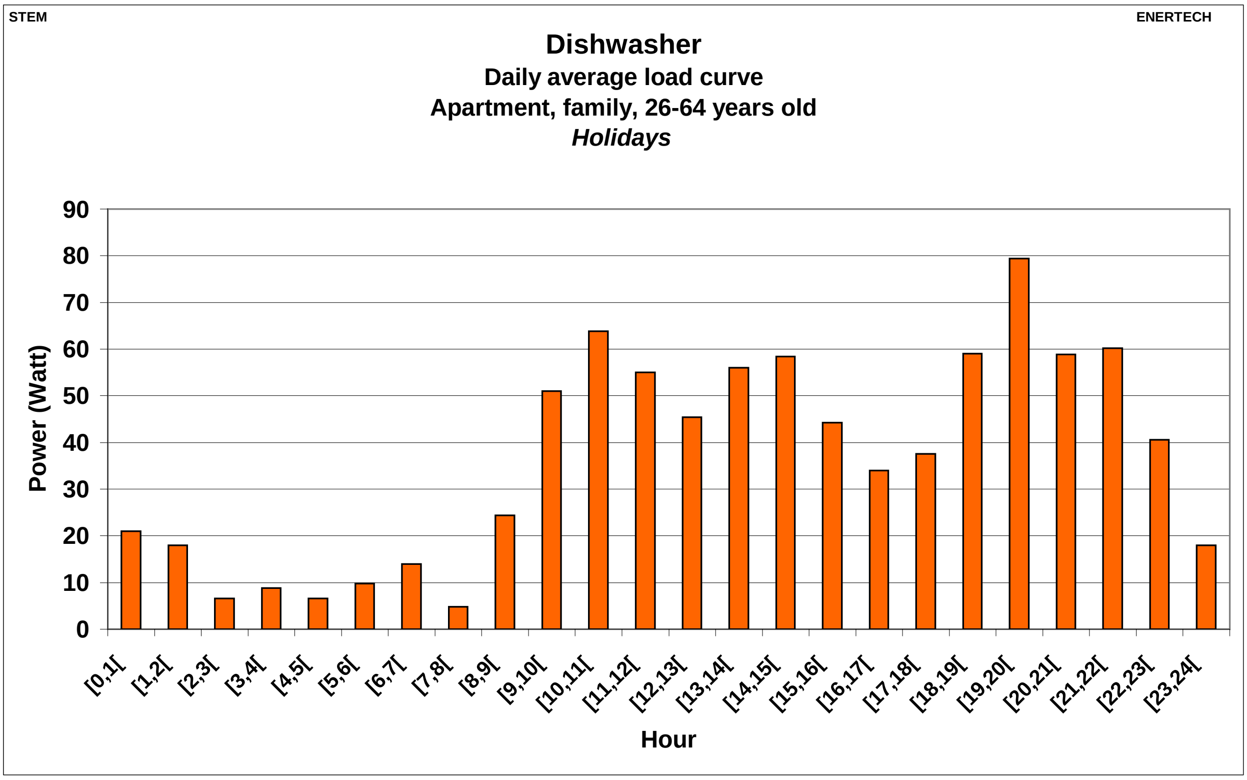


Figure 2.253: Dishwasher – Daily average load curve – Apartment, family, 26-64 years old – Holidays

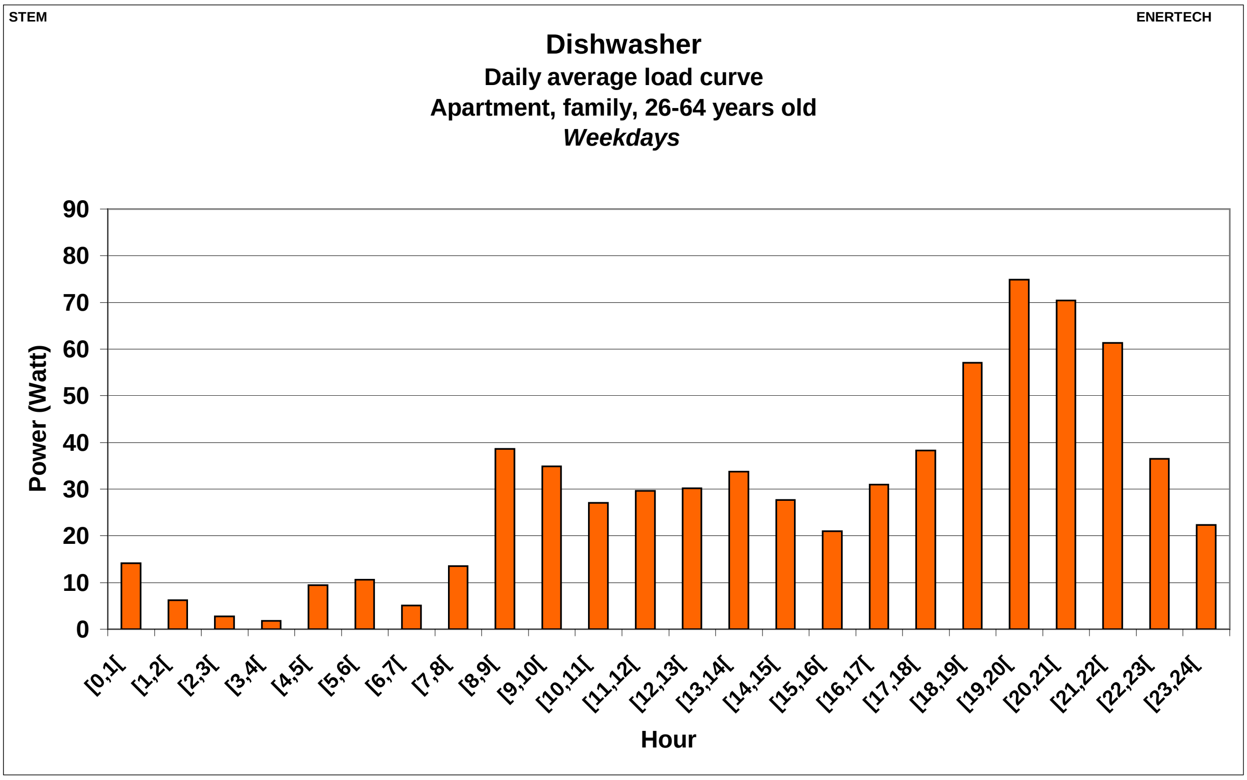


Figure 2.254: Dishwasher – Daily average load curve – Apartment, family, 26-64 years old – Weekdays

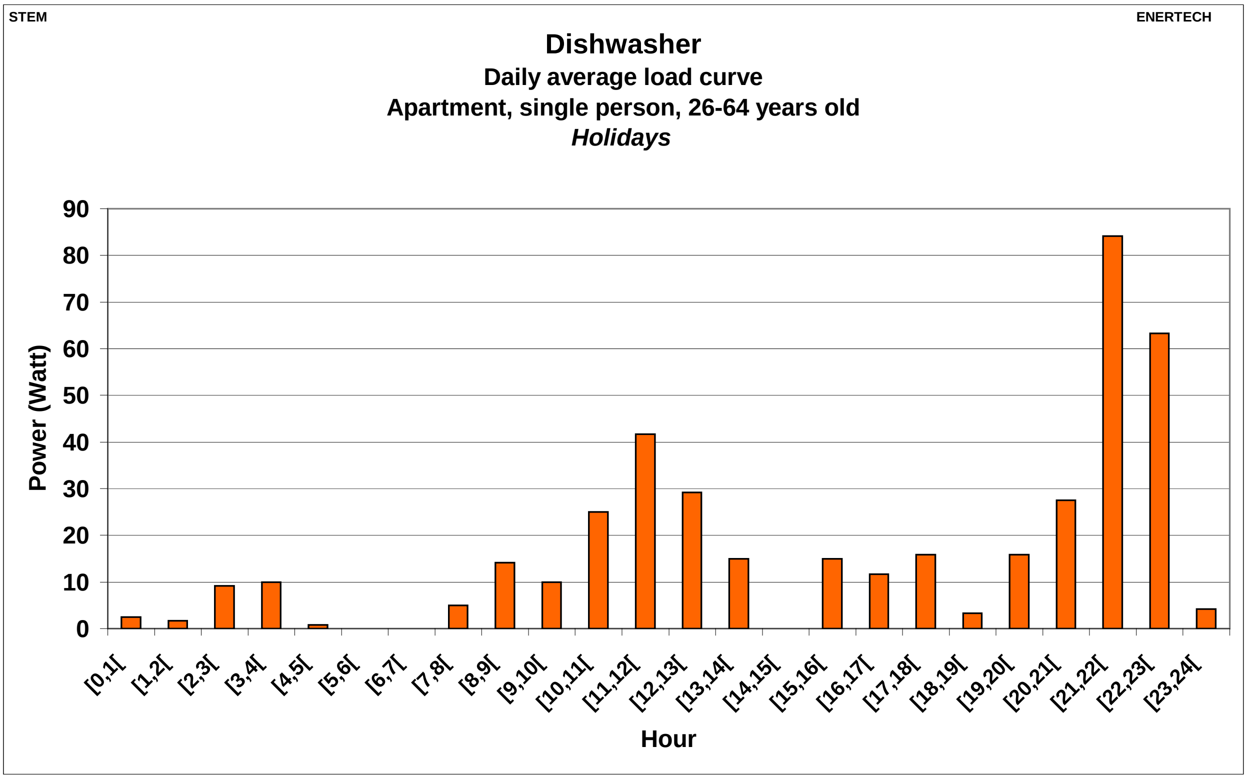


Figure 2.255: Dishwasher – Daily average load curve – Apartment, single person, 26-64 years old – Holidays

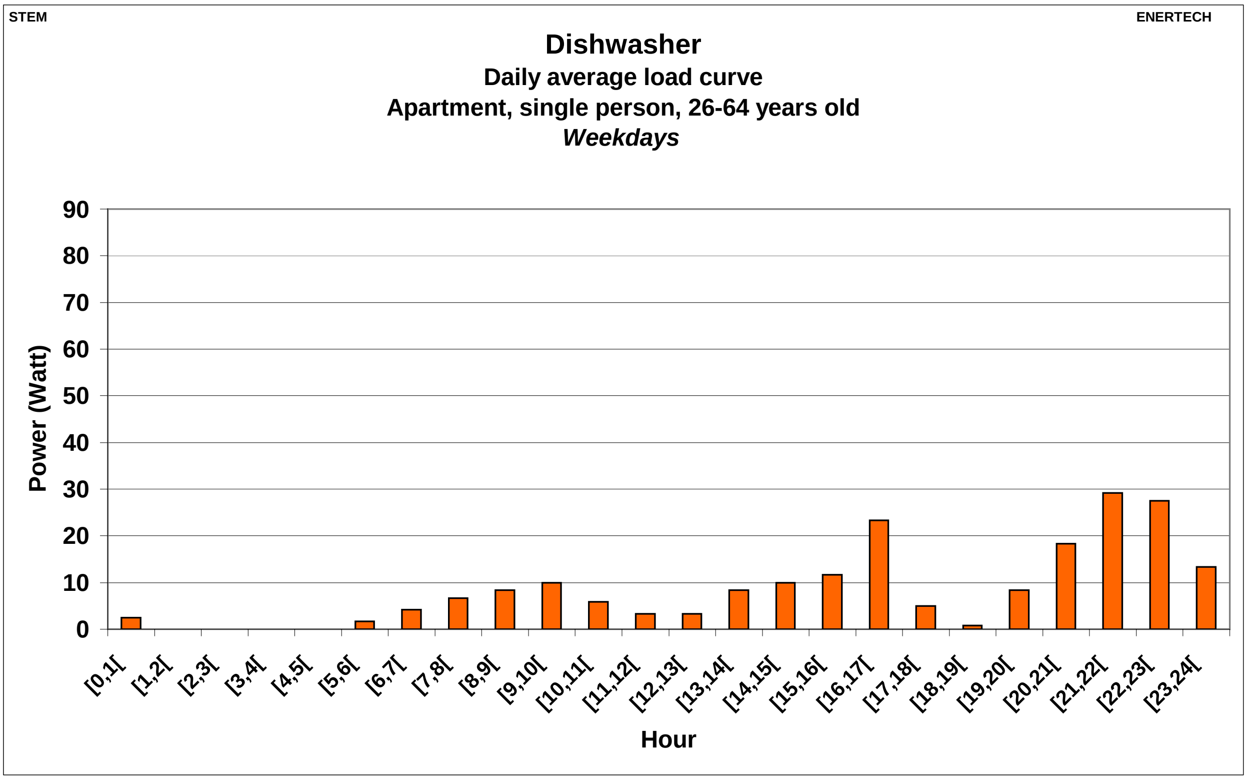


Figure 2.256: Dishwasher – Daily average load curve – Apartment, single person, 26-64 years old – Weekdays

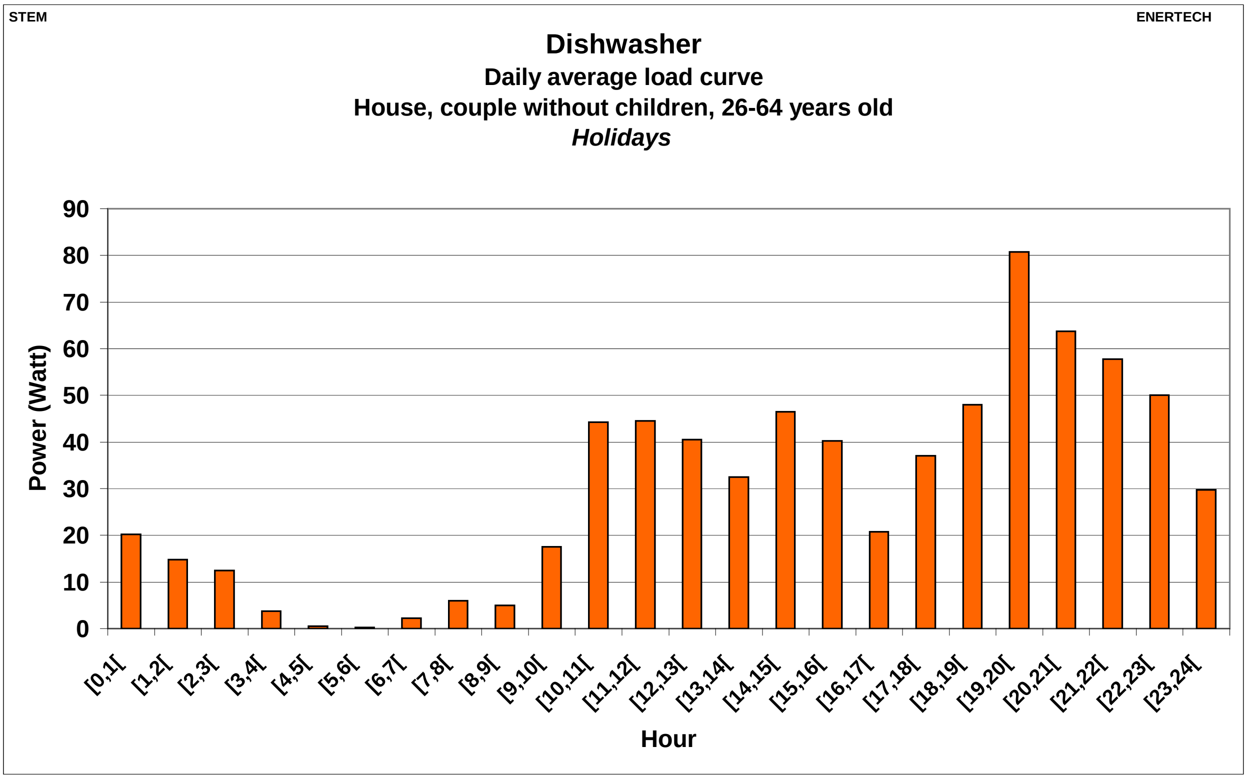


Figure 2.257: Dishwasher – Daily average load curve – House, couples without children, 26-64 years old – Holidays

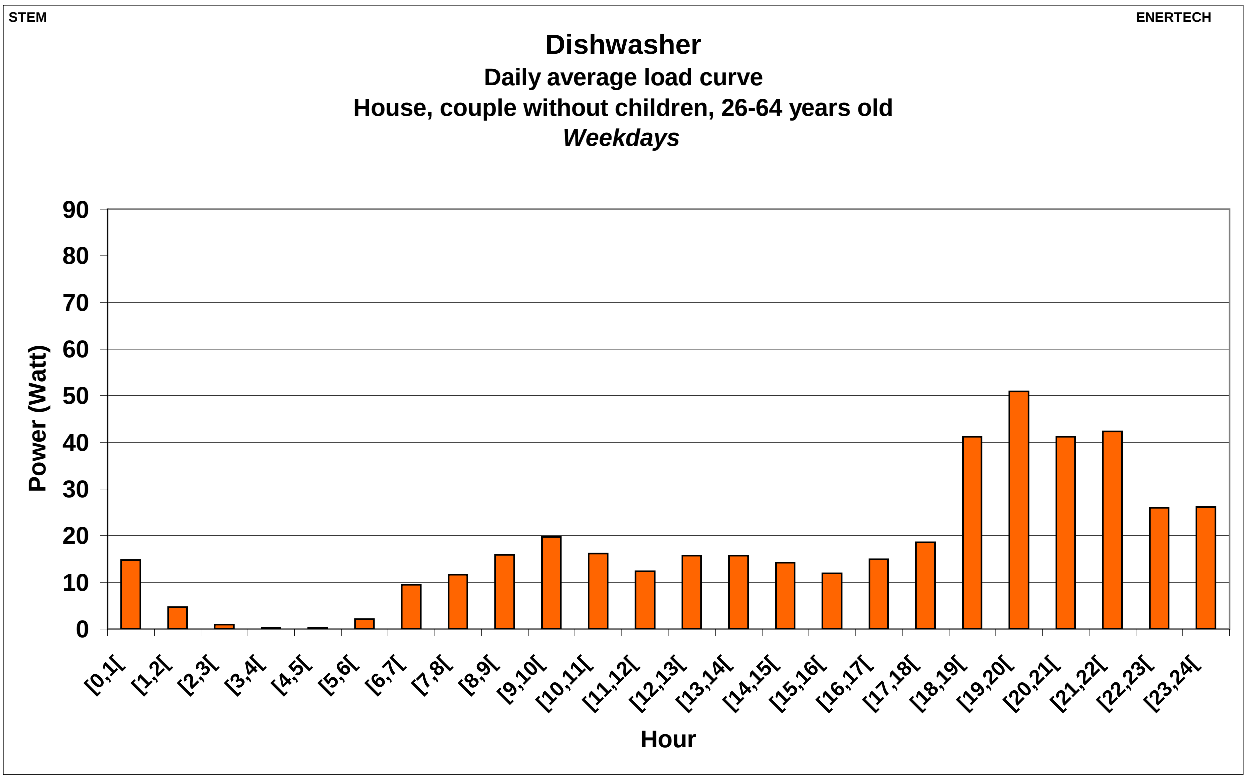


Figure 2.258: Dishwasher – Daily average load curve – House, couples without children, 26-64 years old – Weekdays

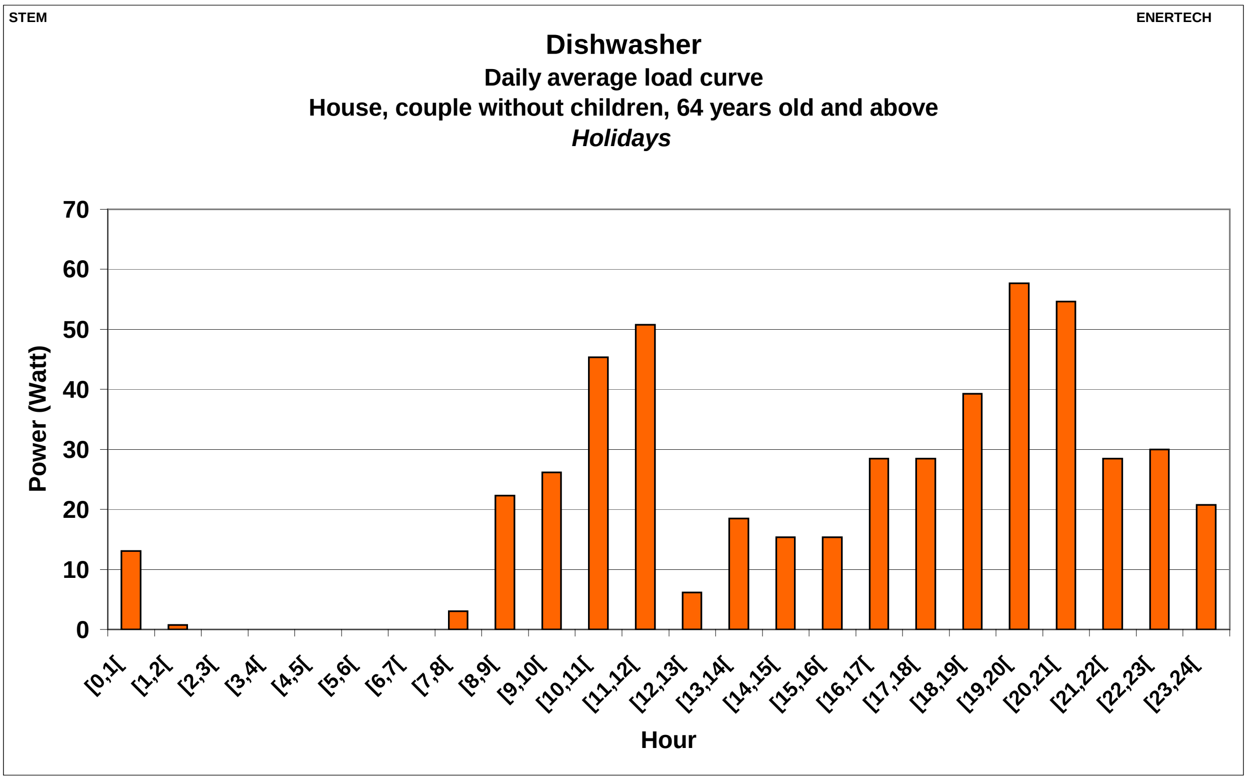


Figure 2.259: Dishwasher – Daily average load curve – House, couples without children, 64 years old and above – Holidays

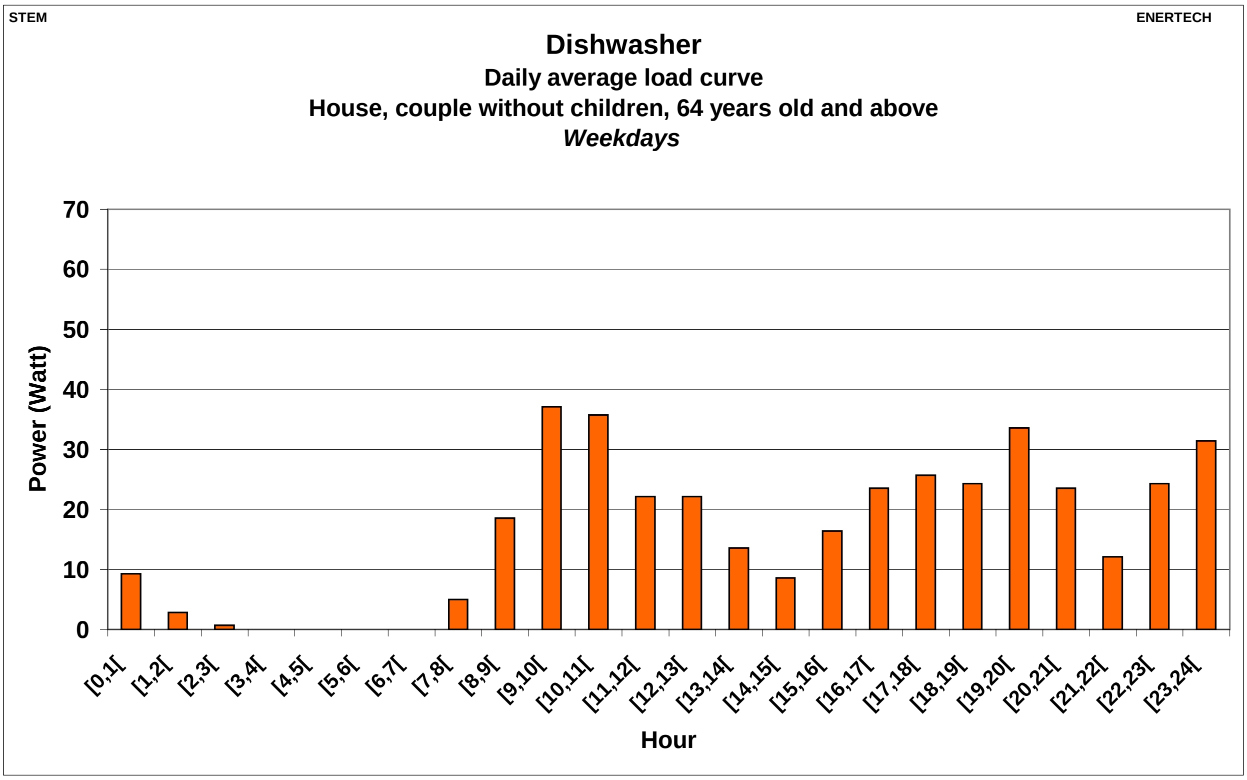


Figure 2.260: Dishwasher – Daily average load curve – House, couples without children, 64 years old and above – Weekdays

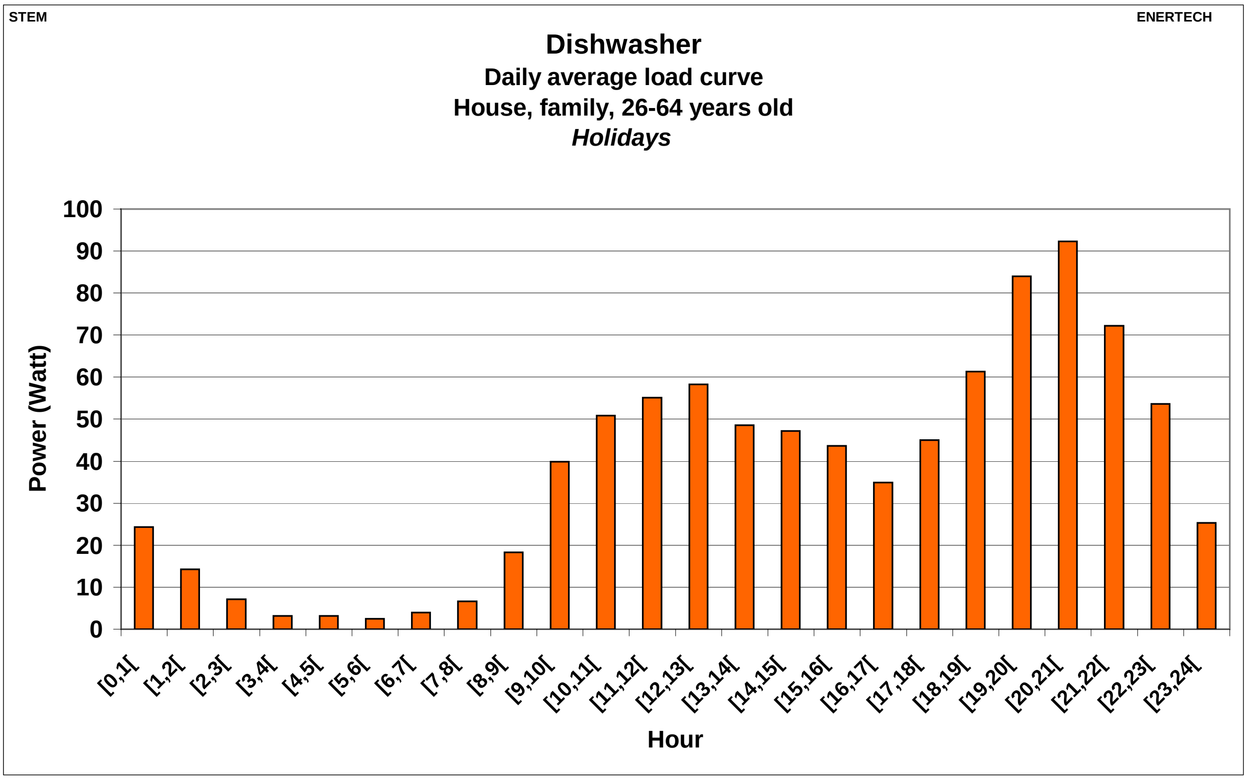


Figure 2.261: Dishwasher – Daily average load curve – House, family, 26-64 years old – Holidays

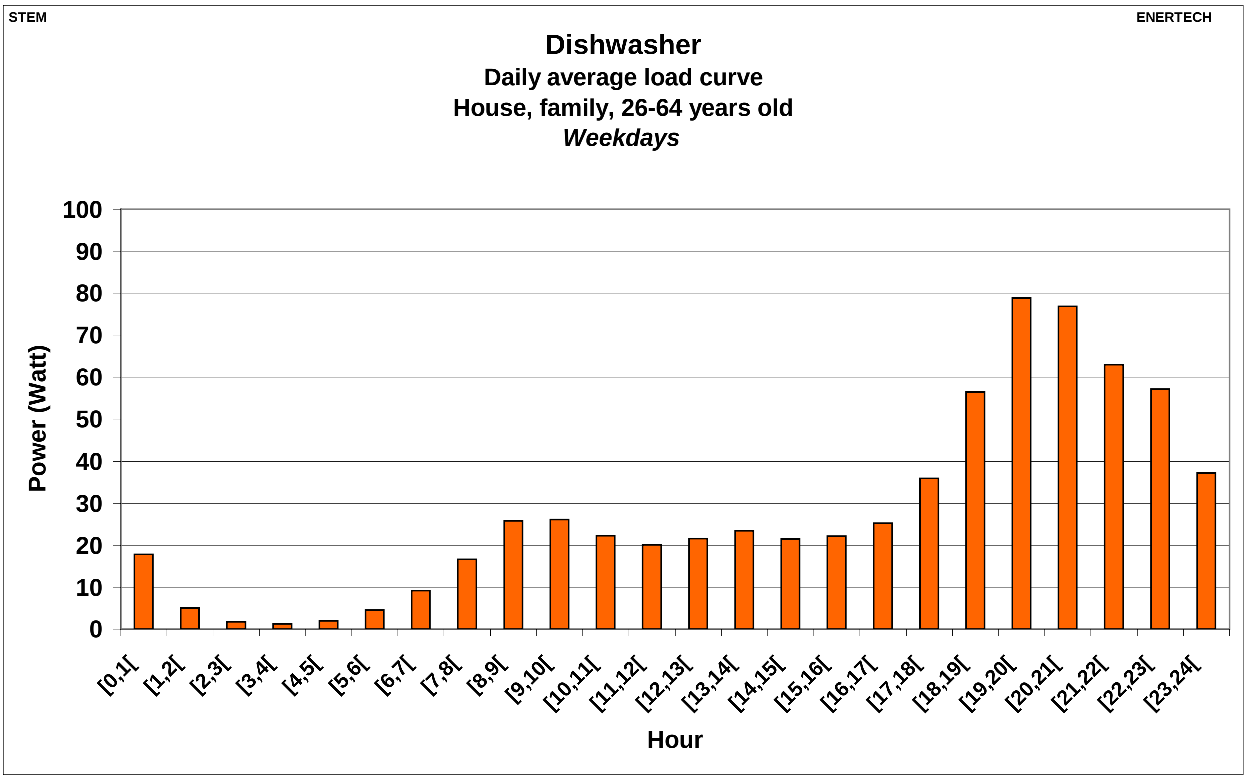


Figure 2.262: Dishwasher – Daily average load curve – House, family, 26-64 years old – Weekdays

Analysis of the wash-cycles

Cycle consumption

Figures 2.263 and 2.264 give us indications about the cycle consumption. Figure 2.263 shows the cumulative frequency of the cycle consumption. All the cycles for all the washing machines were individually listed and sorted in descending order: 80 % of the washing cycles consume less than 750 Wh, 20% less than 300 Wh and only 3 % more than 1 kWh. Figure 2.264 shows the distribution of the cycles. The main cycles are between 400 and 500 Watt.

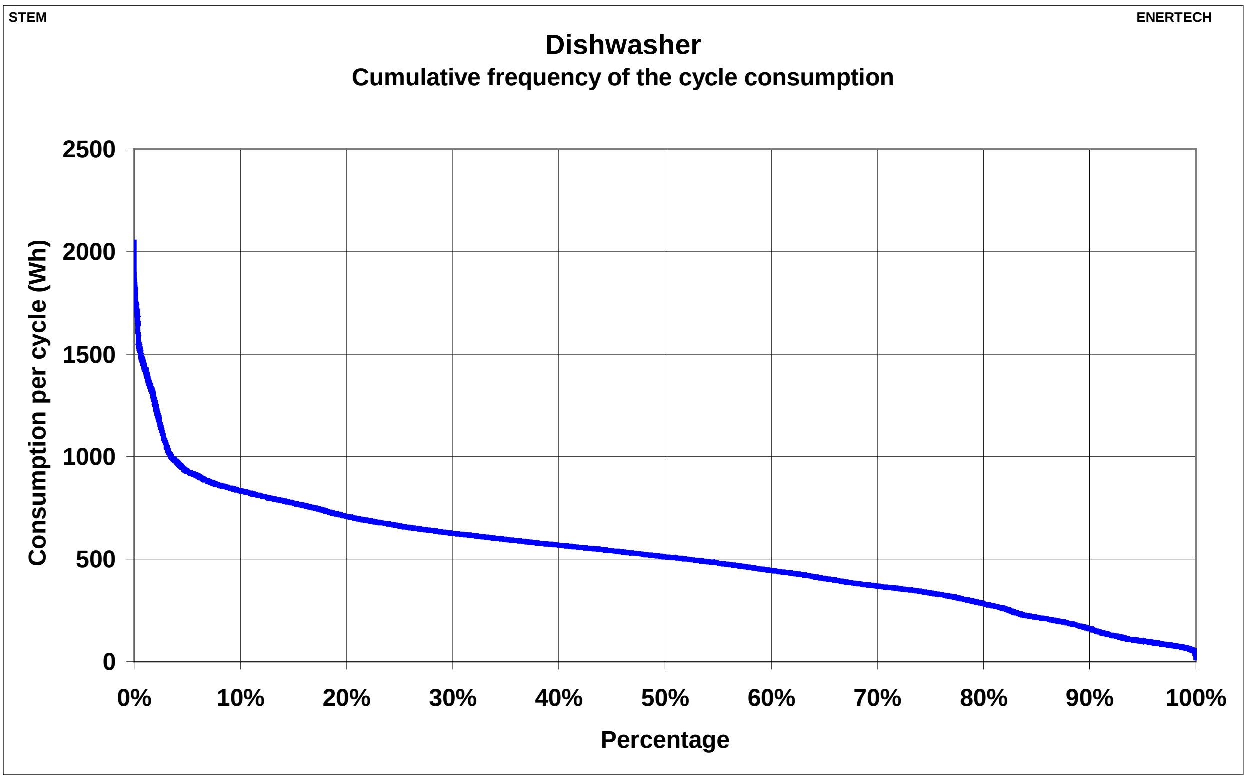


Figure 2.263: Dishwasher – Cumulative frequency of the cycle consumption

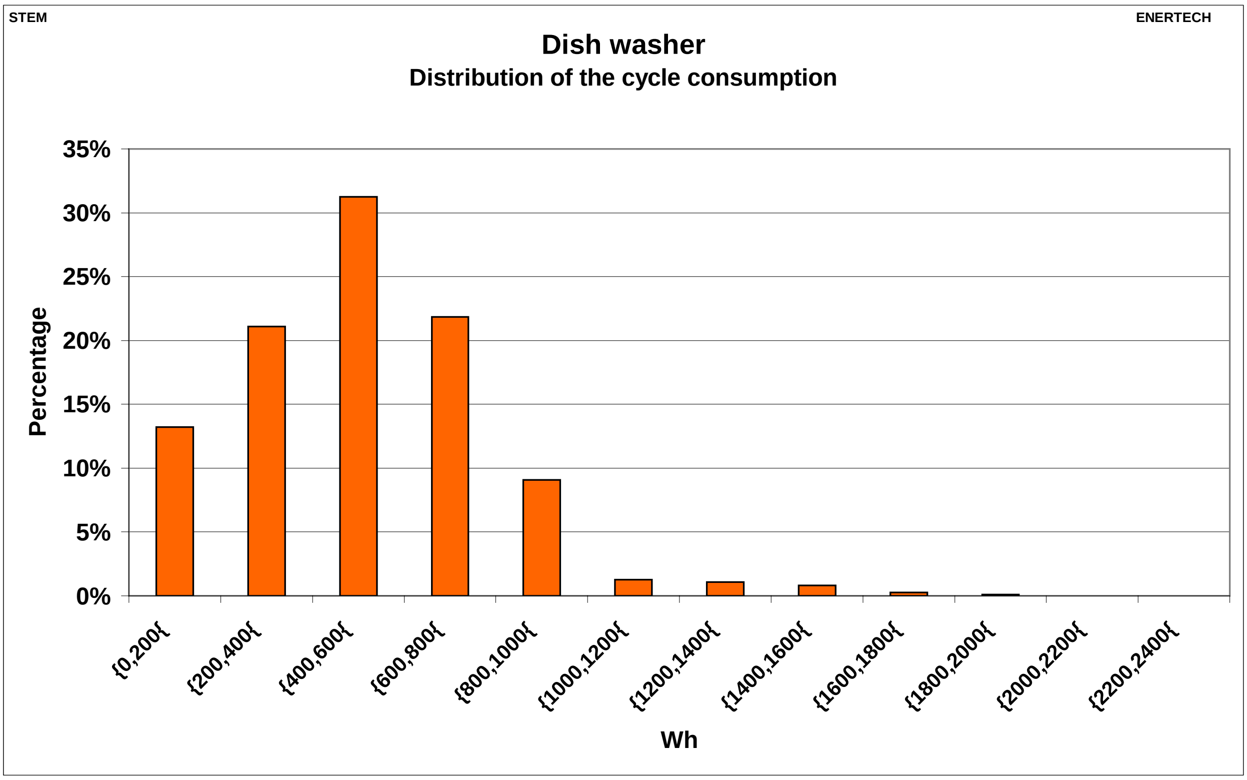


Figure 2.264: Dishwasher – Distribution of the cycle consumption

Number of cycles

Figure 2.264-B and 2.264-C show the number of annual cycles per houses and apartments respectively. Figure 2.264-D and 2.264-E indicates the number of annual cycles per person. The values are higher for apartments than for houses. The size of the dishwashers (6 or 12 dishes) could explain this.

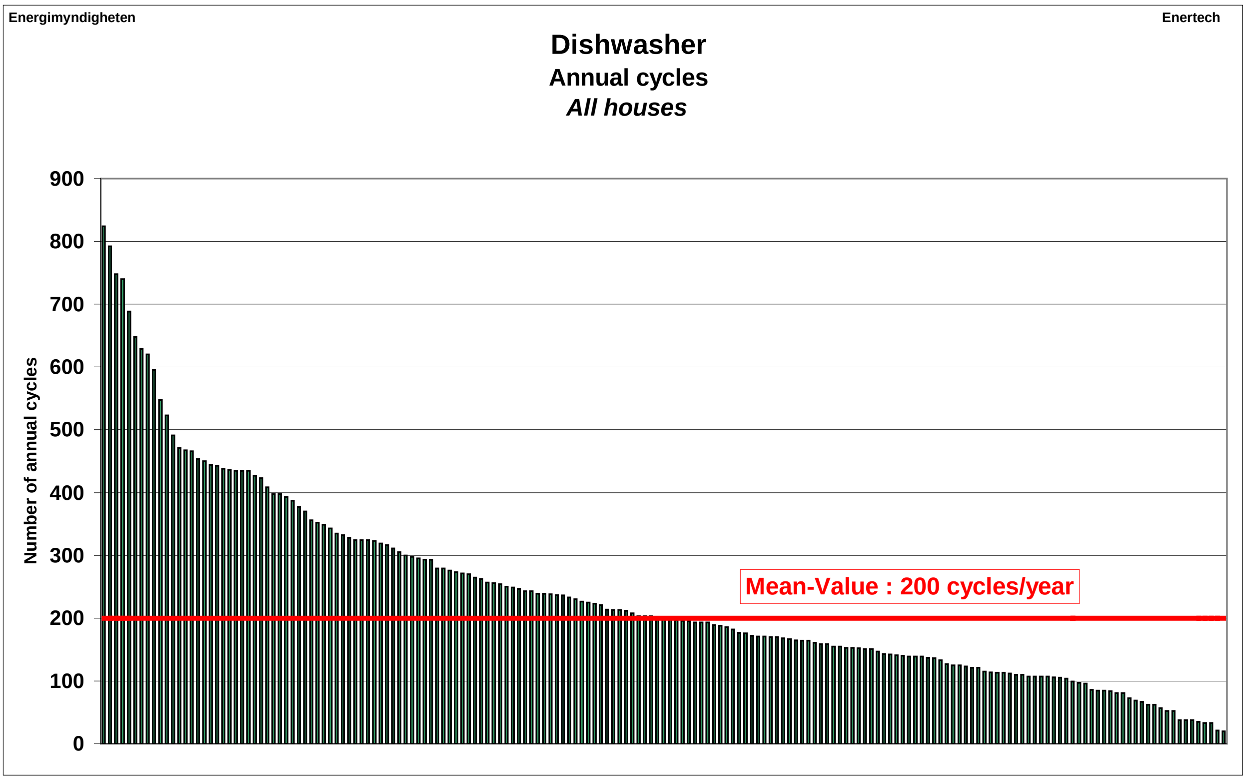


Figure 2.264-B: Dishwasher – Number of annual cycles – All houses

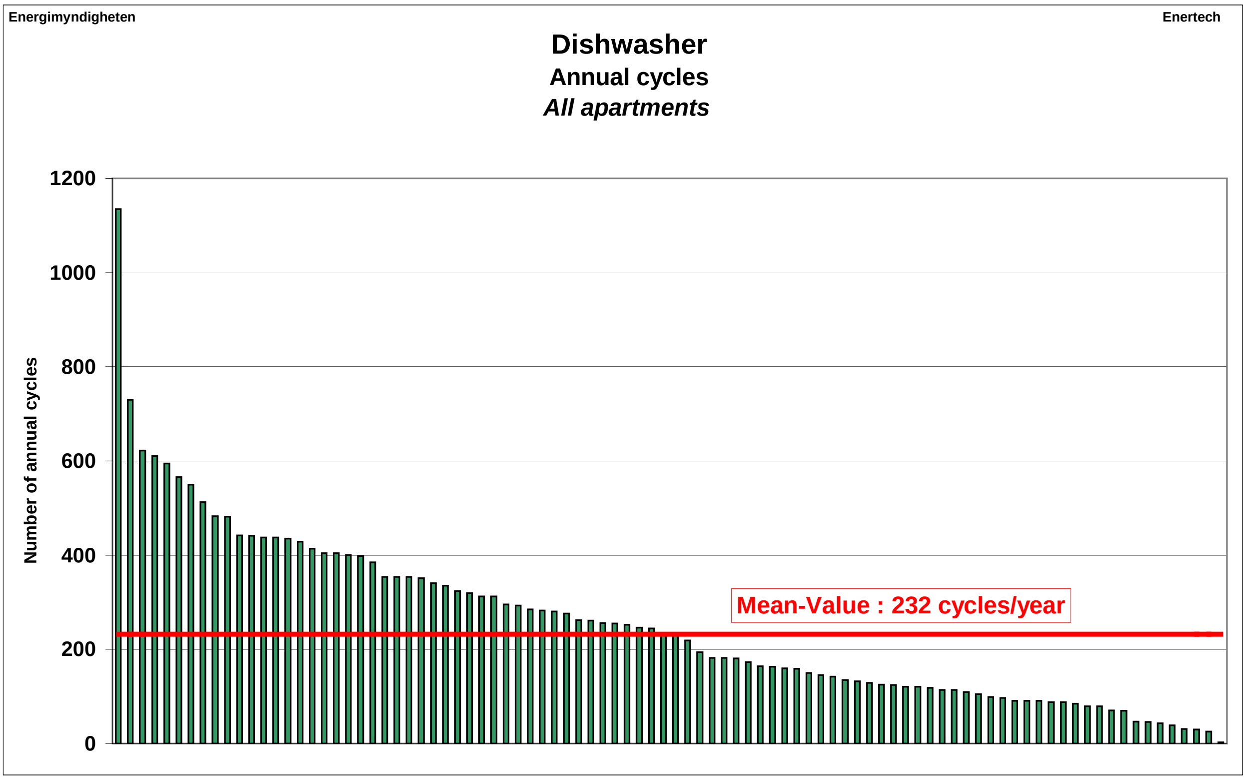


Figure 2.264-C: Dishwasher – Number of annual cycles – All apartments

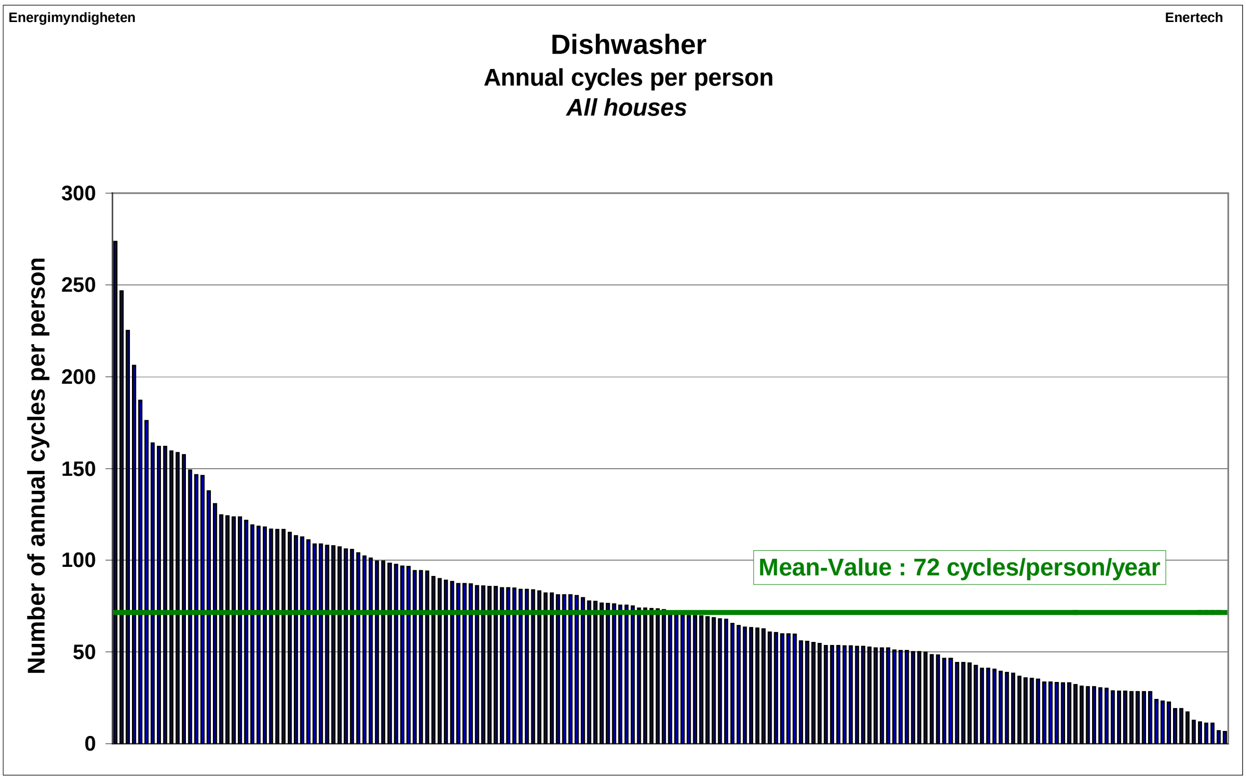


Figure 2.264-D: Dishwasher – Number of annual cycles per persons – All houses

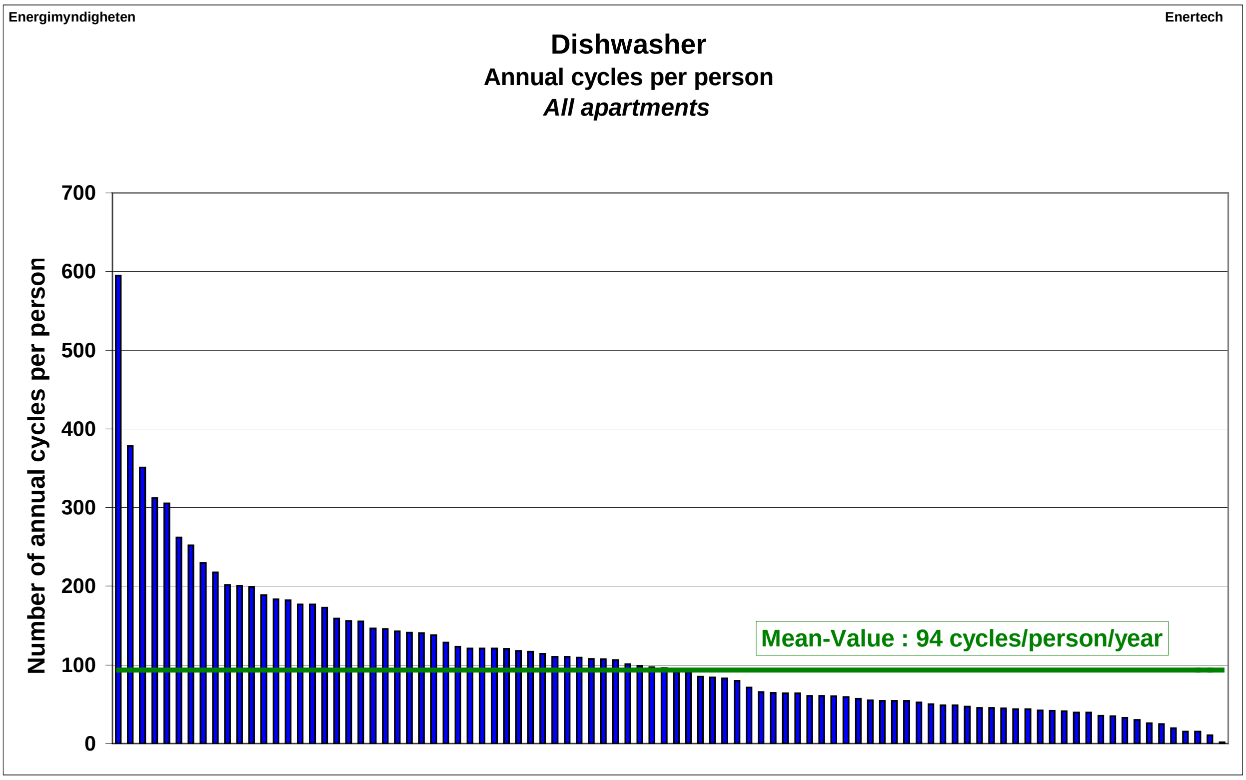


Figure 2.264-E: Dishwasher – Number of annual cycles per persons – All apartments

COOKING

Average possession of appliances

The table from figure 2.265-A shows the average number of appliances per type of household. The number between brackets indicates the number of households used to calculate the average possession so the results for the last two categories has to be treated with care as only 3 and 4 households were analysed. There is no big difference between houses and apartments except for the stoves that are more present in houses.

	Coffee machine	*Espresso machine*	*Food mixer*	*Grill*	*Microwave*	*Oven*	*Stove*	*Water boiler*
Apartment, couples without children, 26-64 years old (41)	0,51	0,02	0,00	0,00	0,78	0,24	0,73	0,51
Apartment, couples without children, 64 years old and above (14)	0,43	0,00	0,07	0,00	0,71	0,29	0,71	0,29
Apartment, family, 26-64 years old (81)	0,40	0,05	0,00	0,01	0,89	0,27	0,72	0,41
Apartment, single person, 26-64 years old (41)	0,34	0,00	0,00	0,00	0,73	0,34	0,61	0,32
Apartment, single person, 64 years old and above (10)	0,50	0,00	0,00	0,00	0,80	0,20	0,70	0,30
All apartments	0,41	0,03	0,01	0,01	0,81	0,28	0,69	0,39
House, couples without children, 26-64 years old (46)	0,48	0,04	0,00	0,00	0,89	0,35	0,74	0,39
House, couples without children, 64 years old and above (21)	0,62	0,00	0,00	0,00	0,90	0,33	0,76	0,29
House, family, 26-64 years old (125)	0,44	0,04	0,00	0,00	0,90	0,18	0,93	0,46
House, single person, 26-64 years old (3)	0,33	0,00	0,00	0,00	0,67	0,33	0,67	0,33
House, single person, 64 years old and above (4)	0,50	0,00	0,00	0,00	0,50	0,00	1,00	0,50
All houses	0,47	0,04	0,00	0,00	0,89	0,23	0,86	0,42

Figure 2.265-A: Average number of cooking appliances – Per type of household

Seasonality effect

The consumption of cooking appliances is strongly seasonal, but most of the households were only monitored for one month. The seasonality effect was calculated using the 40 households monitored for one year. For each household, we calculated the weekly consumption by adding all the data per week. The result consists of 52 values per household corresponding to the number of weeks in one year. This set of values were then normalized to 1 (the average value gives one for each set). An average value per week was then calculated using all the data sets. Figure 2.265.1 represents the seasonality curve calculated by this method. This curve was used to calculate the annual consumption for the appliances monitored for less than six month.

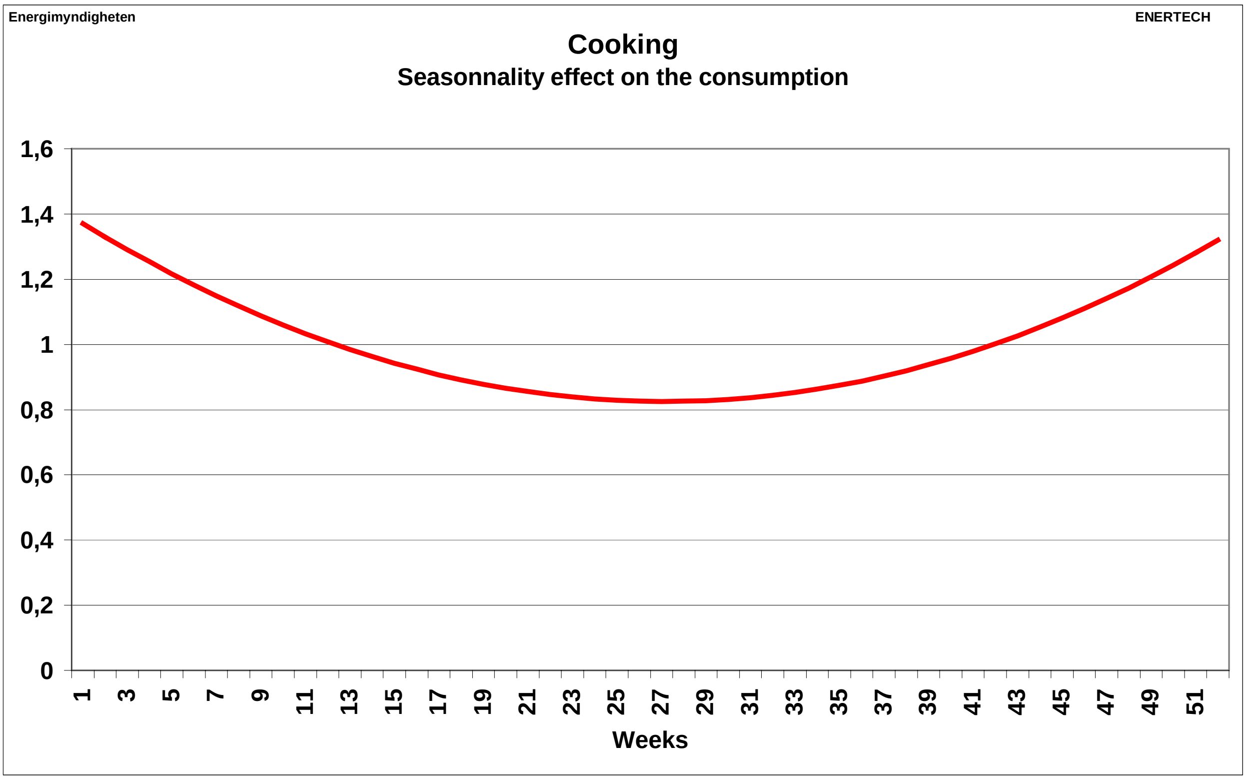


Figure 2.265.1: Cooking – Seasonality effect

Annualized consumptions

The two most consuming appliances present in the cooking familie are the oven and/or the kitchen stove. The rest of the appliances represent only a little part of the total consumption. Figures 2.265 to 2.272 shows the annual consumption per type of household. For the houses, the annual consumption are in the range 192 kWh/year (single person) to 411 kWh/year (family) and for the apartments it goes from 148 kWh (single person) to 377 kWh/year (family). This consumptionshow us that cooking is dependant of the numbers of person in the household as show in figure 2.273.

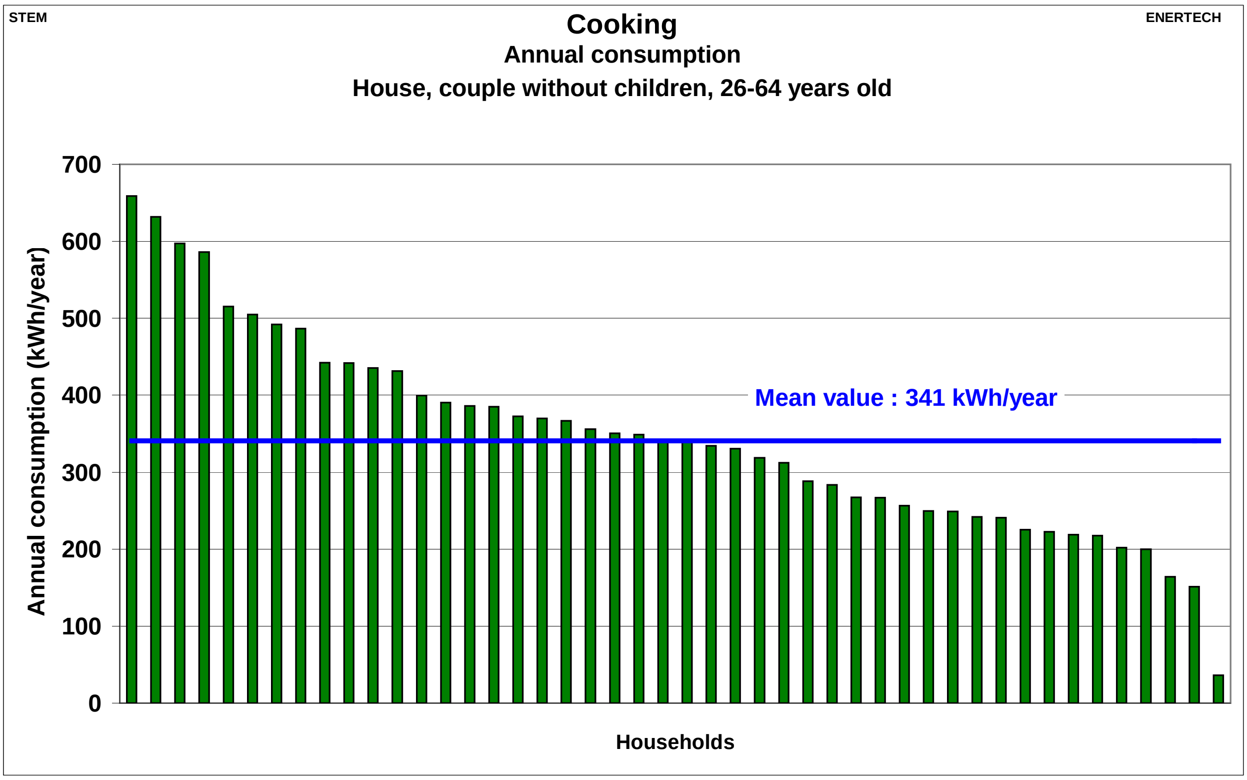


Figure 2.265: Cooking – Annual consumption – House, couples without children, 26-64 years old

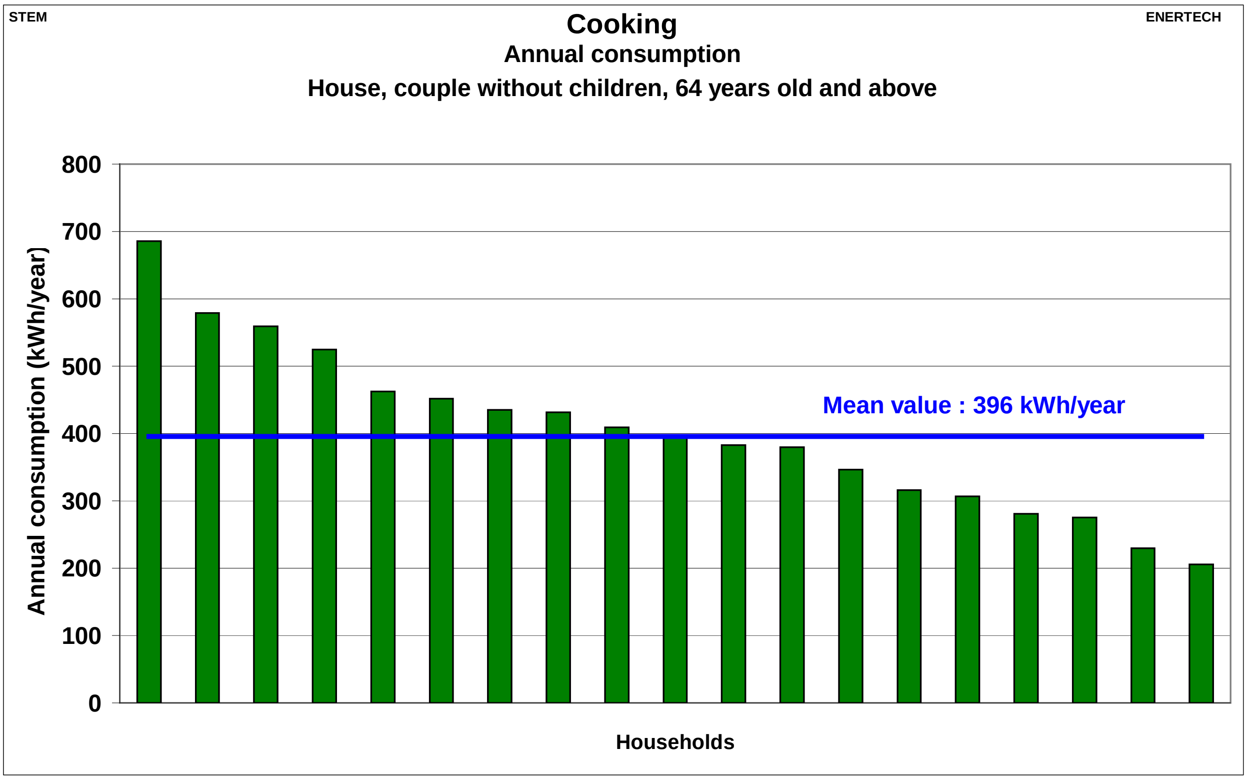


Figure 2.266: Cooking – Annual consumption – House, couples without children, 64 years old and above

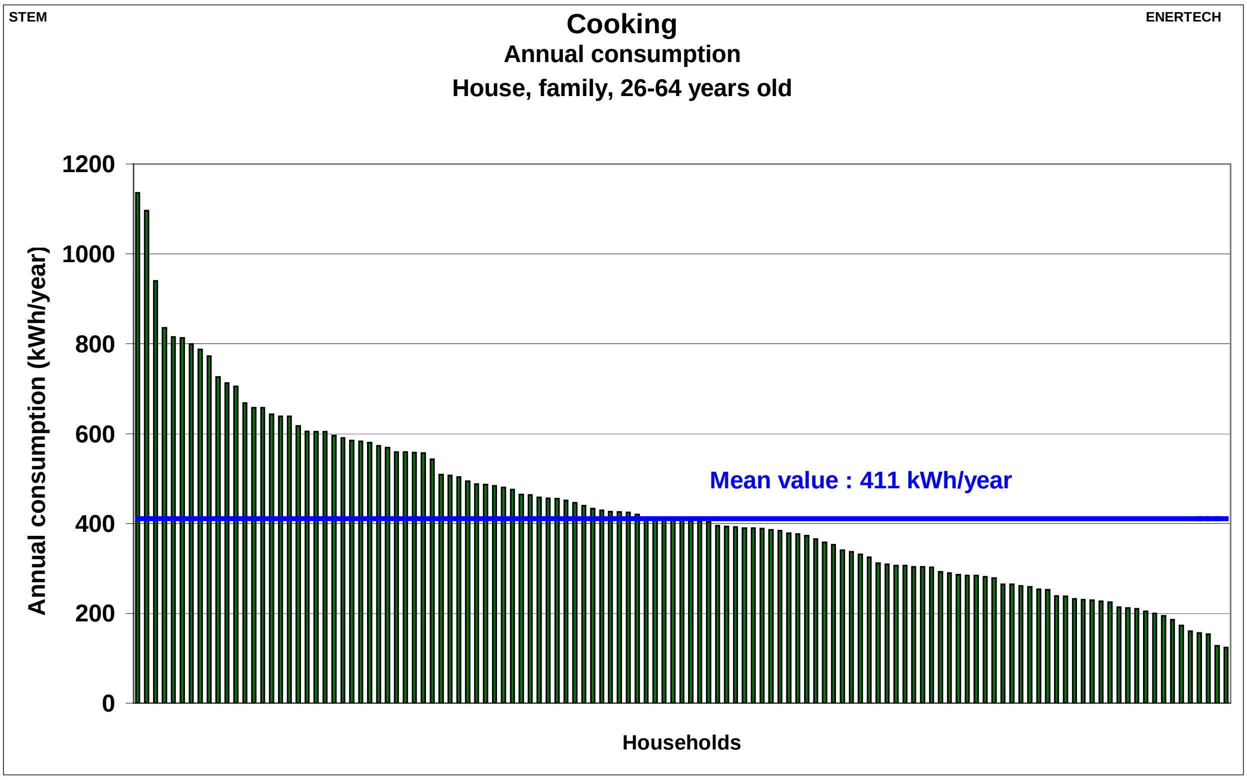


Figure 2.267: Cooking – Annual consumption – House, family, 26-64 years old

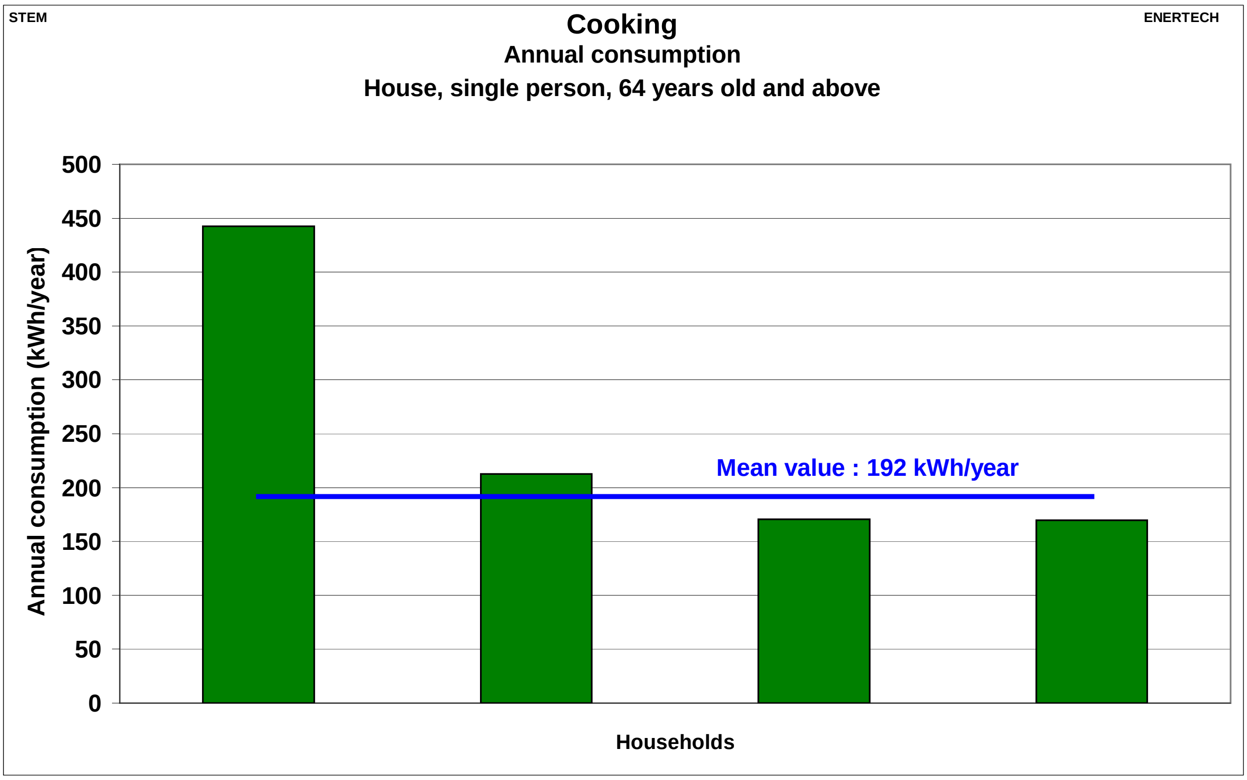


Figure 2.268: Cooking – Annual consumption – House, single person, 64 years old and above

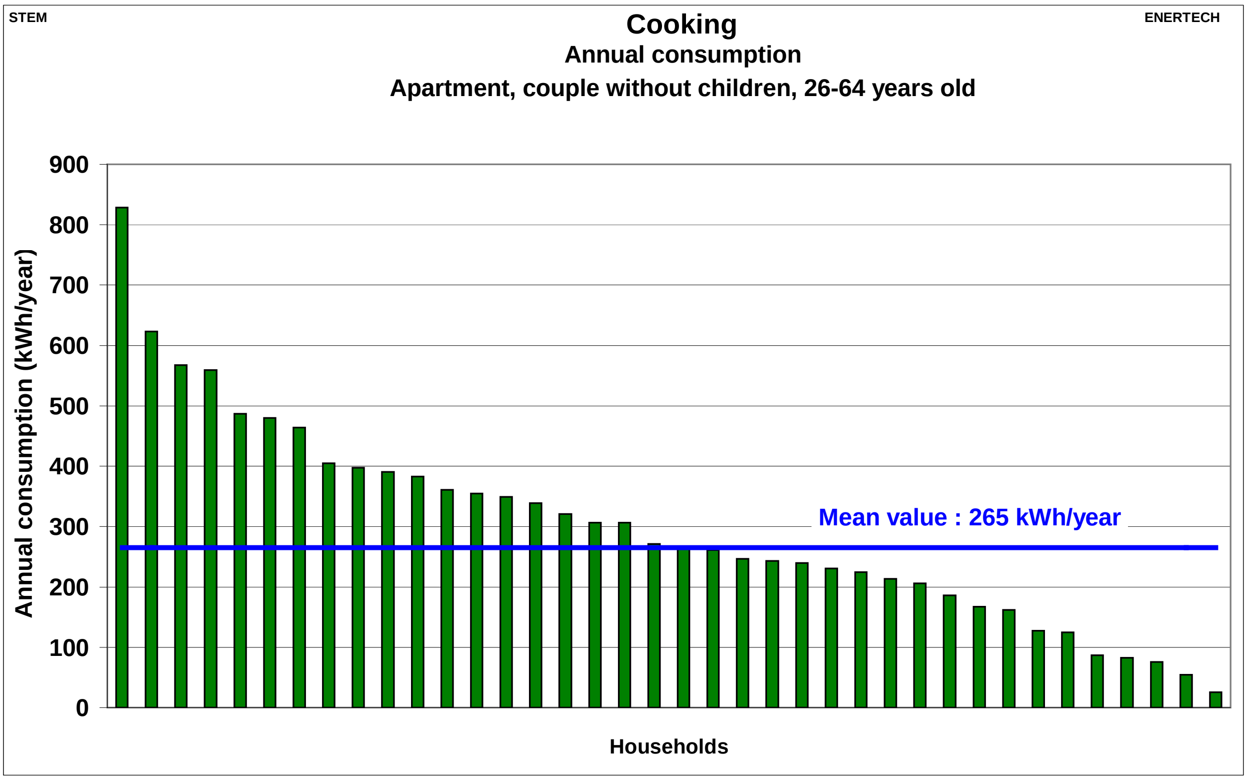


Figure 2.268: Cooking – Annual consumption – Apartment, couples without children, 26-64 years old

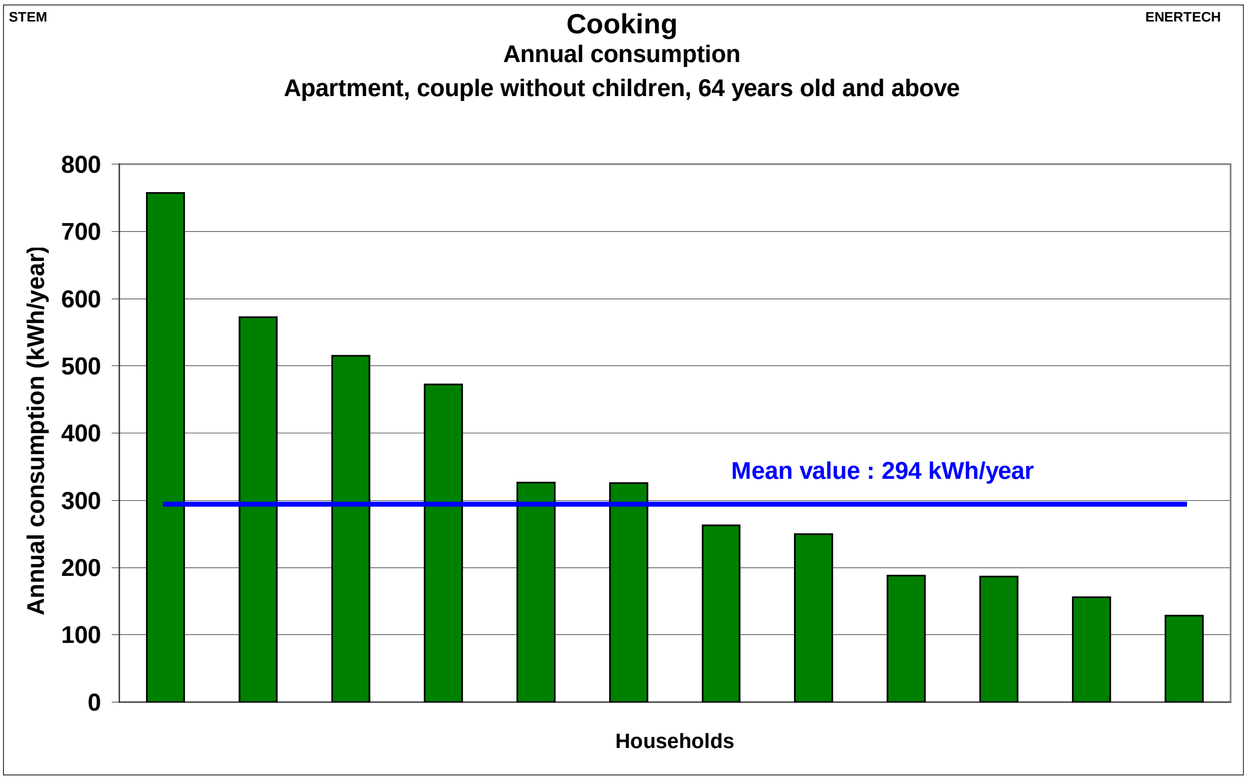


Figure 2.269: Cooking – Annual consumption – Apartment, couples without children, 64 years old and above

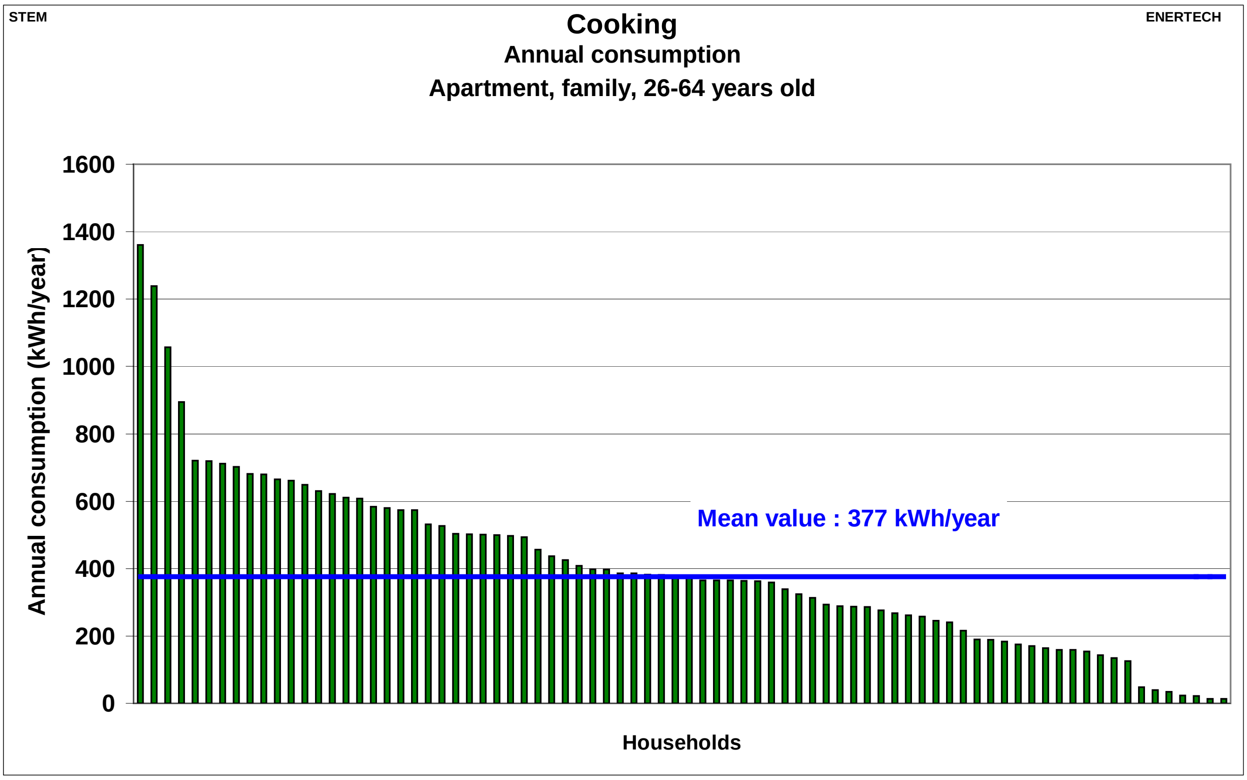


Figure 2.270: Cooking – Annual consumption – Apartment, family, 26-64 years old

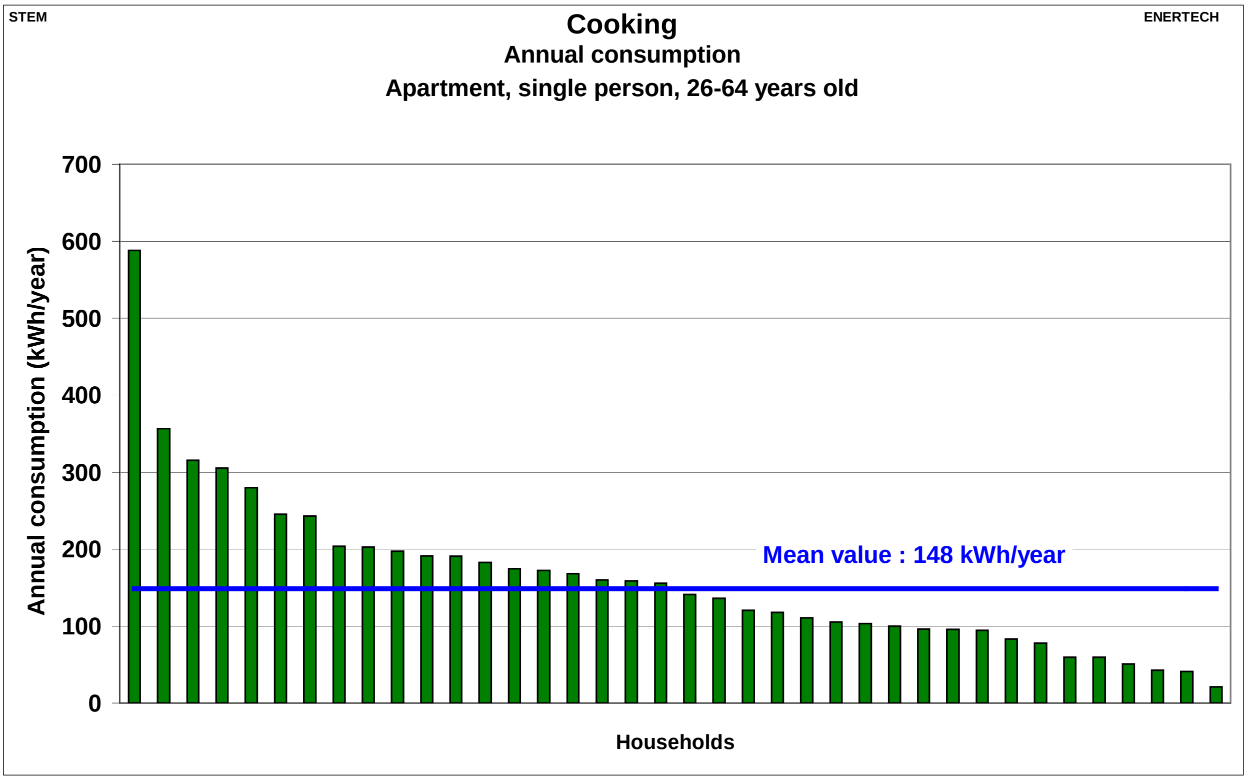


Figure 2.271: Cooking – Annual consumption – Apartment, single person, 26-64 years old

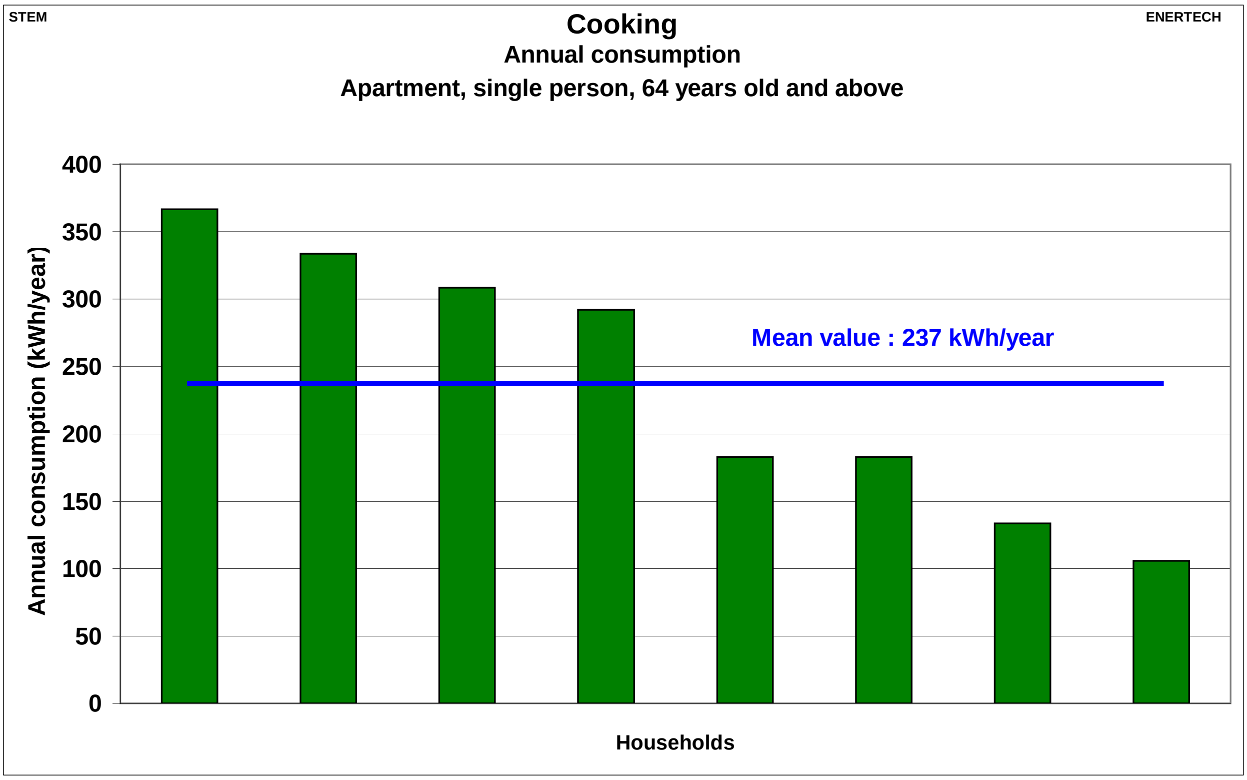


Figure 2.272: Cooking – Annual consumption – Apartment, single person, 64 years old and above

Figure 2.273 shows us the annual consumption per person as a function of the number of persons in the household. The values per person should be treated with some care, since the family structure has to be taken into account as well. This consumption will decrease from 172 kWh/person/year to 160 kWh/person/year for 2 persons to 115 kWh/person/year for 3 and then be stable around this value for 4, 5 or 6 persons. Cooking is efficient in terms of electric consumption if done for more than 2 persons.

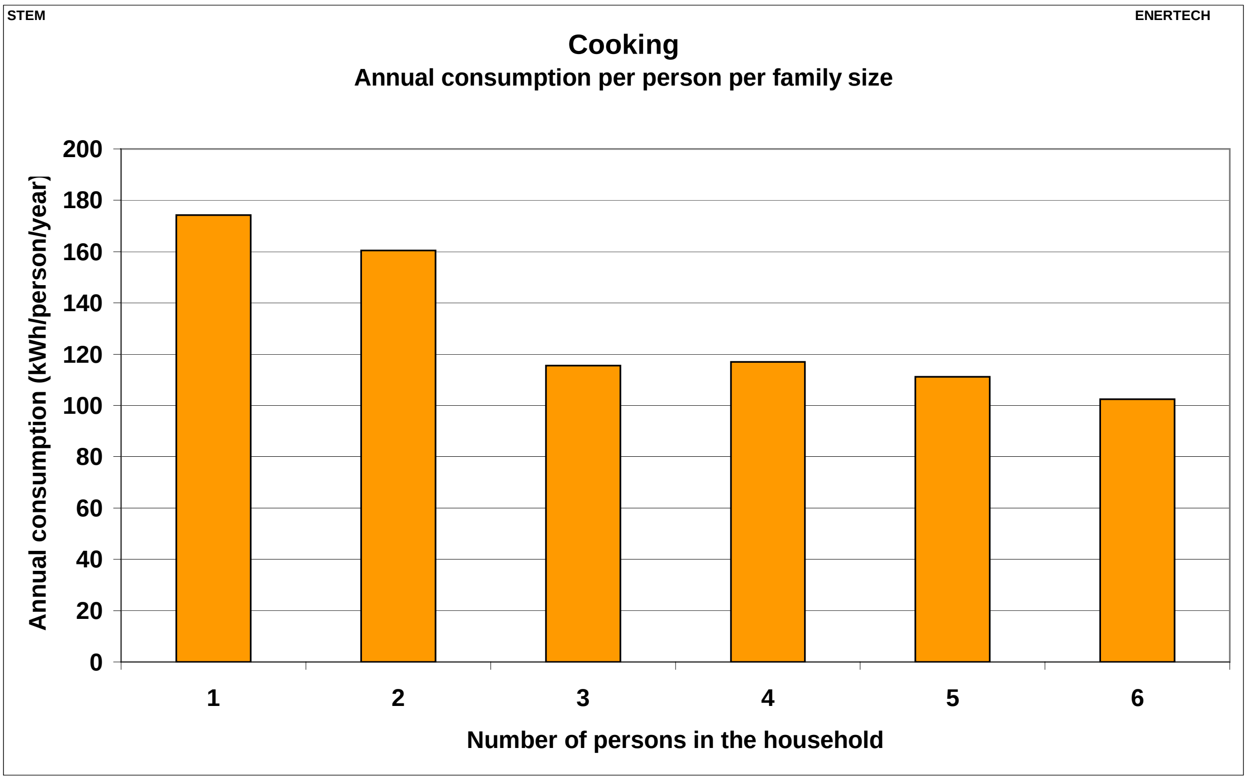


Figure 2.273: Cooking – Annual consumption per person per family size

Hourly load curve

Figures 2.274 to 2.291 show the daily average load curve per type of household per type of day (holidays and weekdays). The main peak for both type of days will be found in the evening between 17:00 and 19:00 but for the holidays, there is also a higher consumption at lunch time (13:00-14:00)

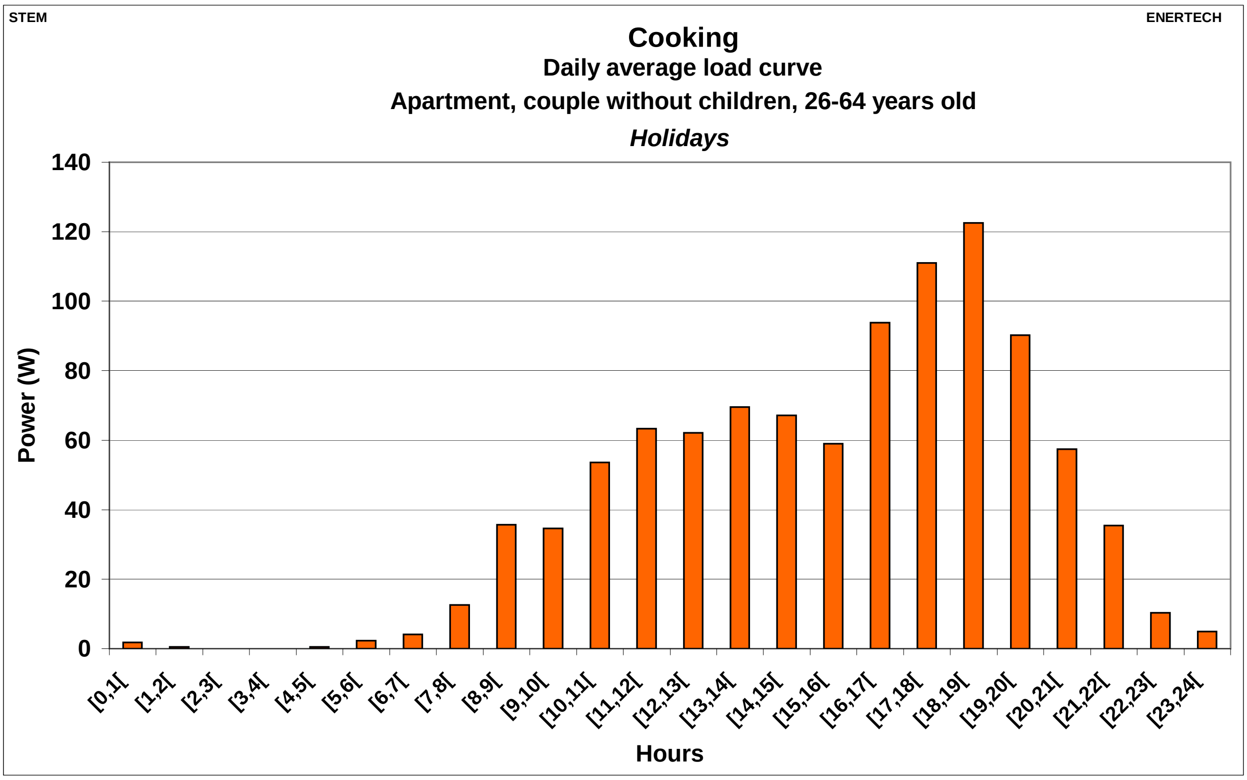


Figure 2.274: Cooking – Daily average load curve – Apartment, couples without children, 26-64 years old – Holidays

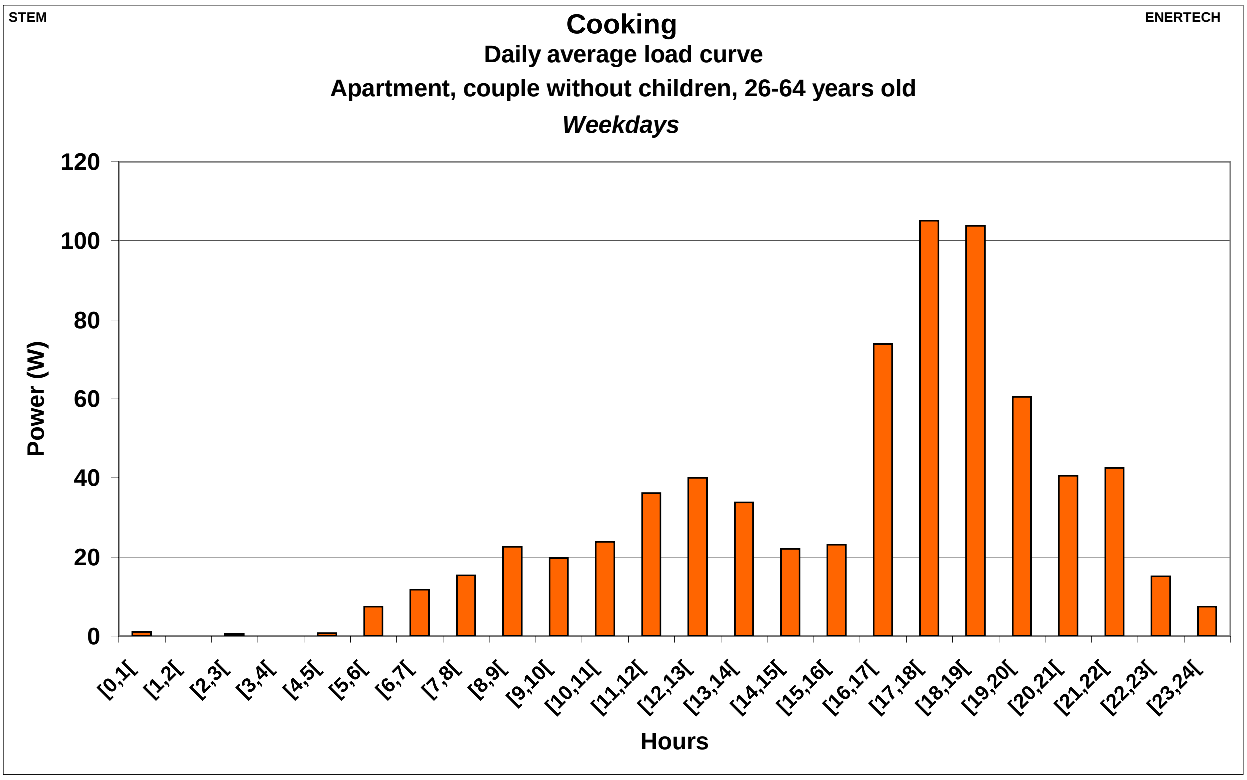


Figure 2.275: Cooking – Daily average load curve – Apartment, couples without children, 26-64 years old – Weekdays

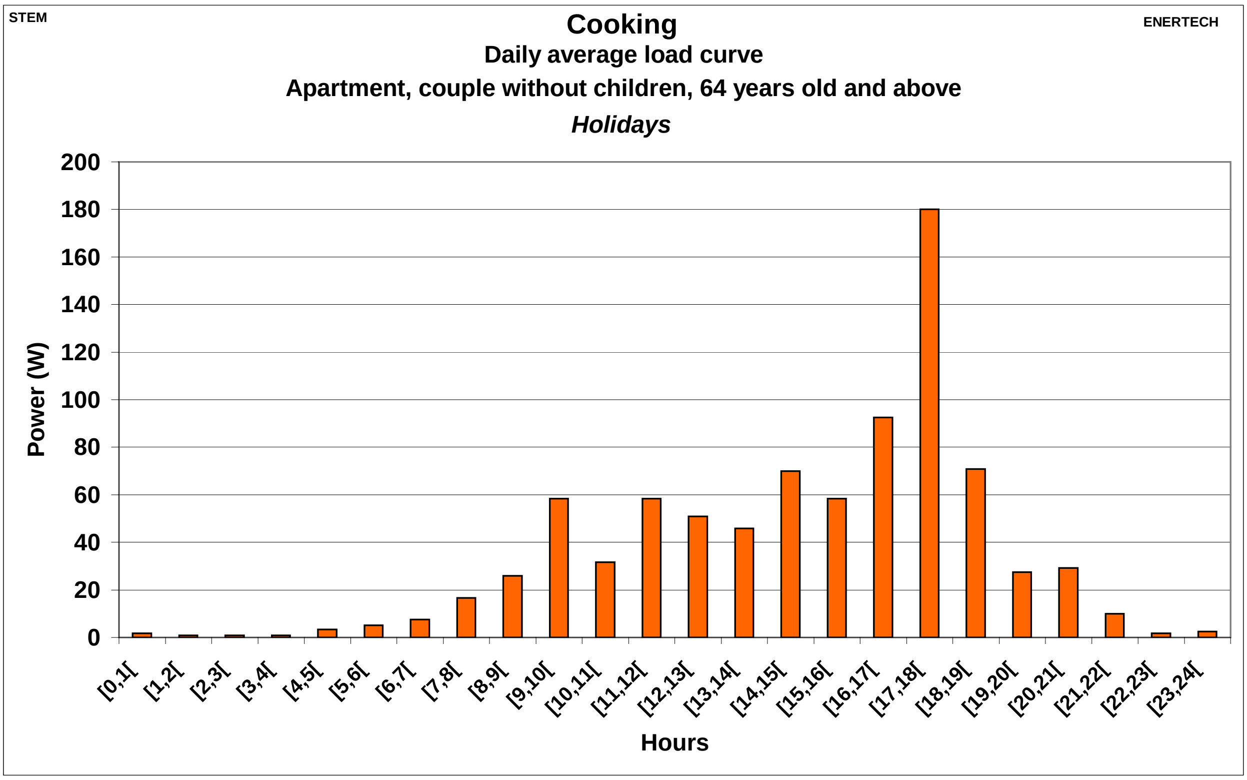


Figure 2.276: Cooking – Daily average load curve – Apartment, couples without children, 64 years old and above – Holidays

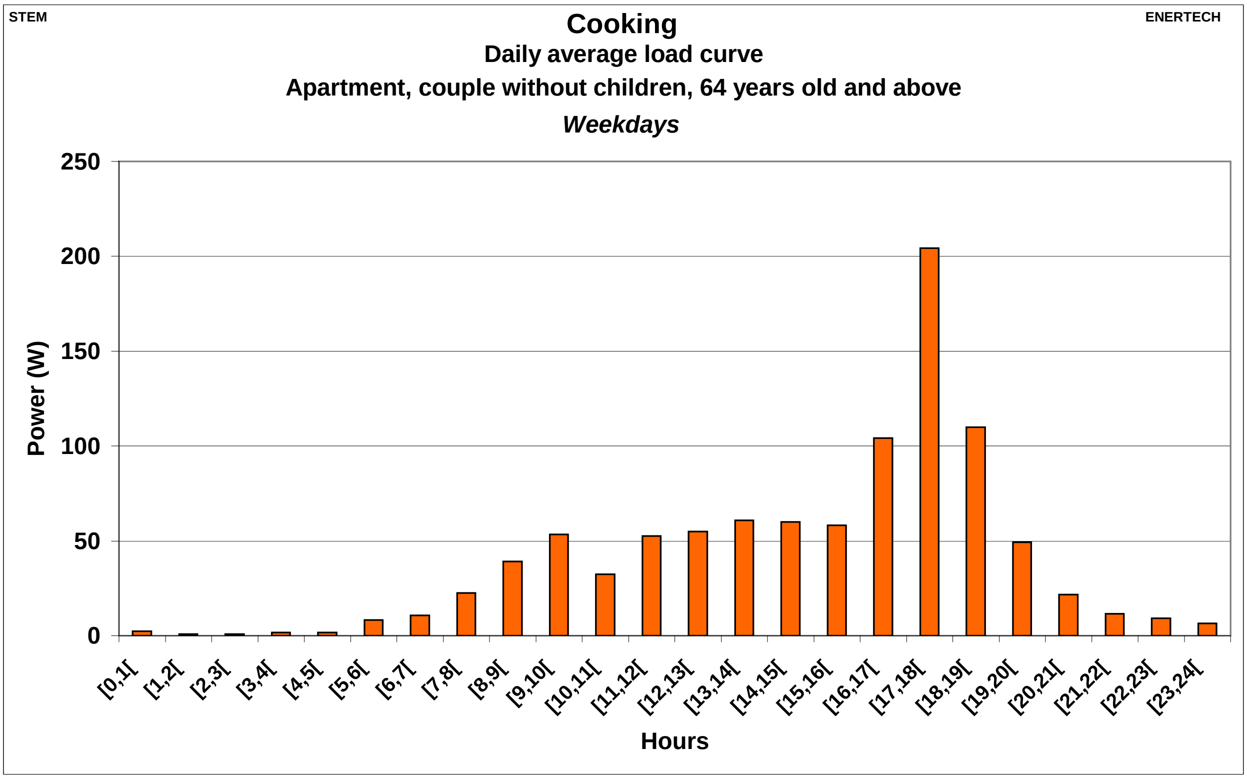


Figure 2.277: Cooking – Daily average load curve – Apartment, couples without children, 64 years old and above – Weekdays

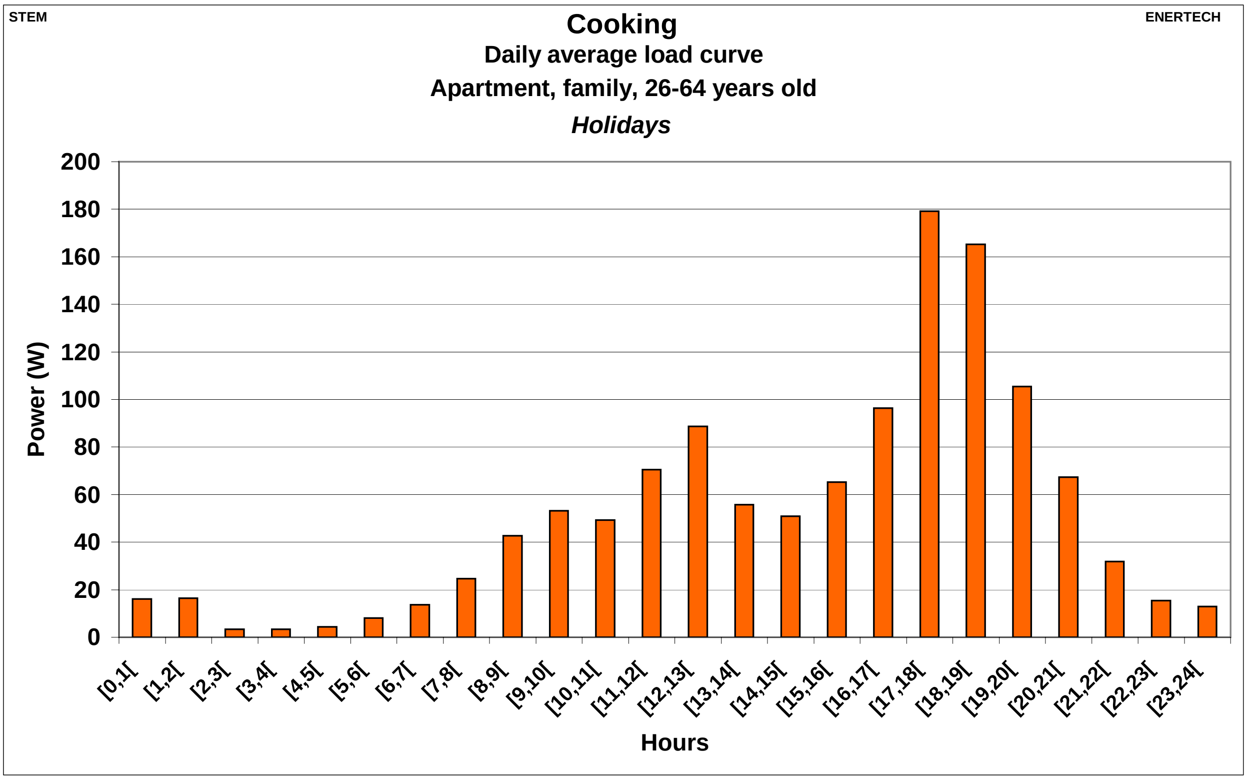


Figure 2.278: Cooking – Daily average load curve – Apartment, family, 26-64 years old – Holidays

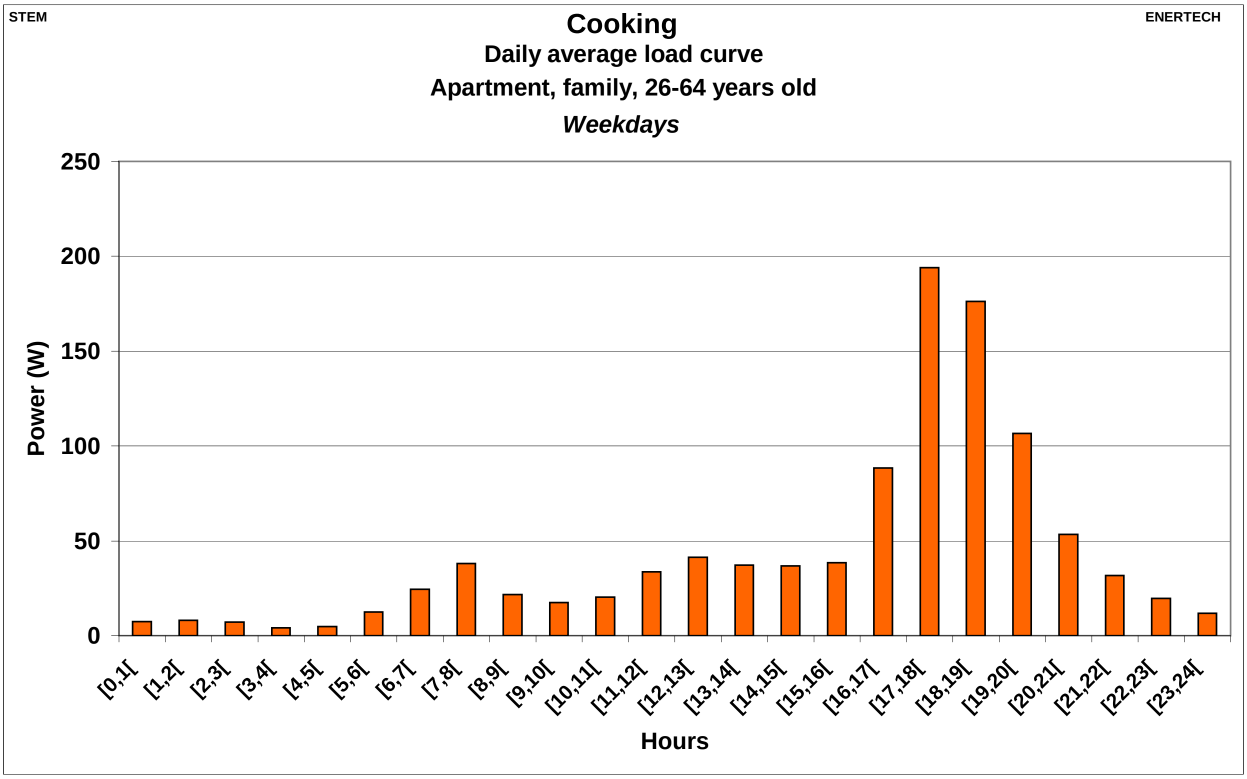


Figure 2.279: Cooking – Daily average load curve – Apartment, family, 26-64 years old – Weekdays

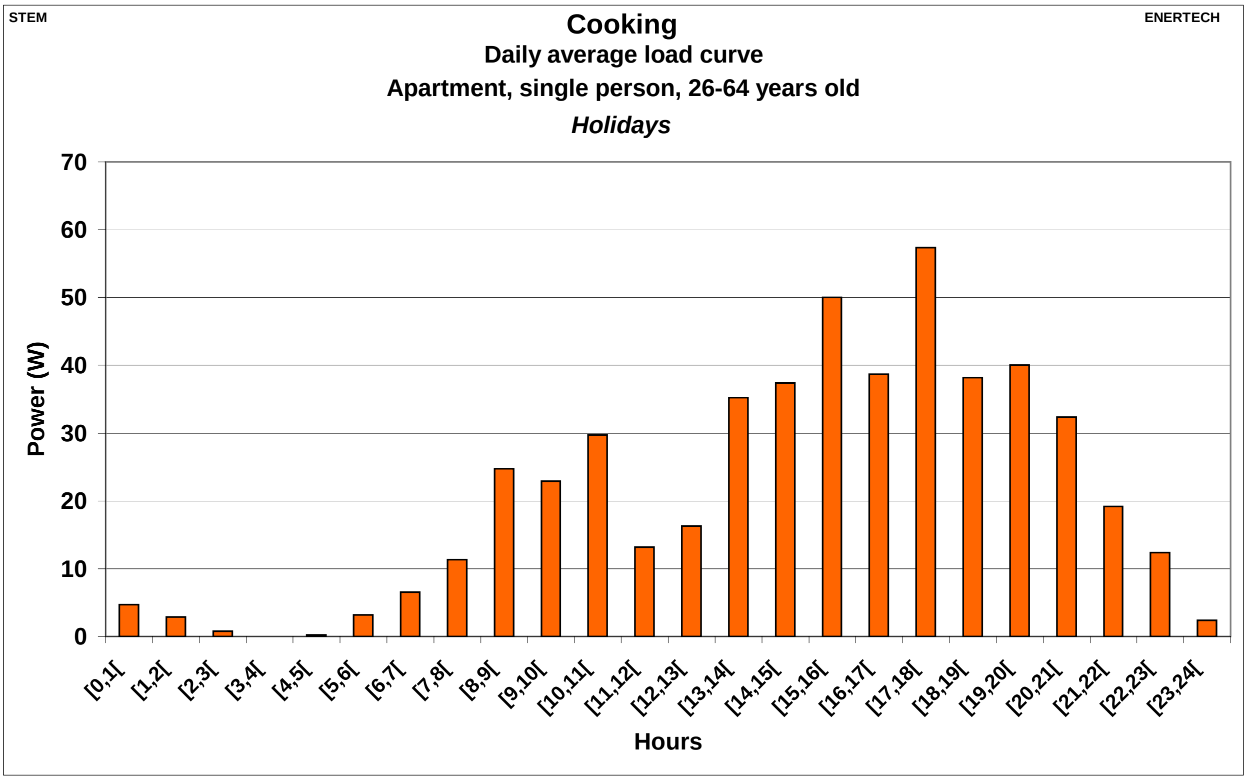


Figure 2.280: Cooking – Daily average load curve – Apartment, single person, 26-64 years old – Holidays

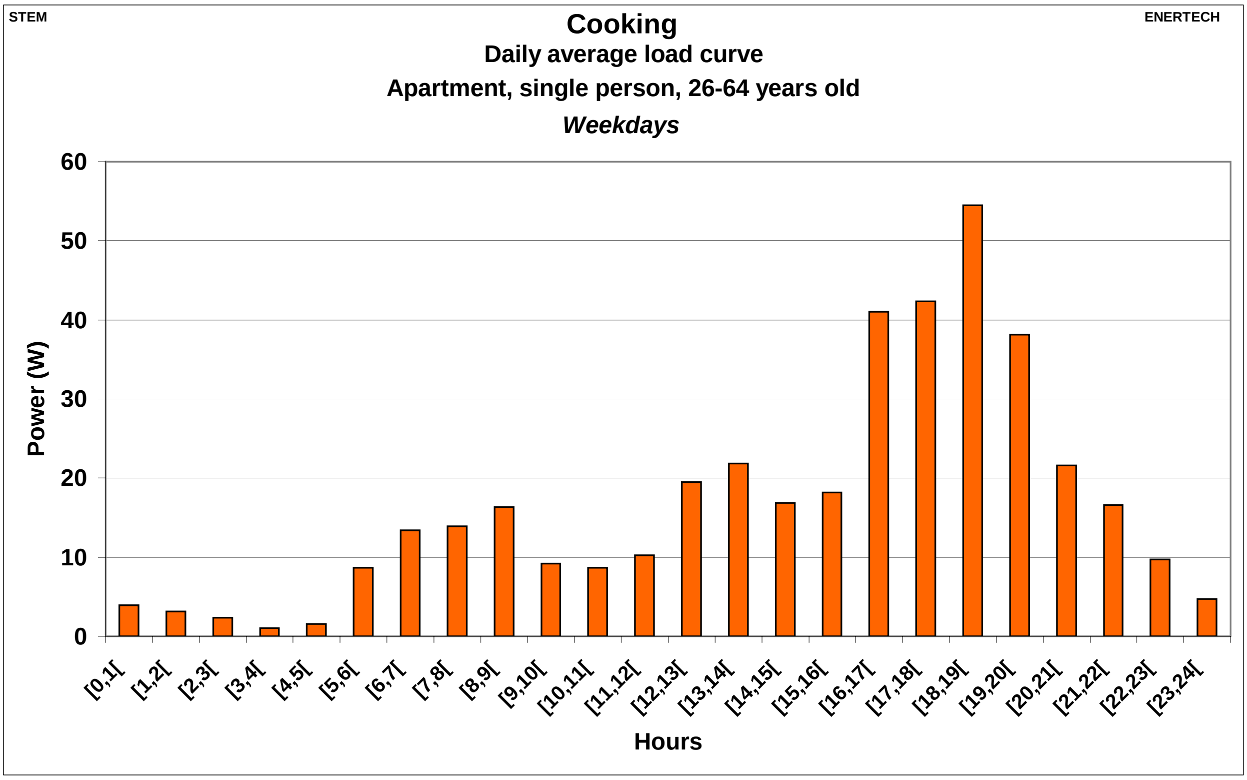


Figure 2.281: Cooking – Daily average load curve – Apartment, single person, 26-64 years old – Weekdays

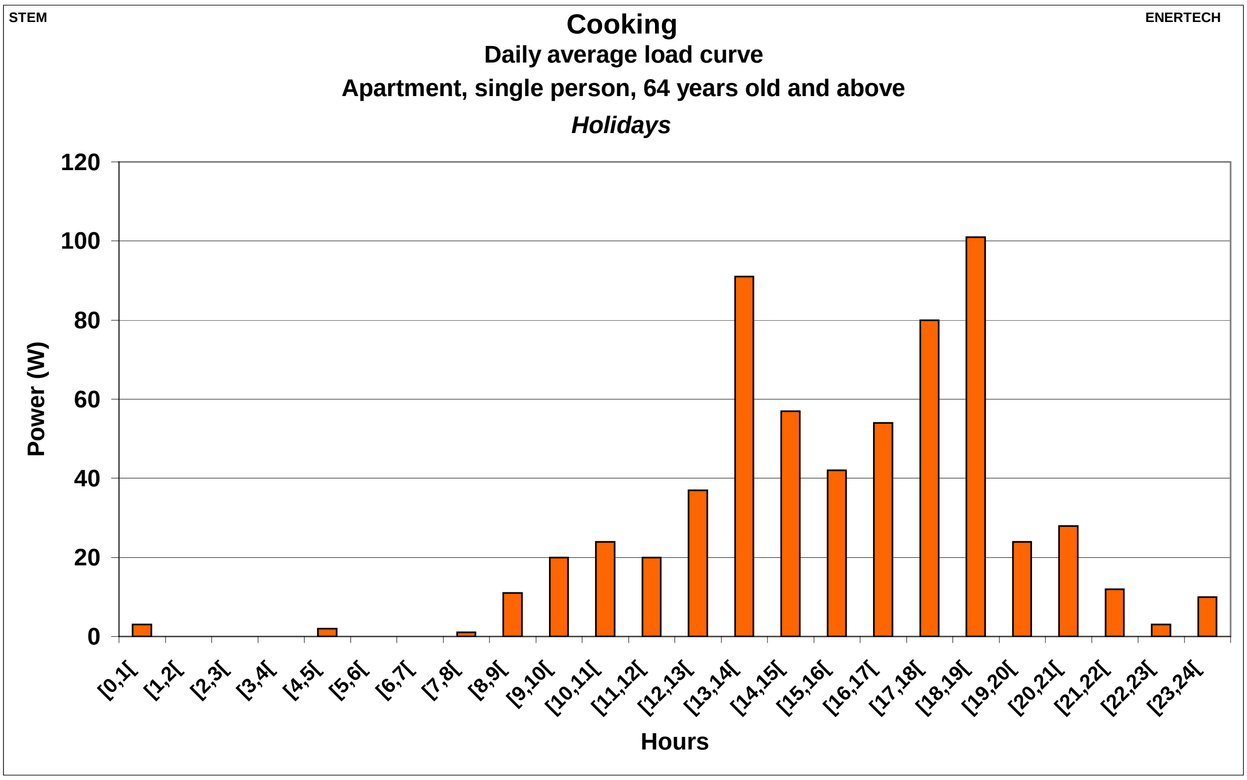


Figure 2.282: Cooking – Daily average load curve – Apartment, single person, 64 years old and above – Holidays

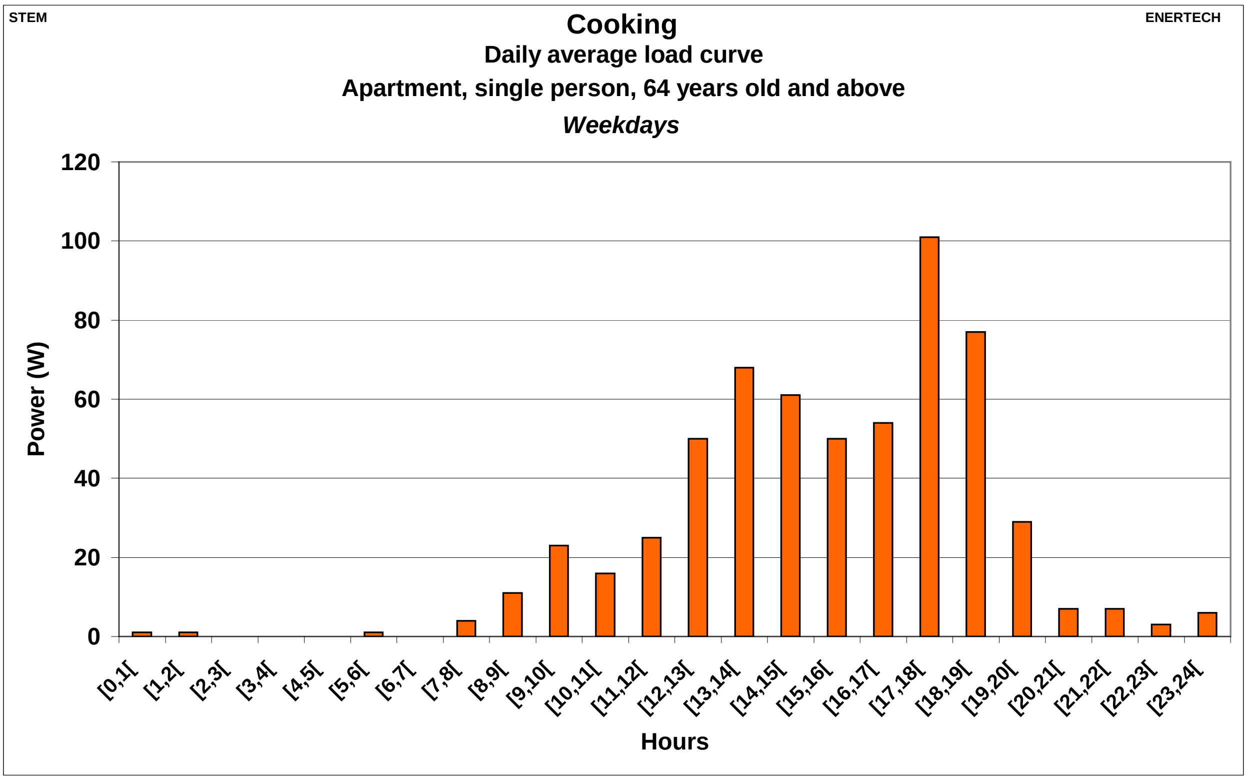


Figure 2.283: Cooking – Daily average load curve – Apartment, single person, 64 years old and above – Weekdays

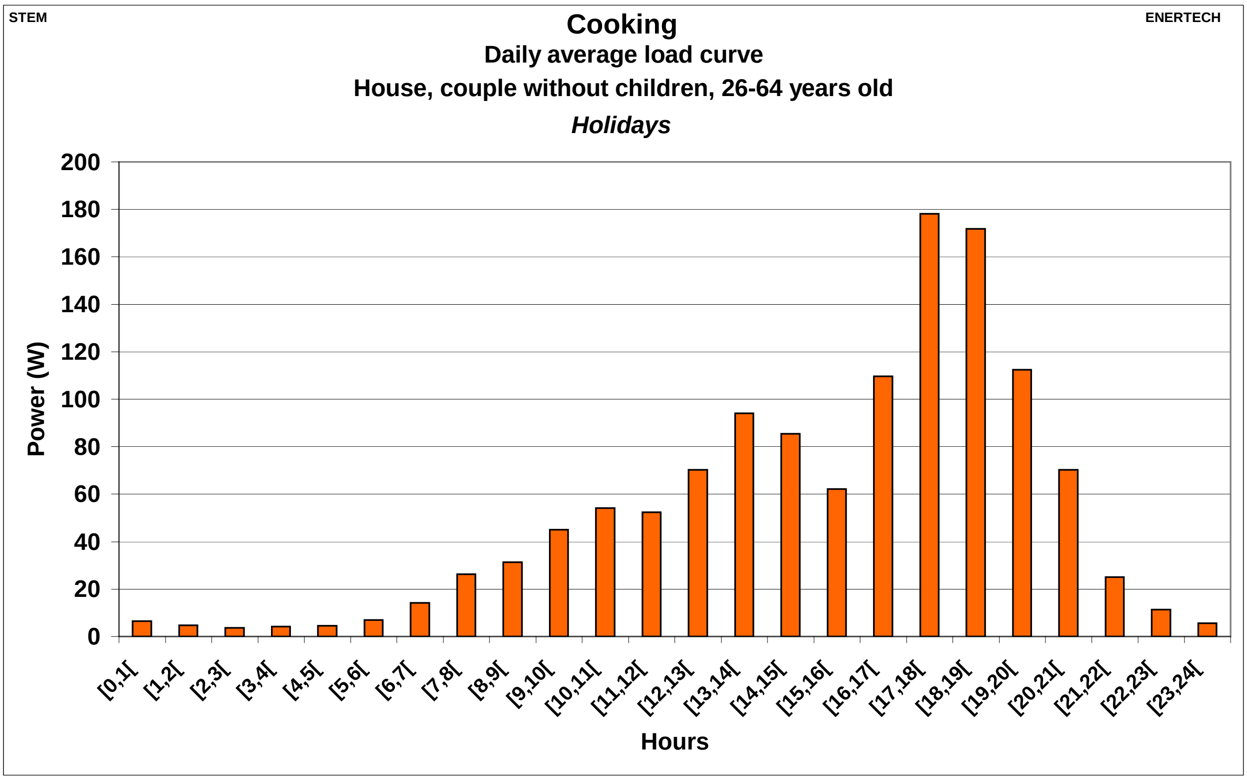


Figure 2.284: Cooking – Daily average load curve – House, couples without children, 26-64 years old – Holidays

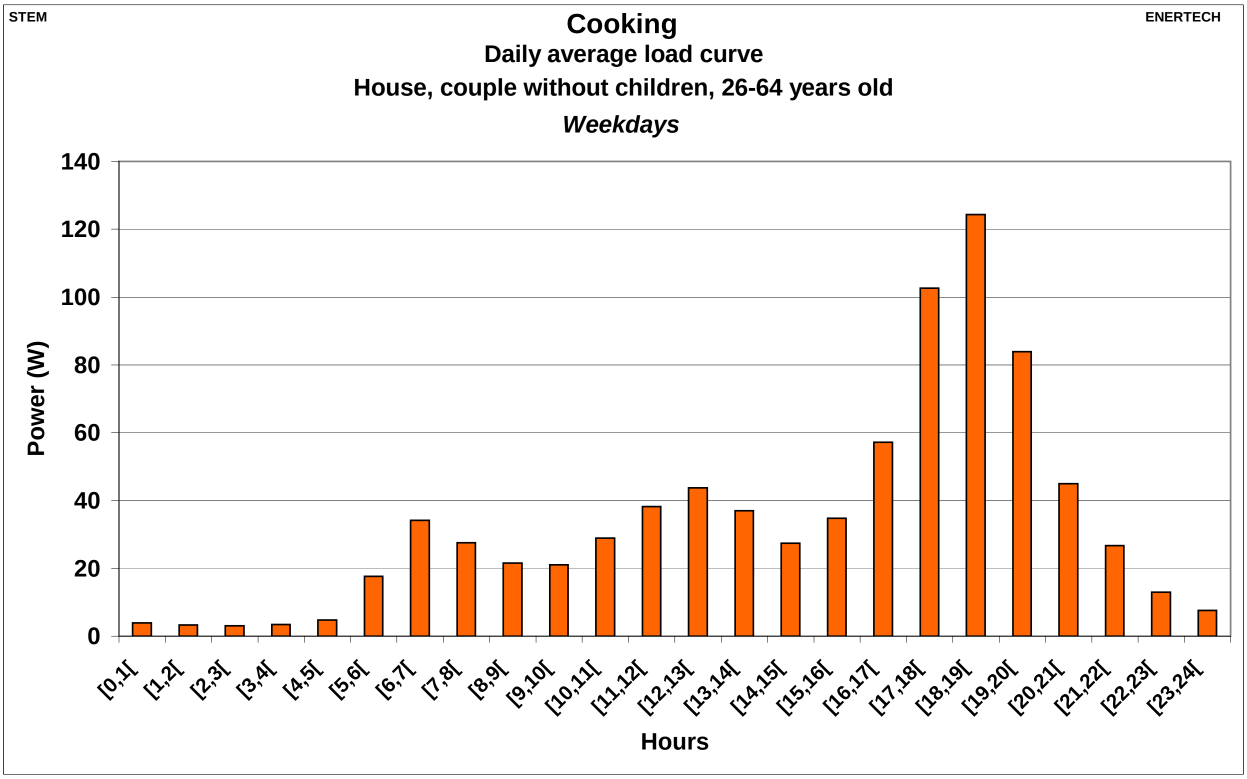


Figure 2.285: Cooking – Daily average load curve – House, couples without children, 26-64 years old – Weekdays

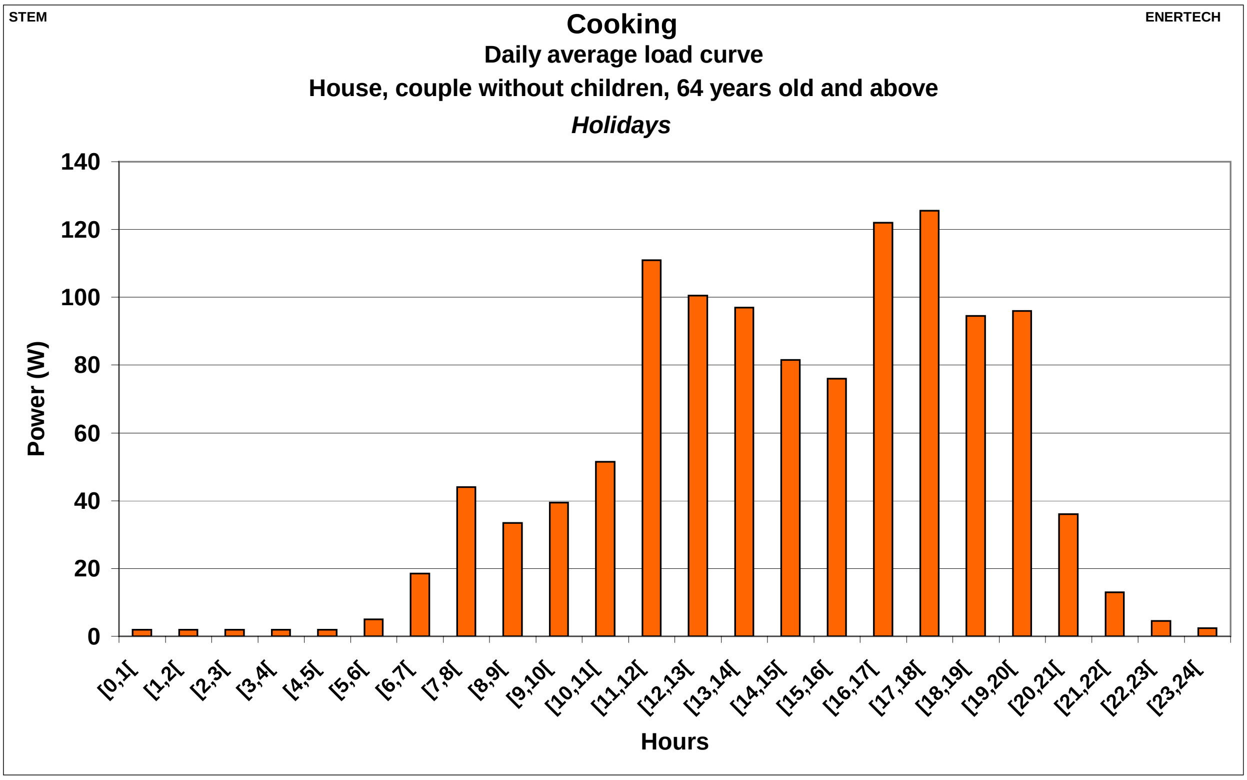


Figure 2.286: Cooking – Daily average load curve – House, couples without children, 64 years old and above – Holidays

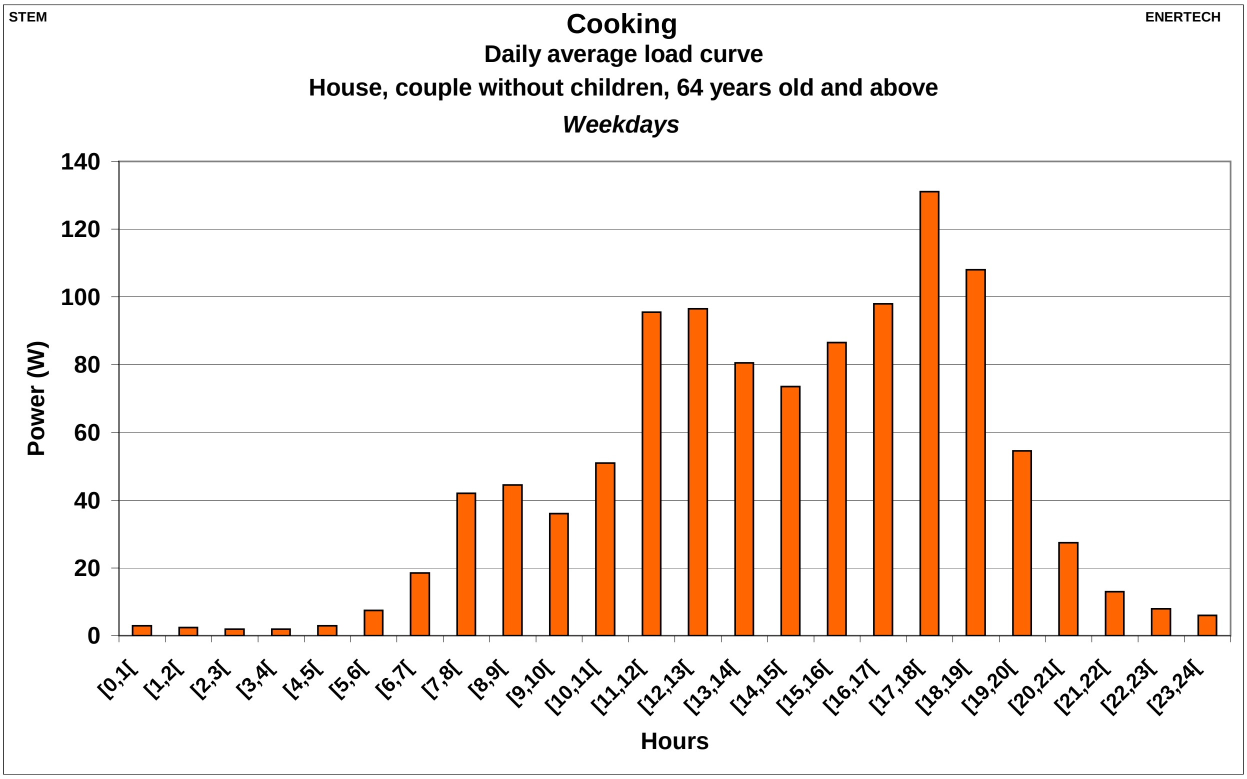


Figure 2.287: Cooking – Daily average load curve – House, couples without children, 64 years old and above – Weekdays

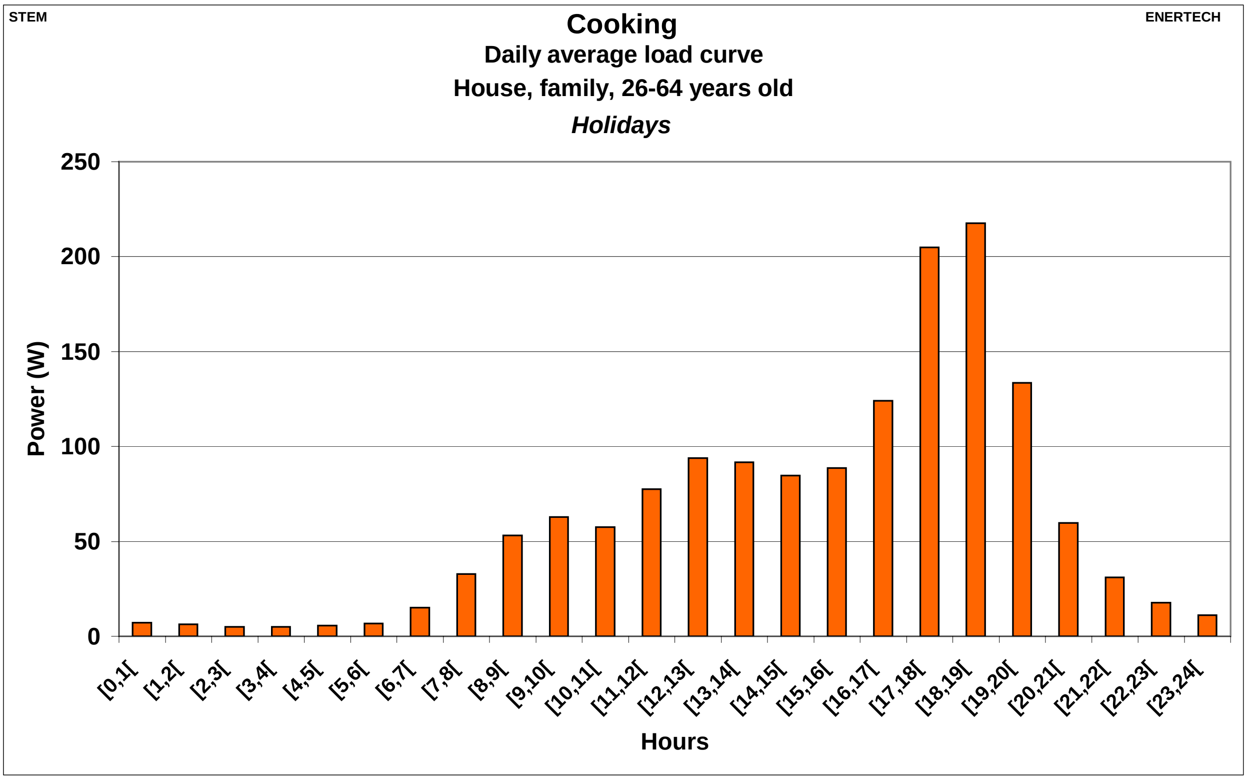


Figure 2.288: Cooking – Daily average load curve – House, family, 26-64 years old – Holidays

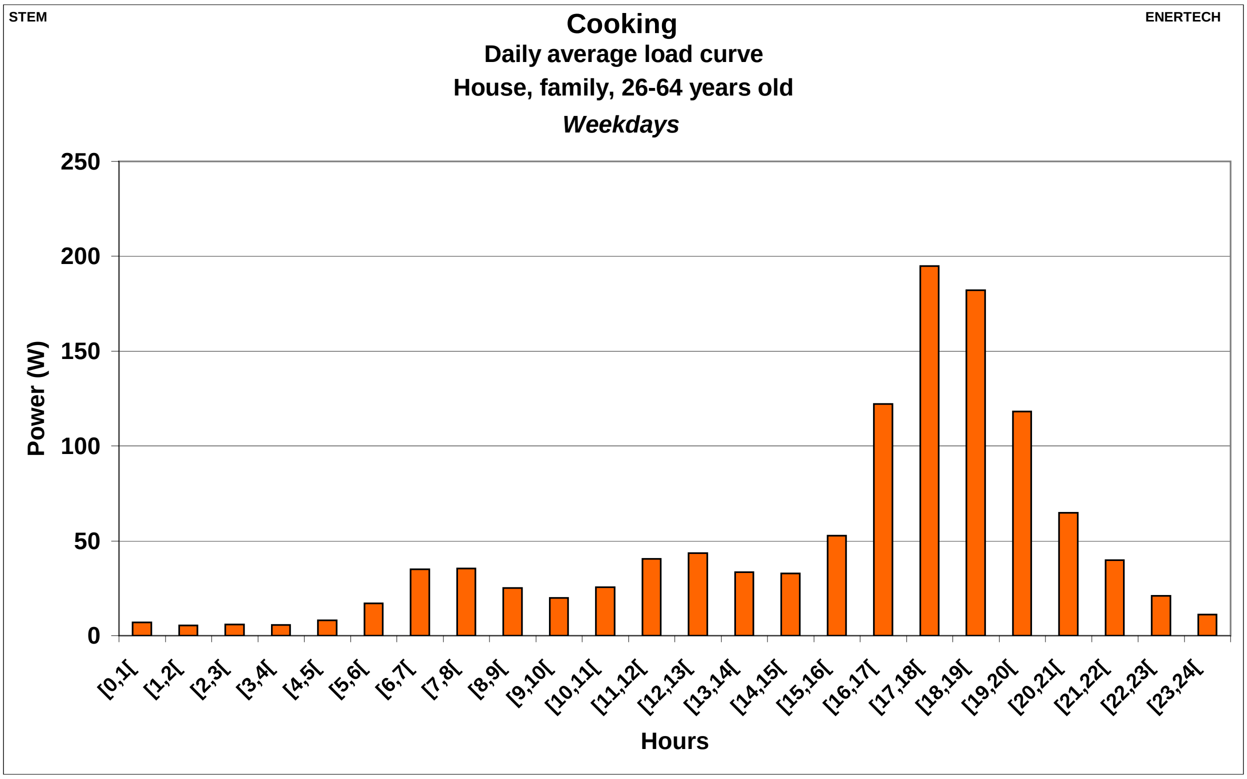


Figure 2.289: Cooking – Daily average load curve – House, family, 26-64 years old – Weekdays

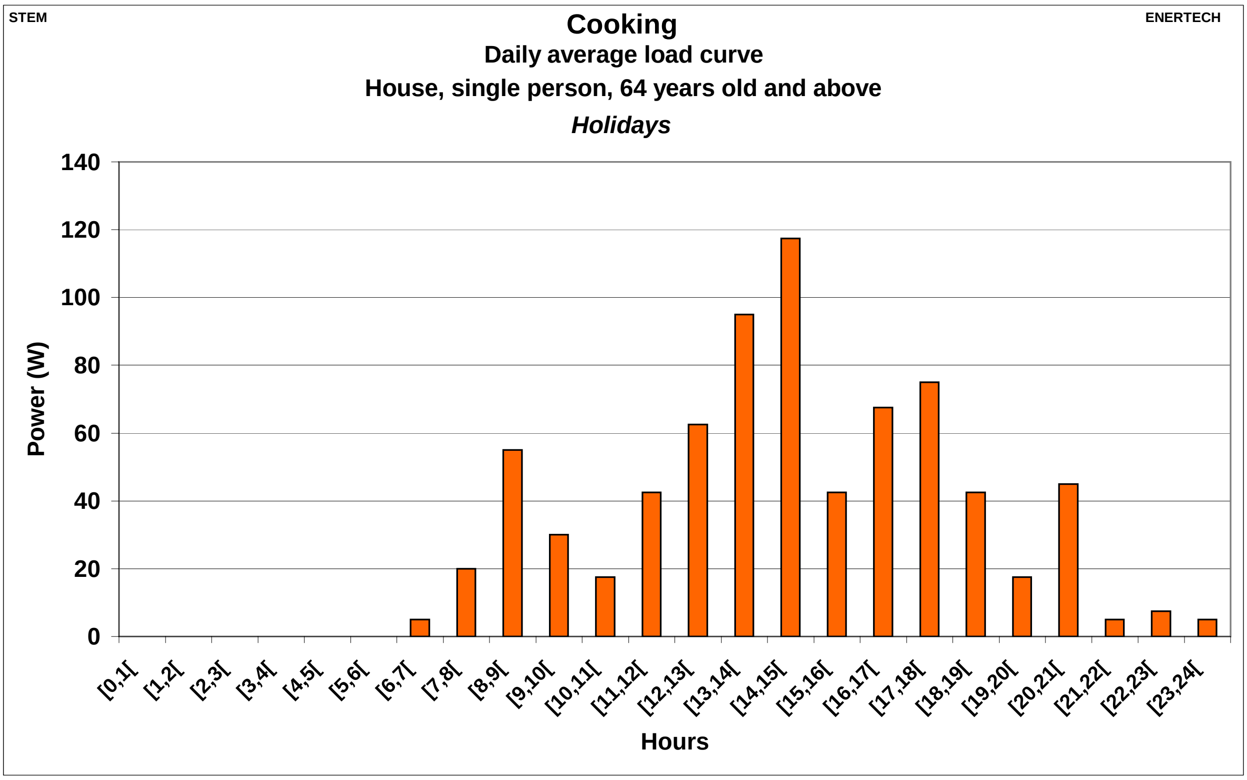


Figure 2.290: Cooking – Daily average load curve – House, single person, 64 years old and above – Holidays

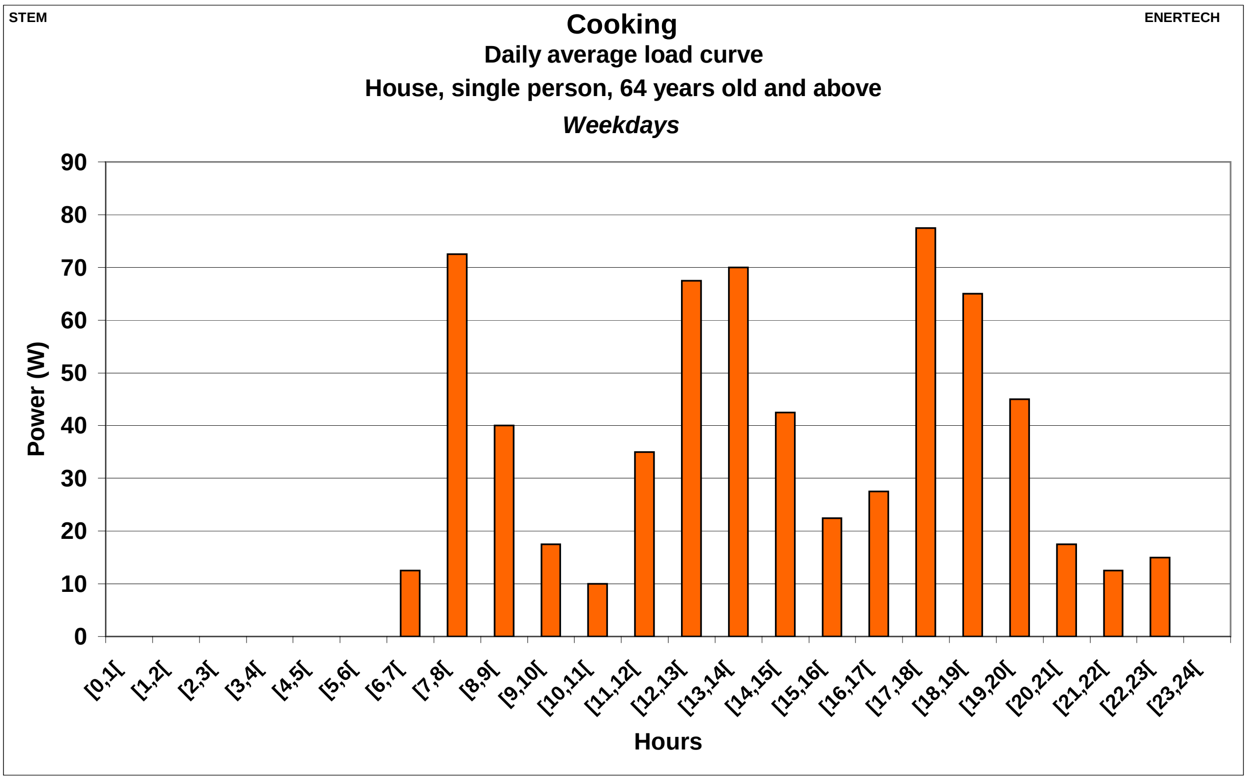


Figure 2.291: Cooking – Daily average load curve – House, single person, 64 years old and above – Weekdays

Annualized consumptionper appliance

Oven

Figures 2.292 and 2.293 show the annual consumption for the oven for houses and apartments. This consumption is 17% higher for the apartments than for the houses.

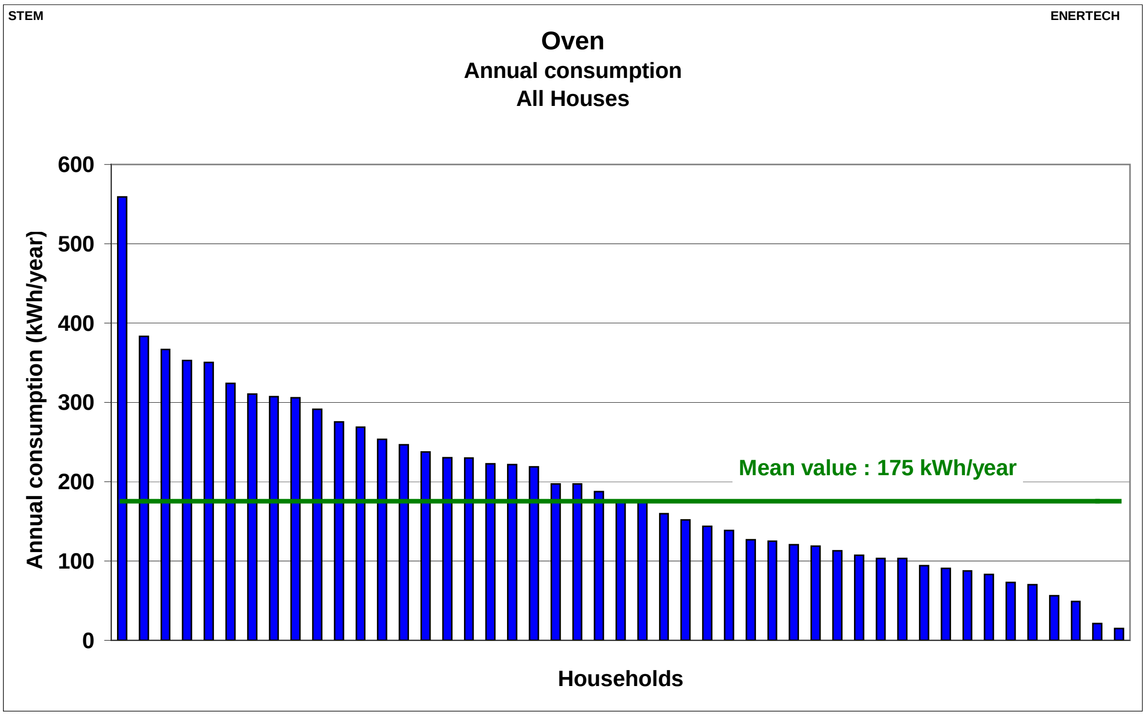


Figure 2.292: Oven – Annual consumption – Houses

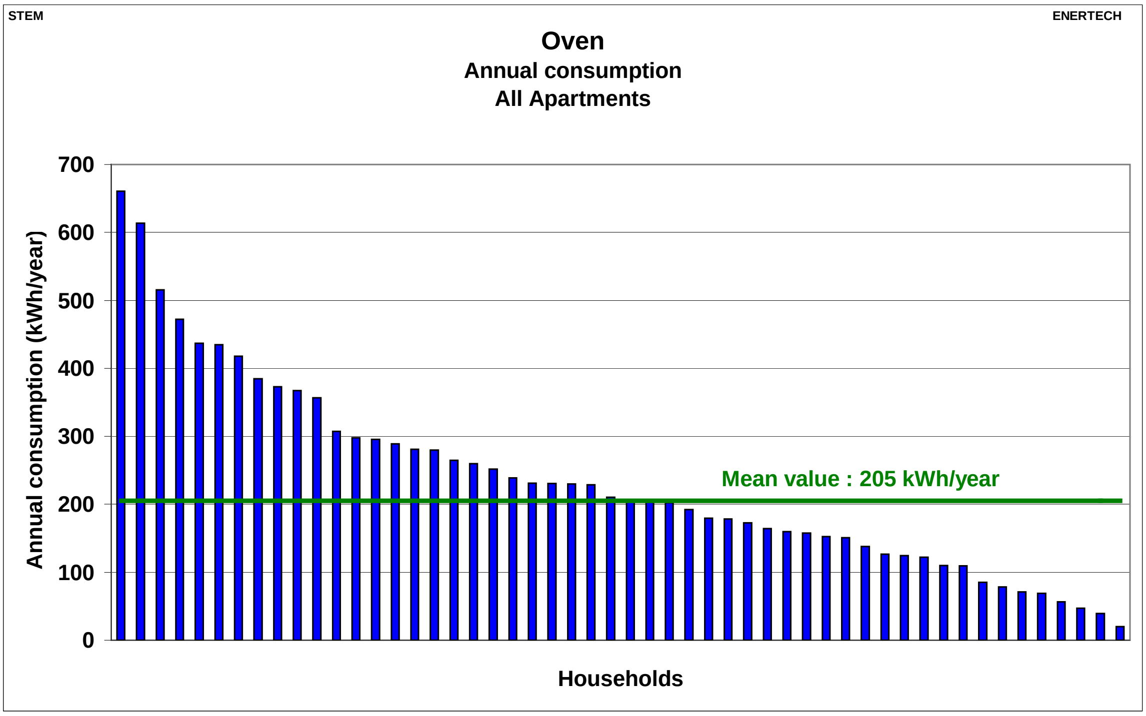


Figure 2.293: Oven – Annual consumption – Apartments

Figure 2.294 shows the annual consumption per person as a function of the number of persons in the household. The values per persons should be treated with some care, since the family structure has to be taken into account as well. We can see that the more persons there are in the household, the lower is the consumption per person.

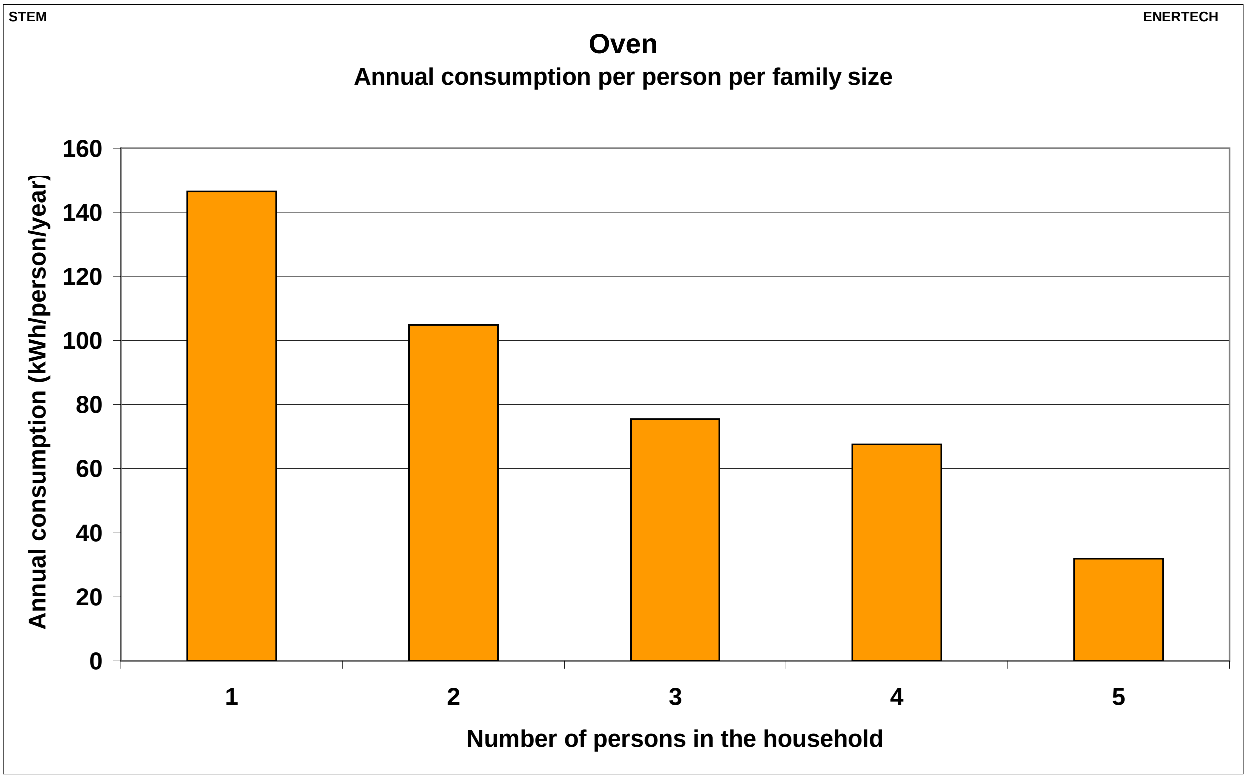


Figure 2.294: Oven – Annual consumption per person per family size

Figures 2.295 to 2.298 shows the daily average load curve for ovens in houses and apartments per type of day (holidays and weekdays). We can see that this appliance is mainly used in the evening between 17:00 and 18:00

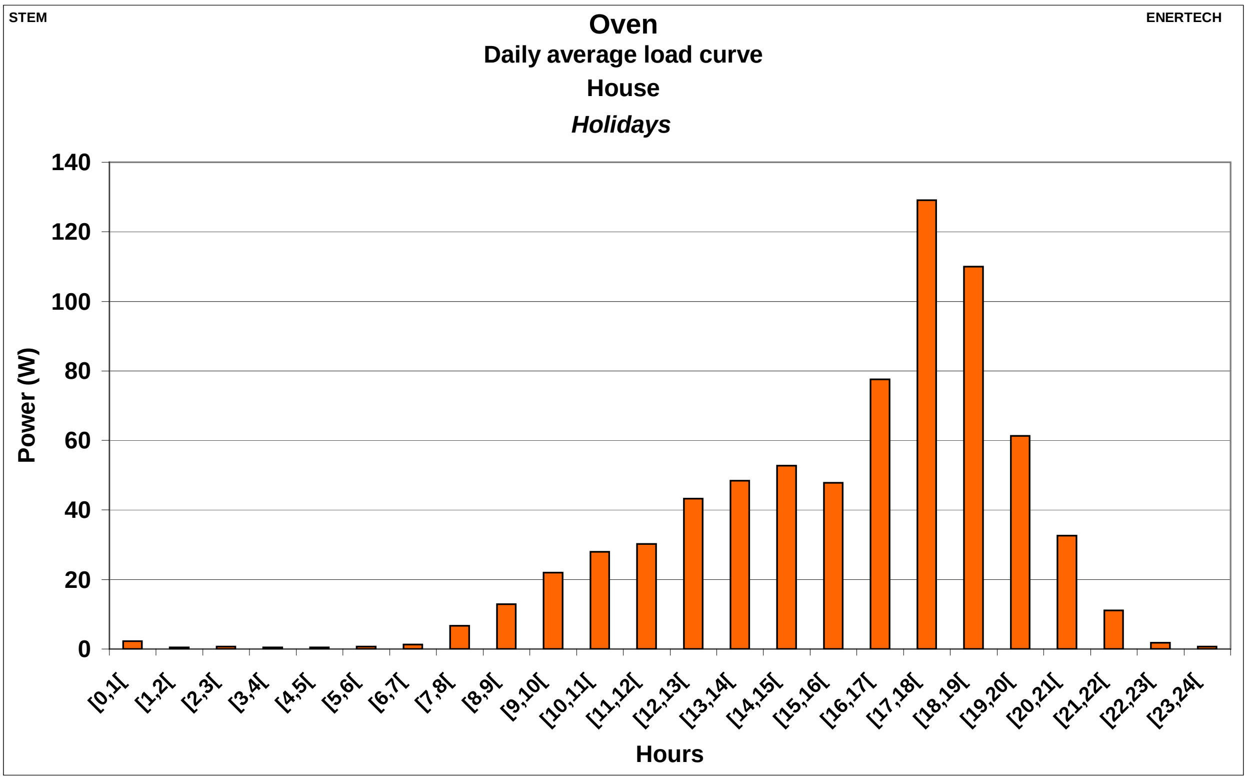


Figure 2.295: Oven – Daily average load curve – Houses – Holidays

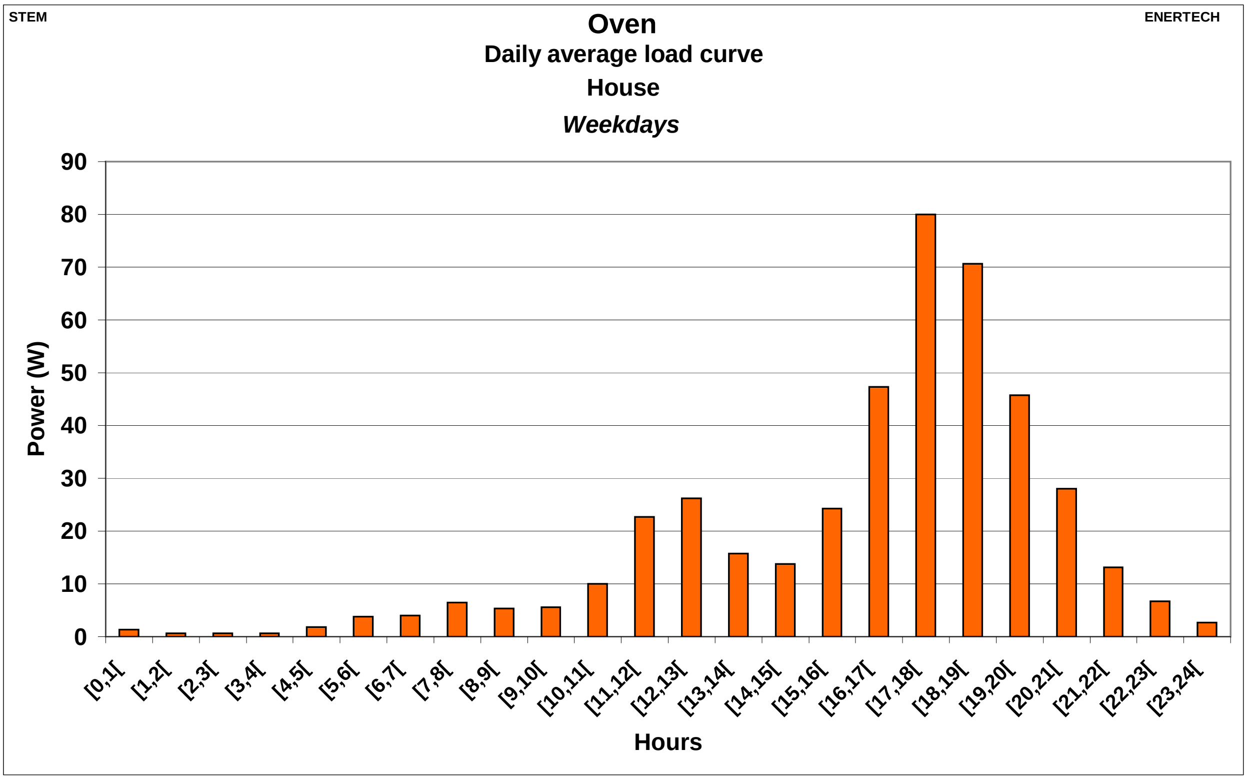


Figure 2.296: Oven – Daily average load curve – Houses – Weekdays

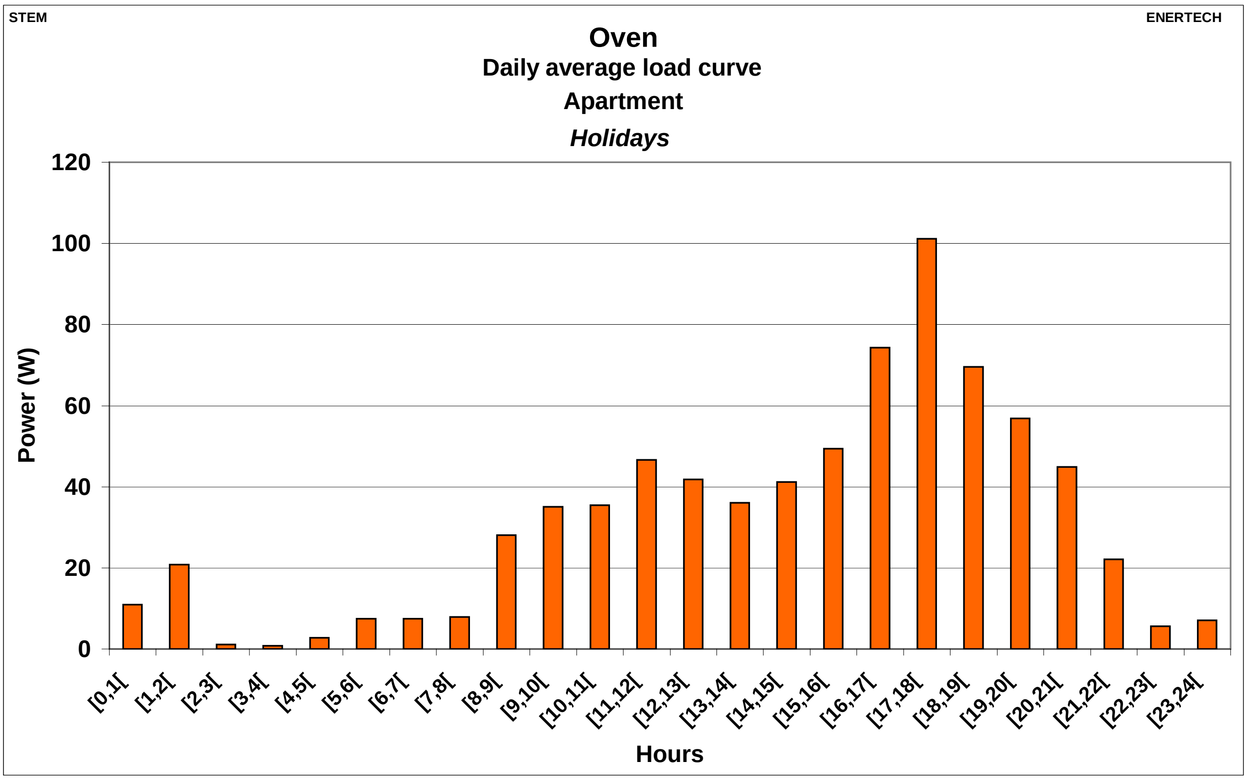


Figure 2.297: Oven – Daily average load curve – Apartment – Holidays

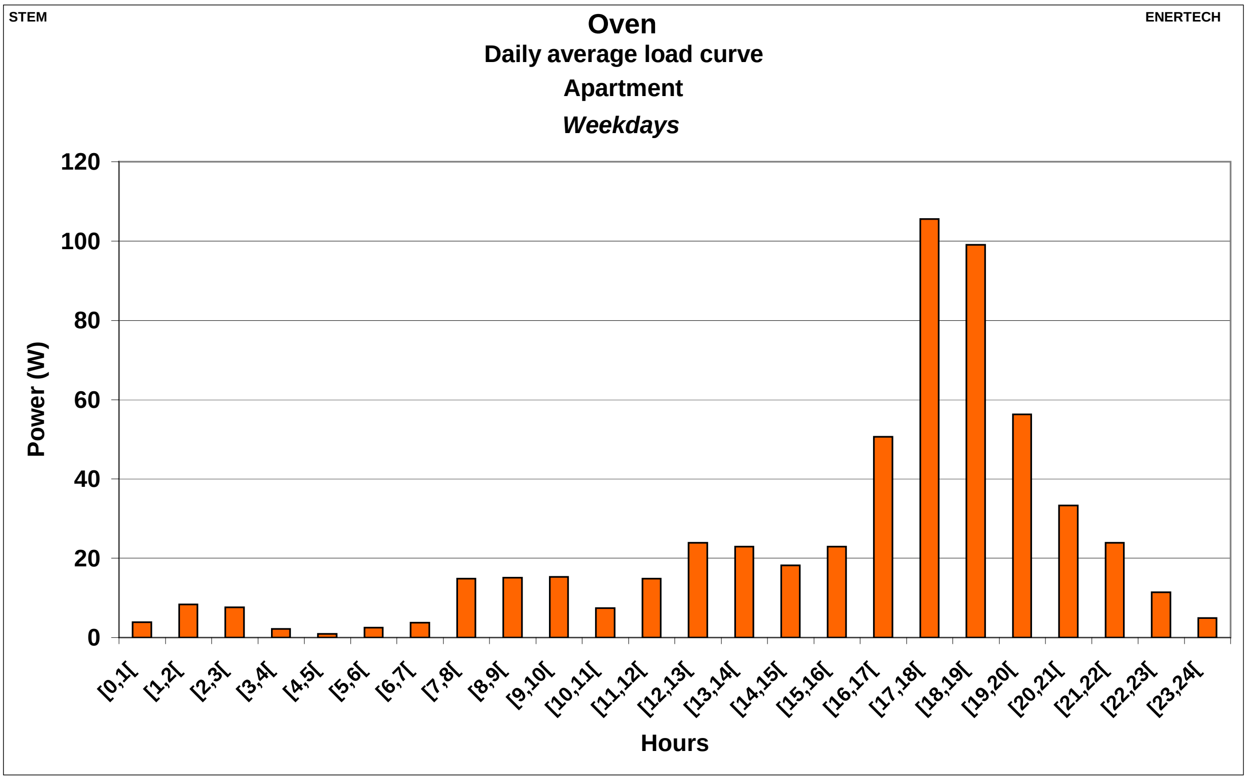


Figure 2.298: Oven – Daily average load curve – Apartment – Weekdays

Kitchen Stove

The next two figures give us the annual consumption for the kitchen stove in houses and apartments. This time the highest consumption will be found for the houses at 281 kWh/year and the apartments consume 20 % less at 218 kWh/year.

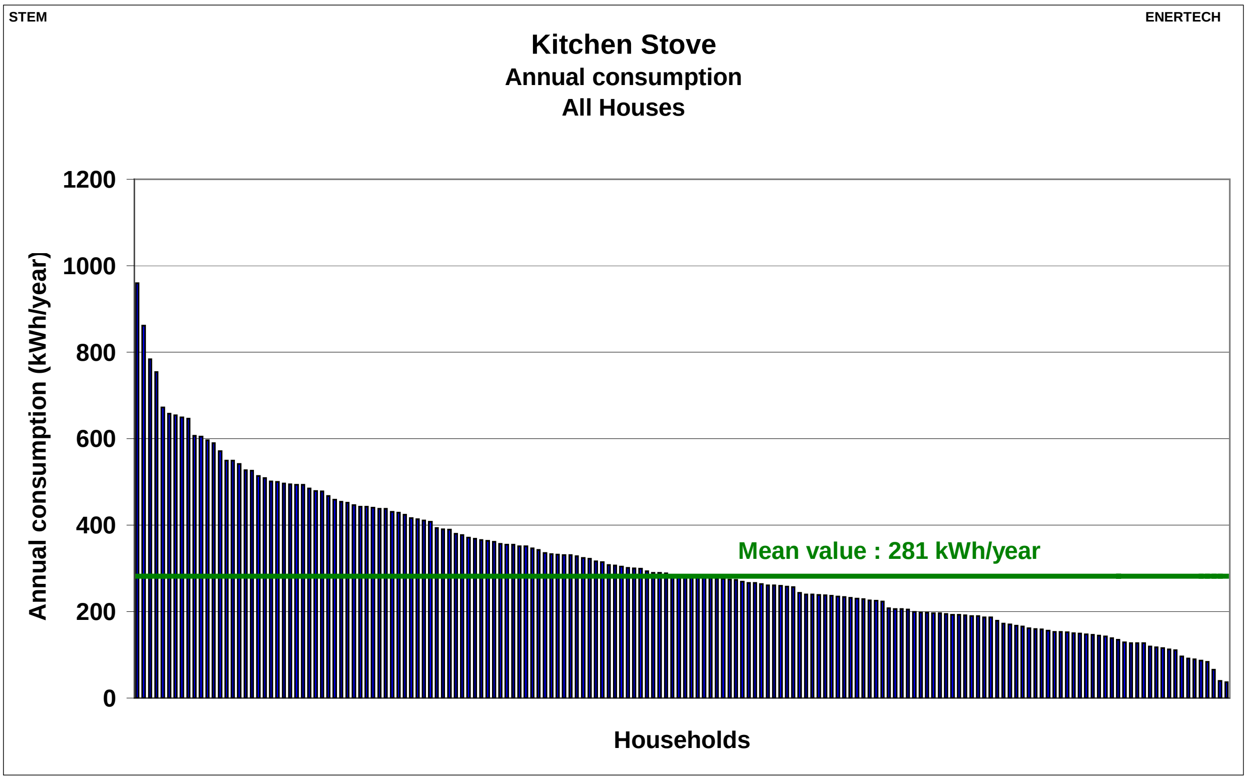


Figure 2.299: Kitchen Stove – Annual consumption – Houses

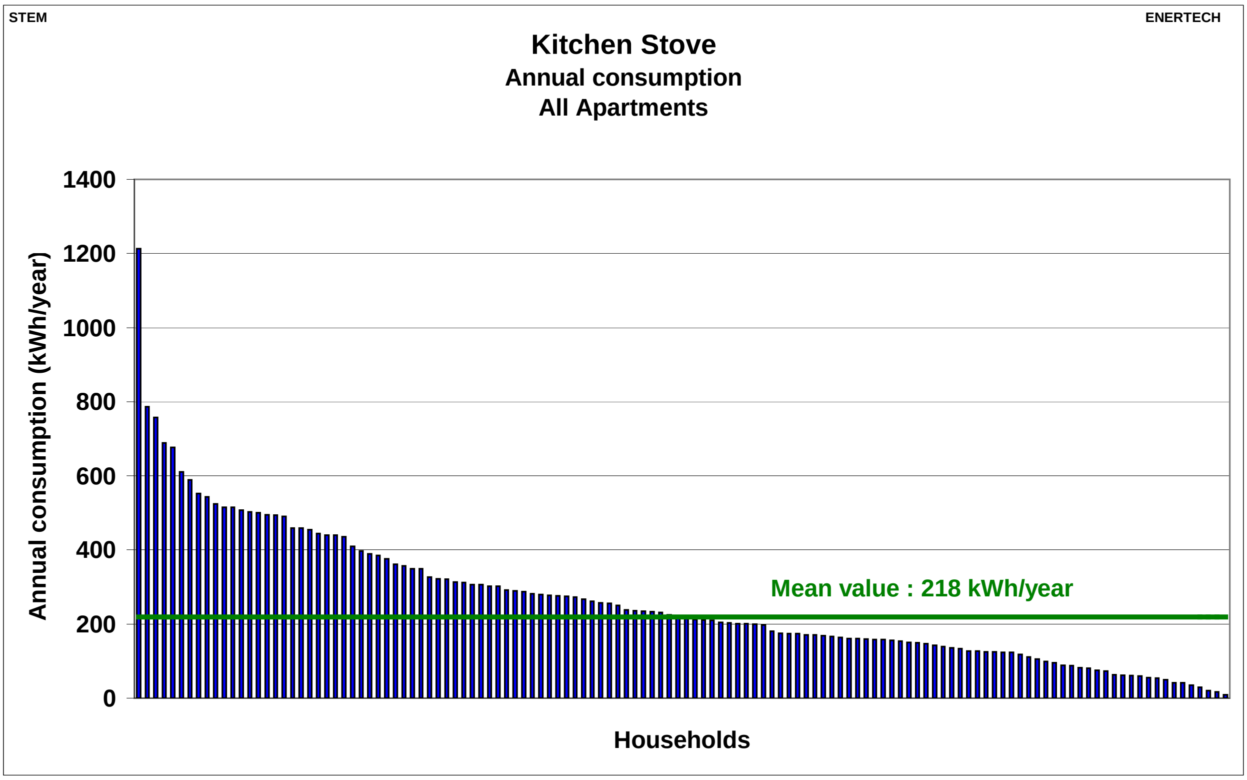


Figure 2.300: Kitchen stove – Annual consumption – Apartments

Figure 2.294 shows the annual consumption per person as a function of the number of persons in the household for the kitchen stove. The values per person should be treated with some care, since the family structure has to be taken into account as well. This consumption will decrease from 142 kWh/person/year to 132 kWh/person/year for 2 persons to 92 kWh/person/year for 3 and then be stable around this value for 4, 5 or 6 persons. Using the kitchen stove for less than 3 persons is very inefficient.

Figures 2.302 to 2.305 represent the daily average load curve for kitchen stove in houses and apartments per type of day (holidays and weekdays). As for the oven, we can see that this appliance is mainly used in the evening between 17:00 and 19:00 and a little bit more at lunch time during the holidays.

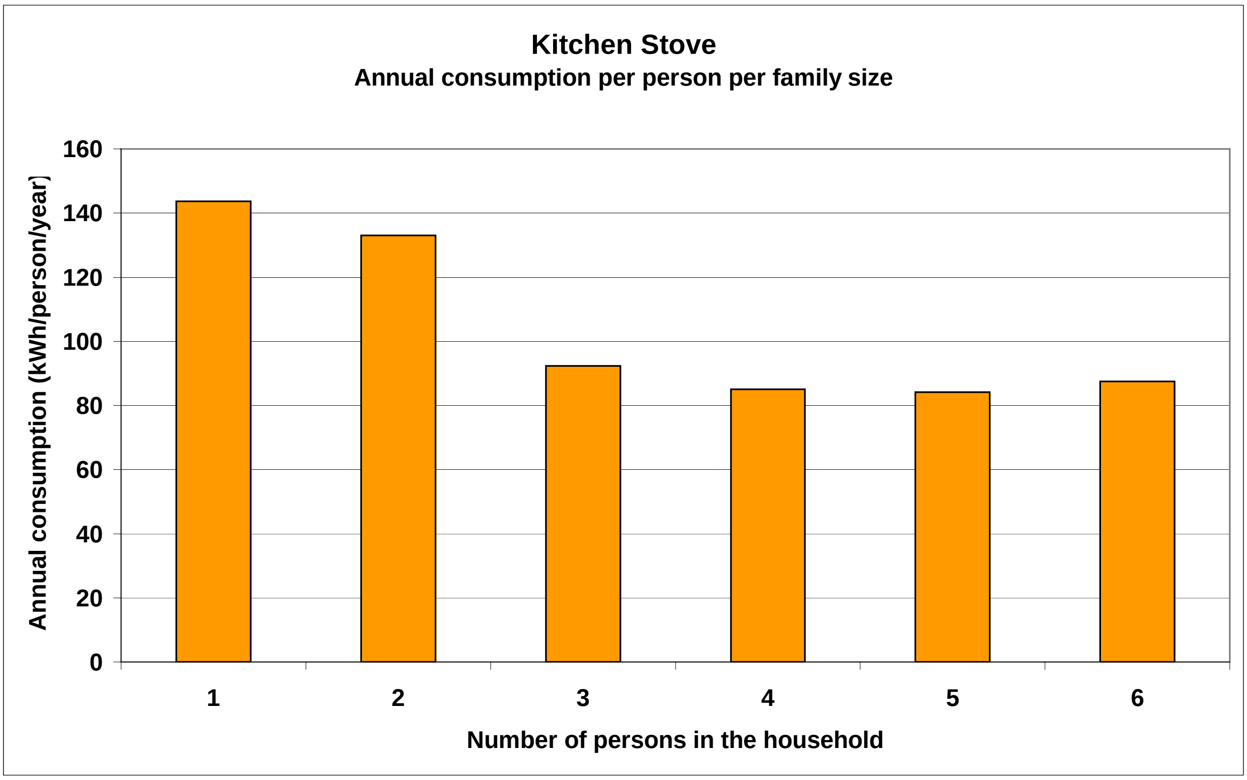


Figure 2.301: Kitchen stove – Annual consumption per person per family size

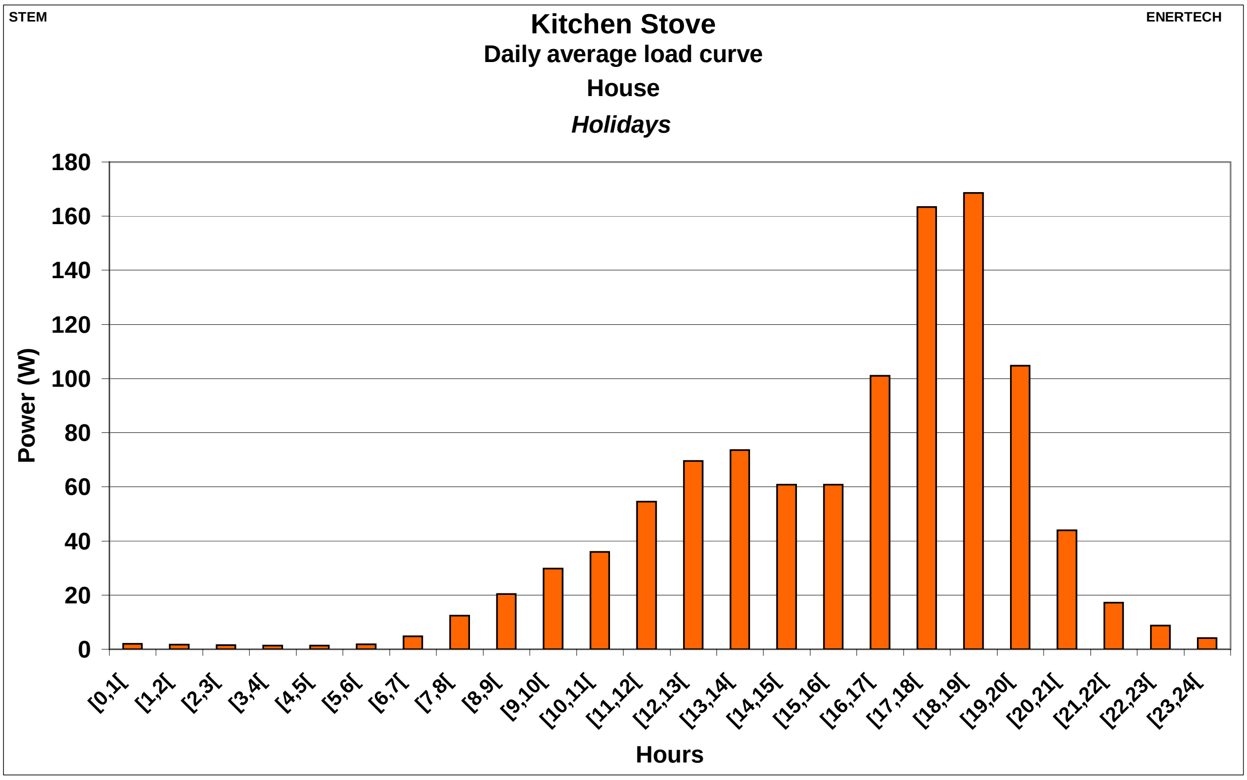


Figure 2.302: Kitchen Stove – Daily average load curve – Houses – Holidays

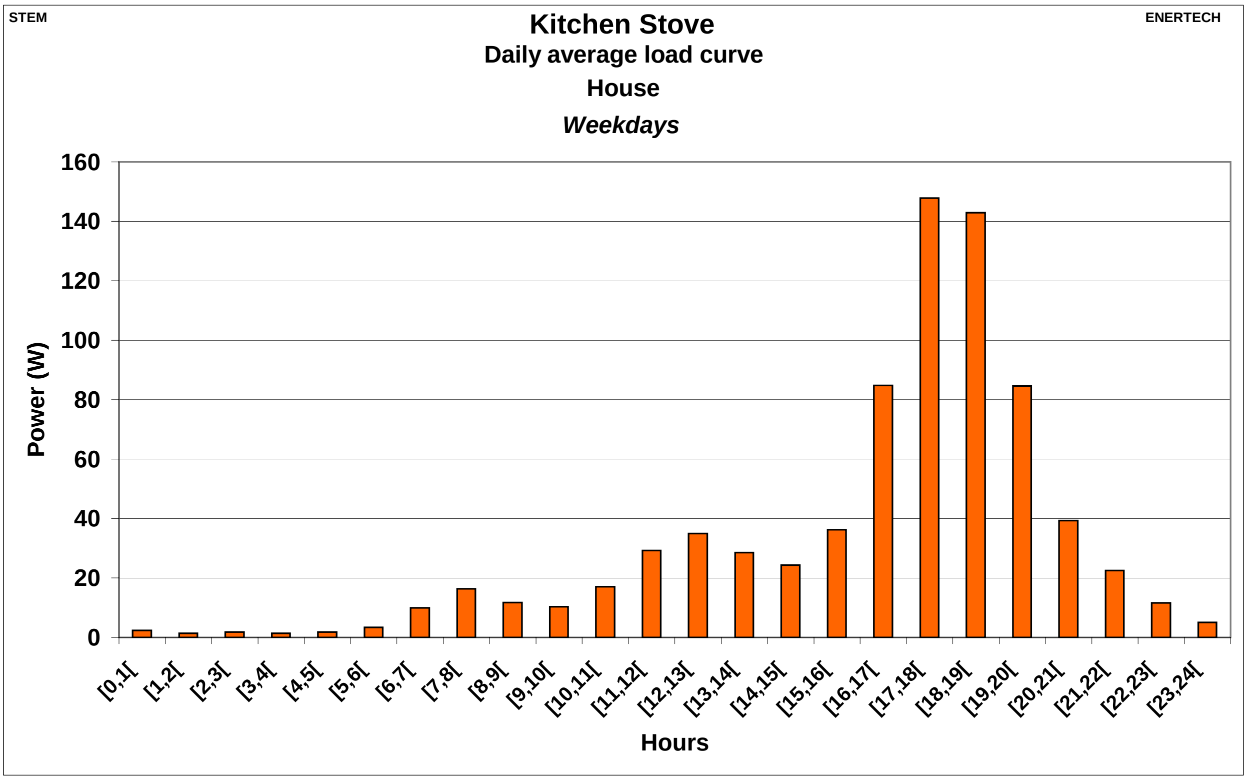


Figure 2.303: Kitchen Stove – Daily average load curve – Houses – Weekdays

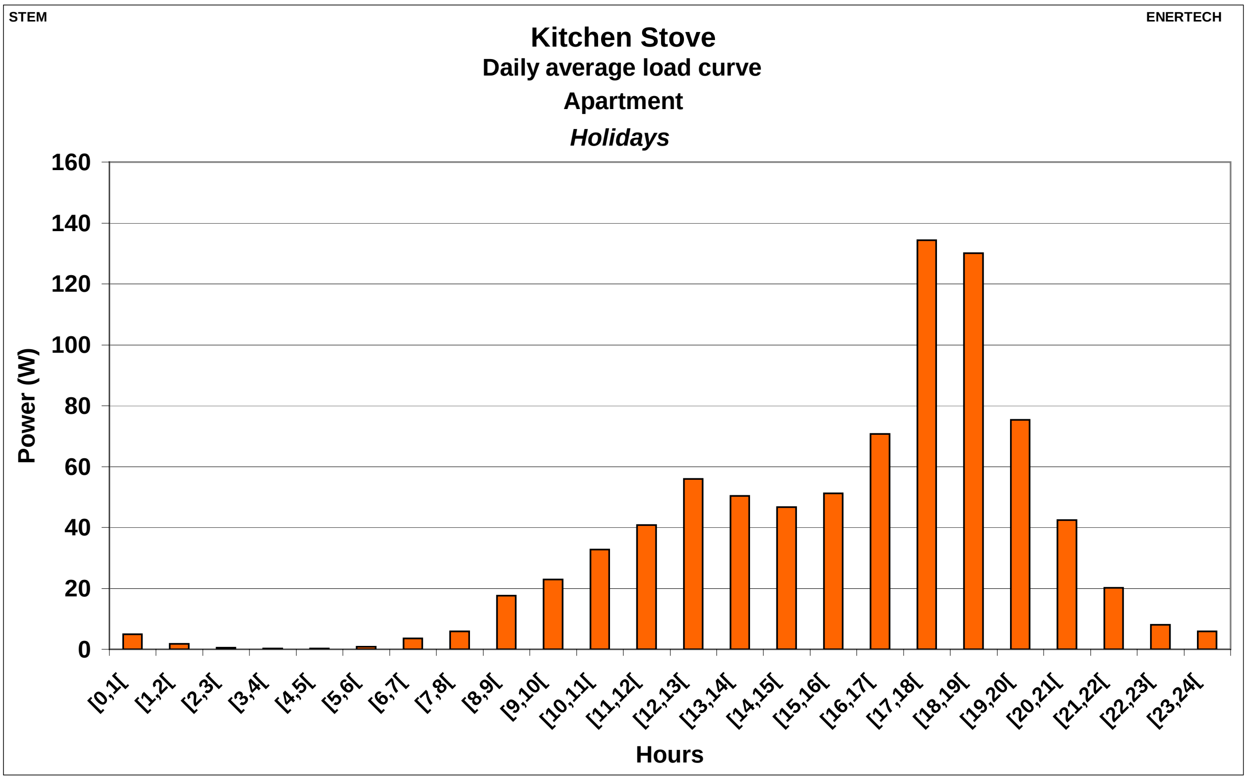


Figure 2.304: Kitchen Stove – Daily average load curve – Apartments – Holidays

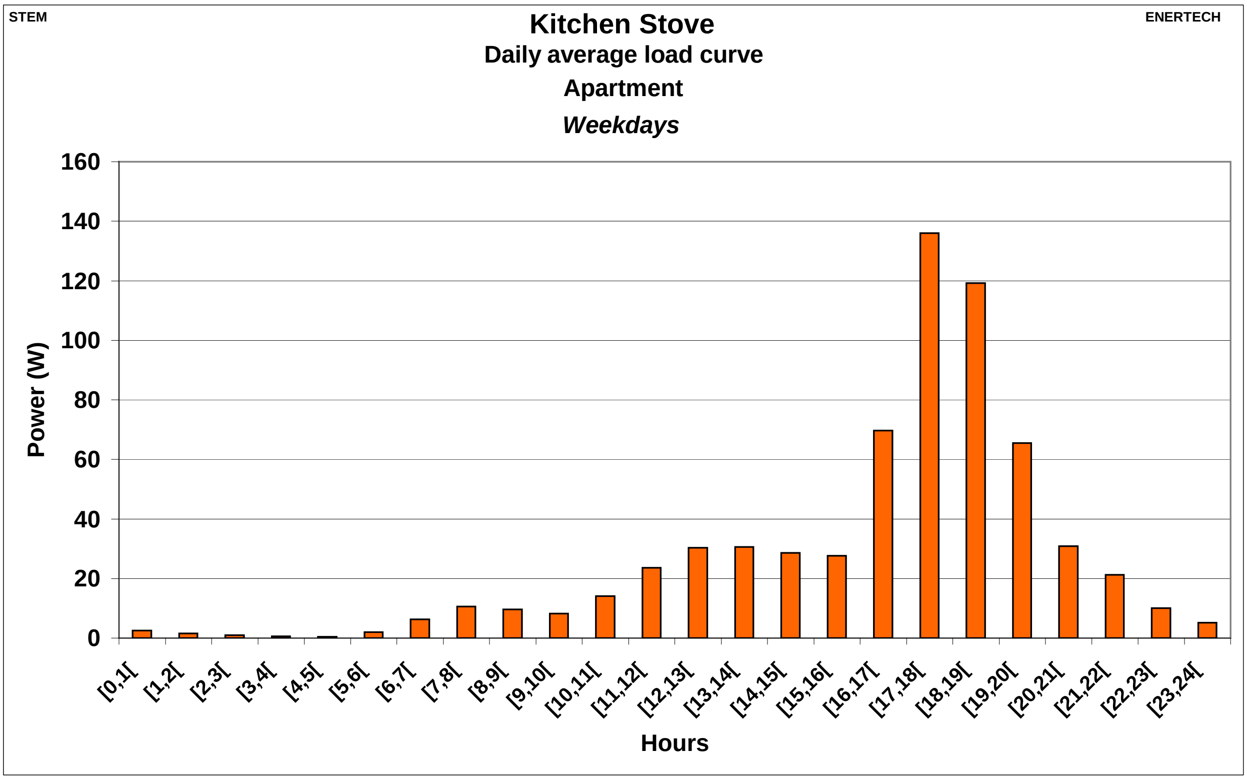


Figure 2.305: Kitchen Stove – Daily average load curve – Apartments – Holidays

Microwave

Microwave ovens are very common in the houses and apartments and their consumption represent only 38 and 29 kWh/year respectively as shown in figures 2.306 and 2.307. Using this appliance to warm cold plates is very easy and fast, that's why they are used all the day along as shown in figures 2.308 to 2.311 which represent the daily average load curve per type of household per type of day (holidays and weekdays).

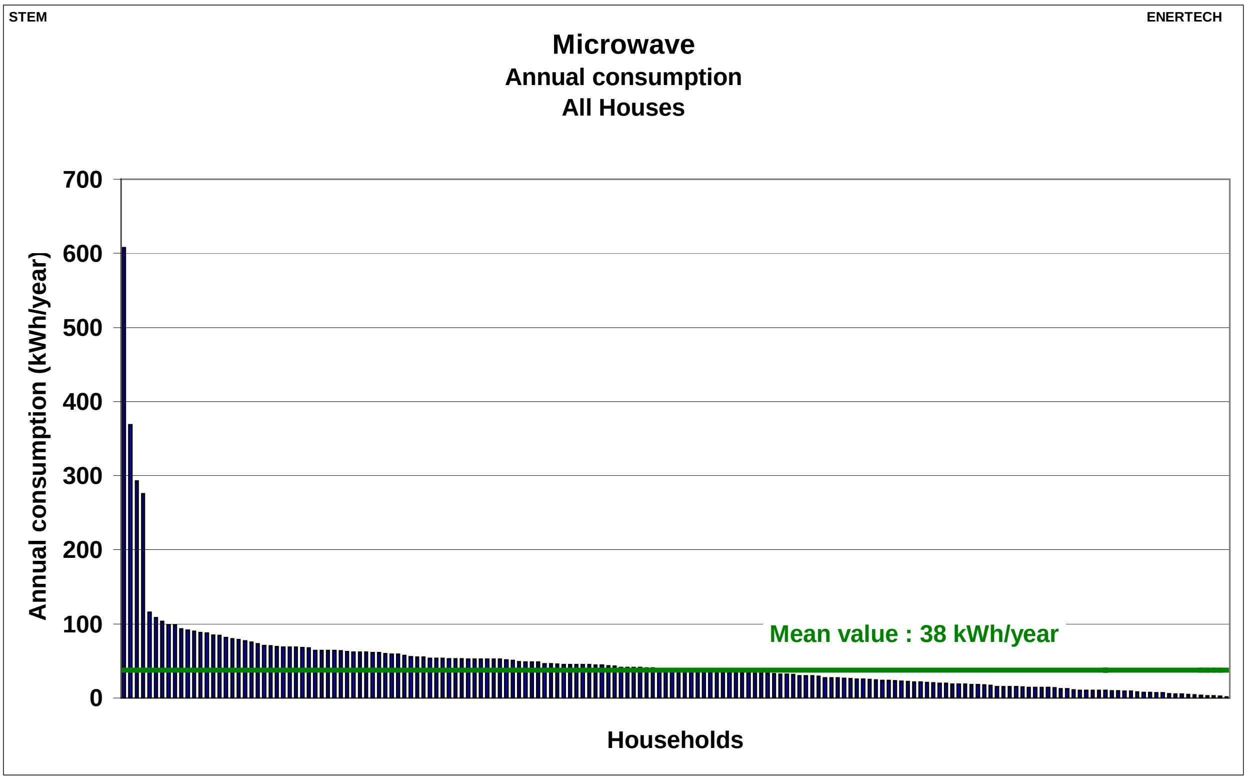


Figure 2.306: Microwave – Annual consumption – Houses

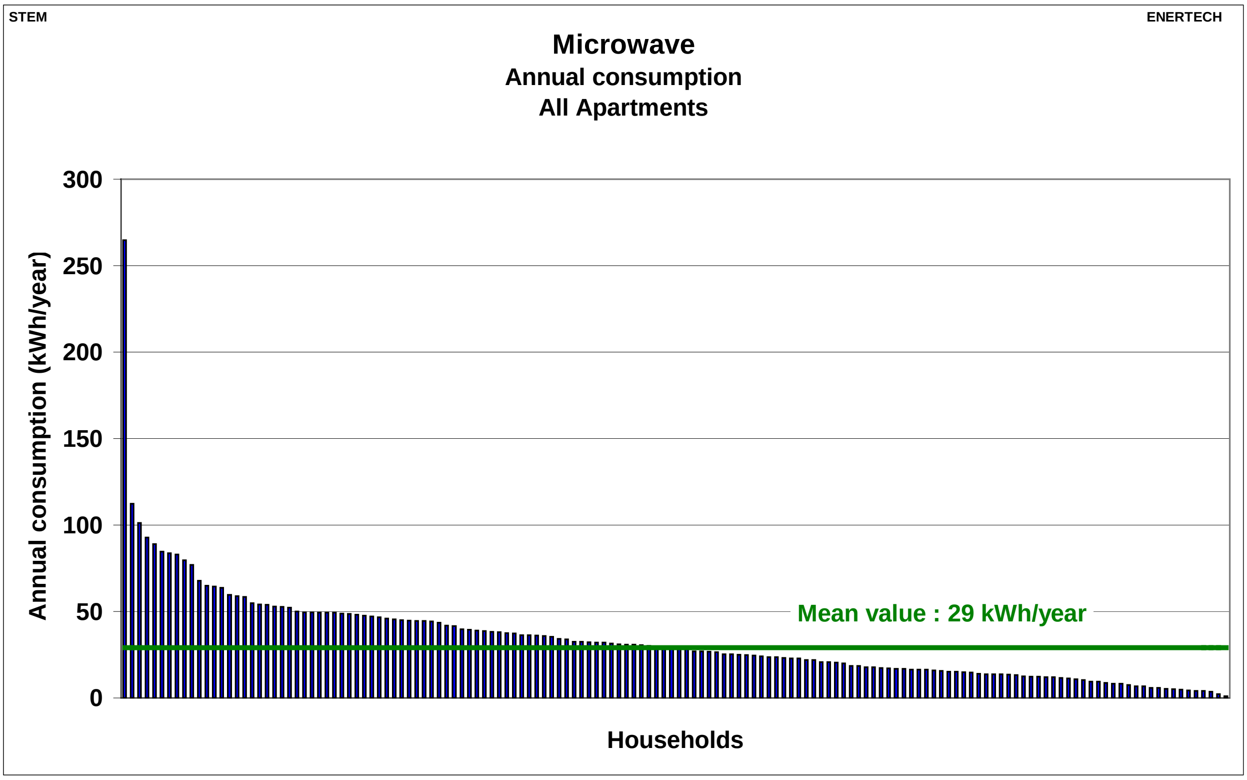


Figure 2.307: Microwave – Annual consumption – Apartments

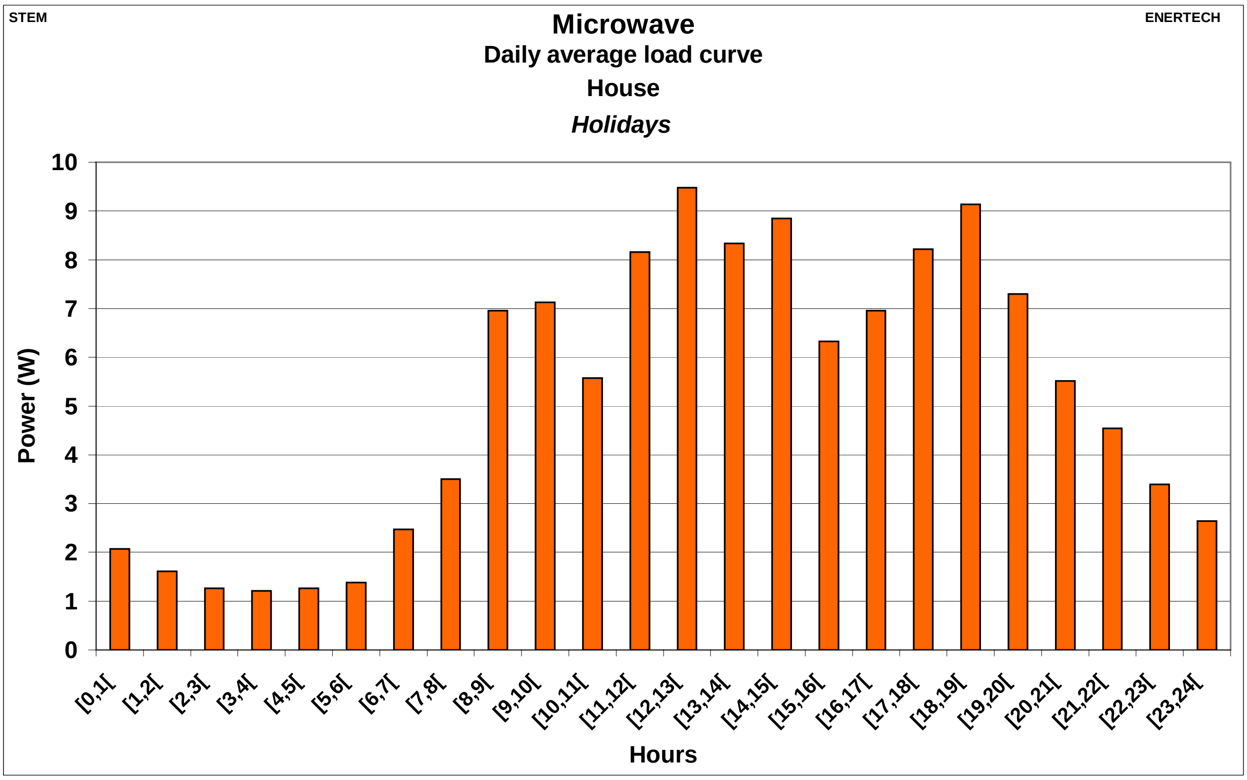


Figure 2.308: Microwave – Daily average load curve – Houses – Holidays

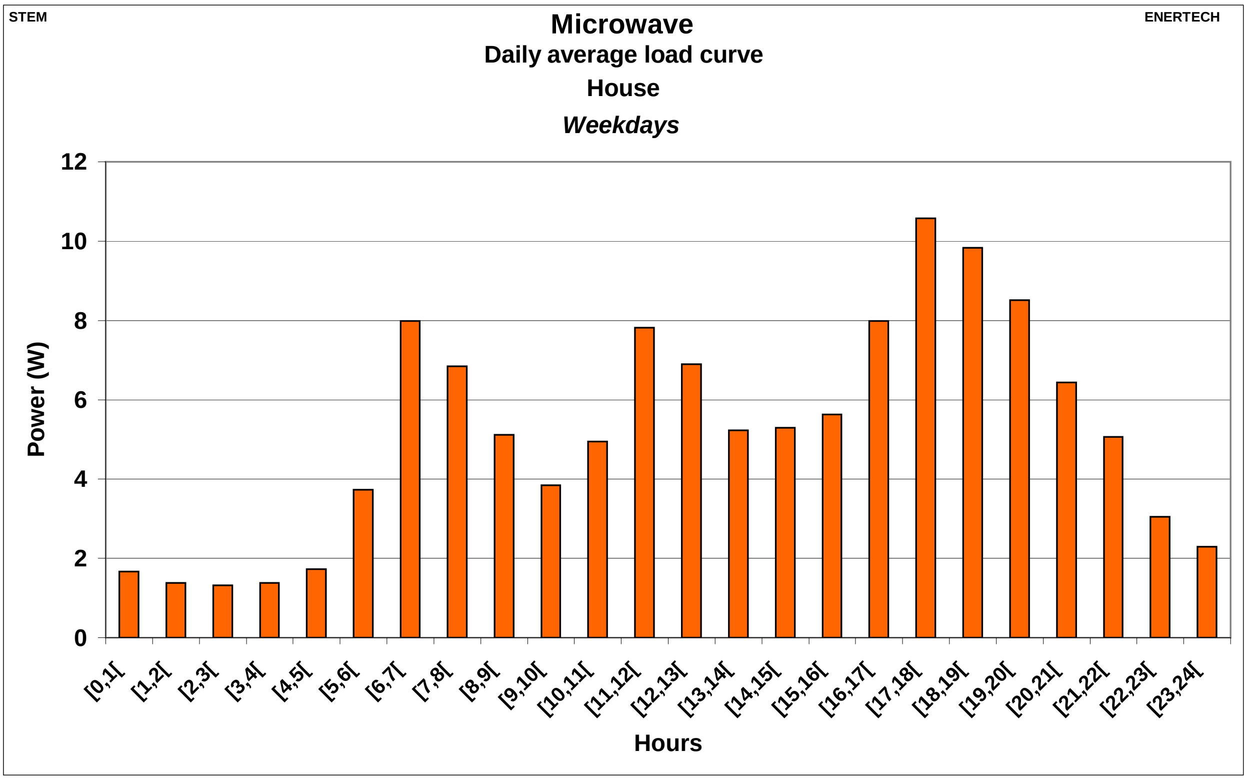


Figure 2.309: Microwave – Daily average load curve – Houses – Weekdays

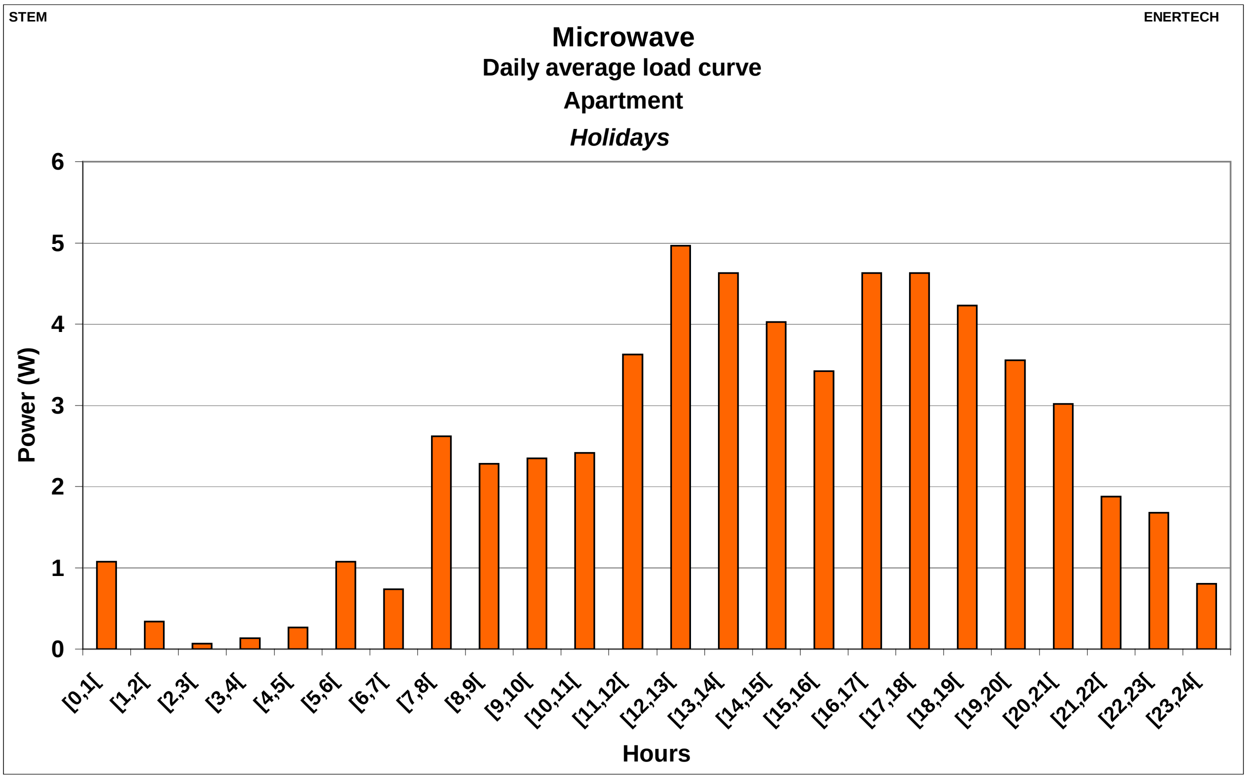


Figure 2.310: Microwave – Daily average load curve – Apartments – Holidays

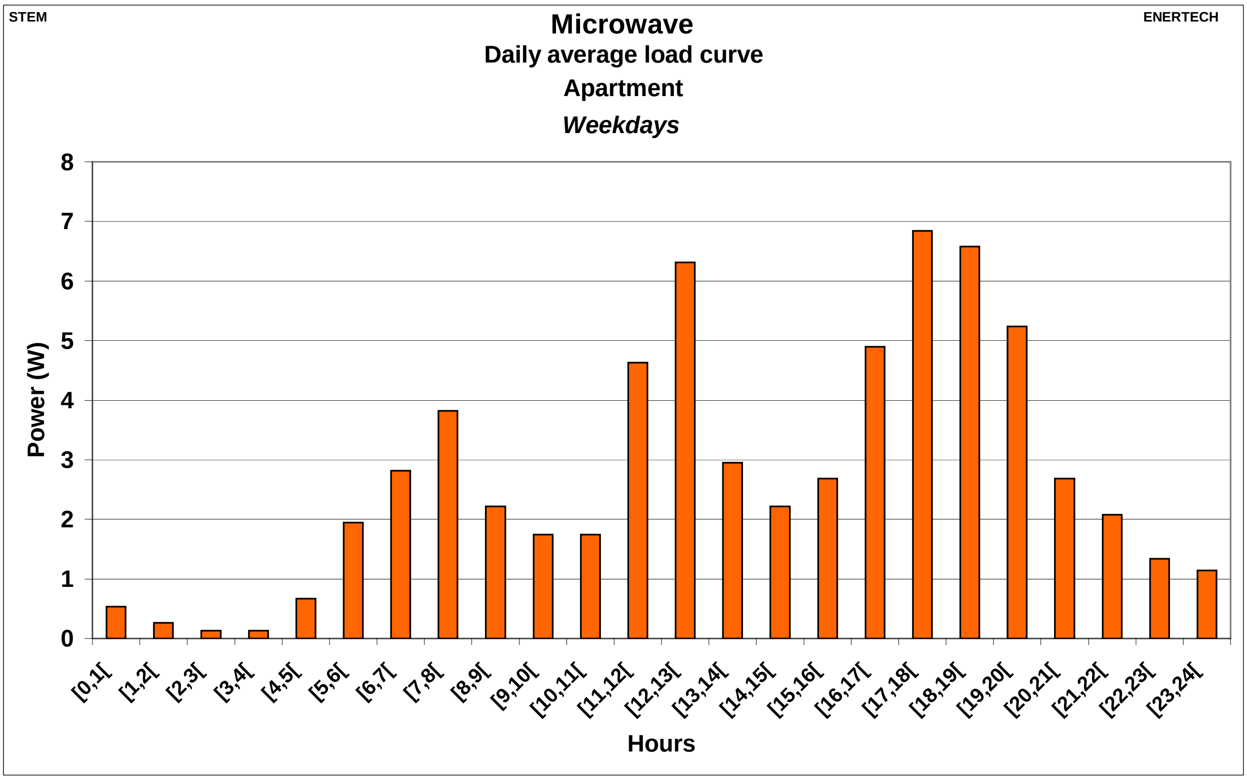


Figure 2.311: Microwave – Daily average load curve – Apartments – Weekdays

Water boiler

As for microwave, water boilers are very common in the Swedish kitchen. Their annual consumption represent 51 kWh/year for houses and 45 kWh/year for apartments. That's more than the microwave and represents up to 23 % of the consumption of a kitchen stove for example.

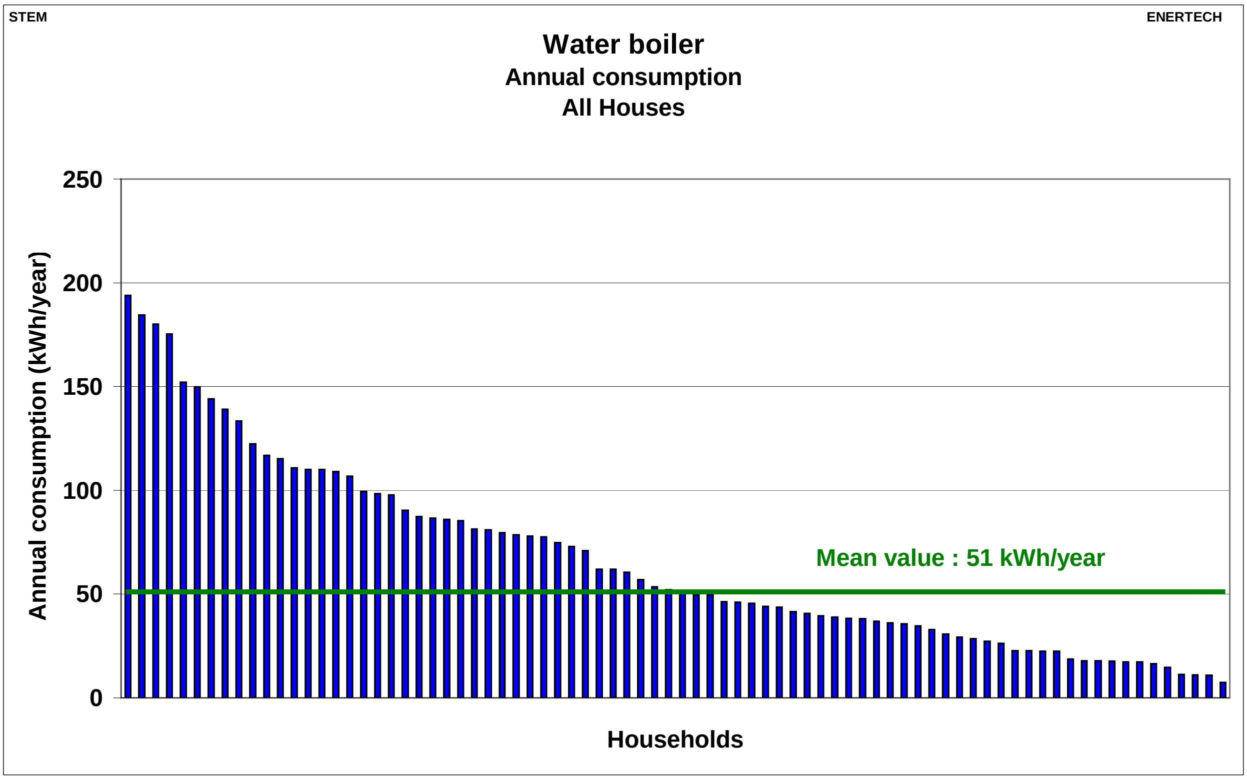


Figure 2.312: Water boiler – Annual consumption – Houses

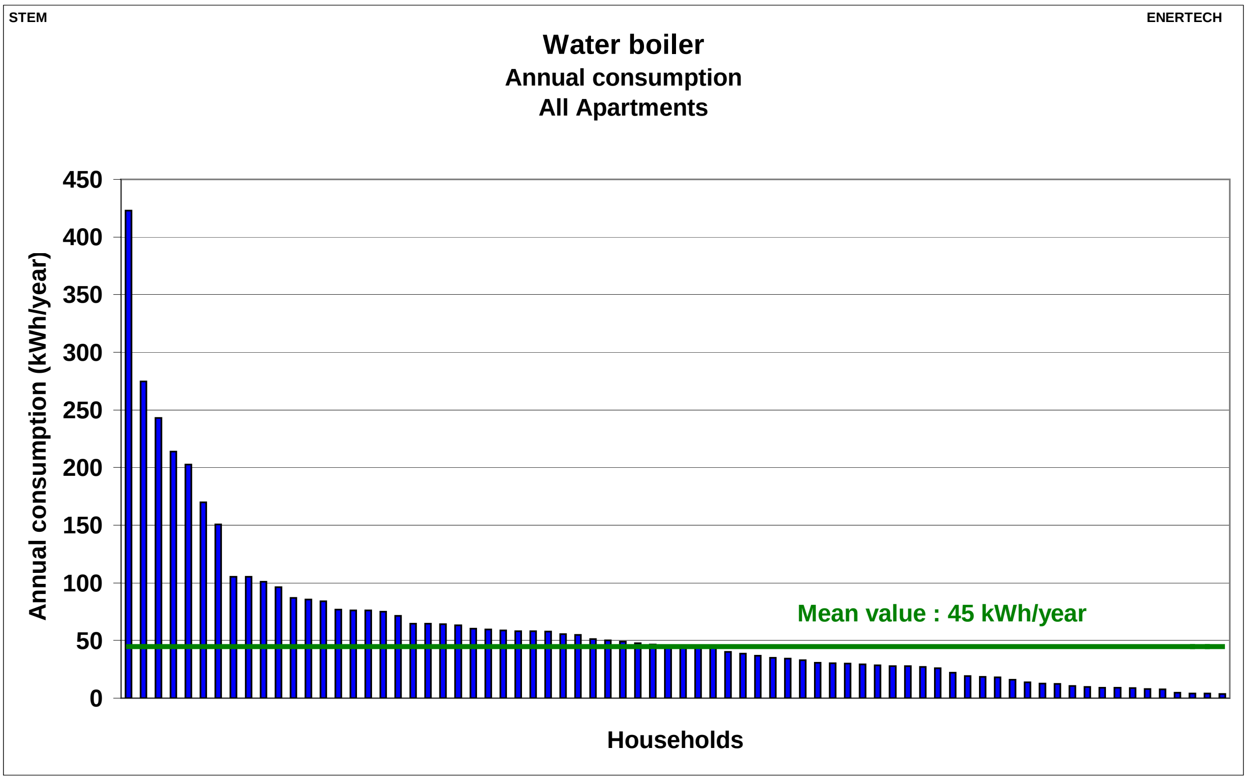


Figure 2.313: Water boiler – Annual consumption – Apartments

LIGHTING

The following analysis was realised thanks to the use of an individual measuring device (called ***Lamp-meter***), associated to each light control point of a household. This device is equipped with an optical sensor, and records the operating duration of all the light sources controlled by the same switch. By simply summing the wattage of all the lamps controlled by this switch, their associated energy consumption can be easily determined from these measured operating durations. This type of operation is obviously not suitable for lighting equipped with dimmer switches (like halogen lights), which were therefore monitored using a ***Serial-wattmeter*** plug.

As a rule, all the light sources of the households should have been monitored during the measurement campaigns.

Let us not forget that a questionnaire allowed us to get an identification of the lighting wattage installed, per type of room and per type of source.

Remarks: in the following chapter, we will use CFL or low energy lights to refer to Compact Fluorescent Lights.

CHARACTERISTICS OF THE LIGHTING IN PLACE

Number of light sources per type

By light source, we mean any bulb, fluorescent strip lighting, low energy light bulb, or halogen spotlight. If a light fitting should comprise several sources (bulbs), each one of them is taken into account separately.

The average total number of light sources per household, all types taken together, is 42, 55.2 if we only count houses and 31.2 for apartments.
Figures 2.314 to 2.316 shows for each type of household, the average number of light sources for each type of bulb per household.

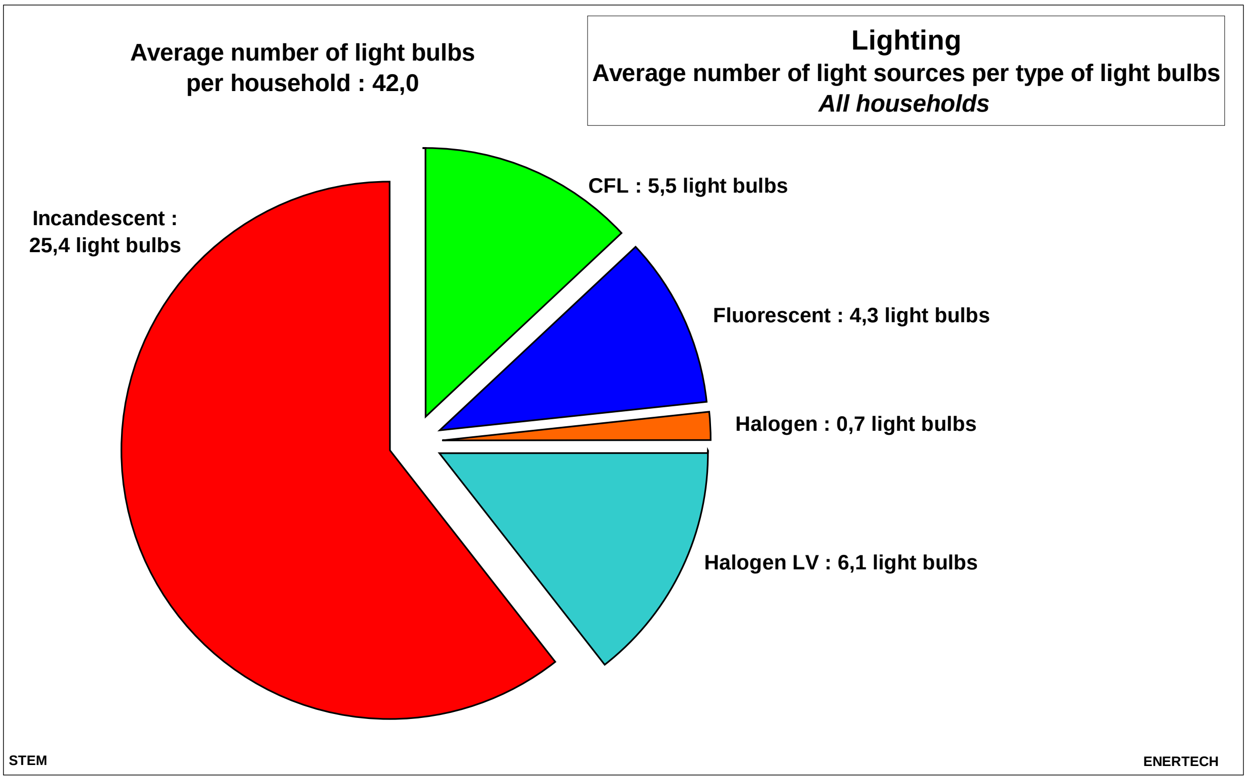


Figure 2.314: Lighting – Average number of light sources per type of light bulbs – All households

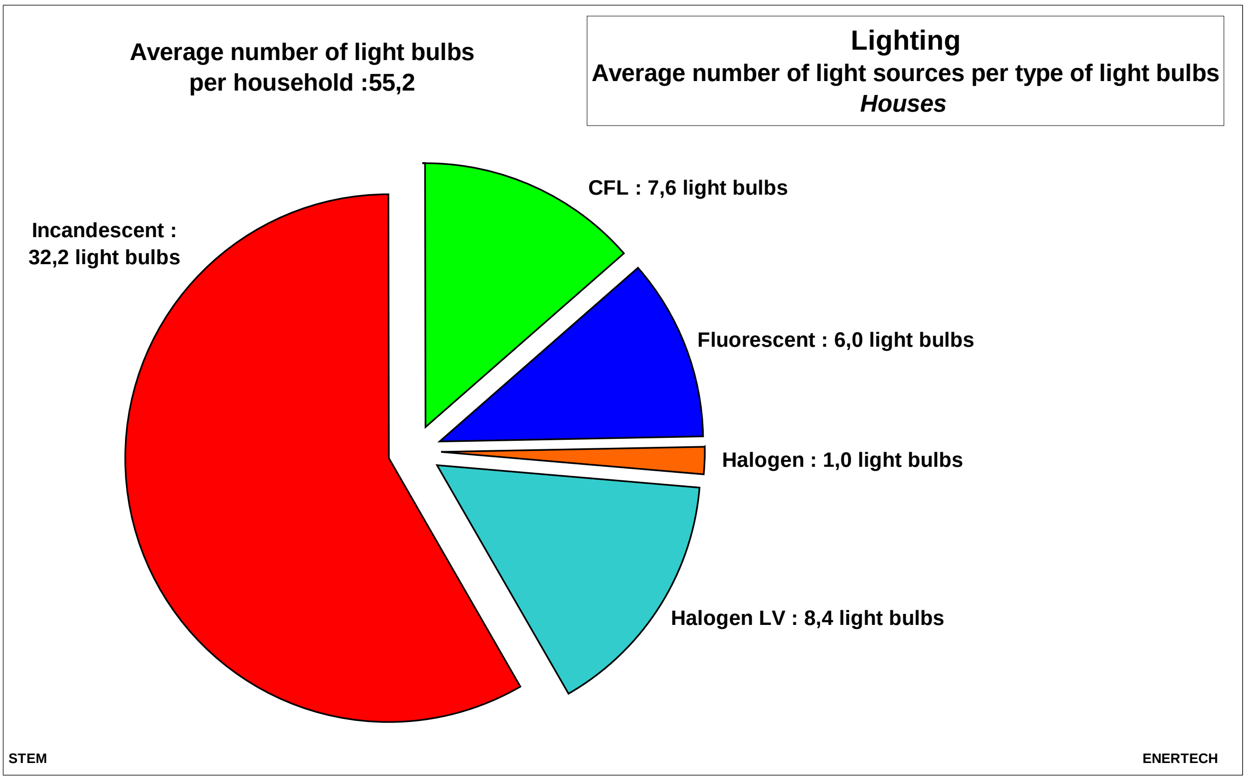


Figure 2.315: Lighting – Average number of light sources per type of light bulbs – houses

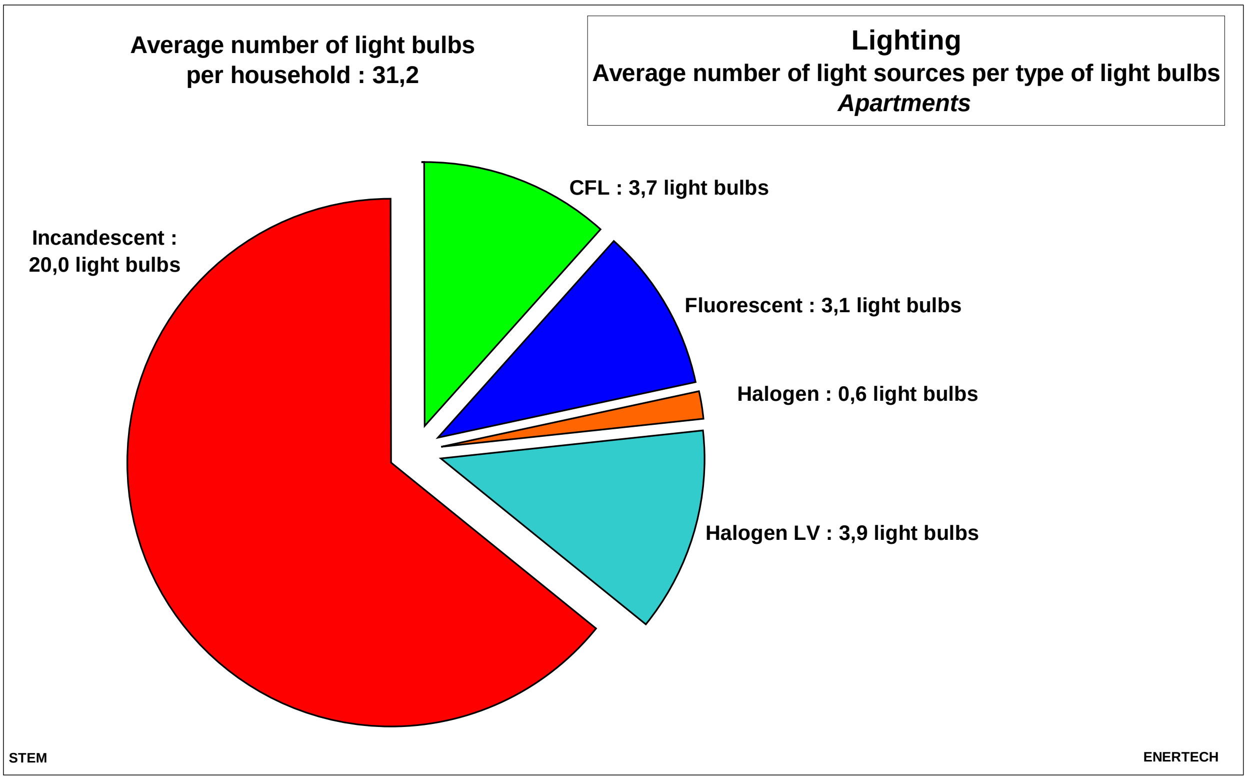


Figure 2.316: Lighting – Average number of light sources per type of light bulbs – apartments

Number of light sources and control points per household

Figures 2.317 and 2.318 show for houses and apartments the average number of light sources and the average number of control points per type of room. Just one control point is counted, for instance if a two-way switch controls one or several light sources.

For both types, the highest number of light sources is found in the living room: 8.9 and 7.1 on average.

Kitchens come in second position followed by the bedrooms.

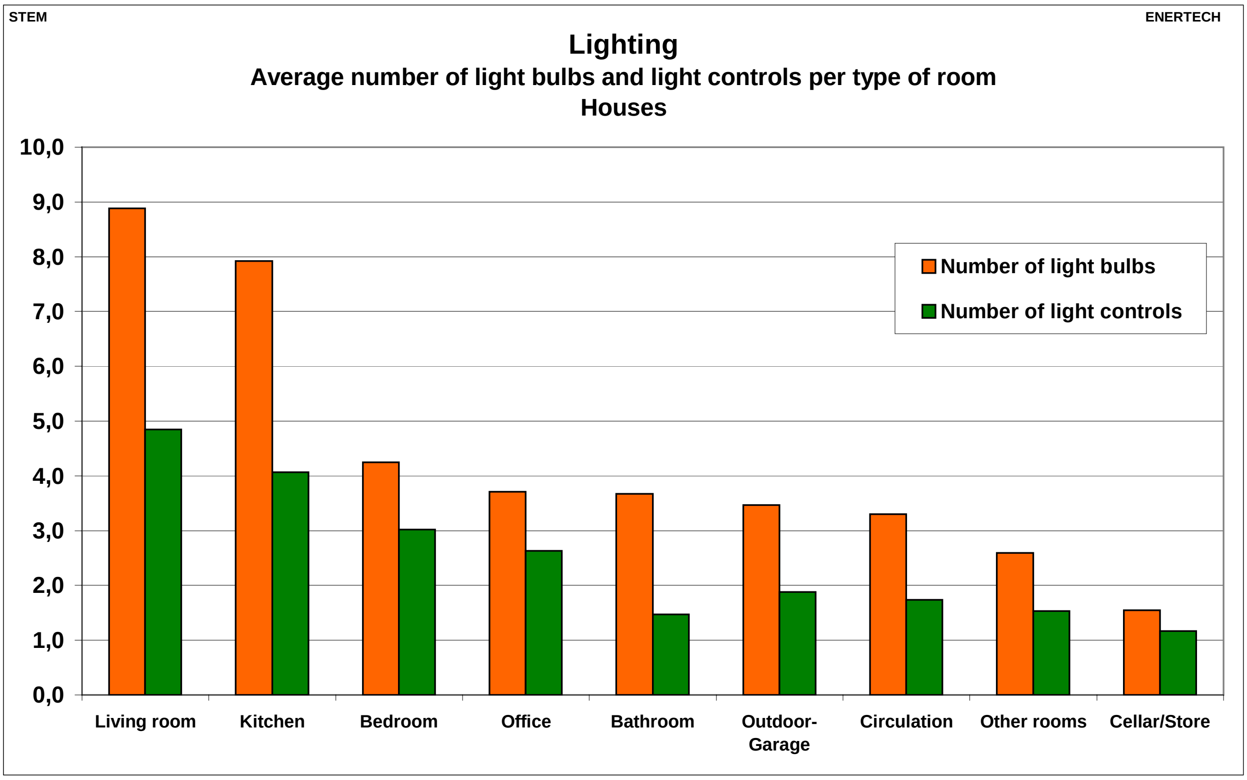


Figure 2.317: Lighting – Average number of light bulbs and controls per type of room – Houses

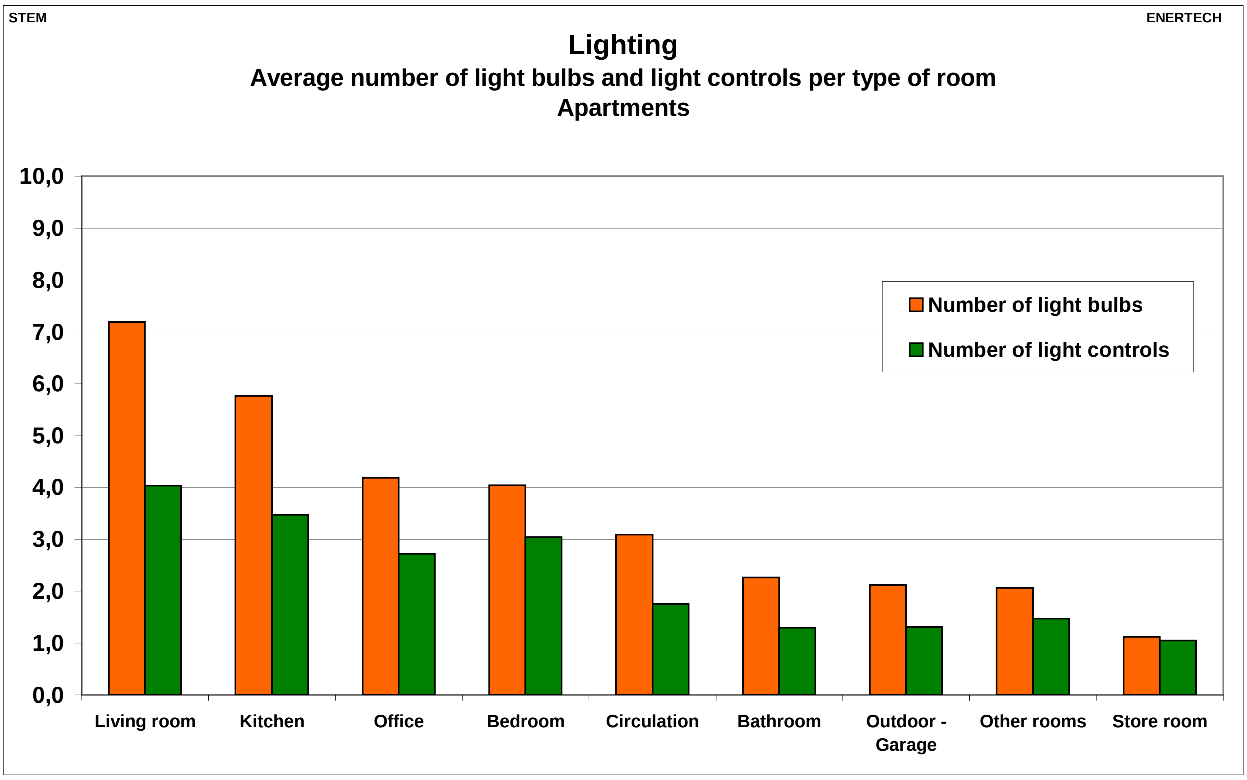


Figure 2.318: Lighting – Average number of light bulbs and controls per type of room – Apartments

Number of light sources per m2

Figures 2.319 and 2.320 show the distribution of the number of bulbs per m² for each type of household. There are more light bulbs per m² for houses (0,43) then for apartments (0,34).

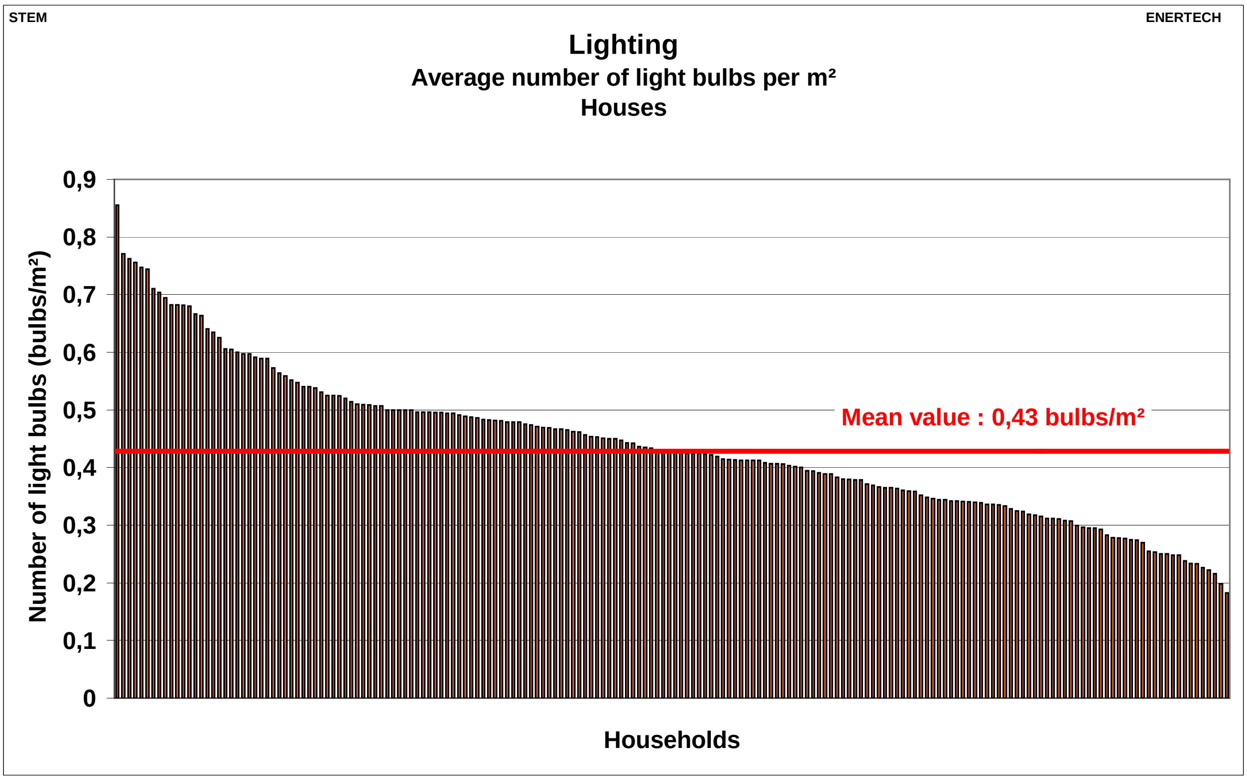


Figure 2.319: Lighting – Number of light bulbs per m² - Houses

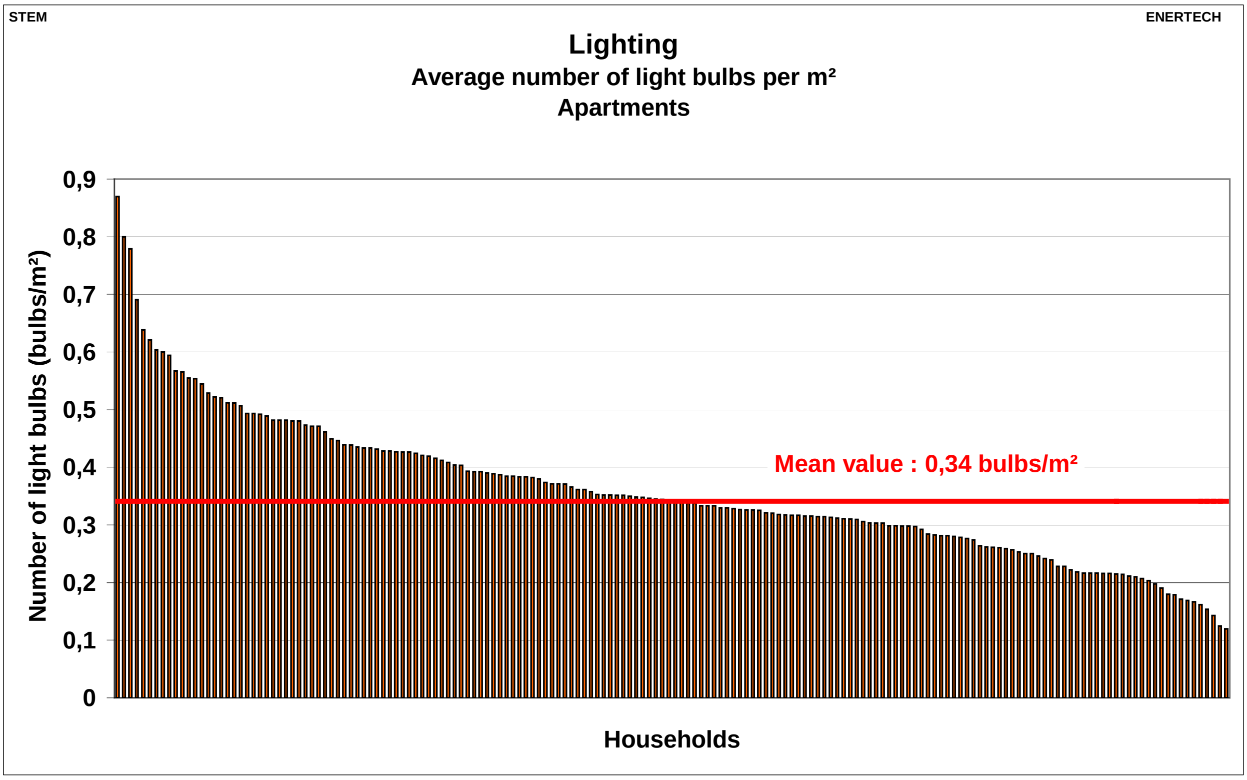


Figure 2.320: Lighting – Number of light bulbs per m² - Apartments

Distribution of the number of bulbs per room and per type of light sources

Figure 2.321 shows the distribution of the number of installed light sources as a function of their nature and the types of room they are in.

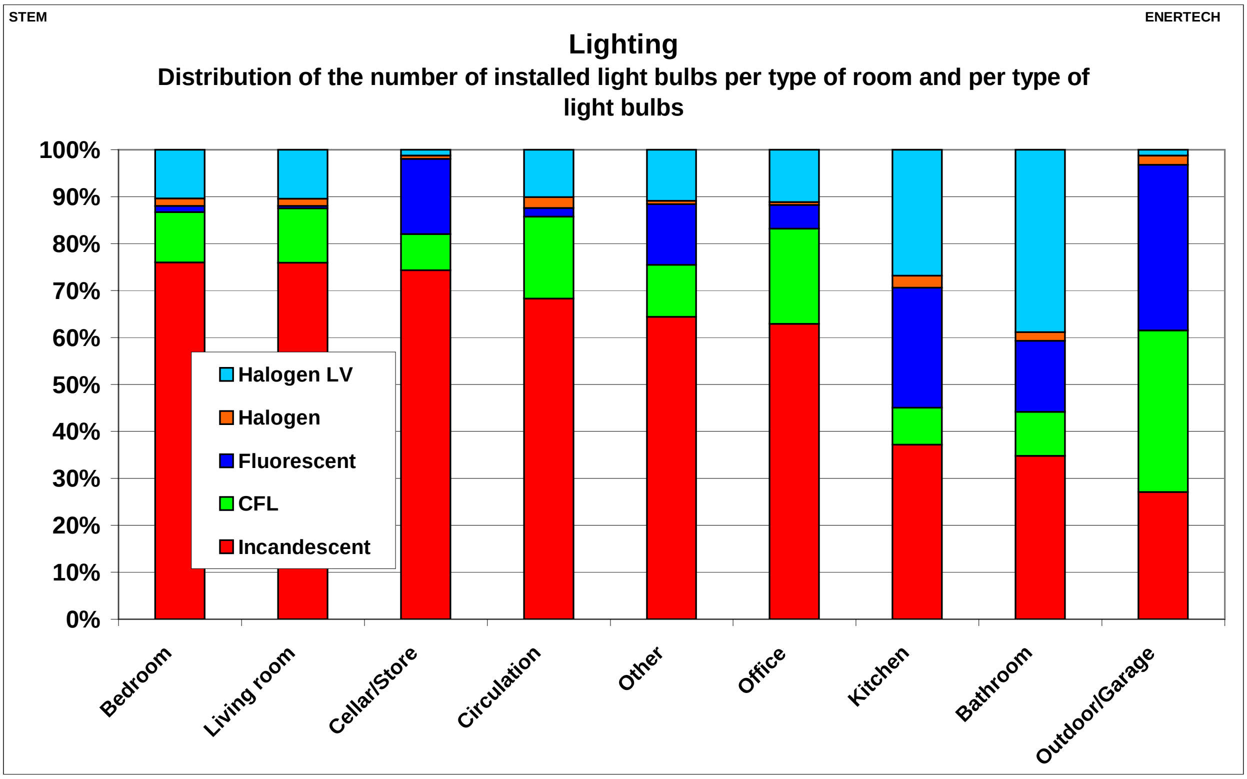


Figure 2.321: Lighting – Distribution of the number of installed light bulbs per type of room and per type of light bulbs – All households

ANALYSIS OF THE INSTALLED LIGHTING WATTAGE

Total installed wattage

Figures 2.322 and 2.323 show the distribution of the total installed lighting wattage for houses and apartments. On average, the total installed wattage, taking all light sources together, is 1618 Watt for houses and 829 Watt for apartments. The ration between houses and apartments is near 2:1 .

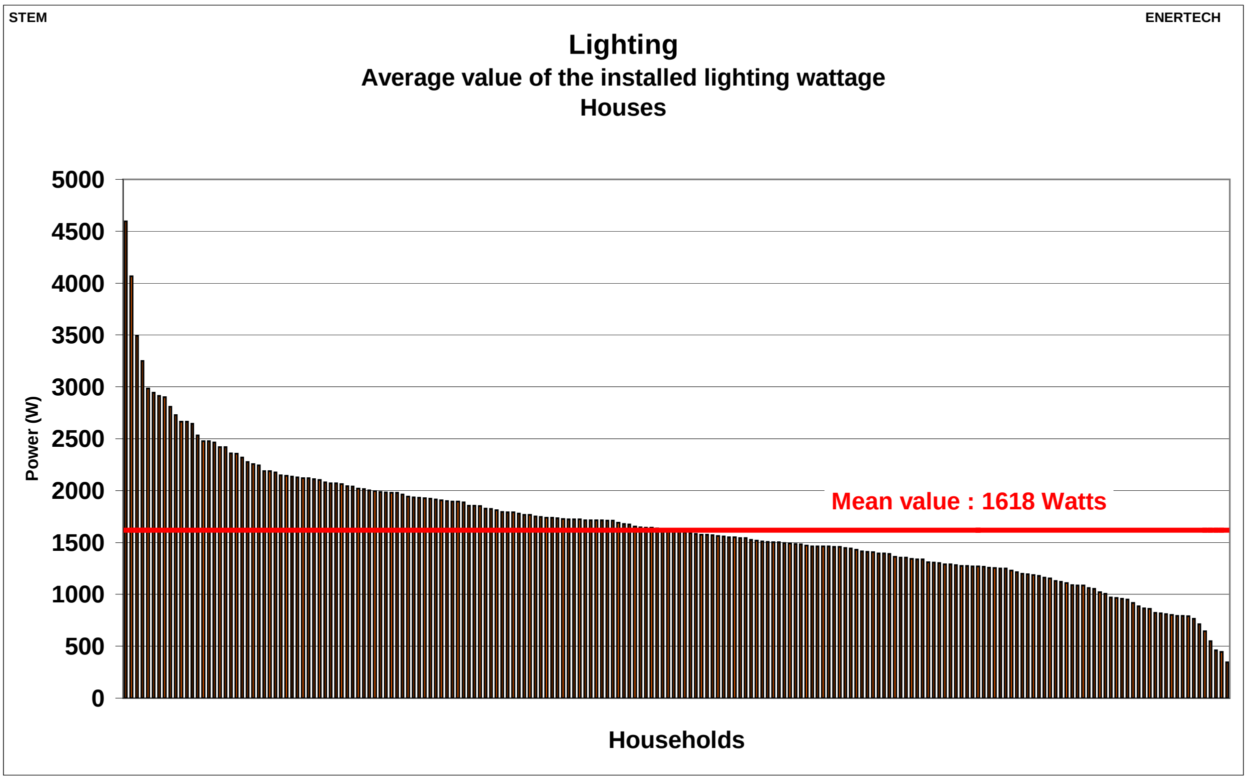


Figure 2.322: Lighting – Average value for the installed lighting wattage – Houses

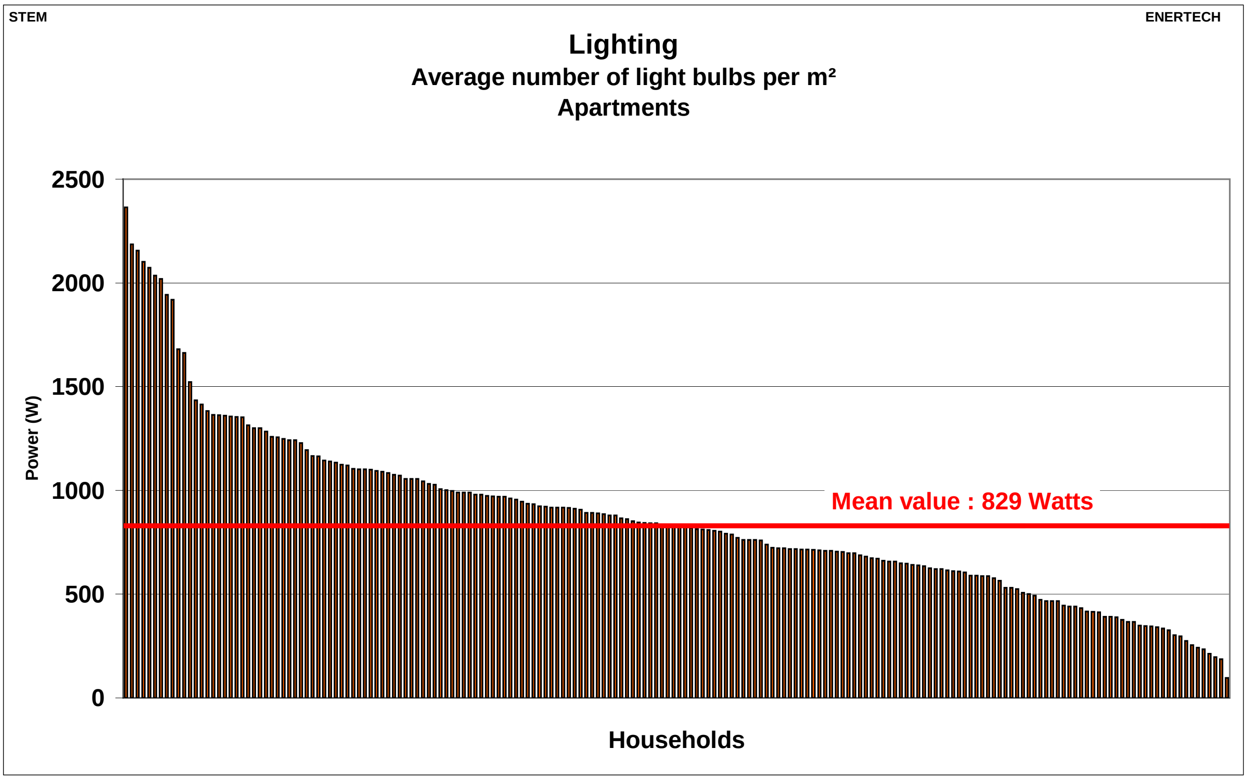


Figure 2.323: Lighting – Average value for the installed lighting wattage – Apartments

Installed wattage per type of light source

Total installed wattage per type of light source

Figure 2.324 and 2.325 shows for houses and apartments the part of each source type in the total installed wattage. This representation obviously leads to giving a low weight to CFLs and other fluorescent strip lights.

It is interesting to note that:

- incandescent lamps represents between 70,5 % in houses and 76,8 % in apartments of the total installed lighting wattage,

- halogen lighting represents between 13 % and 15,5 % of it,

- CFLs represents between 3,8 % (in apartments) to 4,5 % (in houses) of it,

- fluorescent tube lighting represents between 6,3 % (in apartments) to 9,5 % (in houses) of the total installed lighting wattage.

All fluorescent light sources taken together (tube lights and CFLs), represents 14 % of the total installed wattage in houses, and 10% in apartments.

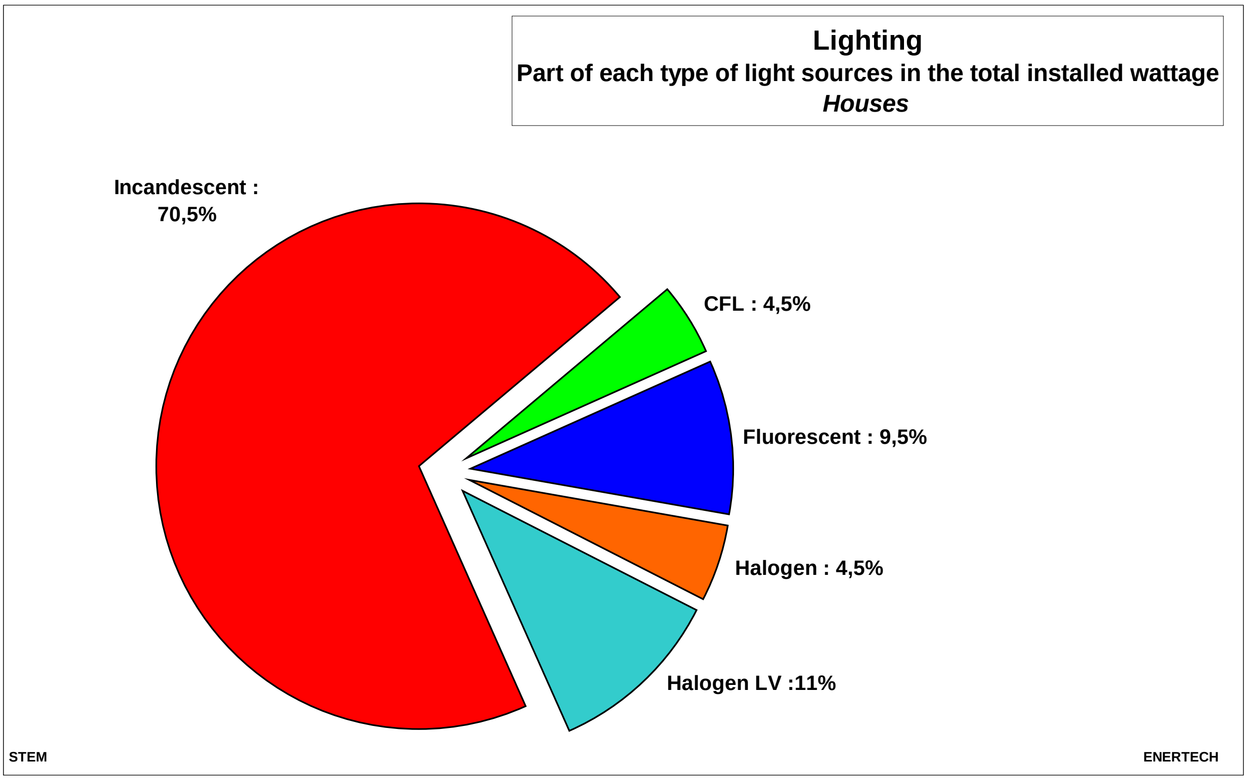


Figure 2.324: Lighting – Part of each type of light sources in the total installed wattage – Houses

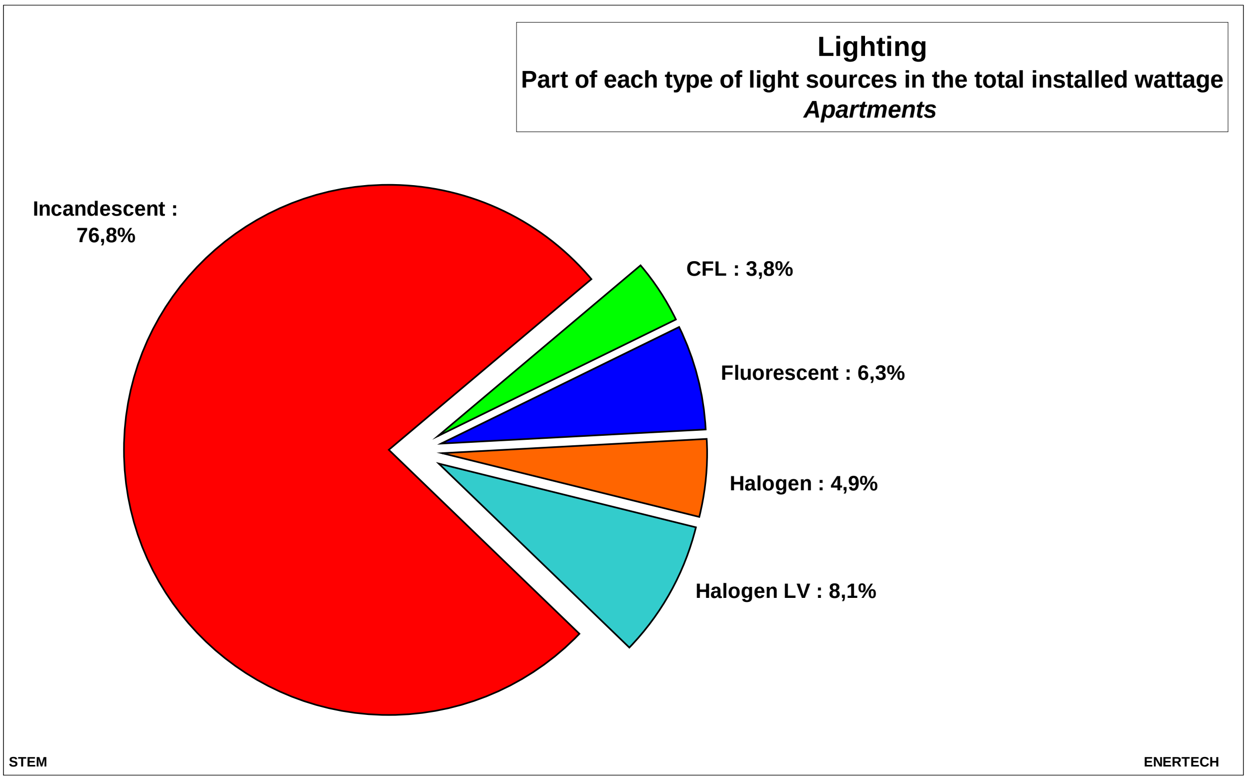


Figure 2.325: Lighting – Part of each type of light sources in the total installed wattage – Apartments

Installed wattage per type of room

Figures 2.326 and 2.327 indicate that for the two types of households, the room with the highest installed wattage is the living-room. Then comes the kitchen.

The values on these graphs are averaged over all the rooms of the same type. The addition of all these different wattages has therefore no physical meaning at all, and will always be different from the household average installed wattages.

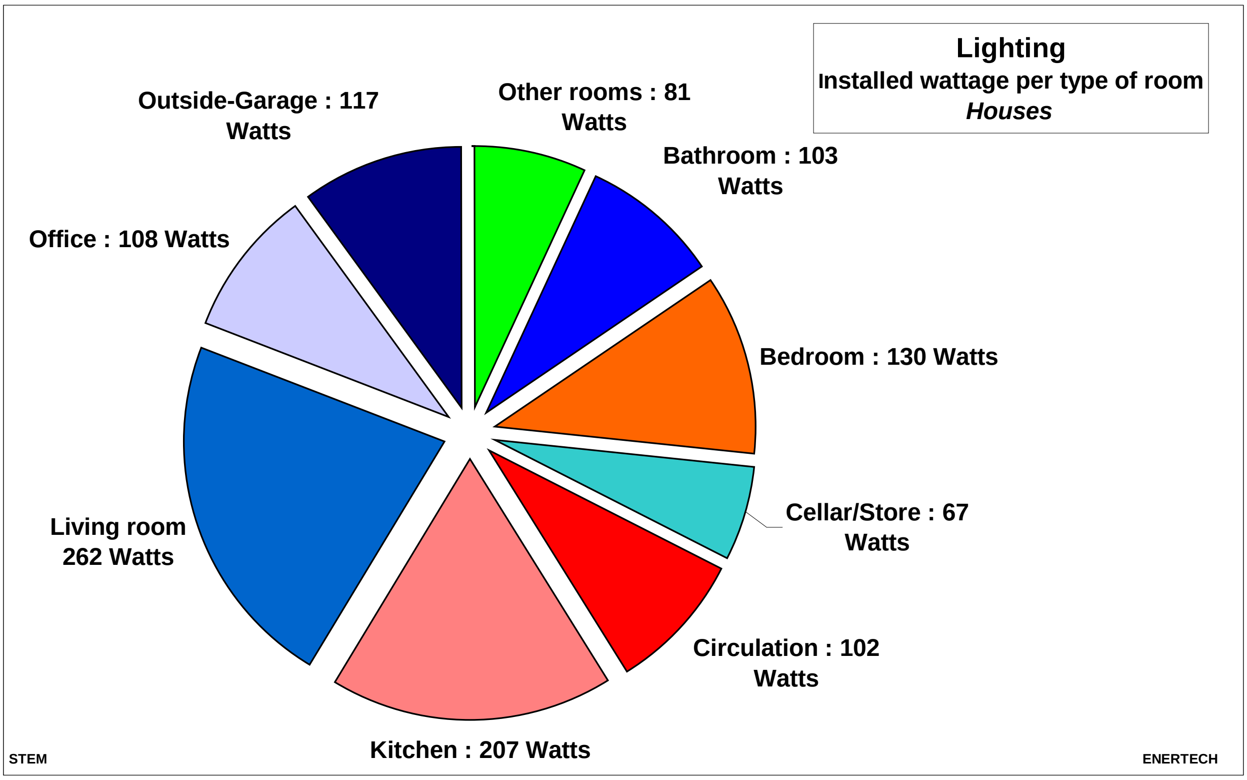


Figure 2.326: Lighting – Installed wattage per type of room – Houses

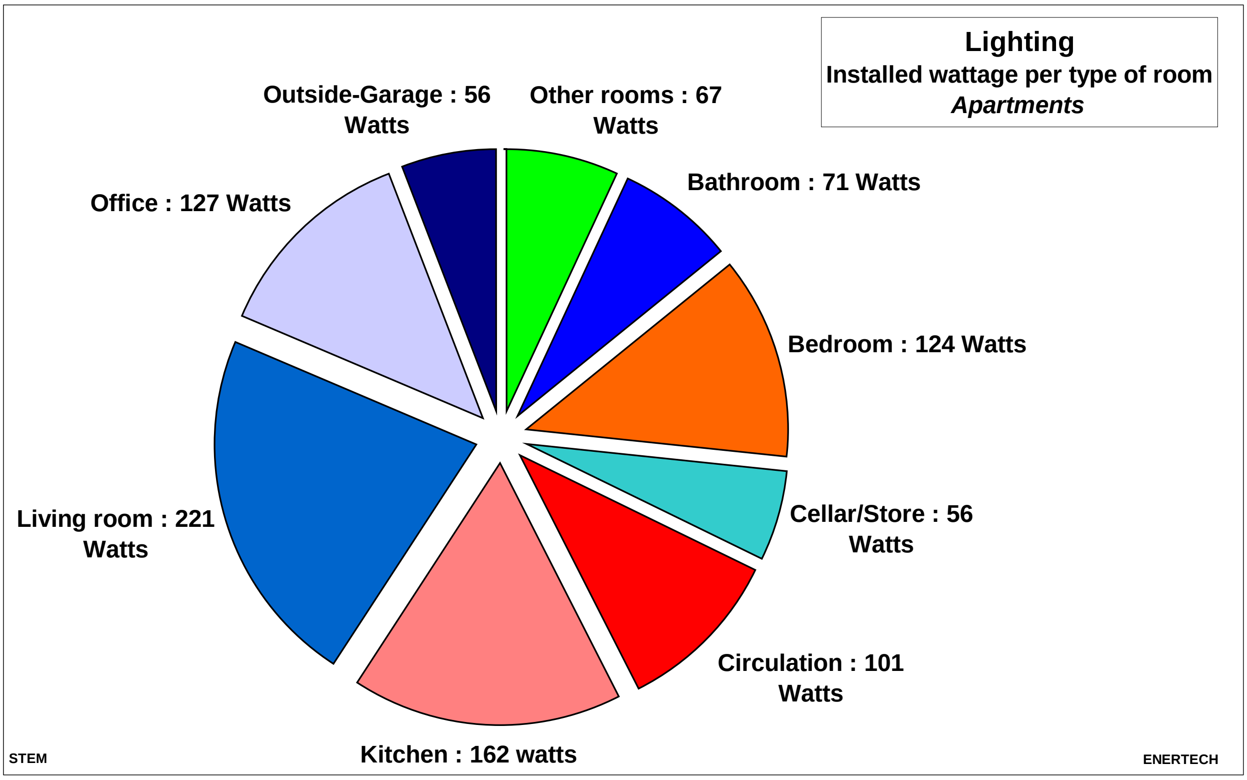


Figure 2.327: Lighting – Installed wattage per type of room – Apartments

Total installed wattage per m²

Figures 2.328 and 2.329 shows, for each type of household, the distributions of the average installed wattage per m². We can see that the values for houses and apartments are very near: 13 W/m² for houses and 11,1 W/m² for apartments.

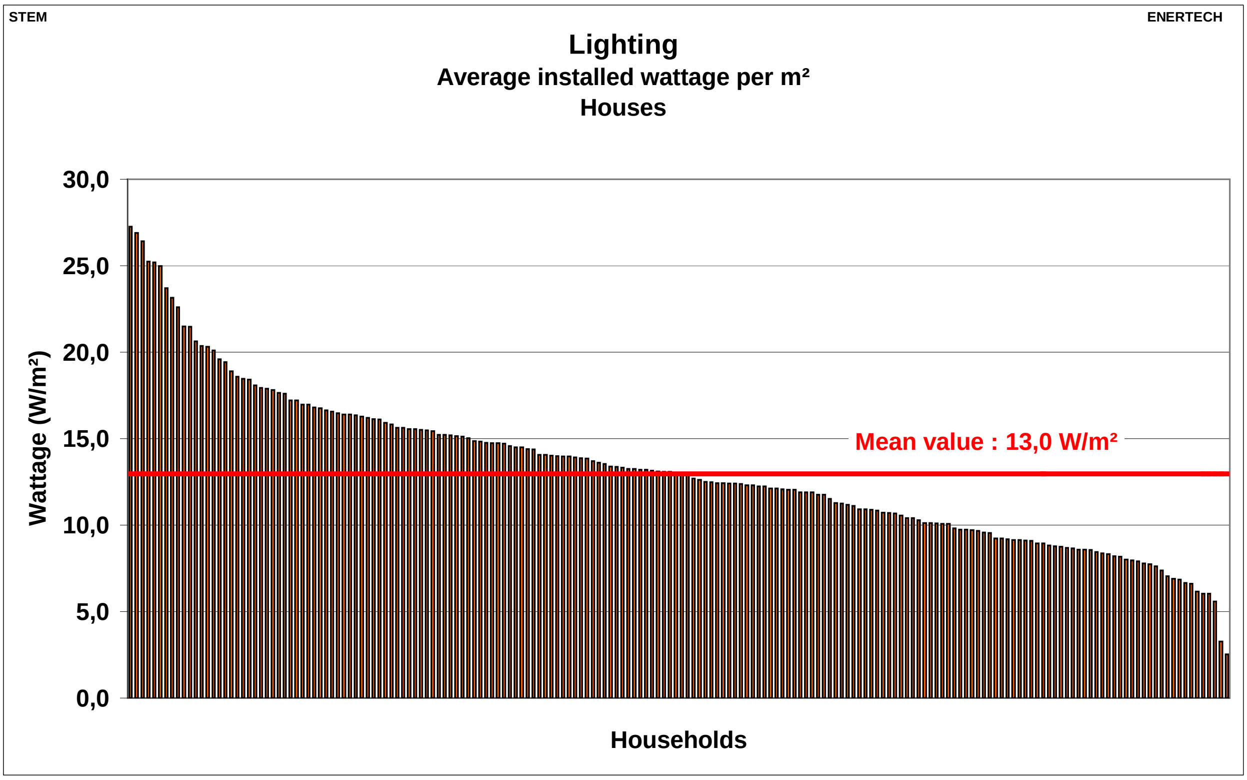


Figure 2.328: Lighting – Average installed wattage per m² - Houses

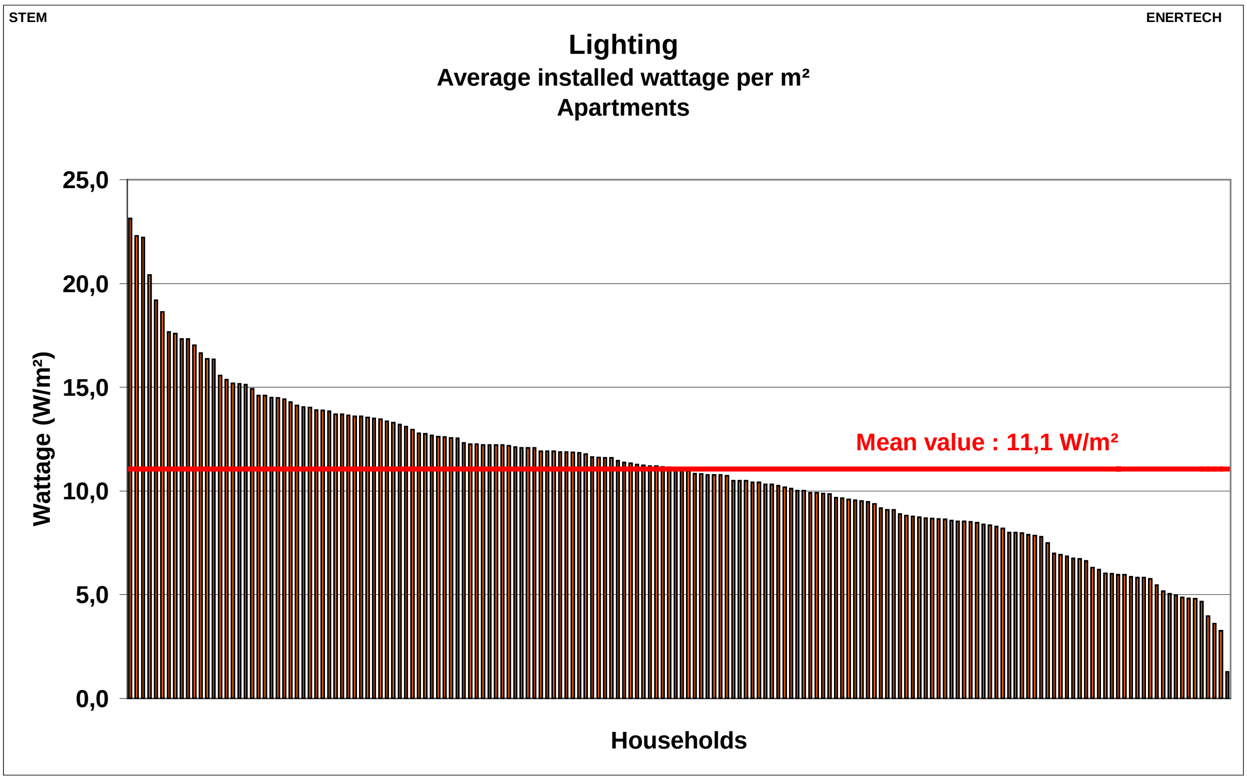


Figure 2.329: Lighting – Average installed wattage per m² - Apartments

Installed wattage per type of source and per m²

Figure 2.330 to 2.339 show the distributions of the installed wattages per sample and per m² for each type of light source.

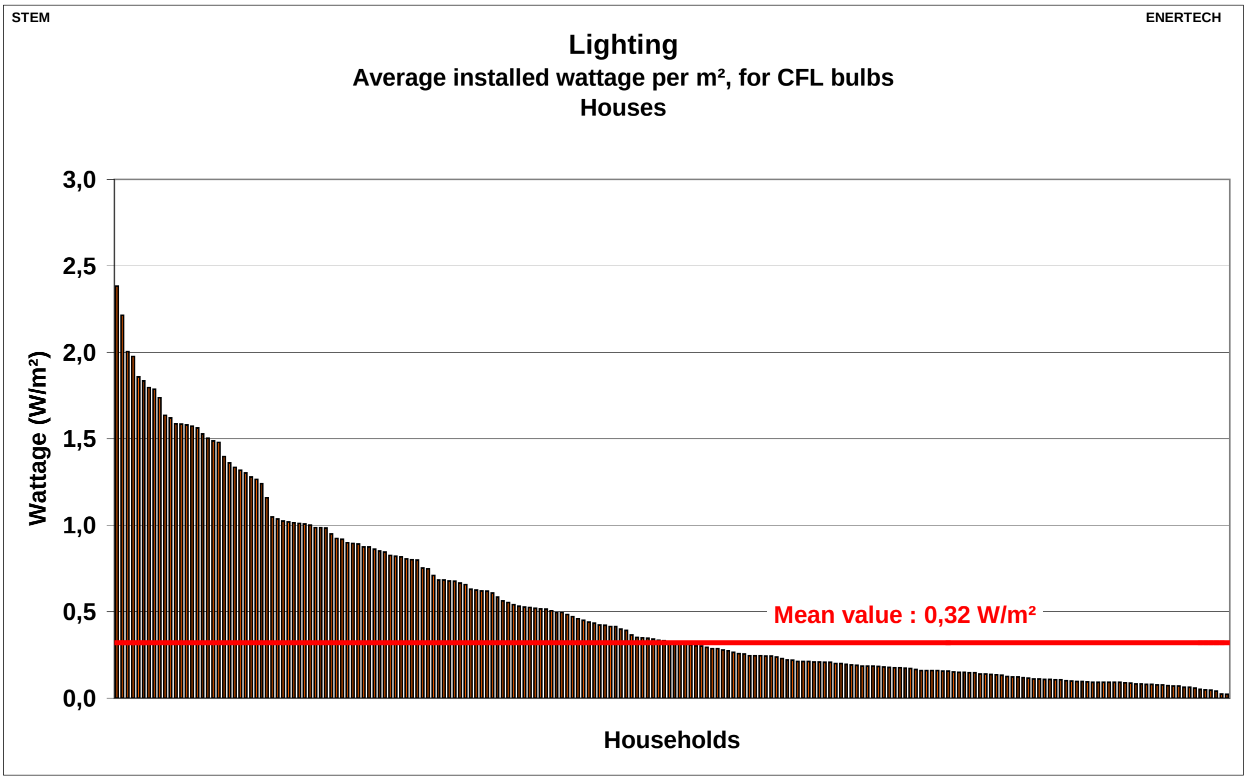


Figure 2.330: Lighting – Average installed wattage per m² for CFL bulbs – Houses

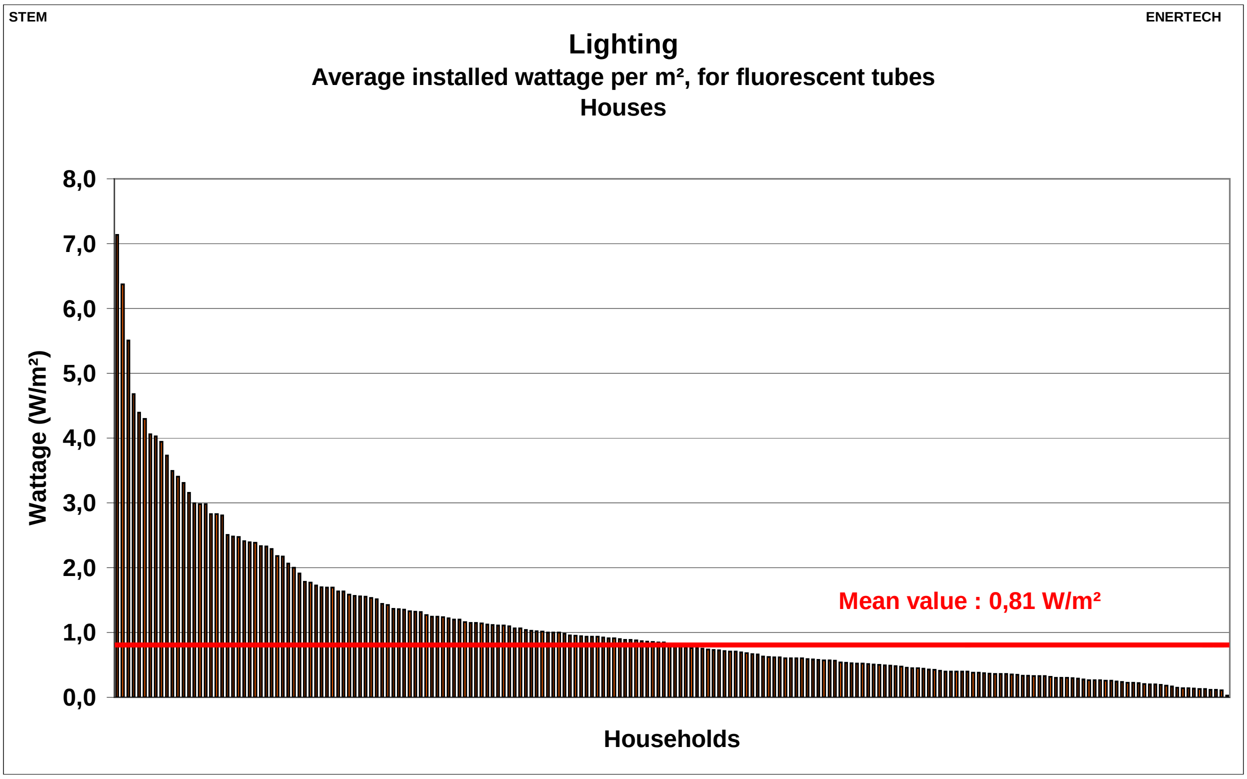


Figure 2.331: Lighting – Average installed wattage per m² for fluorescent tubes – Houses

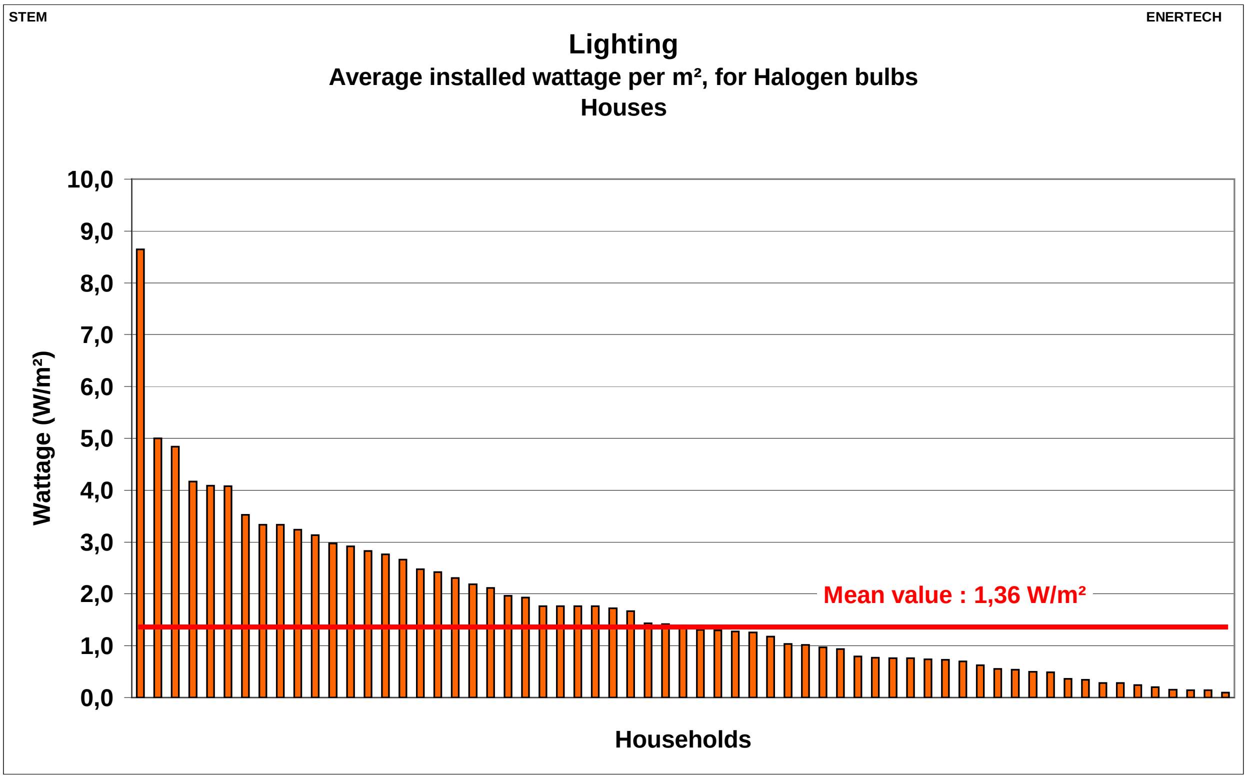


Figure 2.332: Lighting – Average installed wattage per m² for halogen bulbs – Houses

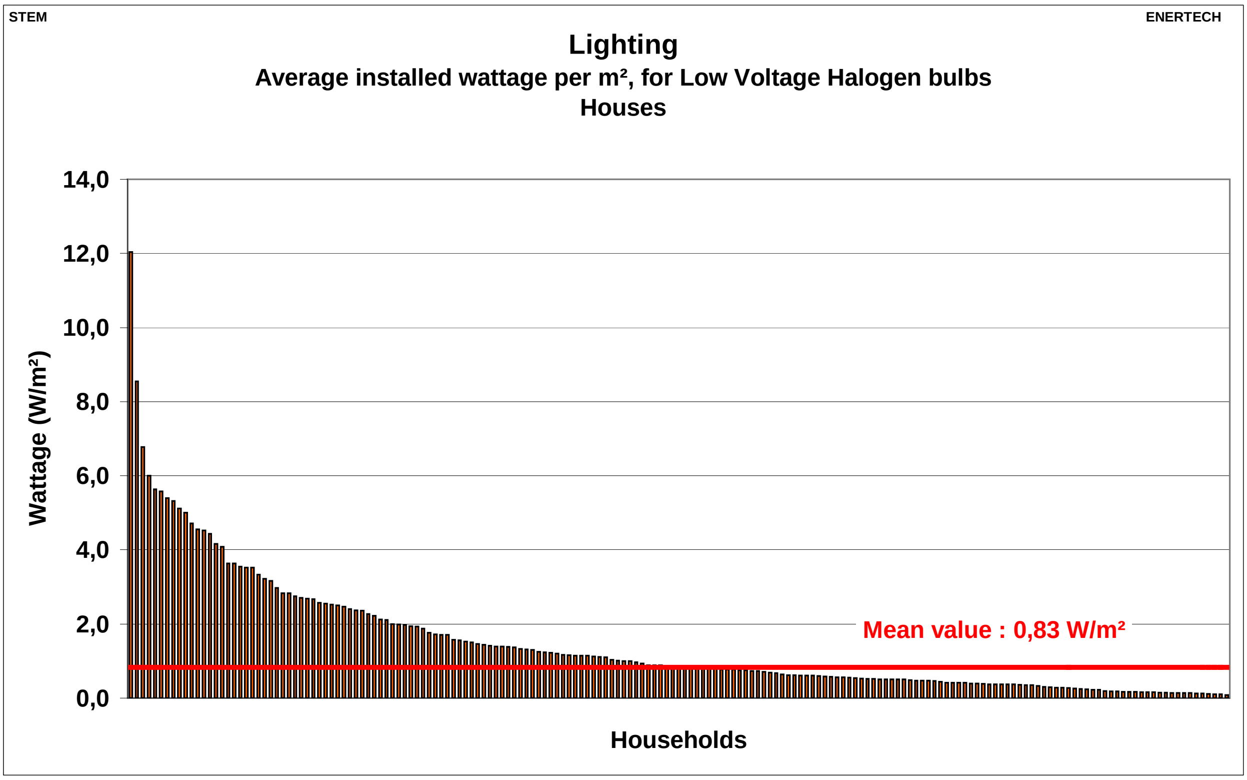


Figure 2.333: Lighting – Average installed wattage per m² for low voltage halogen bulbs – Houses

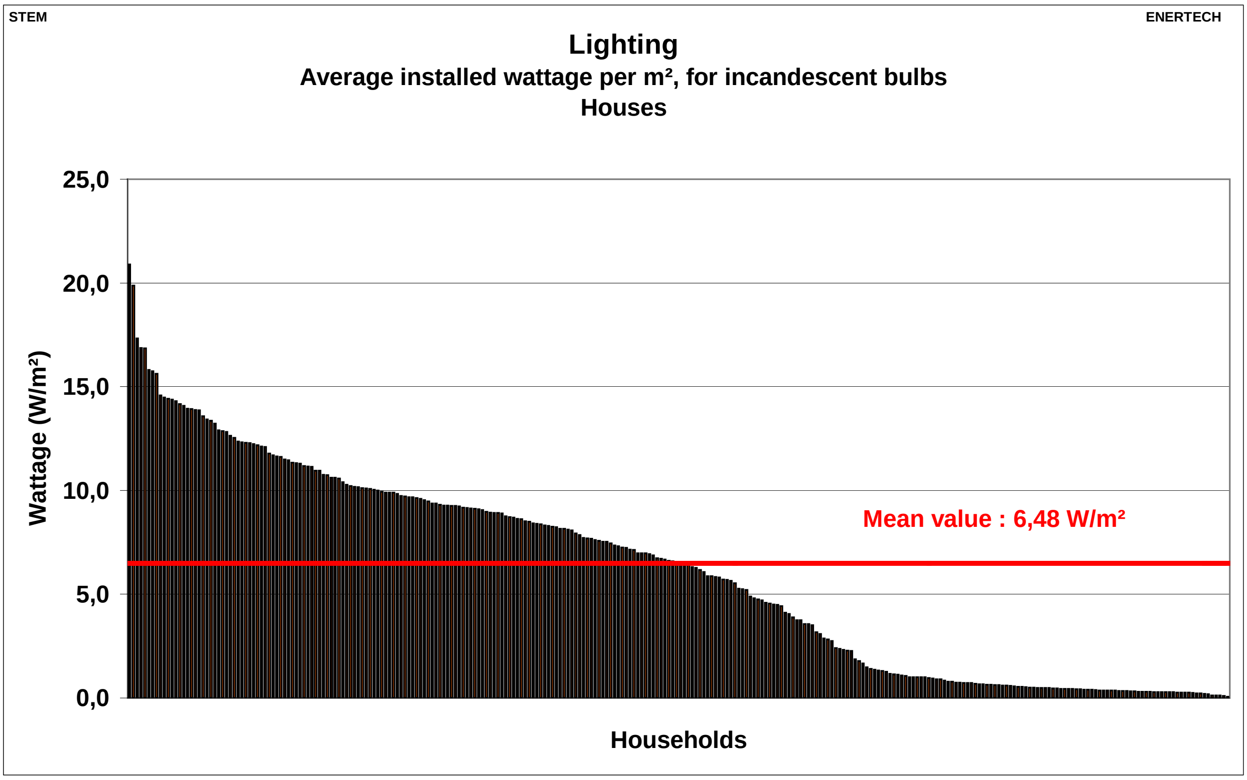


Figure 2.334: Lighting – Average installed wattage per m² for incandescent bulbs – Houses

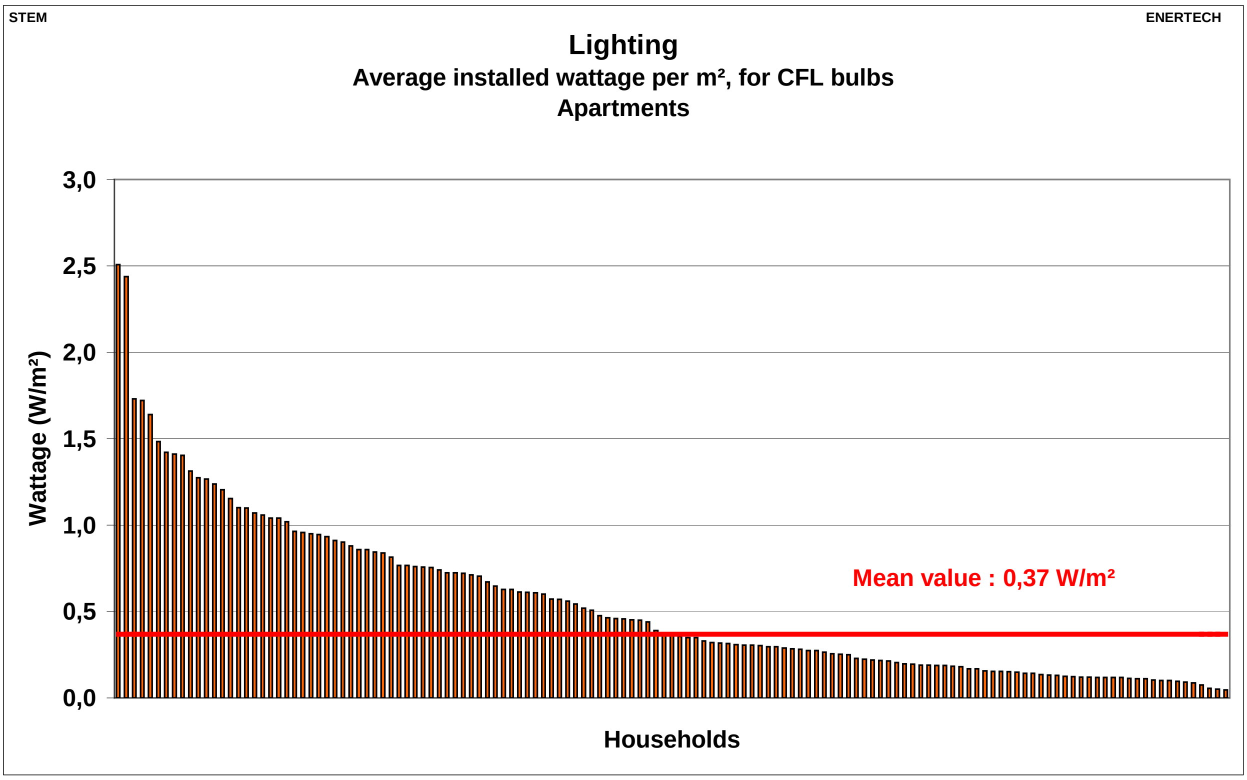


Figure 2.335: Lighting – Average installed wattage per m² for CFL bulbs – Apartments

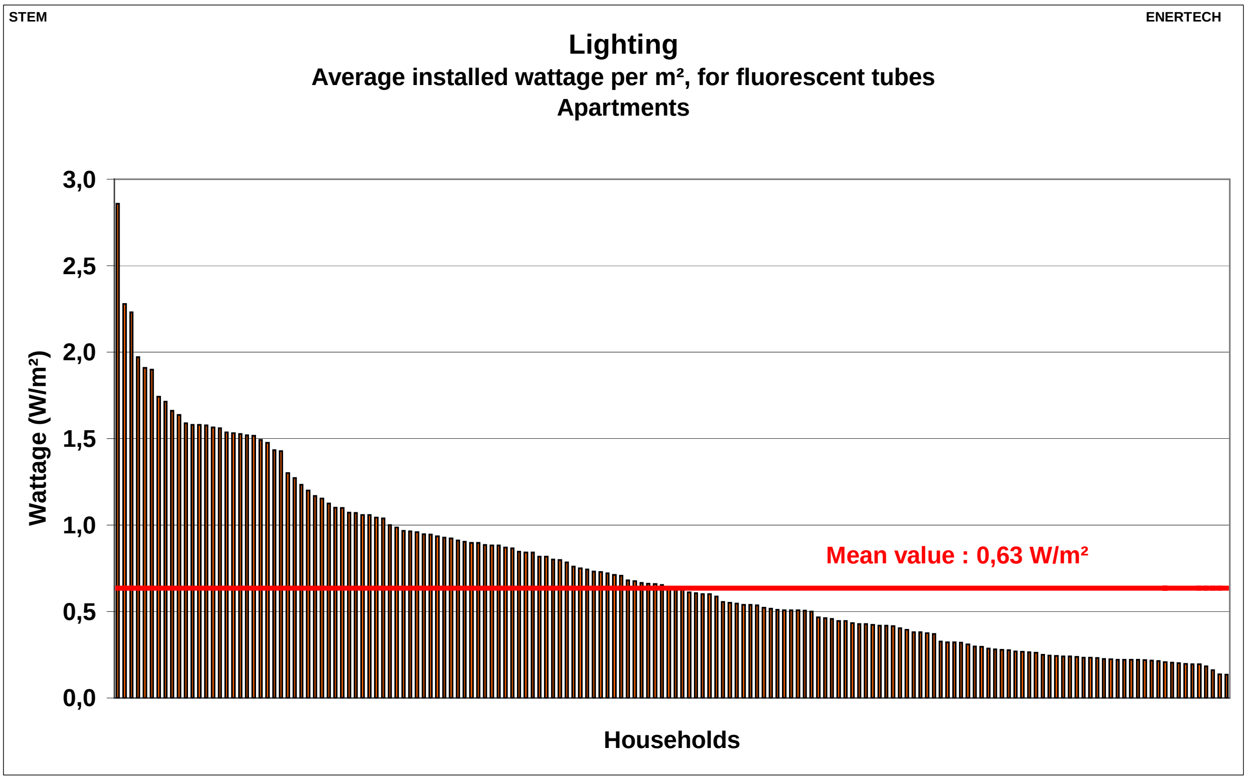


Figure 2.336: Lighting – Average installed wattage per m² for fluorescent tubes – Apartments

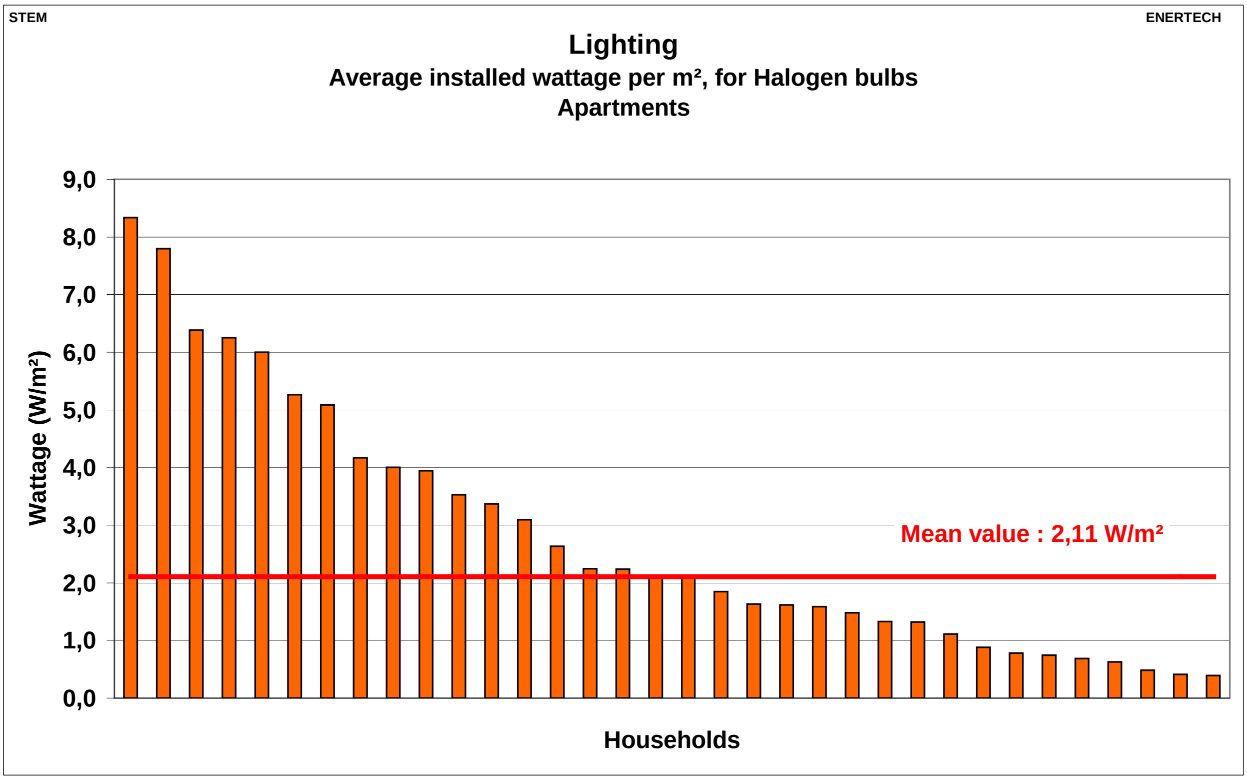


Figure 2.337: Lighting – Average installed wattage per m² for halogen tubes – Apartments

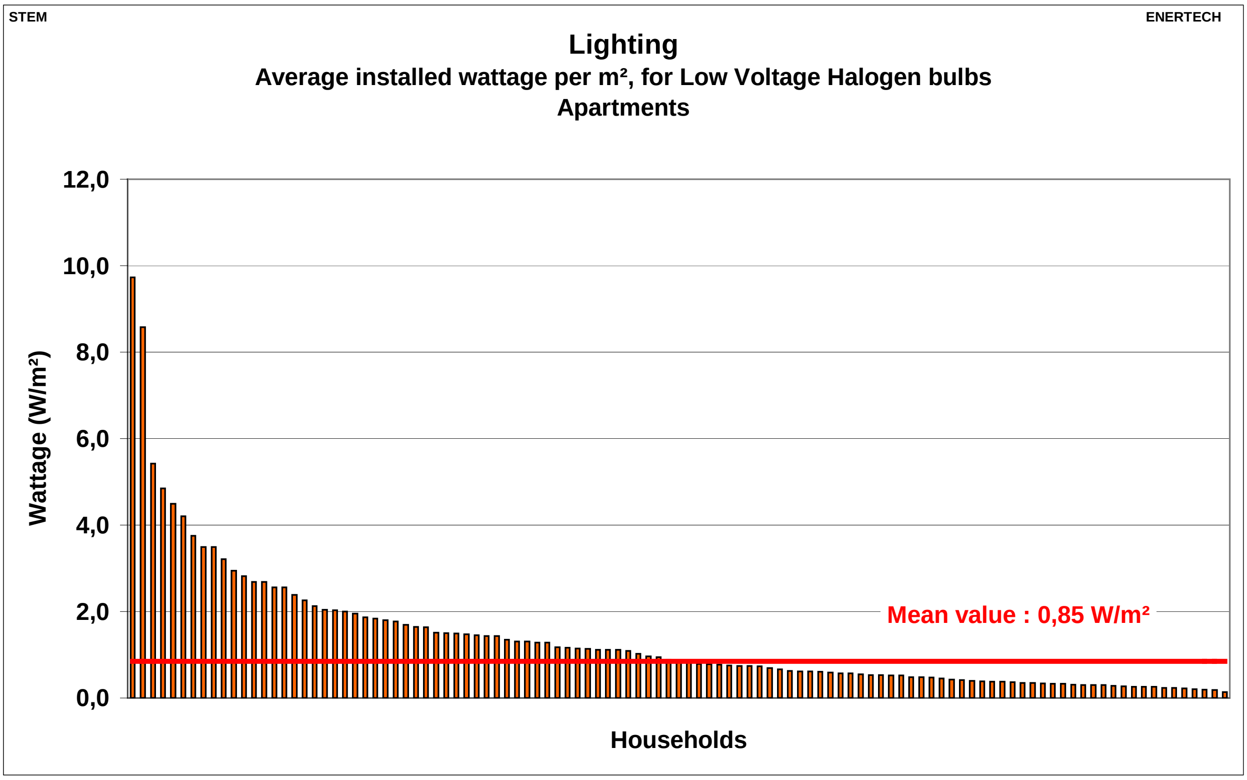


Figure 2.338: Lighting – Average installed wattage per m² for low voltage halogen tubes – Apartments

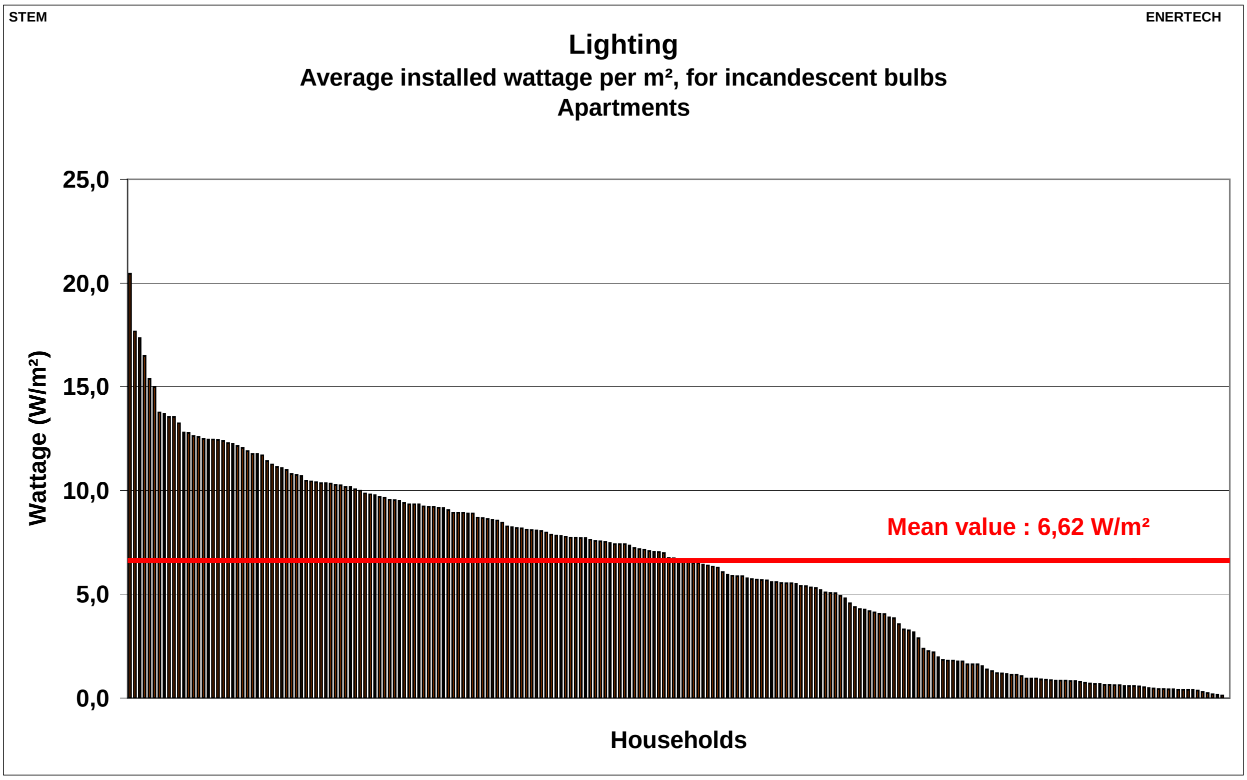


Figure 2.339: Lighting – Average installed wattage per m² for incandescent tubes – Apartments

Distribution of the unit wattage of the bulbs, per type of light source

Graphs 2.340 to 2.344 represent the distributions of the unit lighting wattage for the installed equipment. This is an important point, as it supplies information about the nature of the household equipment, and it also allows to target a better DSM action over a particular type of light source. A succinct analysis can be done for each type of light bulbs:

- almost 34 % of the GLS (General Lighting Service) incandescent bulb wattage is 40 W. Then come the 25 W followed by the 60 W light bulbs (about 27 % and 17 % each). There are almost no 100 W light bulbs,
- halogen lighting is dominated by low voltage halogens, with a wattage lower than 50 W. The dominant class is centred on 20 W (60 %). Powerful halogen lights (more than 250 W) represent 12,5 % of the halogen light stock,
- the stock of fluorescent tube lights essentially comprises 18W (50 %) and 36 W (30 %) tube lights,
- low energy light stock comprises 40 % of 11 W CFL bulbs (9-12 W class), and then 7 W.

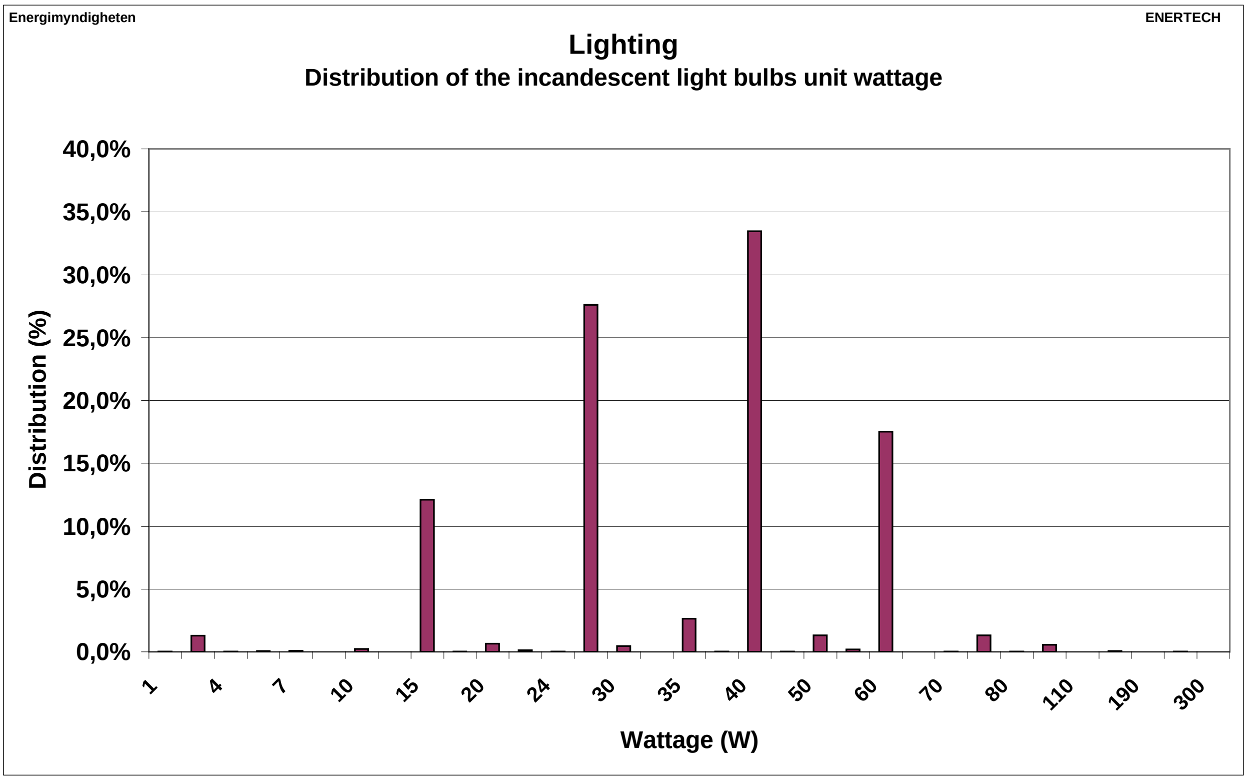


Figure 2.340: Lighting – Distribution of the incandescent light bulbs unit wattage

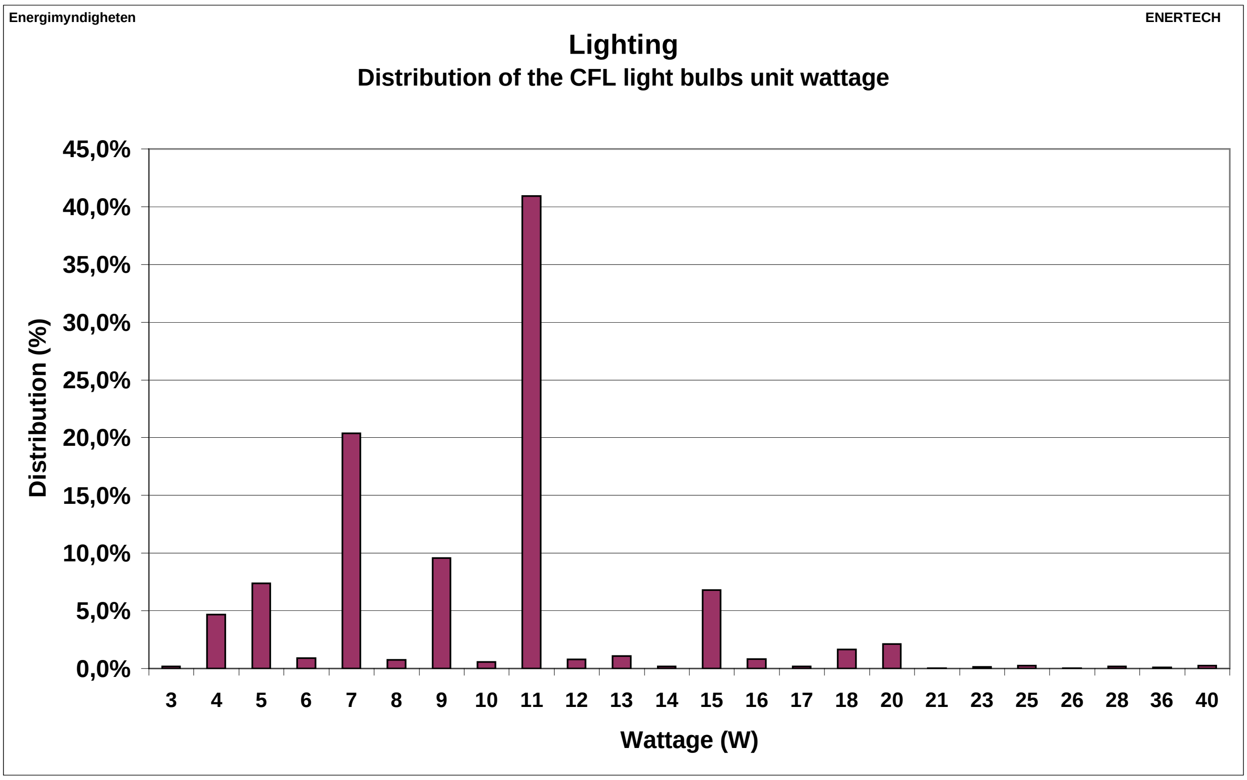


Figure 2.341: Lighting – Distribution of the CFL light bulbs unit wattage

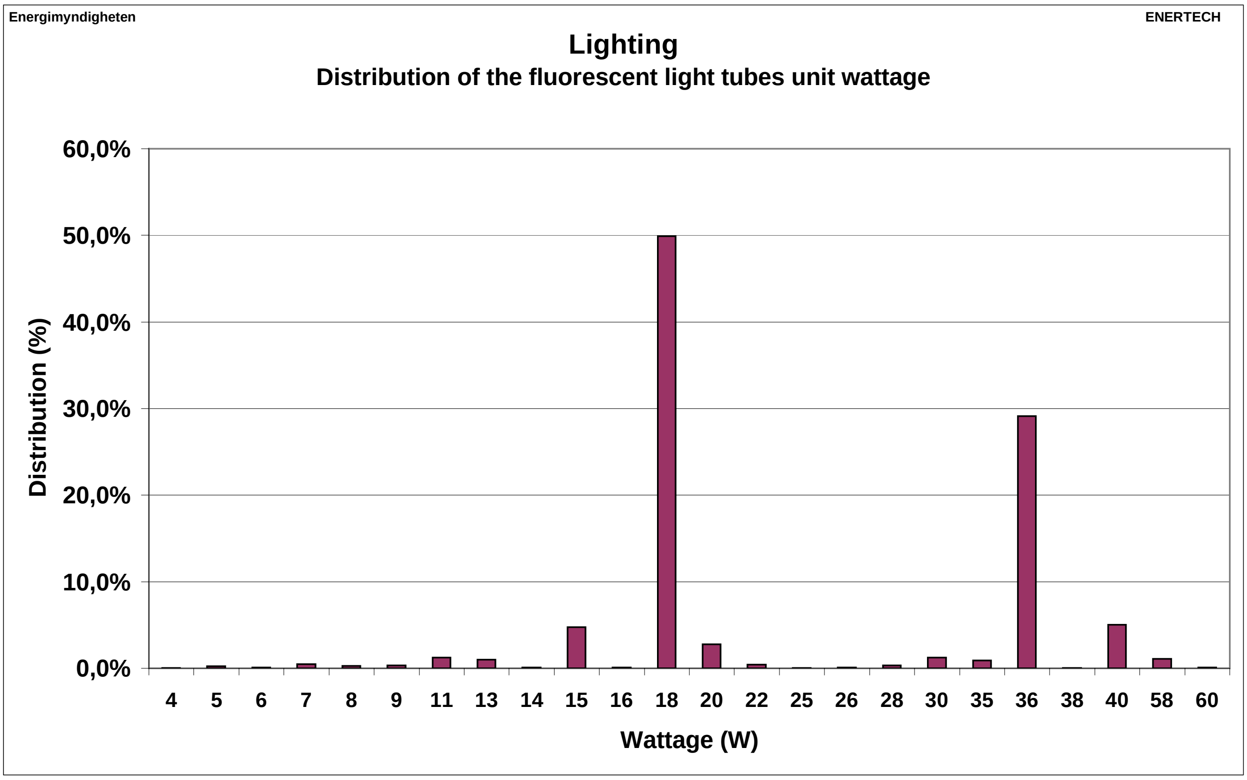


Figure 2.342: Lighting – Distribution of the fluorescent light tubes unit wattage

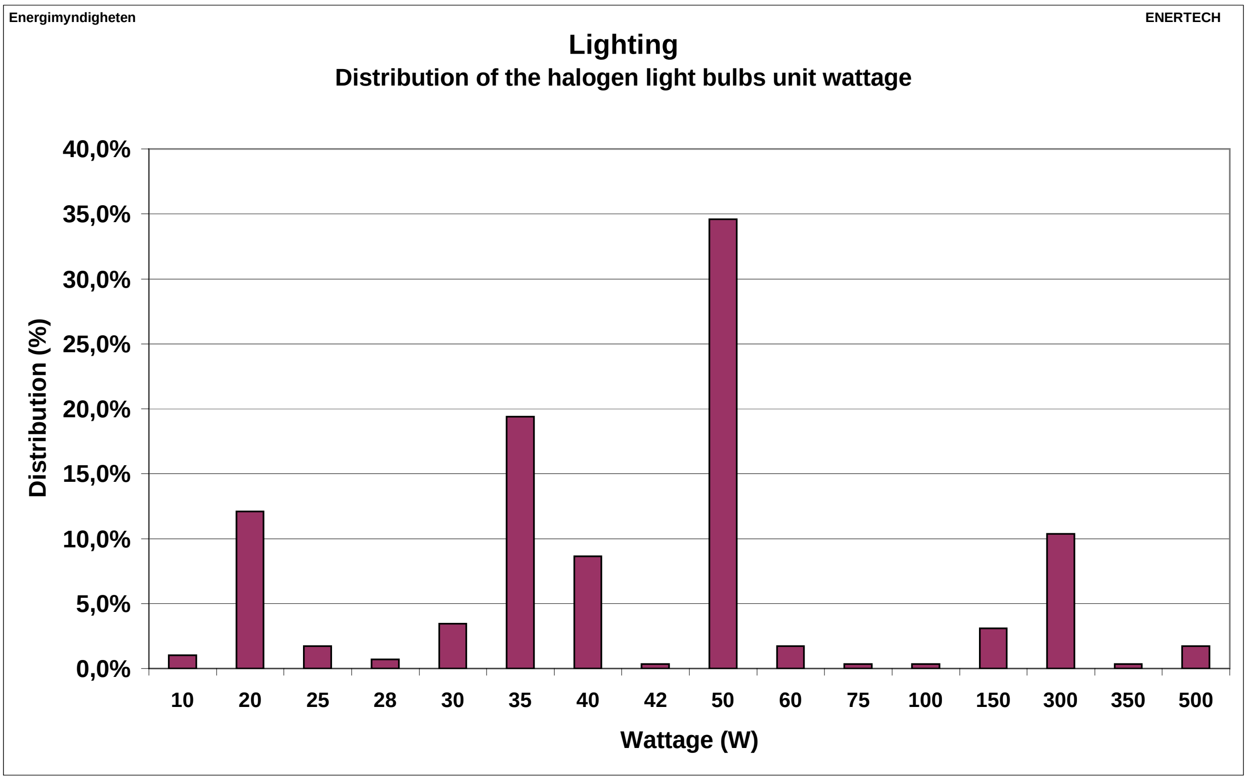


Figure 2.343: Lighting – Distribution of the halogen light bulbs unit wattage

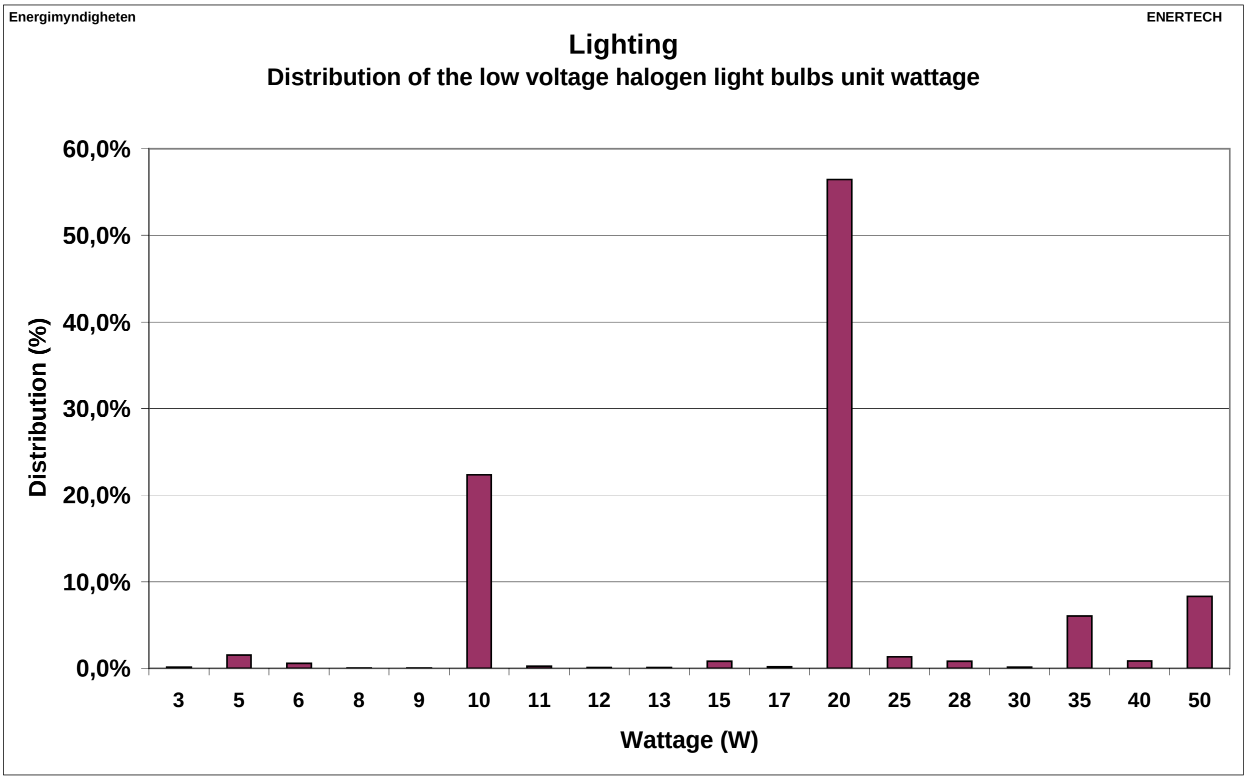


Figure 2.344: Lighting – Distribution of the low voltage halogen light bulbs unit wattage

ANNUALIZED LIGHTING CONSUMPTION

Seasonality effect

The consumption for lighting is strongly seasonal, but most of the households were only monitored for one month. The seasonality effect was calculated using the 40 households monitored for one year. For each household, we calculated the weekly consumption by adding all the data per week. The result output consists of 52 values per household corresponding to the number of weeks in one year. This set of values was then normalized to 1 (the average value gives one for each set). An average value per week was then calculated using all the data sets. Figure 2.345 represents the seasonality curve calculated by this method. This curve was used to calculate the annual consumption for the lights monitored for less than six month.

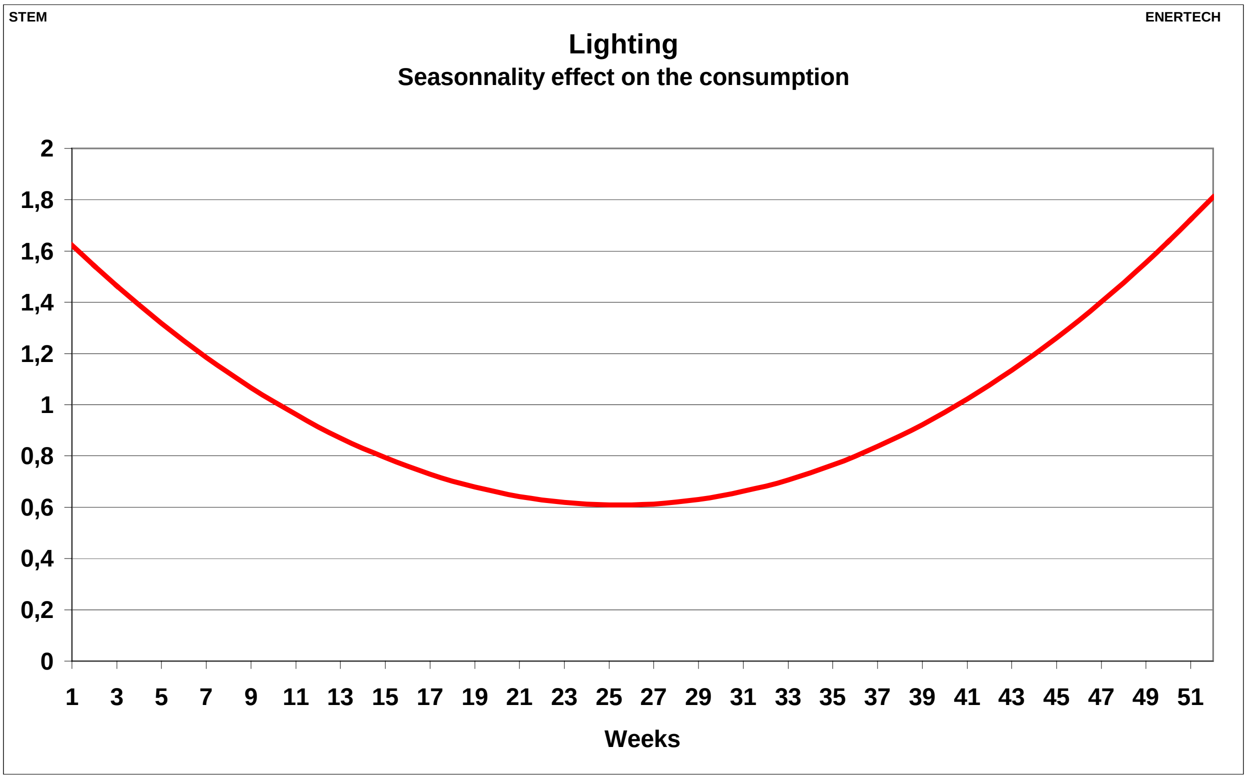


Figure 2.345: Lighting – Seasonality effect on the consumption

Annualized consumption per household

Figures 2.346 to 2.353 represent the distribution of the total lighting consumption for the different household categories. For houses, the annual consumption is in the range 646-937 kWh/year and 240-691 kWh/year for apartments.

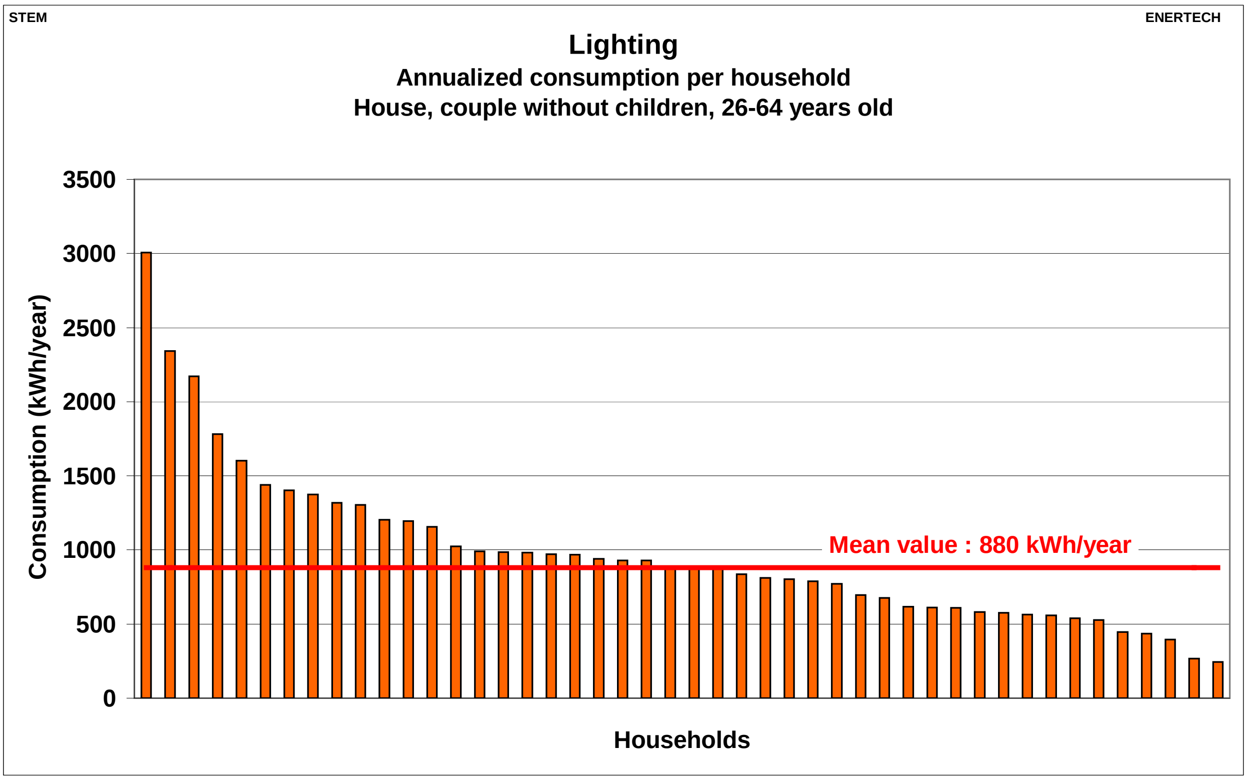


Figure 2.346: Lighting – Annualized consumption – House, couples without children, 26-64 years old

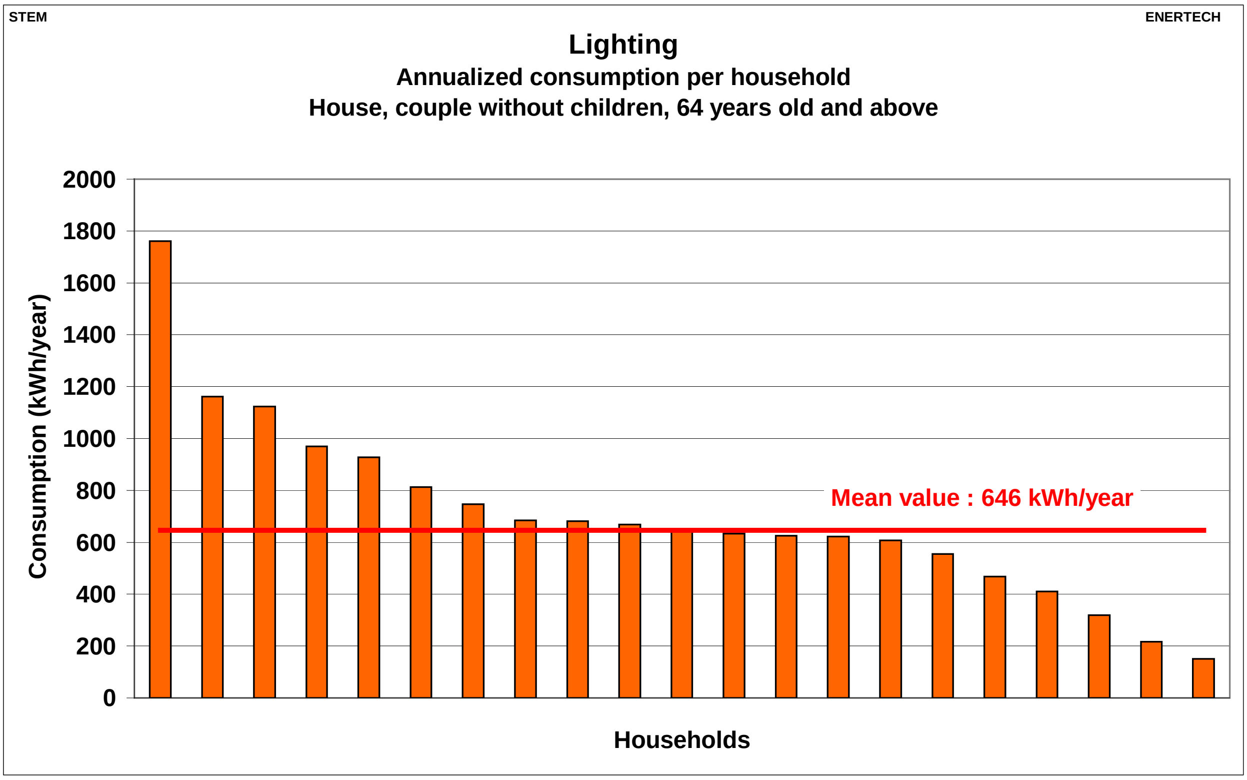


Figure 2.347: Lighting – Annualized consumption – House, couples without children, 64 years old and above

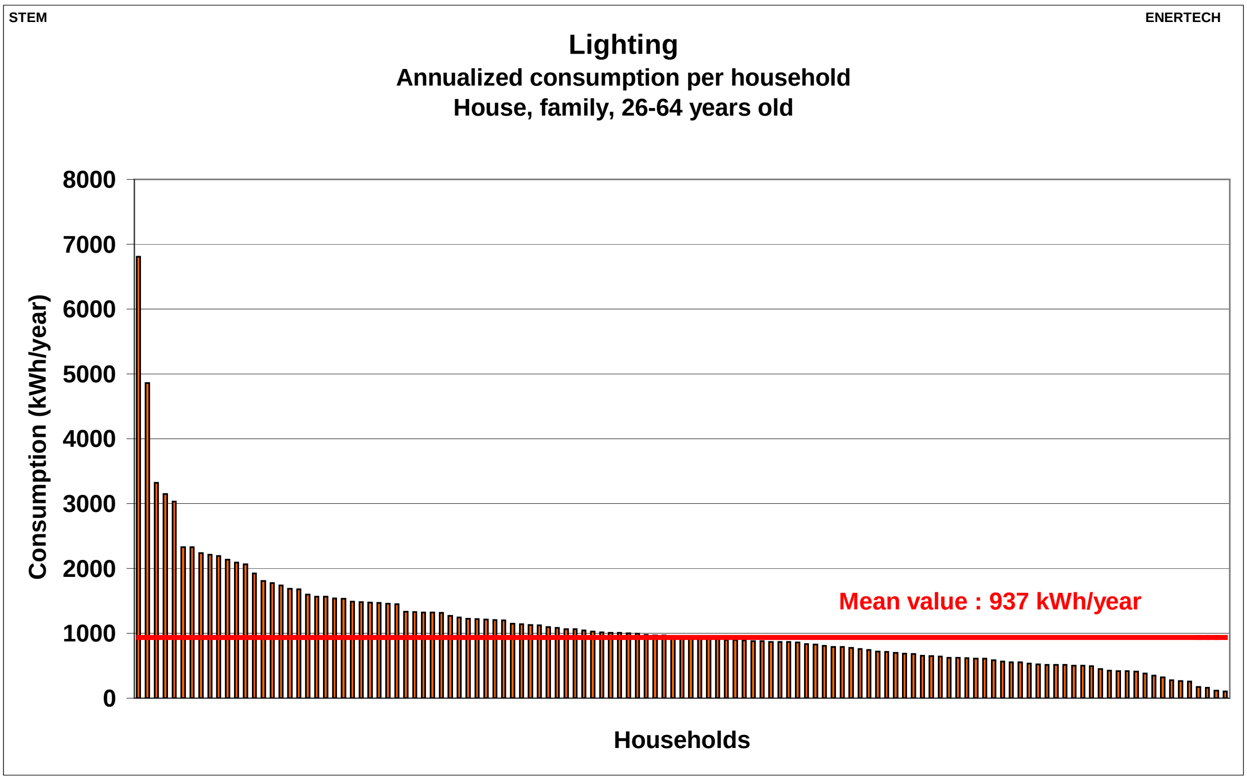


Figure 2.348: Lighting – Annualized consumption – House, family, 26-64 years old

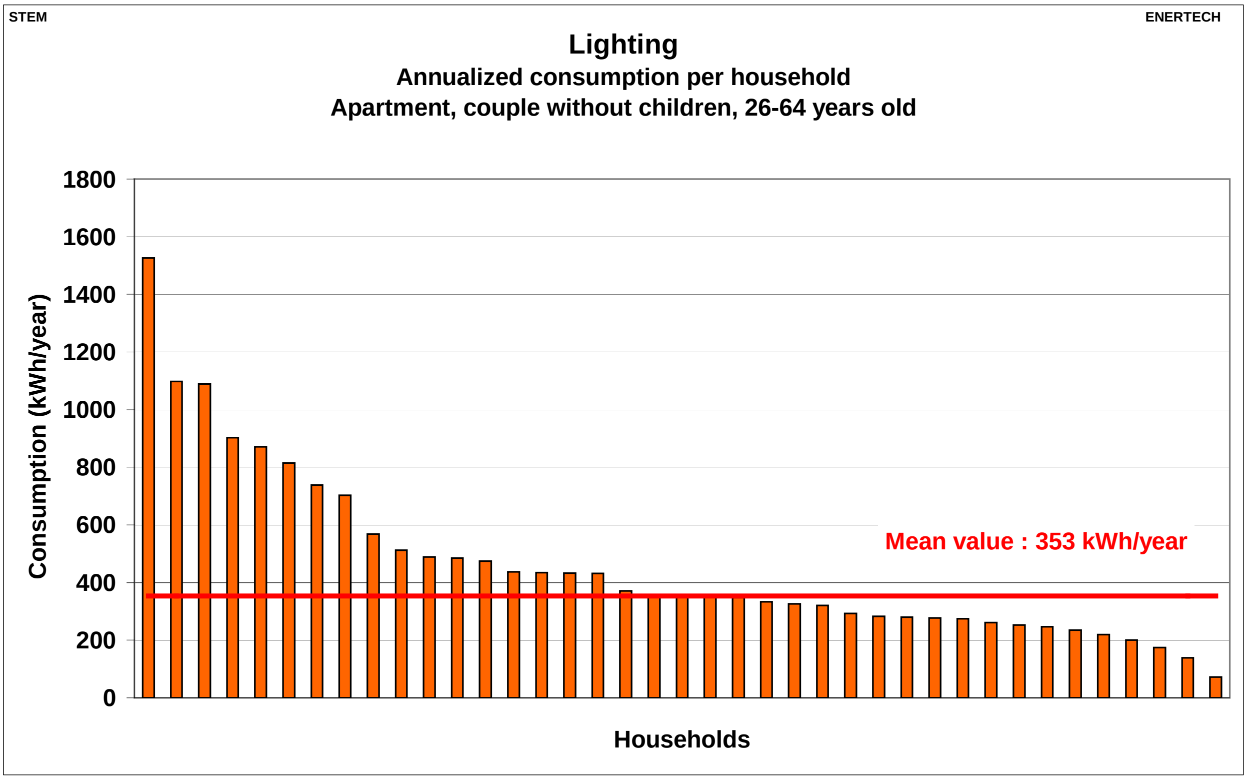


Figure 2.349: Lighting – Annualized consumption – Apartment, couples without children, 26-64 years old

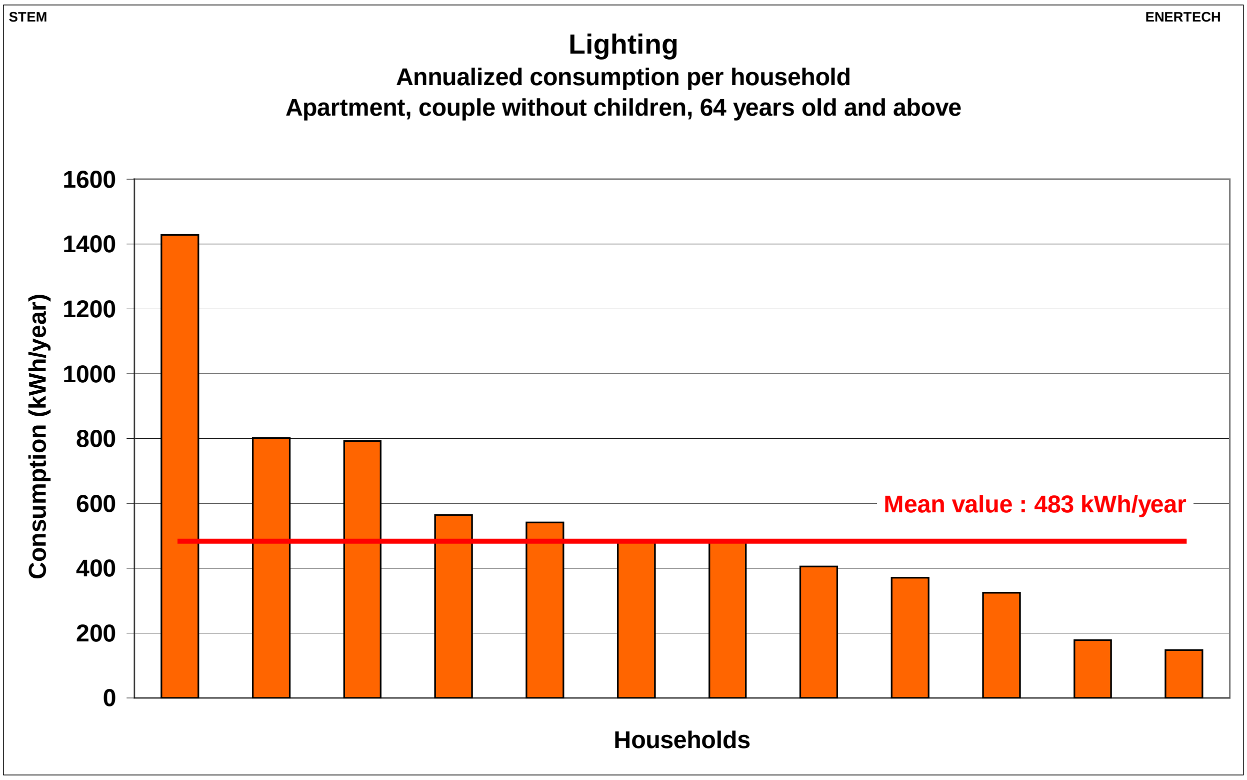


Figure 2.350: Lighting – Annualized consumption – Apartment, couples without children, 64 years old and above

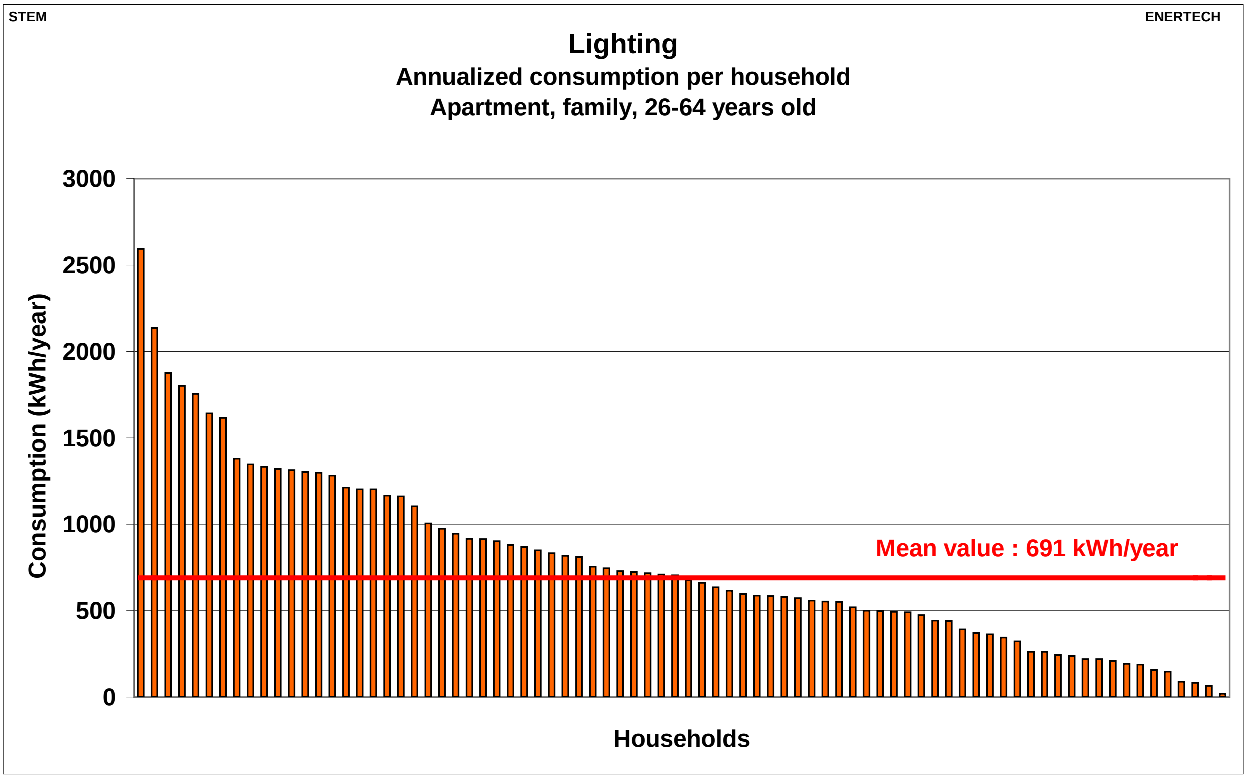


Figure 2.351: Lighting – Annualized consumption – Apartment, family, 26-64 years old

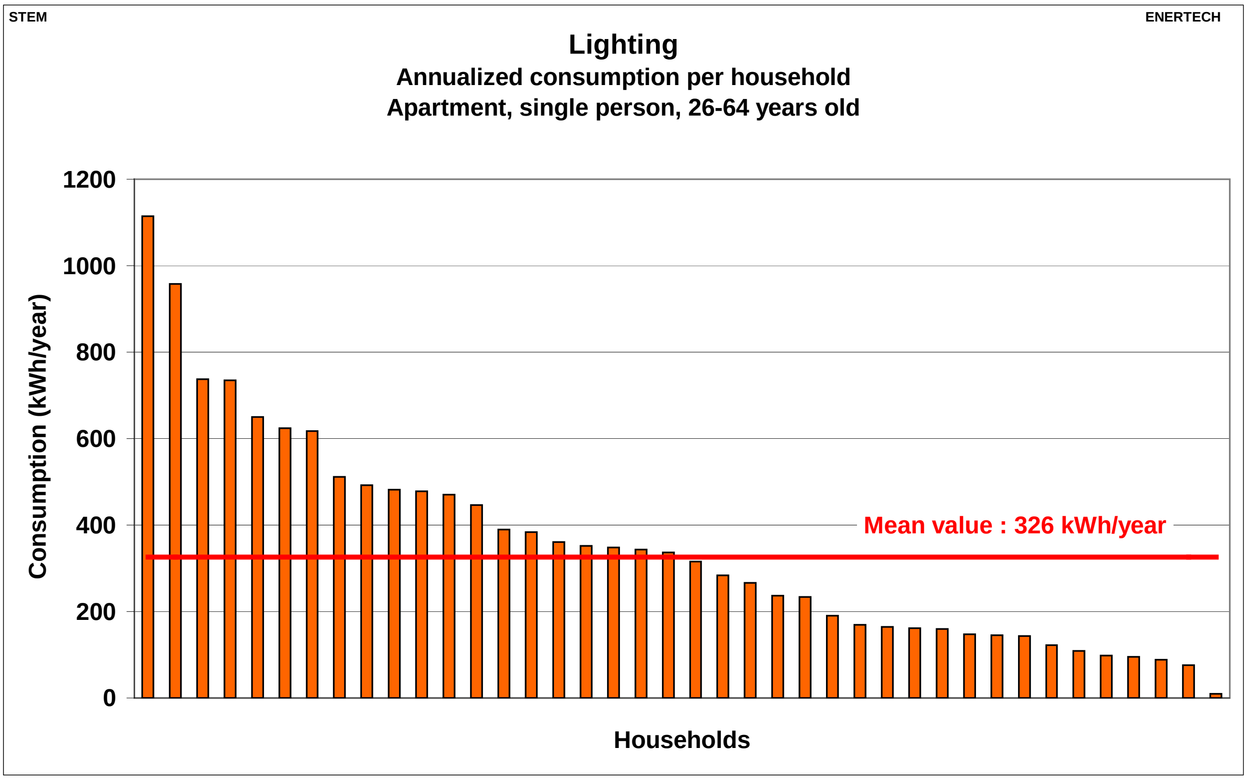


Figure 2.352: Lighting – Annualized consumption – Apartment, single person, 26-64 years old

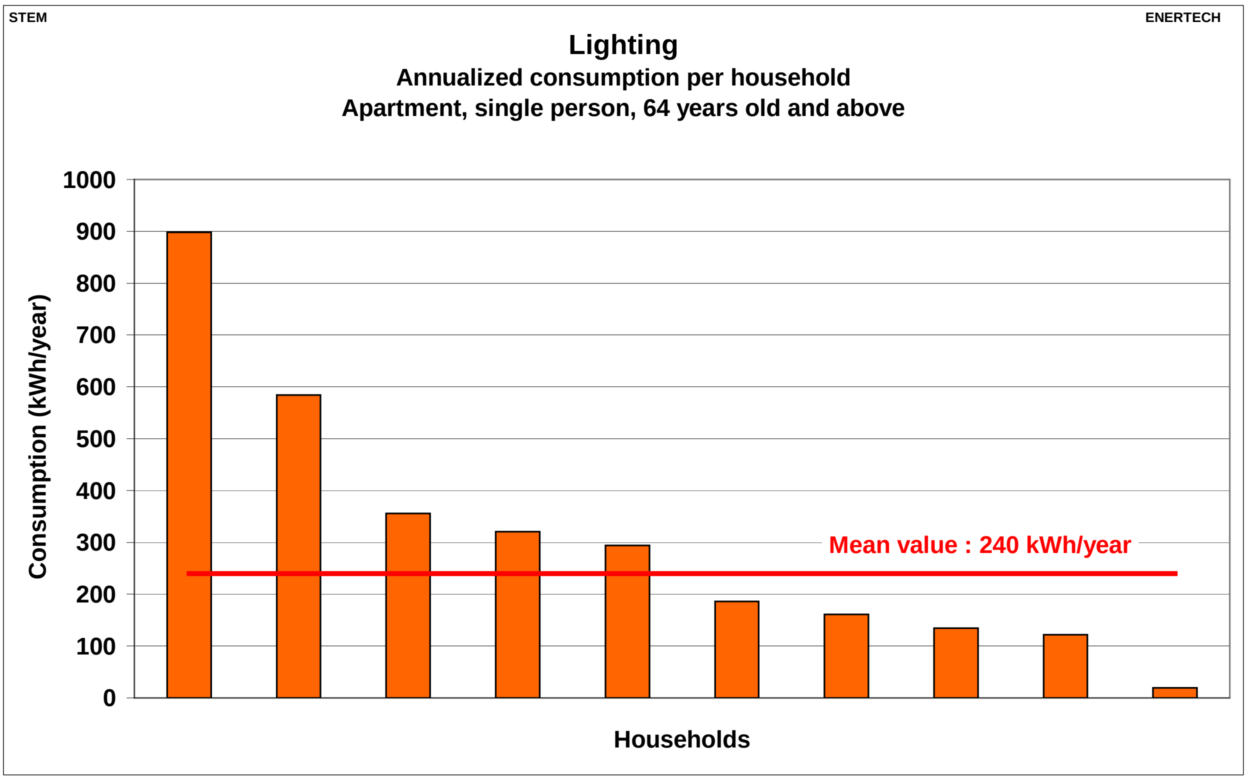


Figure 2.353: Lighting – Annualized consumption – Apartment, single person, 64 years old and above

Annualized consumption per person

Figure 2.354 shows us the annual consumption per person as a function of the number of persons in the household. The values per persons should be treated with some care, since the family structure has to be taken into account as well. This consumption is equal to 340 kWh/person/year for 1 or 2 persons, 285 kWh/person/year for household with 3 or 4 persons and then decrease to 200 kWh/person for 6 persons.

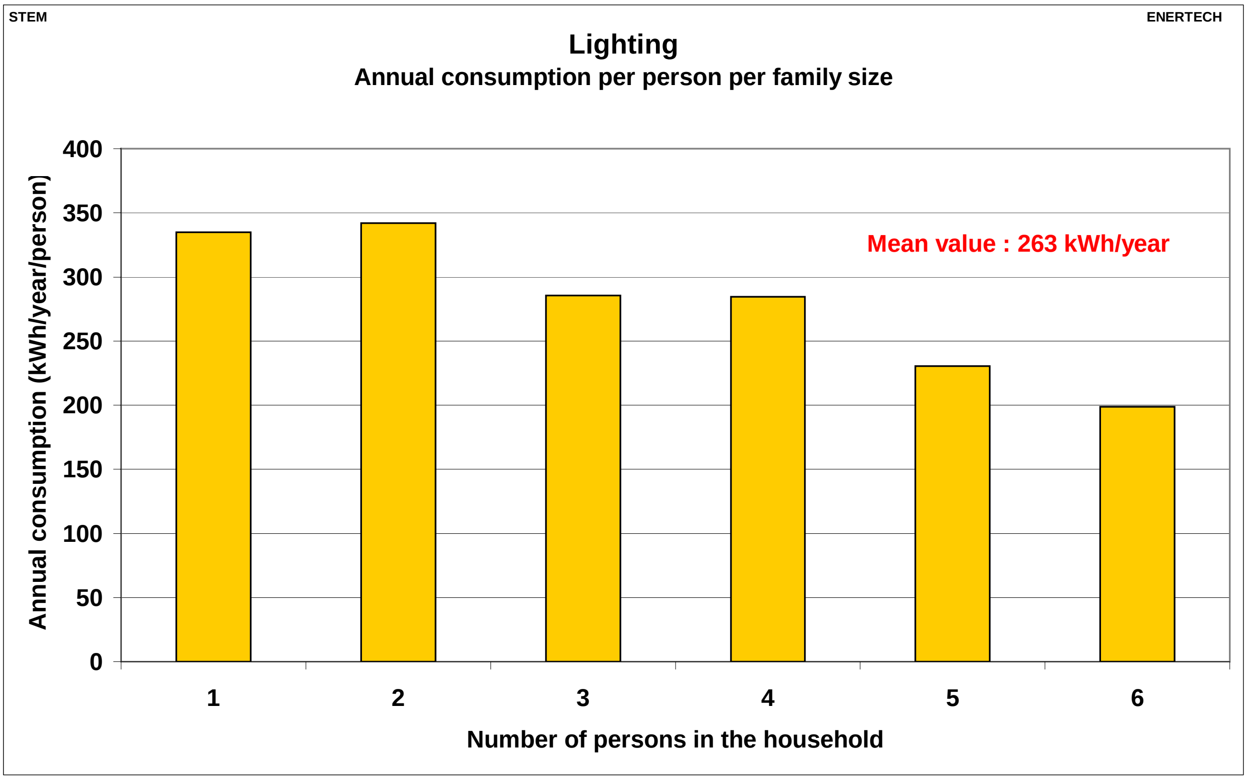


Figure 2.354: Lighting: Annual consumption per person

Annualized consumption per m2

Figures 2.355 and 2.356 show us the annual consumption per m² for both types of households. It is interesting to note that the values are very near: 6,7 kWh/m²/year for houses and 6,3 kWh/m²/year for apartments so it's the difference of size between houses and apartments that will explain the difference of consumption between the two.

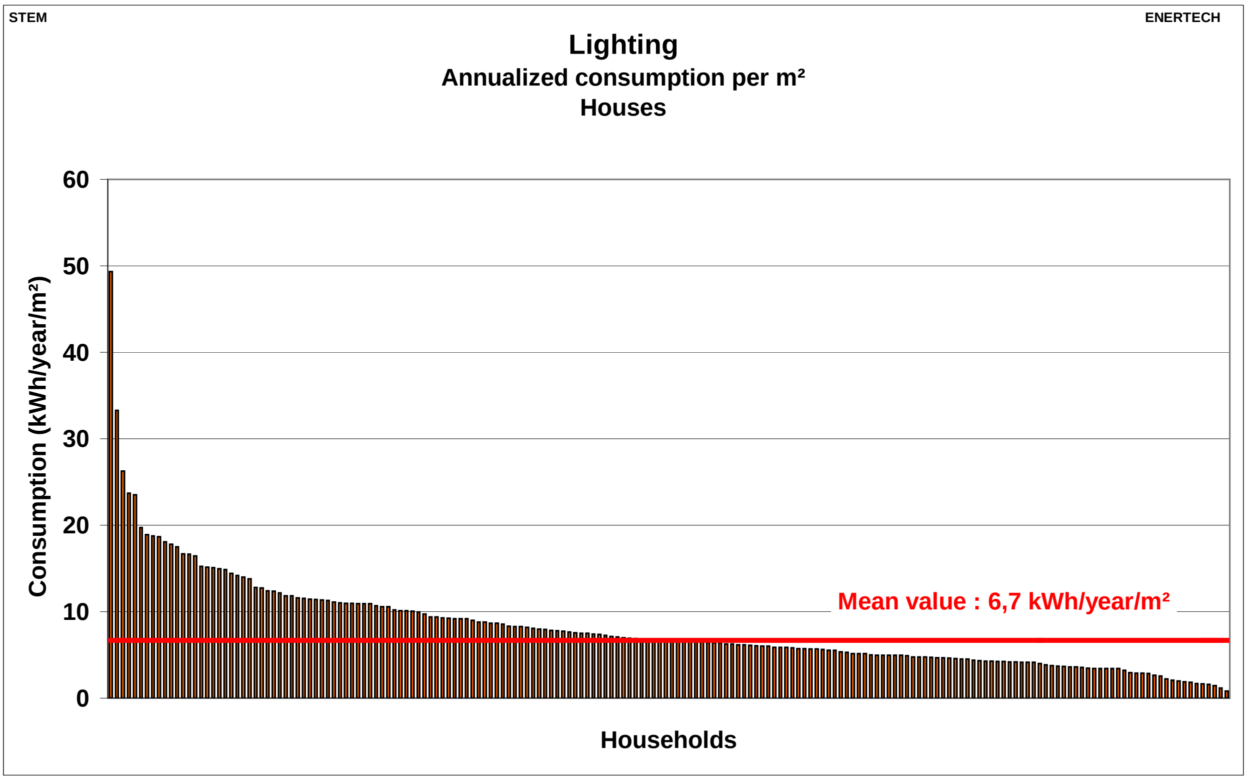
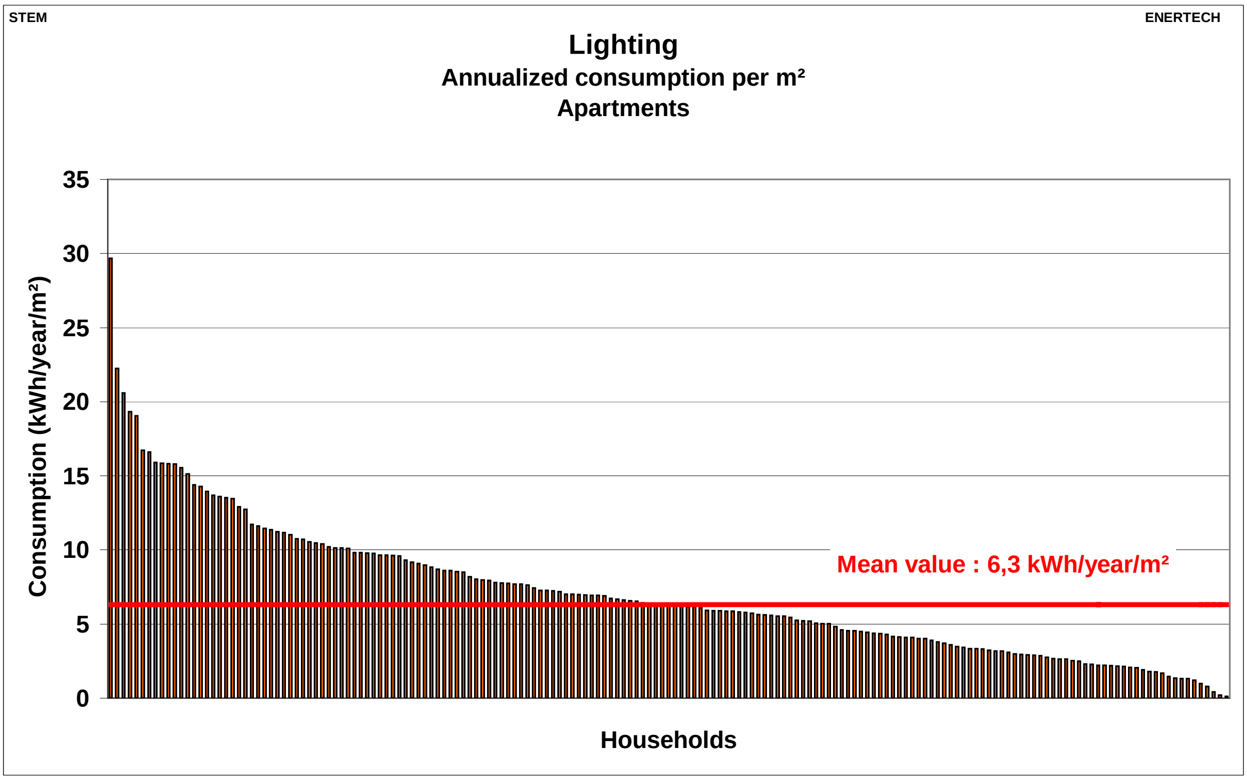


Figure 2.355: Lighting – Annual consumption per m² - Houses

Figure 2.356: Lighting – Annual consumption per m² - Apartments



Annualized consumption per type of room

Figures 2.357 and 2.358 will answer the question

What is the average lighting consumption of a living-room or a bedroom for both type of households ?

The two rooms with the highest consumption are the living room and the kitchen. For houses, the kitchen take the first place with 178 kWh/year followed by the living room with 150 kWh/year. For apartments, the living room will beat the kitchen.

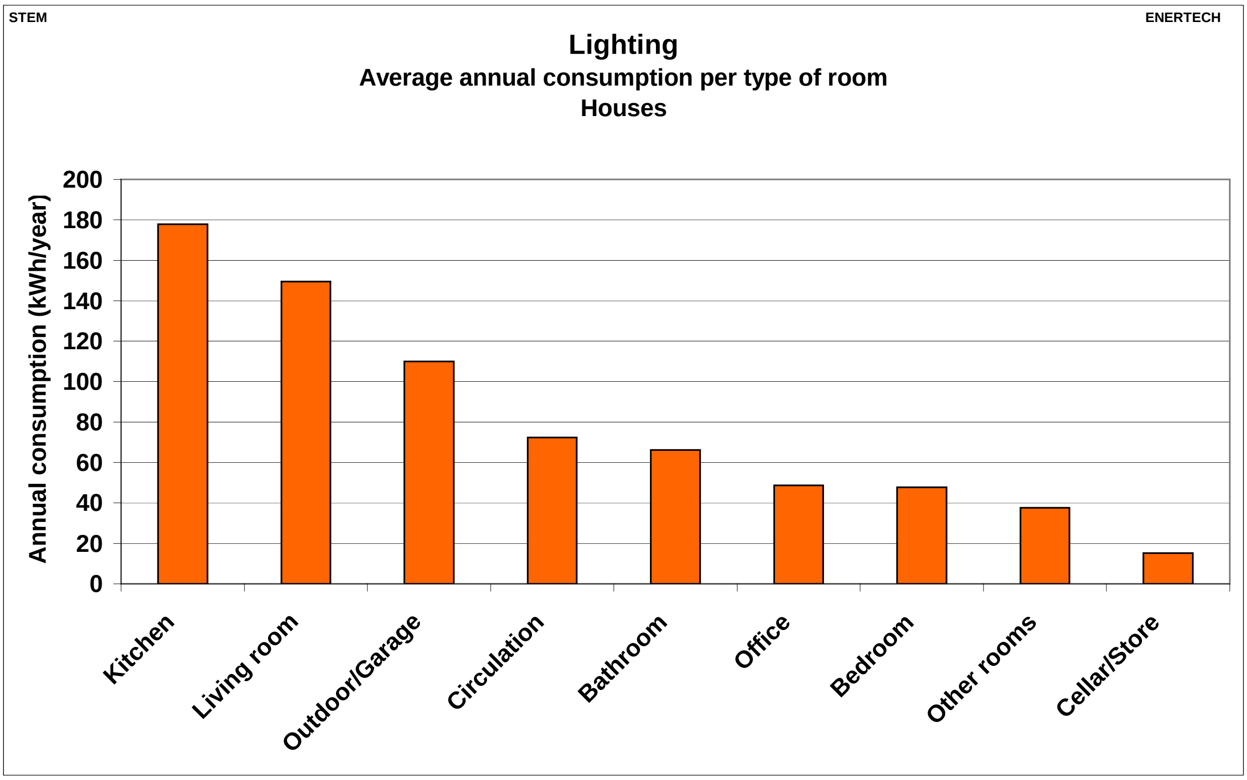


Figure 2.357: Lighting – Annual consumption per type of room – Houses

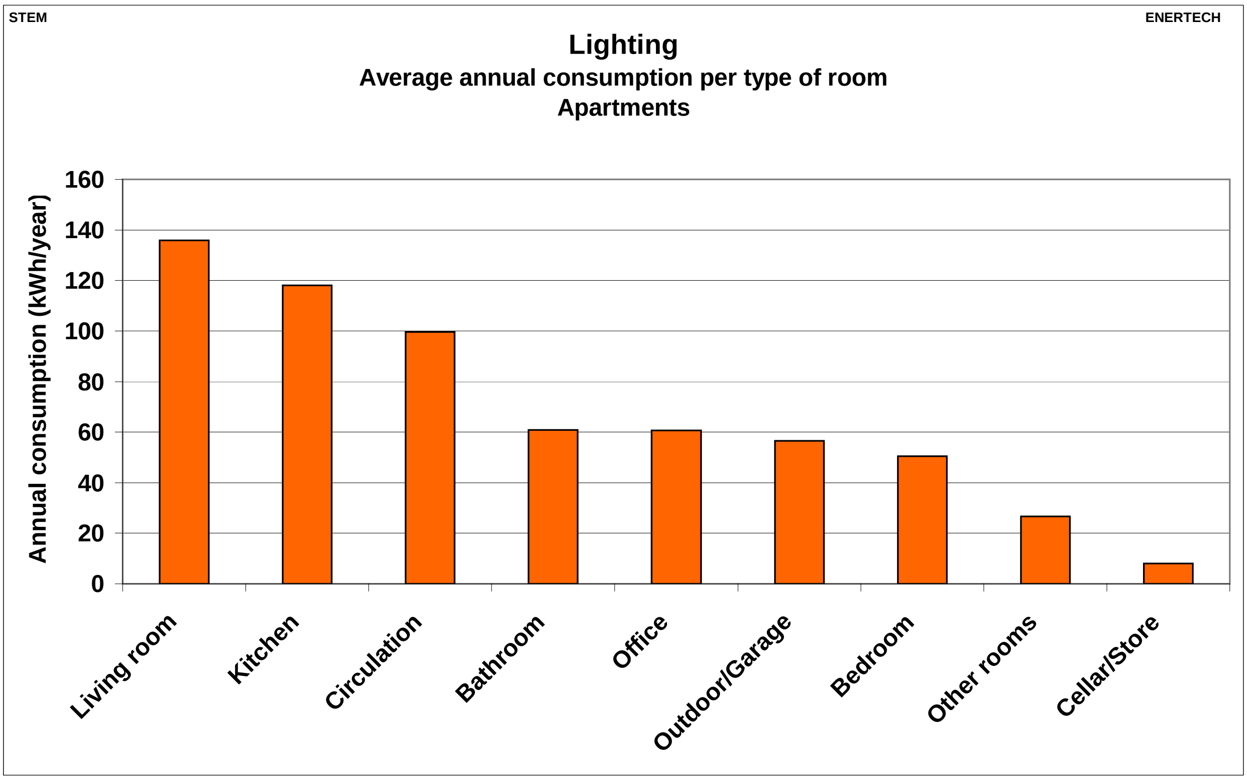


Figure 2.358: Lighting – Annual consumption per type of room – Apartments

STRUCTURE OF THE ANNUALIZED LIGHTING CONSUMPTION

Structure of the consumption per type of room, from the grid point of view

Figure 2.359 shows the consumption structure per type of room, from the grid point of view. In order to obtain this graph, we summed all observed consumption for every household over all the measurement periods, and we grouped them together by type of room. Then we referred the total consumption of each type of room to the total observed lighting consumption of all the households. The result tells us about the final usage of the supplied electricity.

This study highlights that in the houses, there’s no “most consuming room”, the total consumption is split between the different type of rooms. For apartments, the kitchen, the living room and circulations represent 60% of the total consumption.

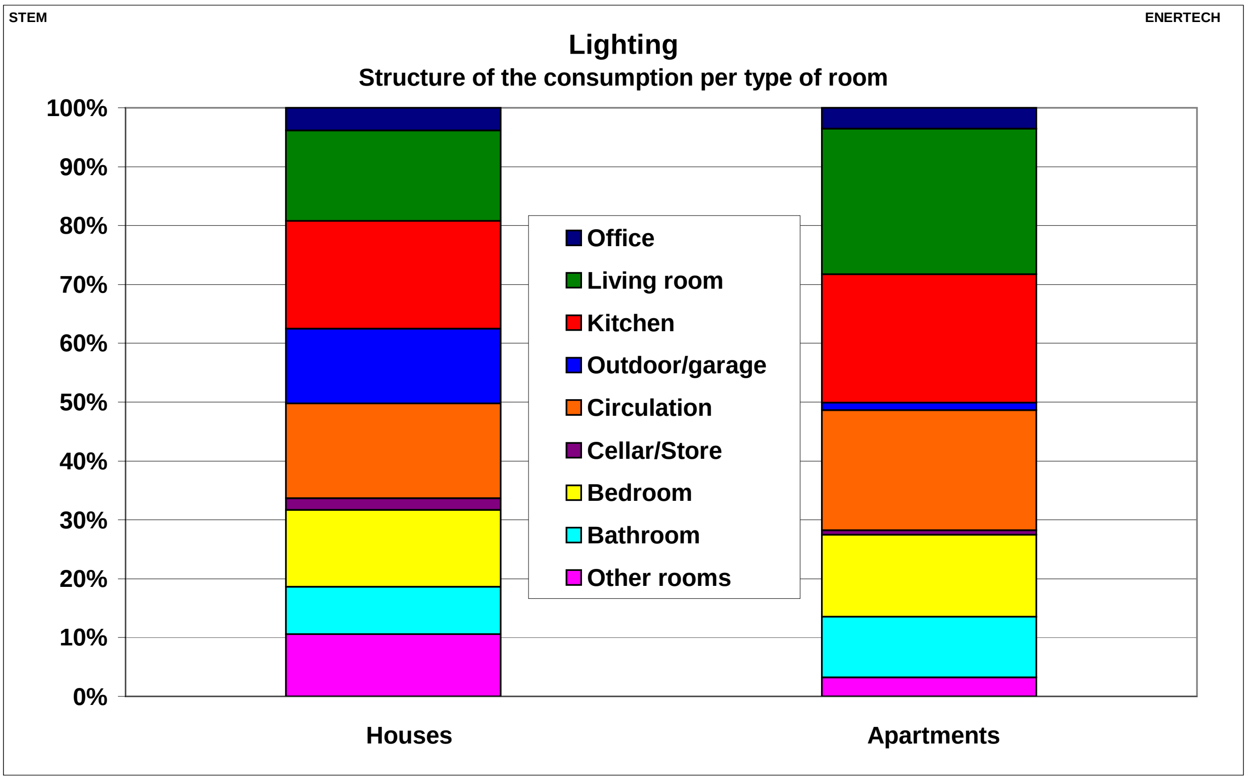


Figure 2.359: Lighting – Structure of the annual consumption per type of room – From the grid point of view

Structure of the consumption per type of light source, from the grid point of view

Figure 2.360 shows the same kind of analysis as in the former paragraph, but as a function of the light source type, and not of the room type.

Taking into account its very low energy efficiency, incandescence lighting represents the most important part of the total lighting consumption, with 65 % for houses and 72 % for apartments. If the halogen part is added, the part of these merged sources is 82 % for houses and 86 % for apartments. Finally, the low energy lamps fraction, varies from 6 to 10 %.

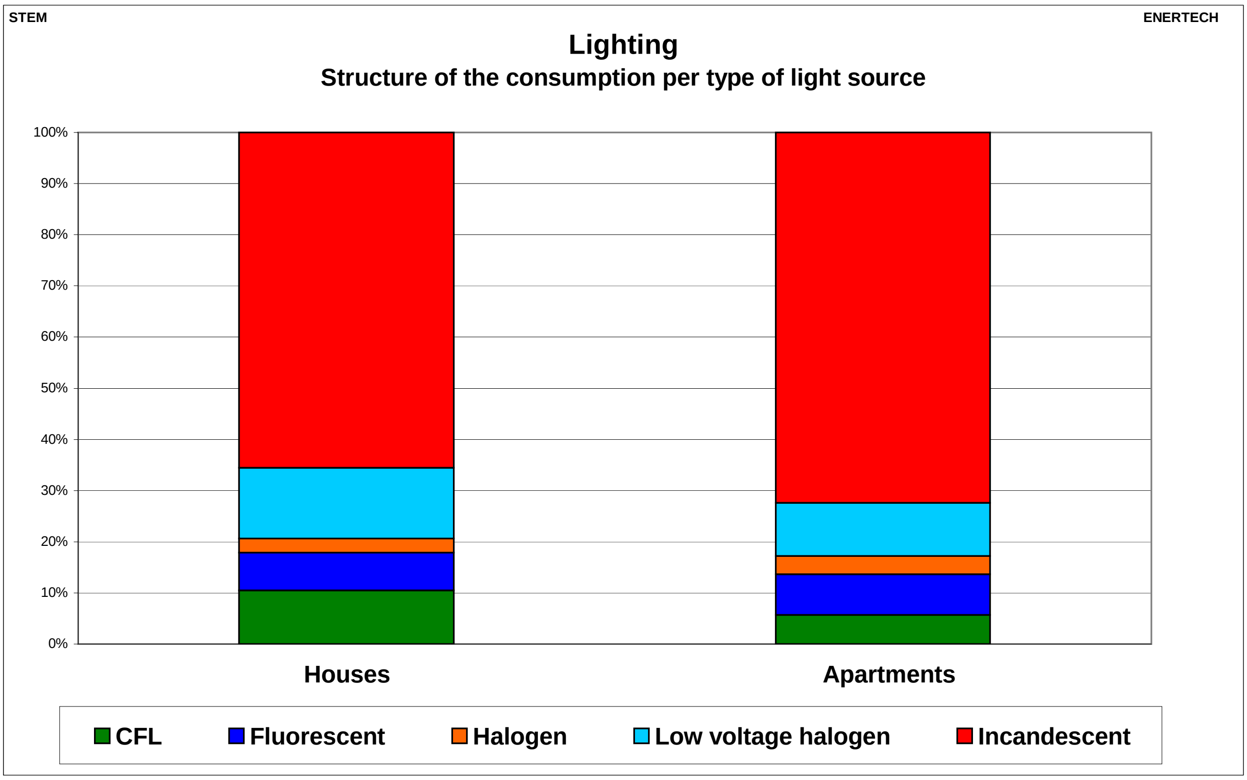


Figure 2.360: Lighting – Annual consumption per type of light sources – From the grid point of view

AVERAGE HOURLY LOAD CURVE

Hourly load curve per type of household

Figures 2.361 to 2.378 represent the average hourly load curve observed for the households as a whole, for each type of household.

It is notable that lighting consumption during the night exist in any type of household. It is less than probable that this consumption could be entirely due to night users. Here is a potential energy saving that is sometimes significant.

The main peak is always between 20:00 and 22:00 and goes from 135 to 300 Watt for houses and 90 to 200 Watt for apartments. The maximum power demand for the two types of households is always obtained for families.

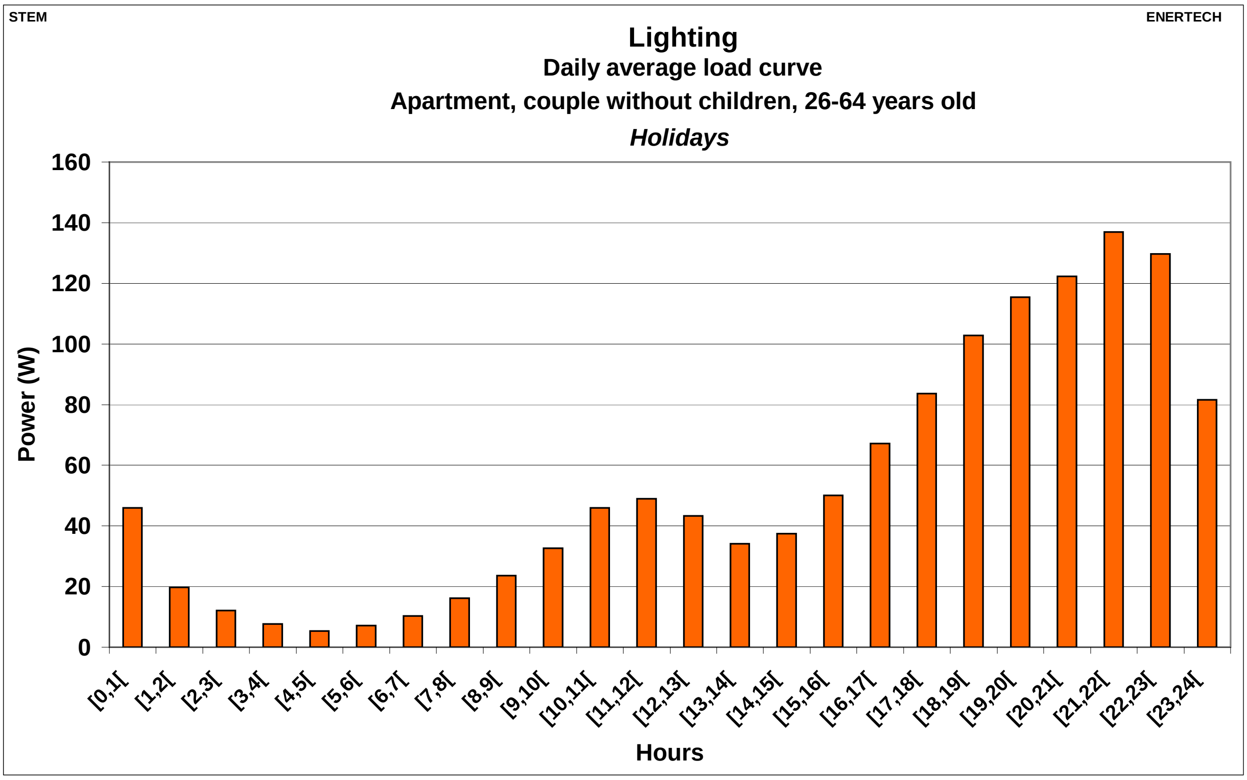


Figure 2.361: Lighting – Daily average load curve – Apartment, couples without children, 26-64 years old – Holidays

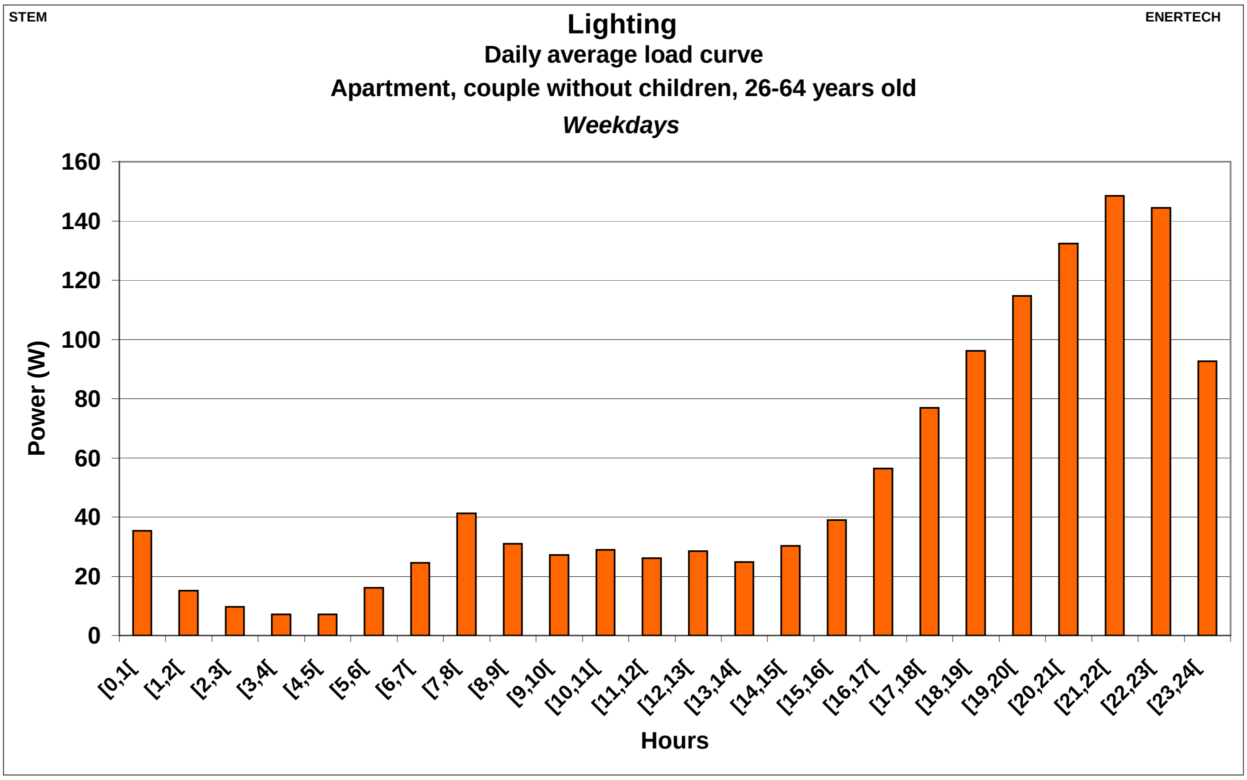


Figure 2.362: Lighting – Daily average load curve – Apartment, couples without children, 26-64 years old – Weekdays

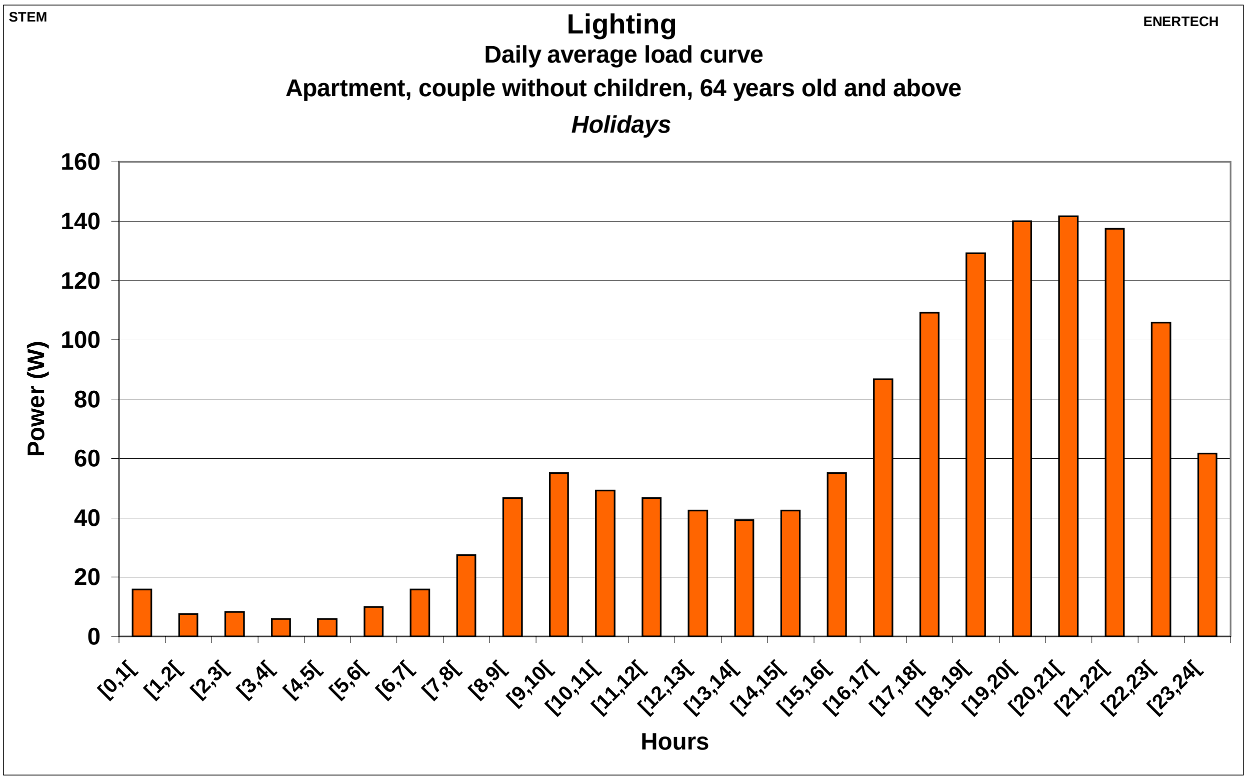


Figure 2.363: Lighting – Daily average load curve – Apartment, couples without children, 64 years old and above – Holidays

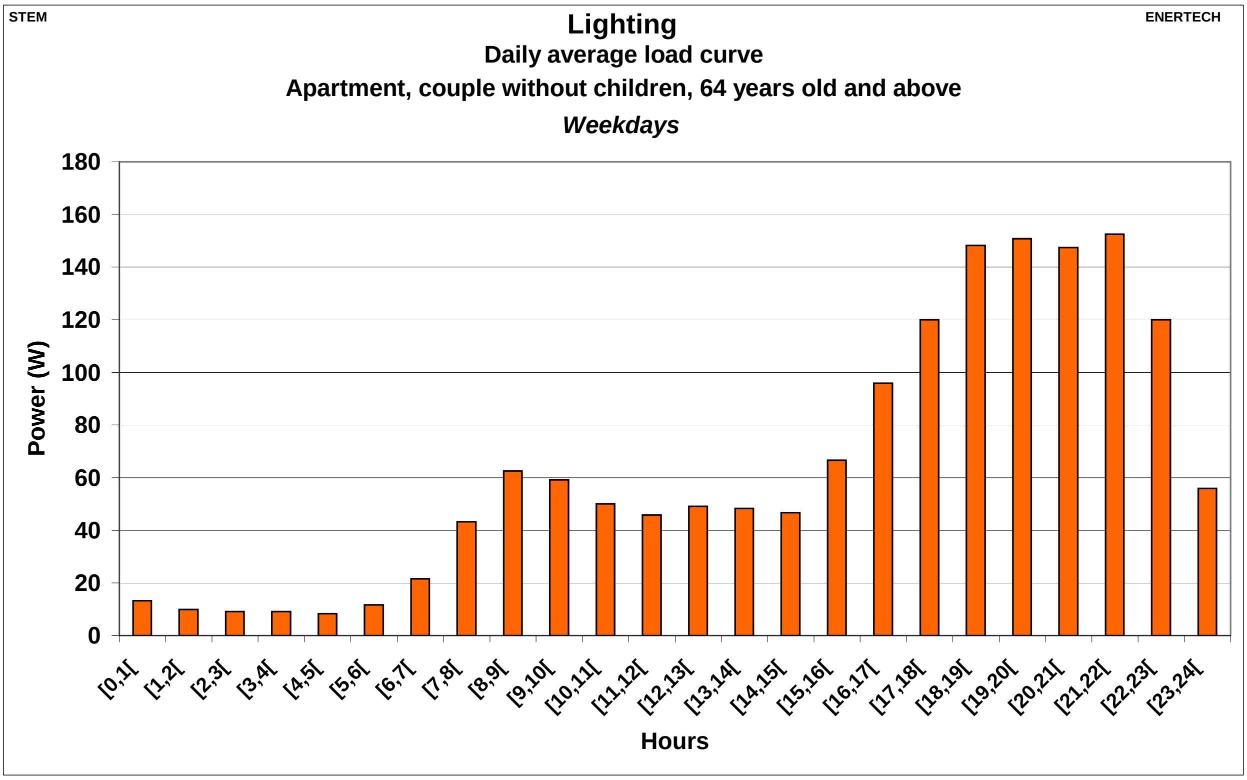


Figure 2.364: Lighting – Daily average load curve – Apartment, couples without children, 64 years old and above – Weekdays

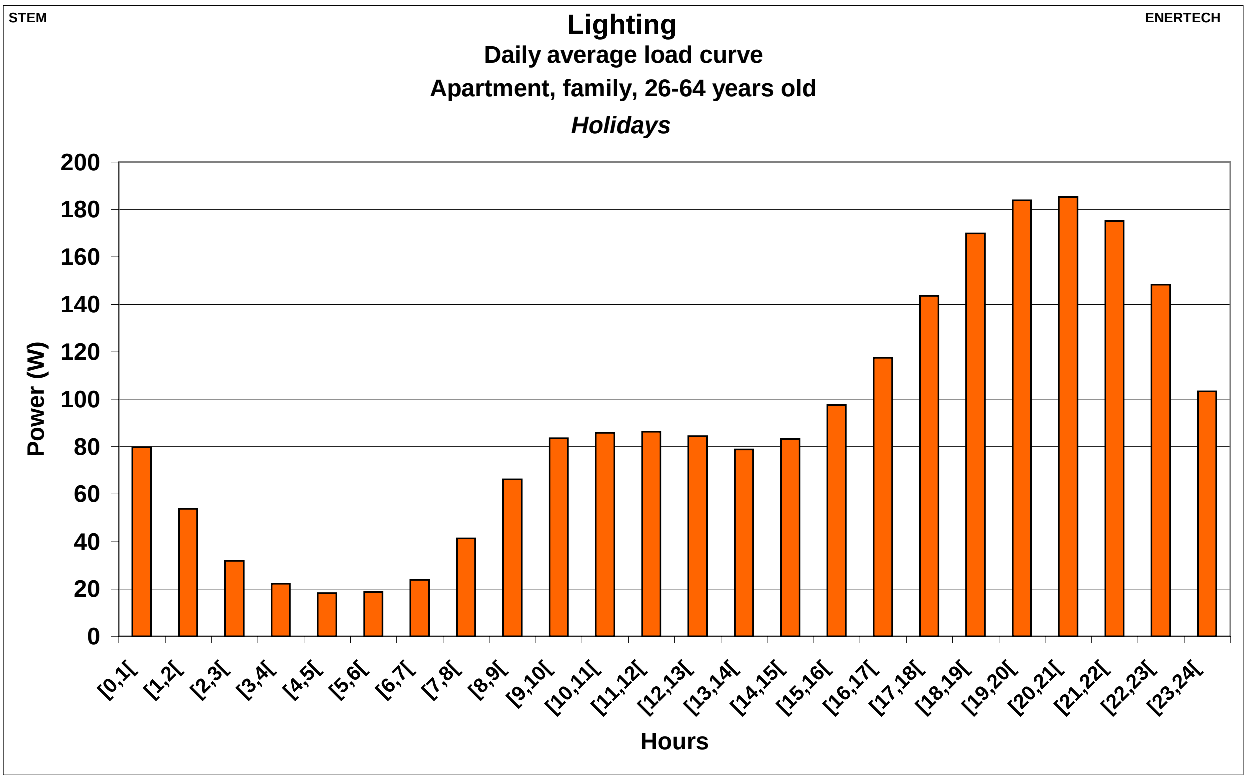


Figure 2.365: Lighting – Daily average load curve – Apartment, family, 26-64 years old – Holidays

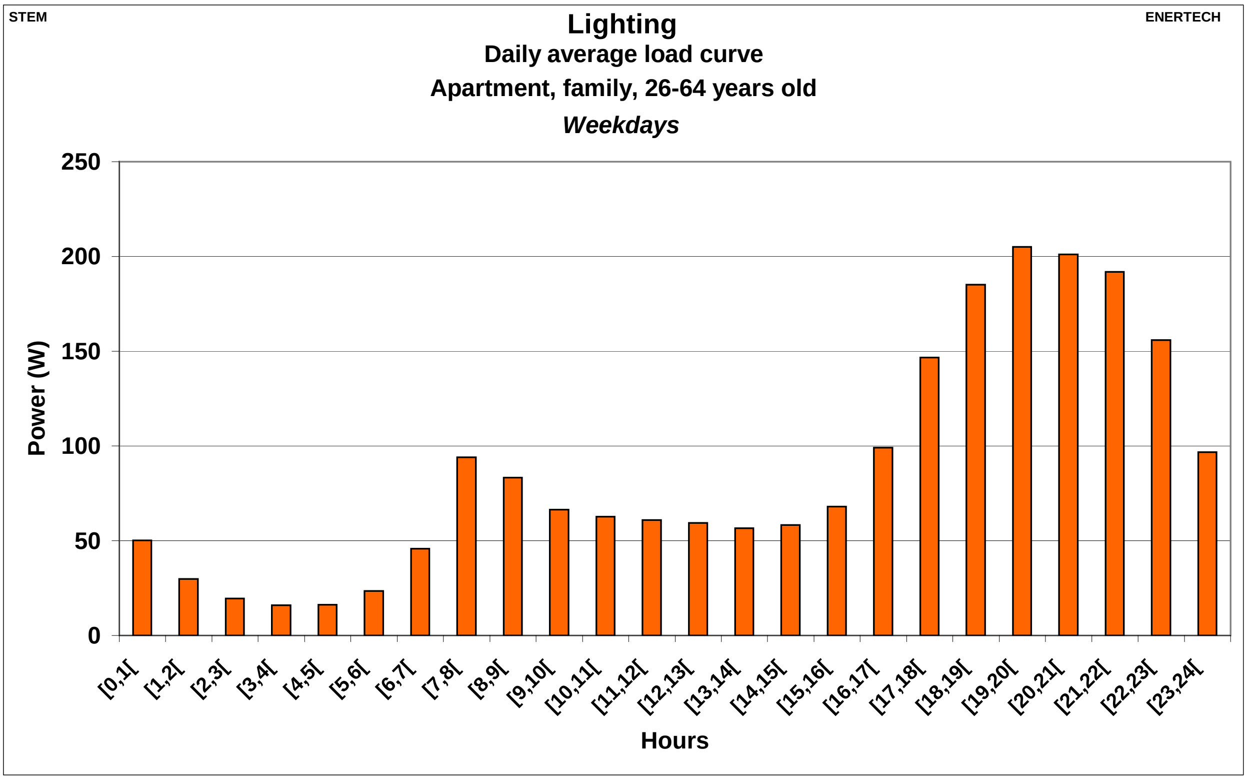


Figure 2.366: Lighting – Daily average load curve – Apartment, family, 26-64 years old – Weekdays

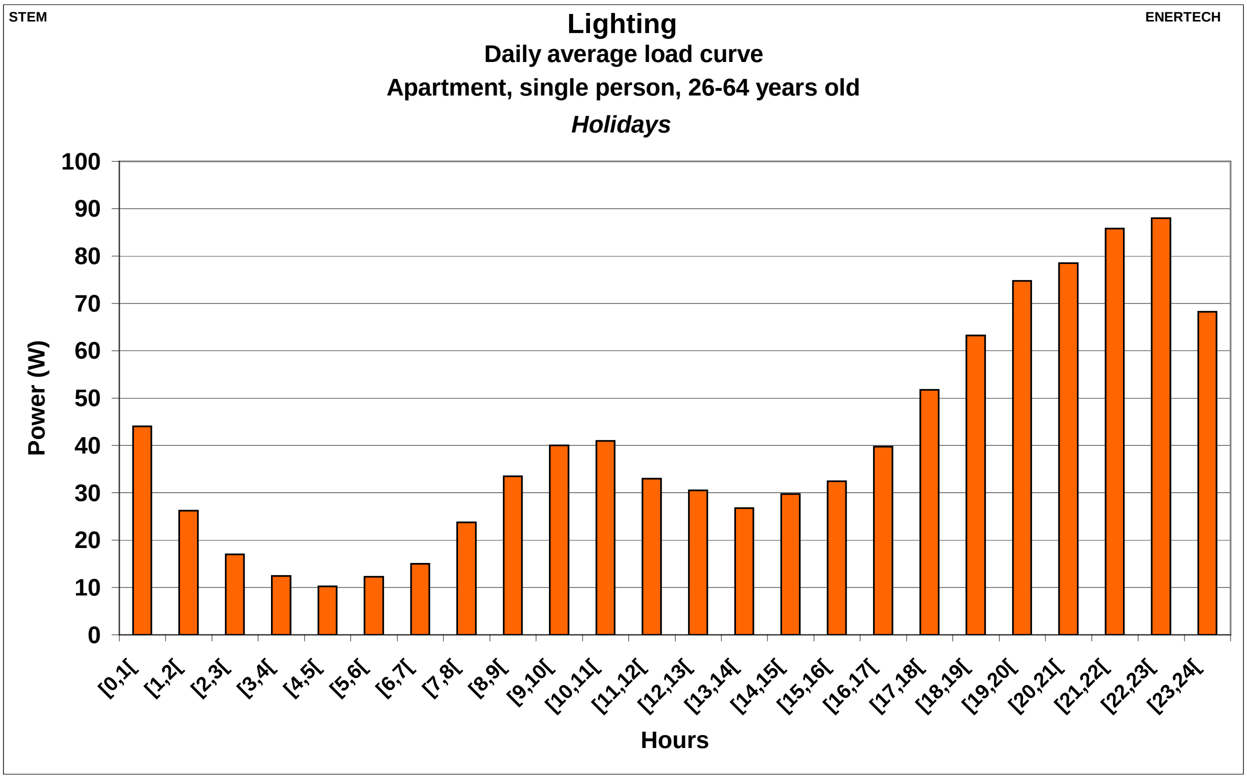


Figure 2.367: Lighting – Daily average load curve – Apartment, single person, 26-64 years old – Holidays

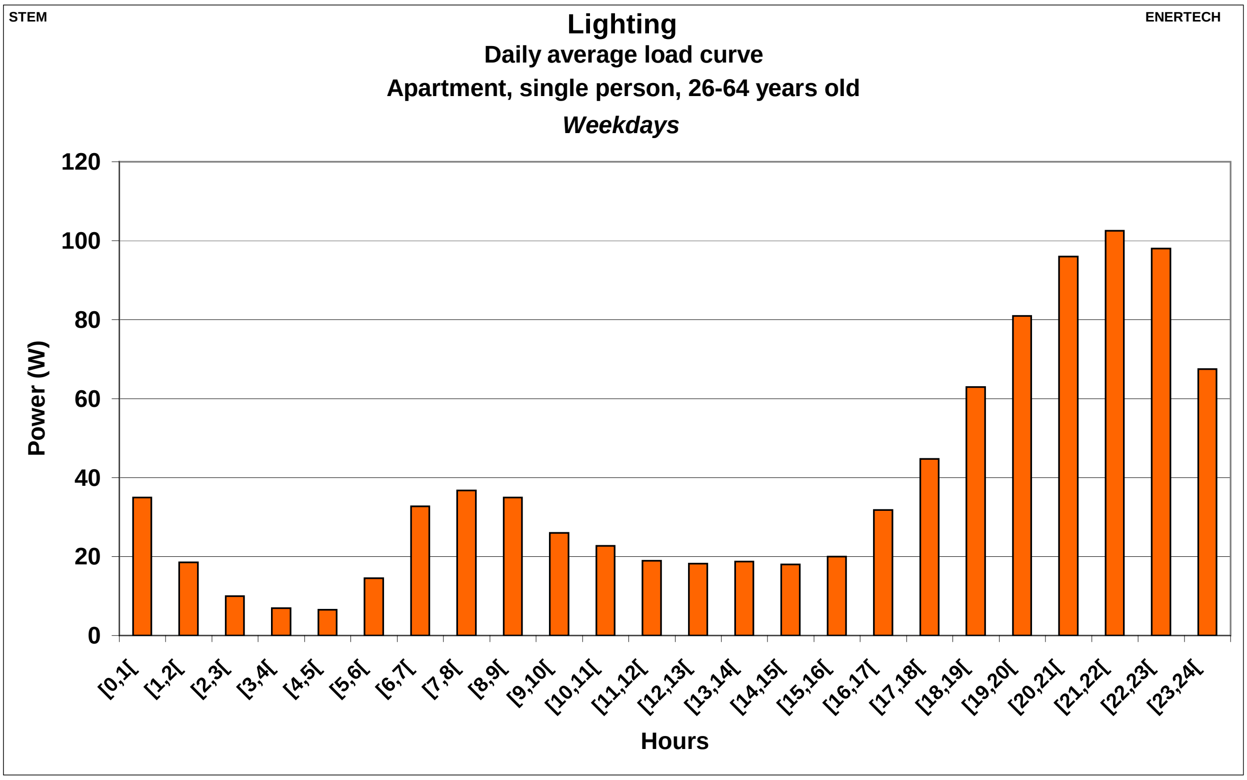


Figure 2.368: Lighting – Daily average load curve – Apartment, single person, 26-64 years old – Weekdays

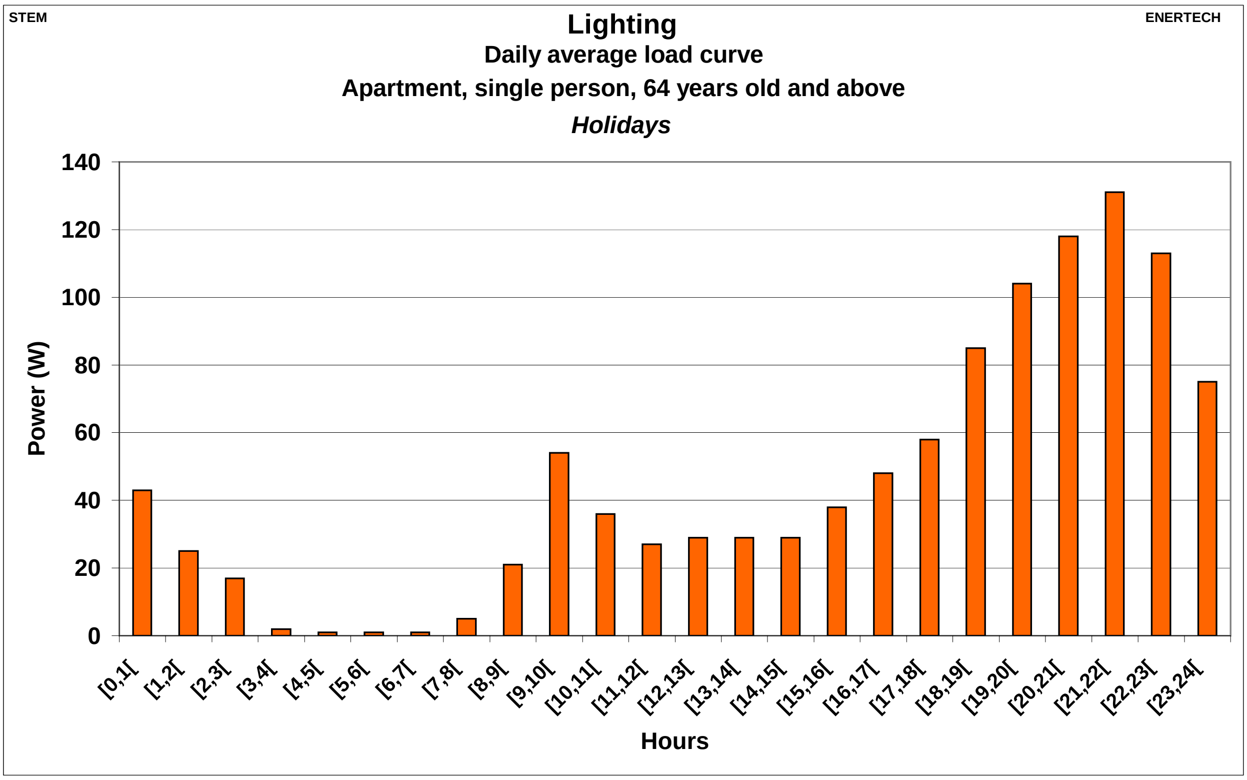


Figure 2.369: Lighting – Daily average load curve – Apartment, single person, 64 years old and above – Holidays

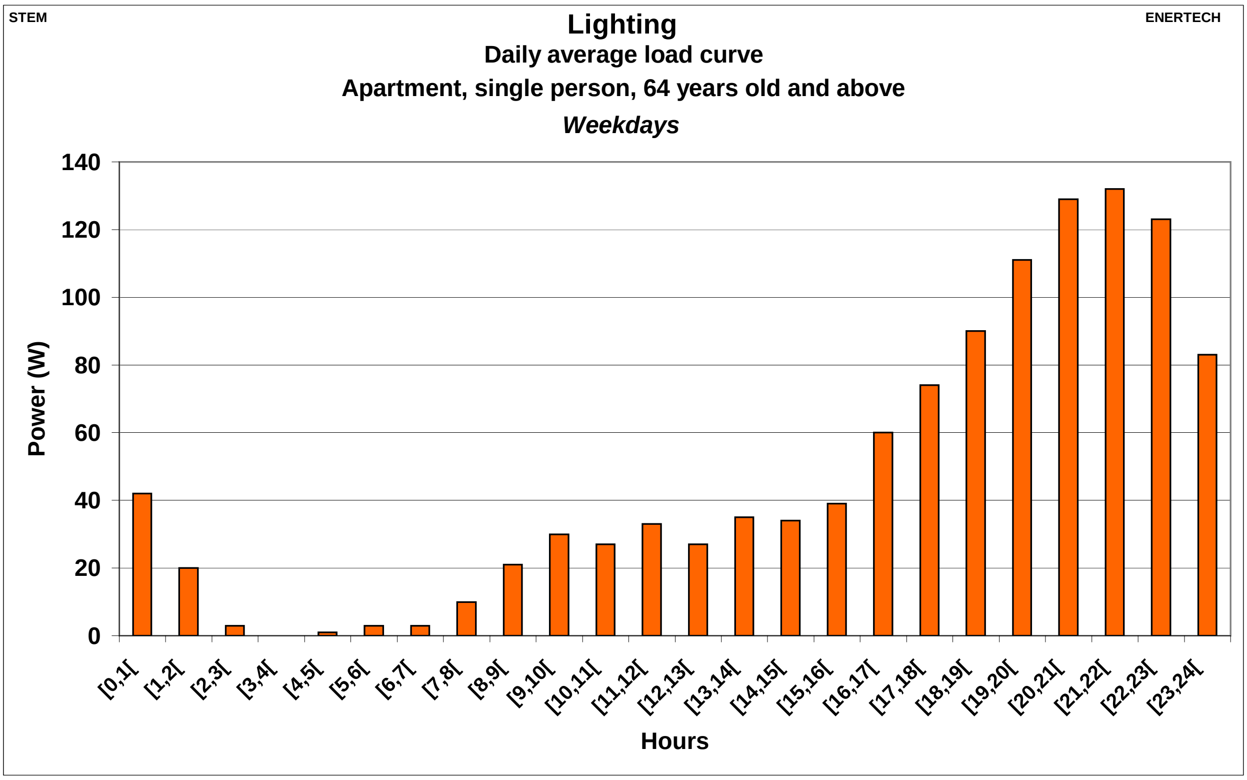


Figure 2.370: Lighting – Daily average load curve – Apartment, single person, 64 years old and above – Weekdays

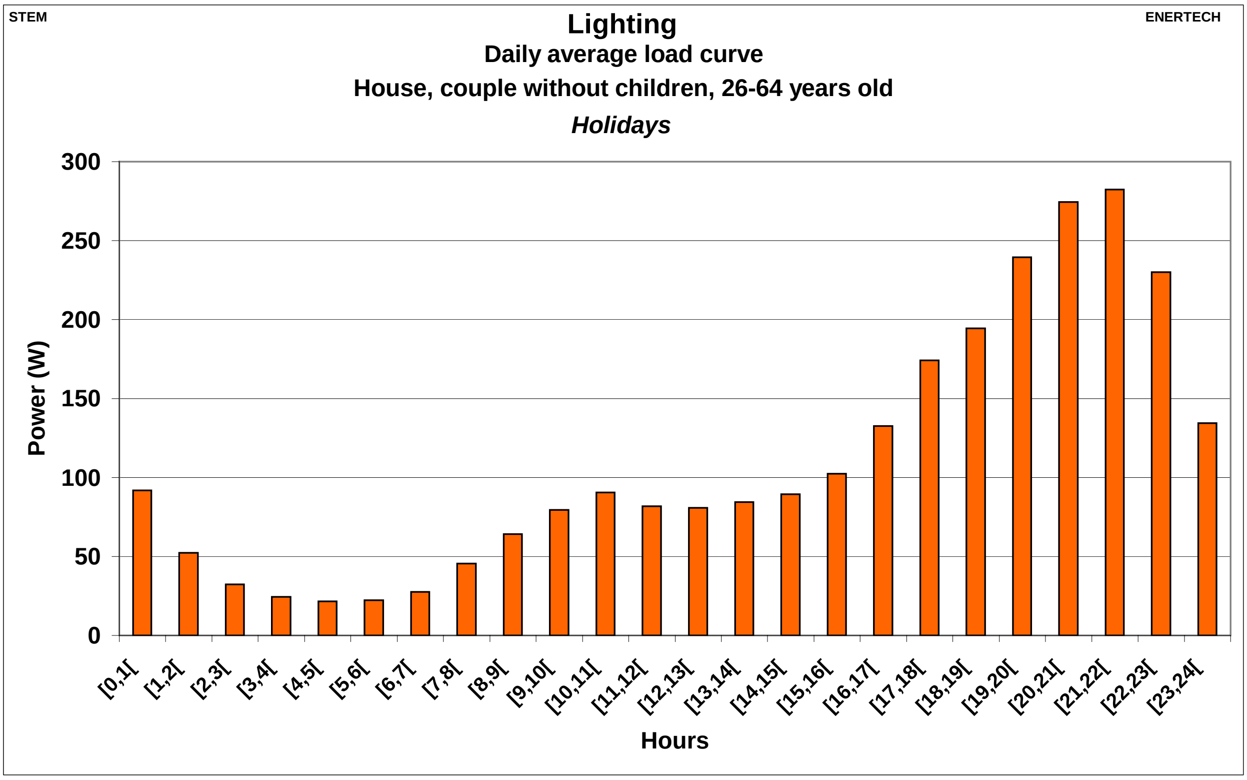


Figure 2.371: Lighting – Daily average load curve – House, couples without children, 26-64 years old – Holidays

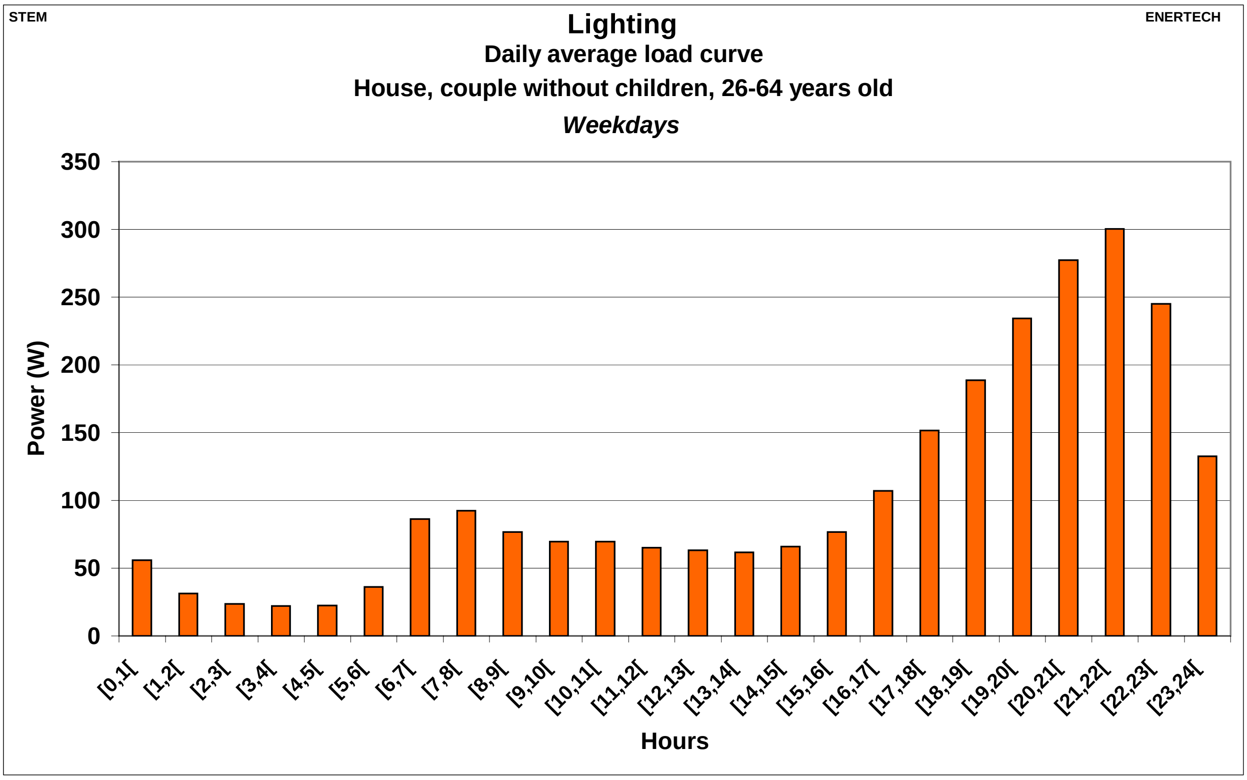


Figure 2.372: Lighting – Daily average load curve – House, couples without children, 26-64 years old – Weekdays

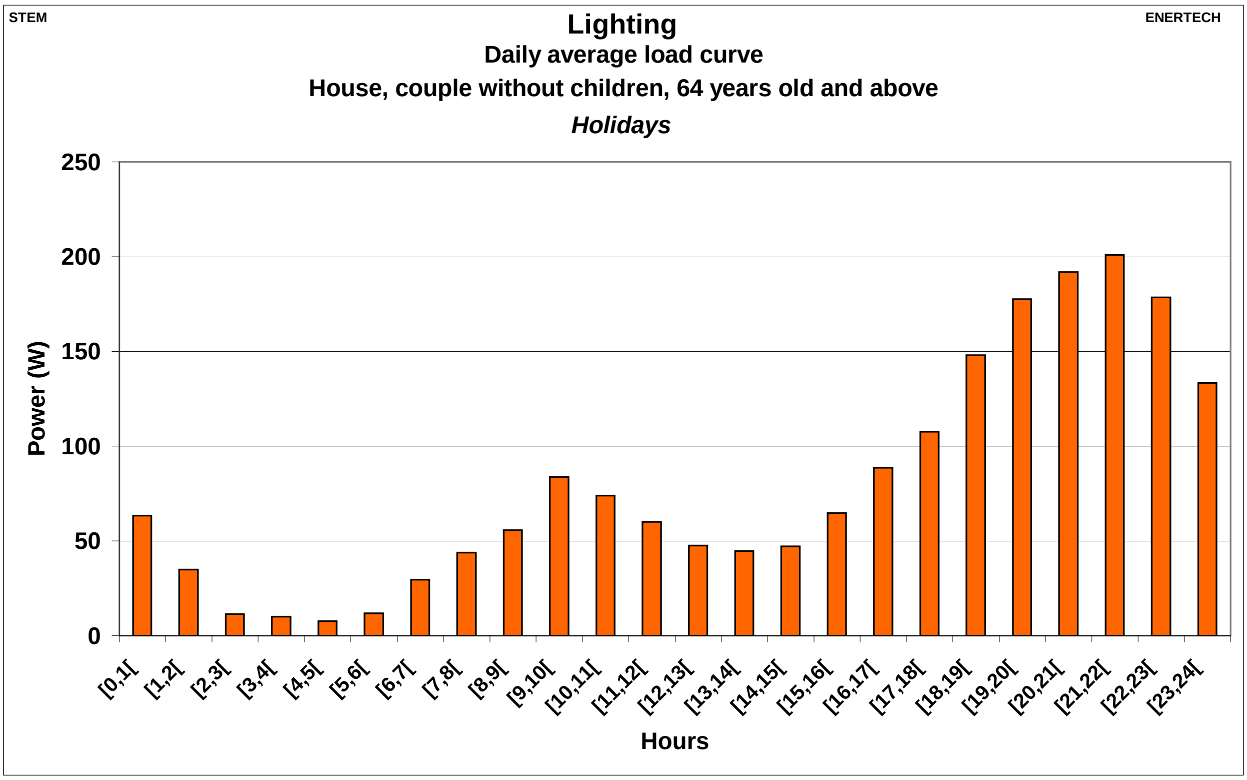


Figure 2.373: Lighting – Daily average load curve – House, couples without children, 64 years old and above – Holidays

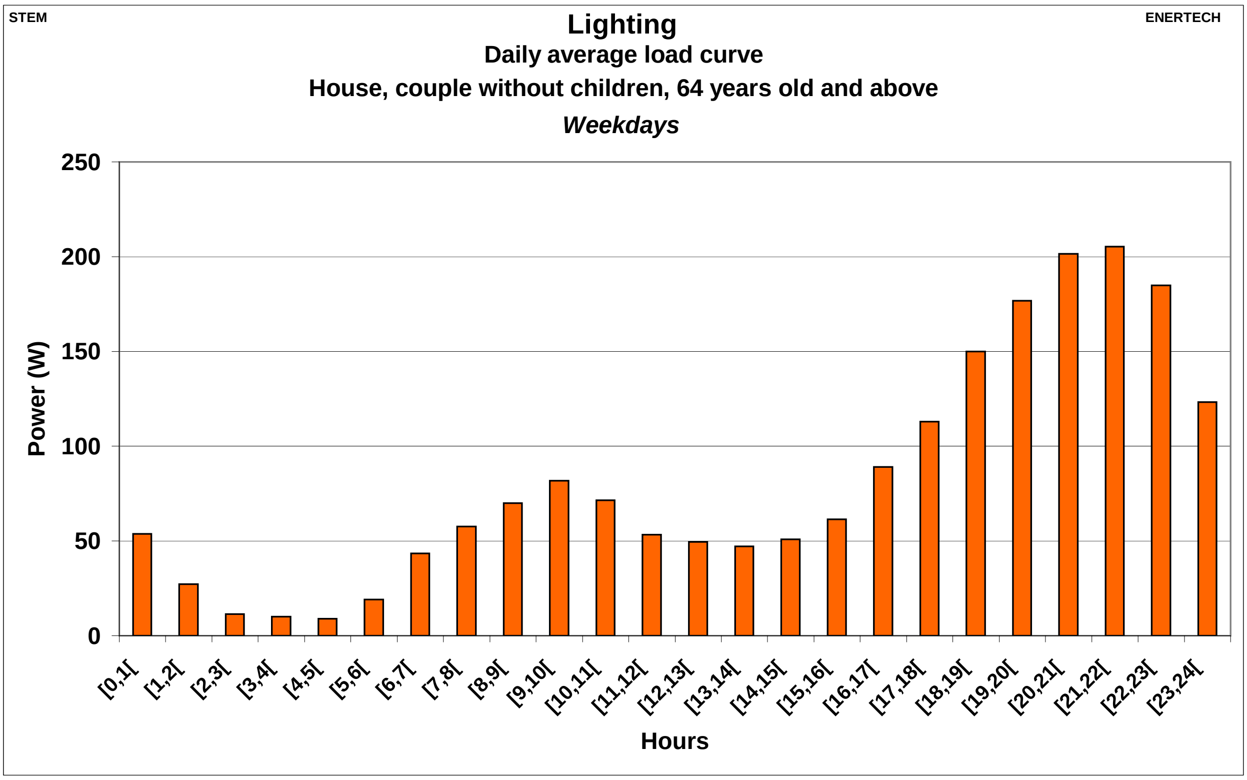


Figure 2.374: Lighting – Daily average load curve – House, couples without children, 64 years old and above – Weekdays

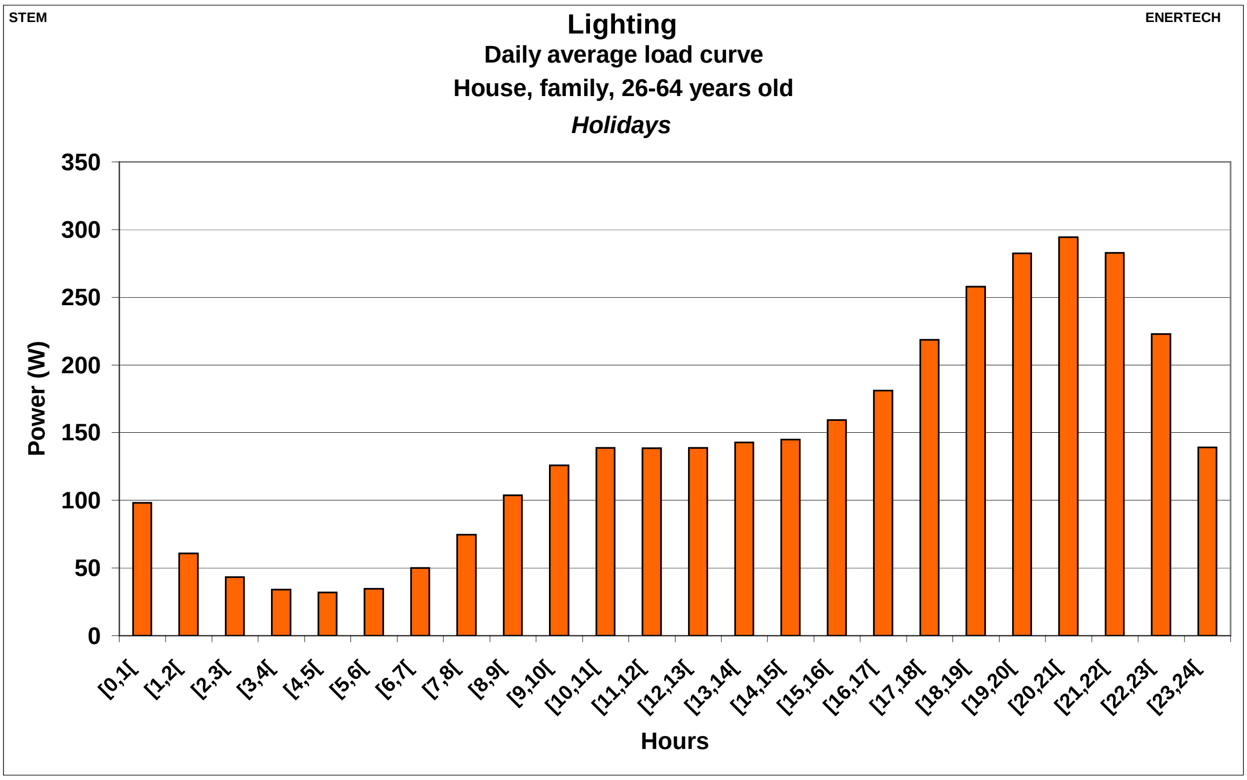


Figure 2.375: Lighting – Daily average load curve – House, family, 26-64 years old – Holidays

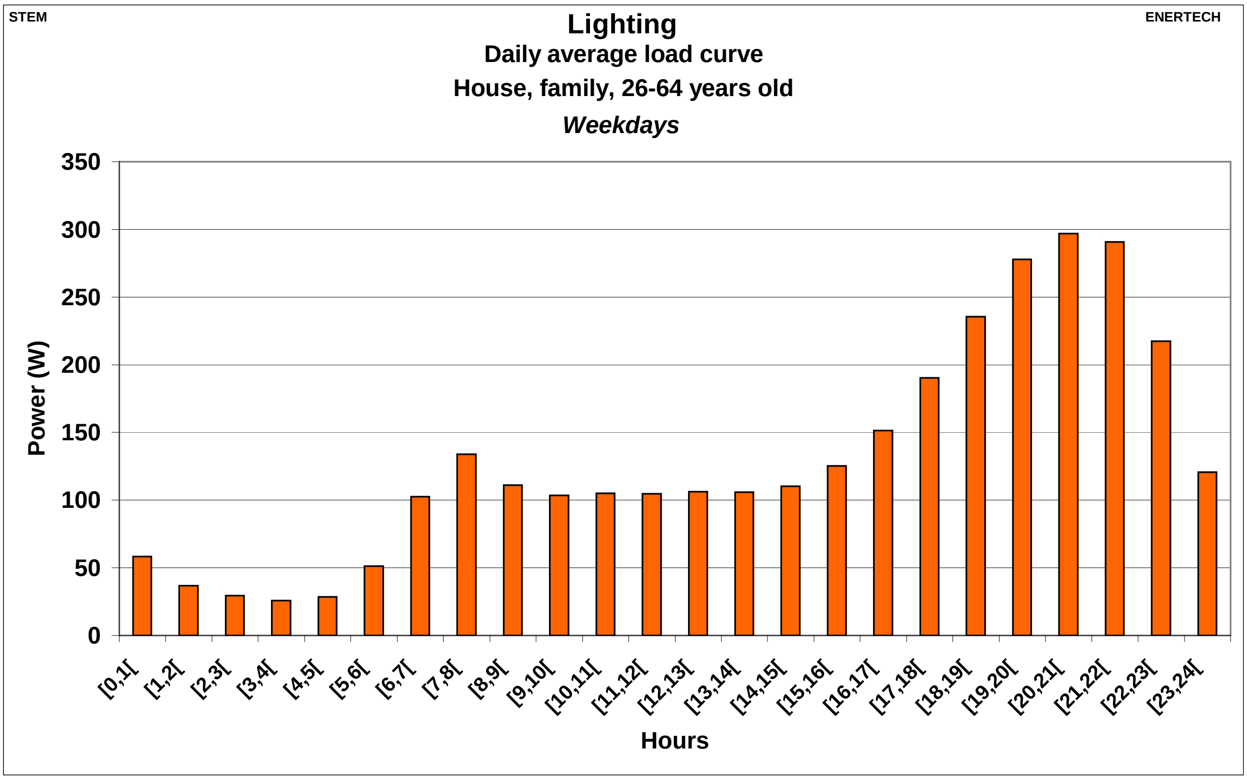


Figure 2.376: Lighting – Daily average load curve – House, family, 26-64 years old – Weekdays

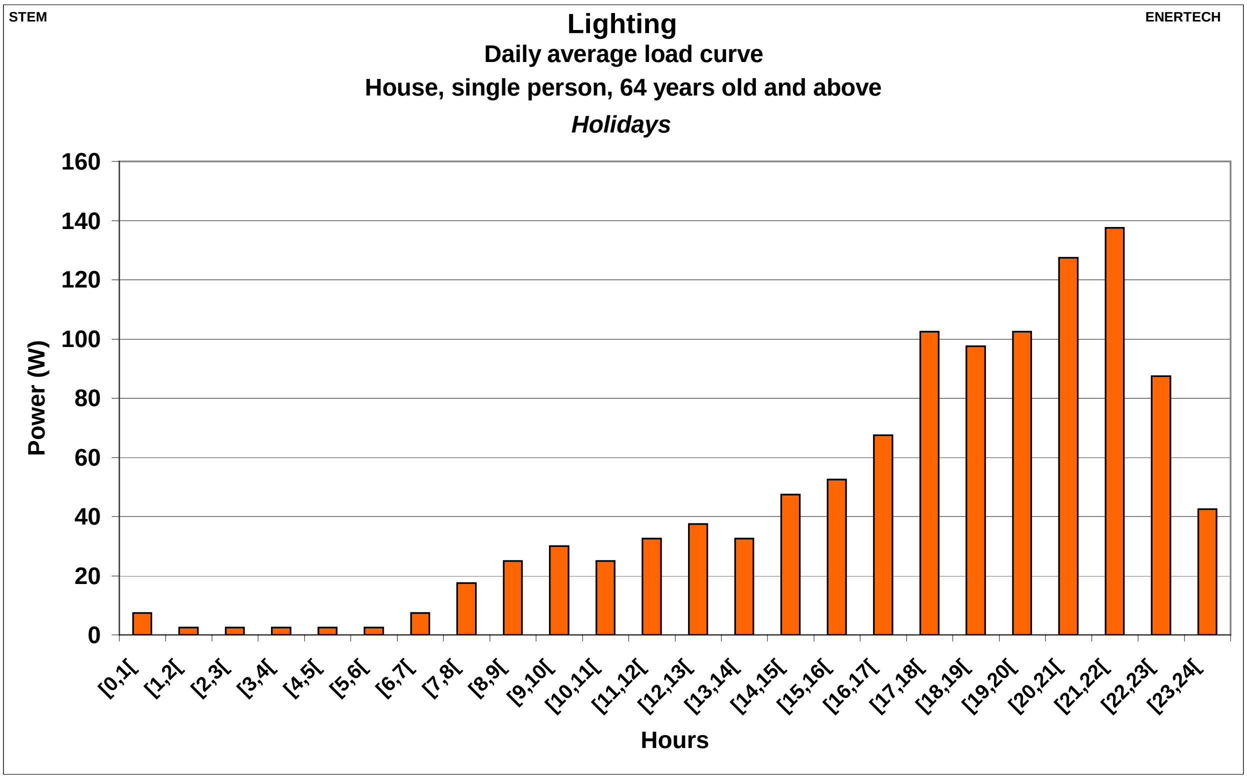


Figure 2.377: Lighting – Daily average load curve – House, single person, 64 years old and above – Holidays

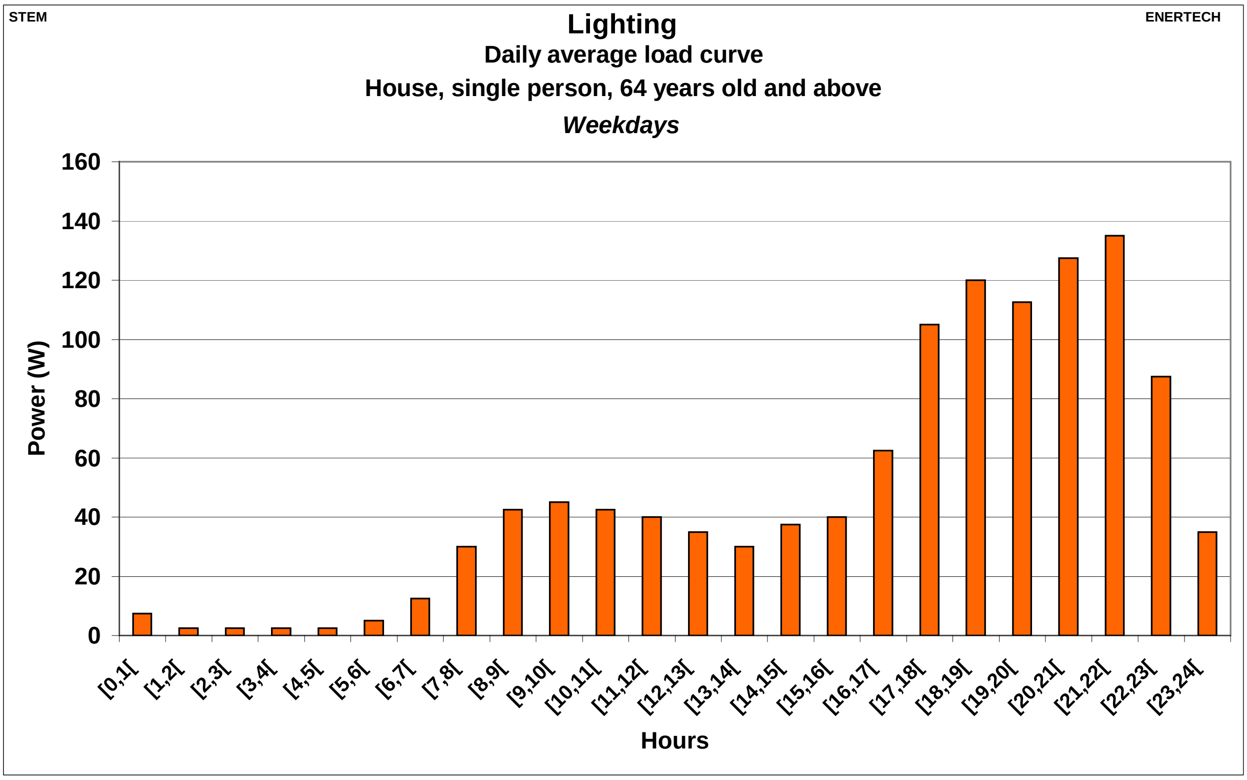


Figure 2.378: Lighting – Daily average load curve – House, single person, 64 years old and above – Weekdays

AUDIOVISUAL SITE

Description of the monitored equipment

In order to limit the number of meters used, parts of the existing appliances were monitored together with TV’s always monitored apart. We rather looked for a total vision of the audiovisual consumptions, by monitoring in each household the « audiovisual site». This site usually groups all the equipment that are around television sets. Here is the average composition of the audiovisual site for houses and apartments:

Device	Houses	Apartments
TV	2,11	1,52
Hi-fi	1,12	0,88
DVD player	0,98	0,73
VCR	0,83	0,72
Satellite	0,72	0,29
Home cinema	0,12	0,08
Xbox	0,05	0,02
Surround system	0,03	0,00
PS2	0,03	0,07
Projector	0,02	0,02
Cable TV Box	0,01	0,01
Tuner	0,01	0,01

Figure 2.379.1: Composition of the audiovisual site

The table from Figure 2.379.2 shows the individual numbers of each appliance composing the audiovisual site:

Device	Houses	Apartments
TV	419	285
Hi-fi	223	166
DVD	195	138
VCR	166	136
Satellite	143	55
Home cinema	23	15
Xbox	9	4
Surround system	6	0
PS2	6	13
Projector	3	3
Cable TV Box	1	1
Tuner	1	1

Figure 2.379.2: Number of appliances monitored per type of appliance

Seasonality effect

The consumption for audiovisual is strongly seasonal, but most of the households were only monitored for one month. The seasonality effect was calculated using the 40 households monitored for one year. For each household, we calculated the weekly consumption by adding all the data per week. The result output consists of 52 values per household corresponding to the number of weeks in one year. This set of values was then normalized to 1 (the average value gives one for each set). An average value per week was then calculated using all the data sets. We calculated two different seasonality curves, one for "Audiovisual site excl. TV" and one for the TV. Figures 2.379.1 and 2.379.2 represent the seasonality curve calculated by this method. These curves were used to calculate the annual consumption for the audiovisual sites and TV's monitored for less than six month. We summed the two results to create the Audiovisual site as analyzed in this chapter.

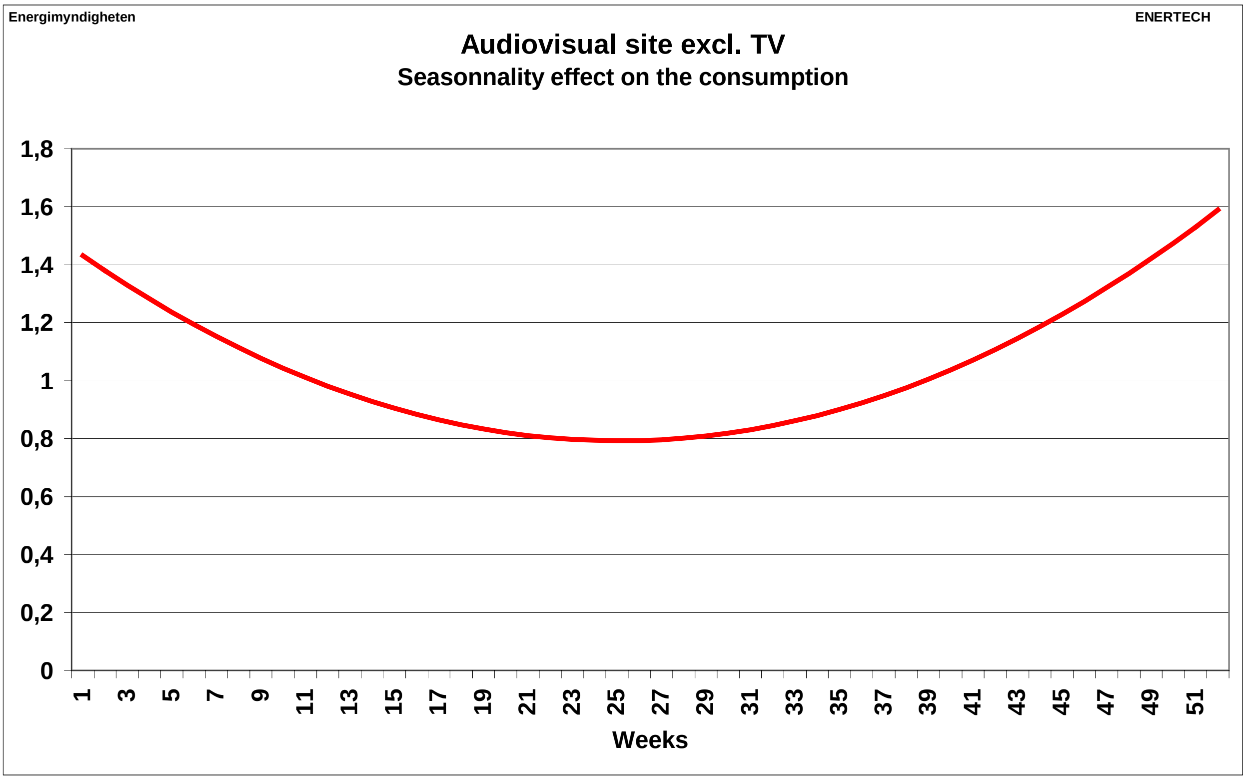


Figure 2.379.1: Audiovisual site excl. TV – Seasonality effect on the consumption

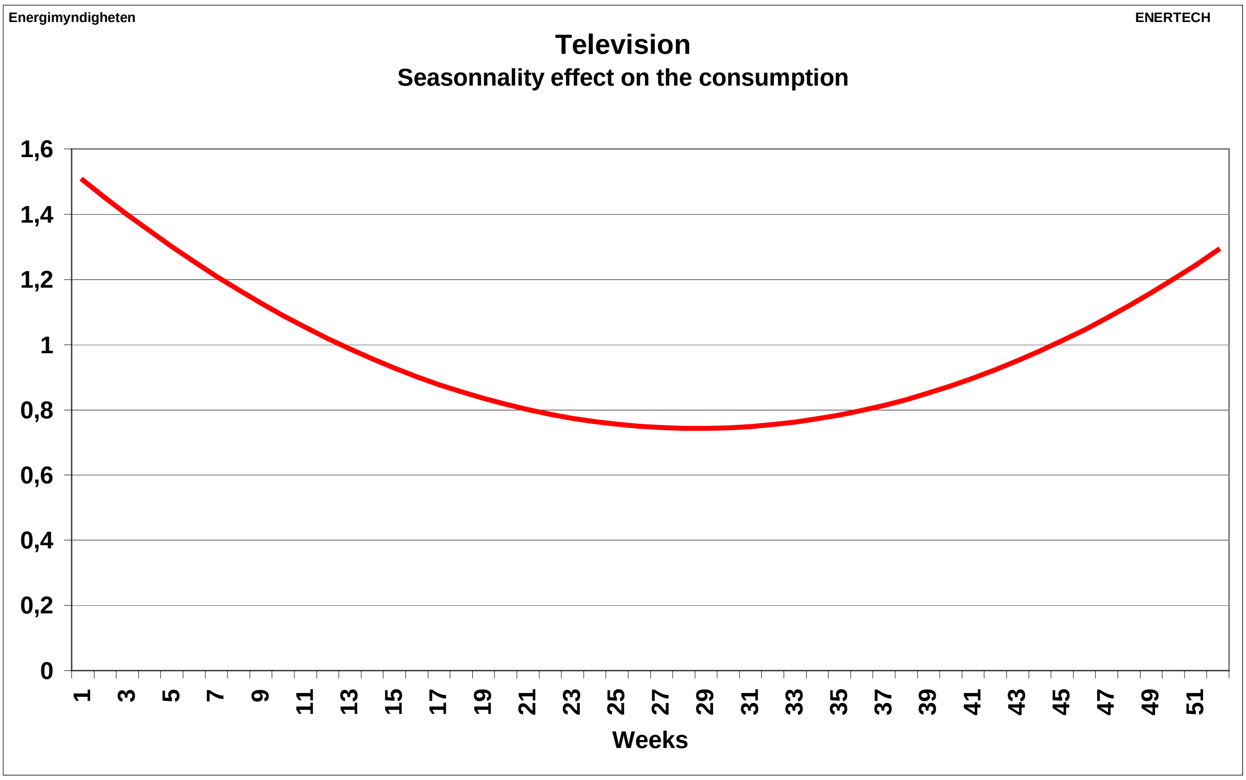


Figure 2.379.2: Television – Seasonality effect on the consumption

Annualized consumption

Figures 2.379 to 2.387 represent the distribution of the total audiovisual site consumption for the different household categories. For houses, the annual consumption is in the range 233-428 kWh/year and 185-309 kWh/year for apartments.

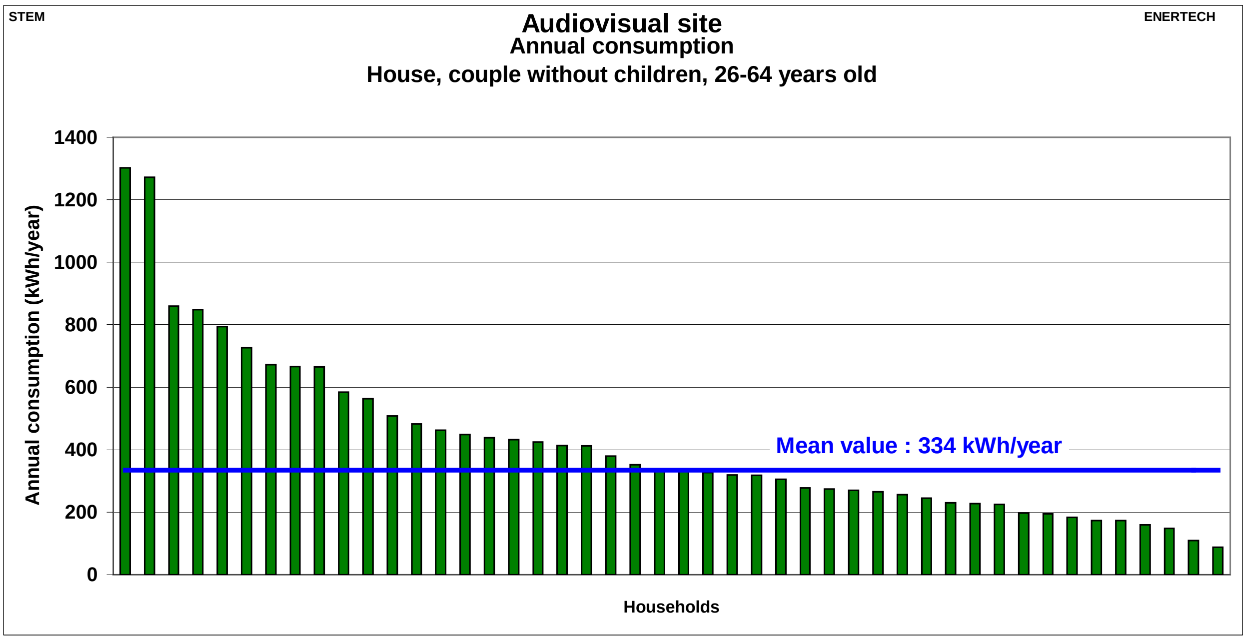


Figure 2.379: Audiovisual site – Annual consumption – House, couples without children, 26-64 years old

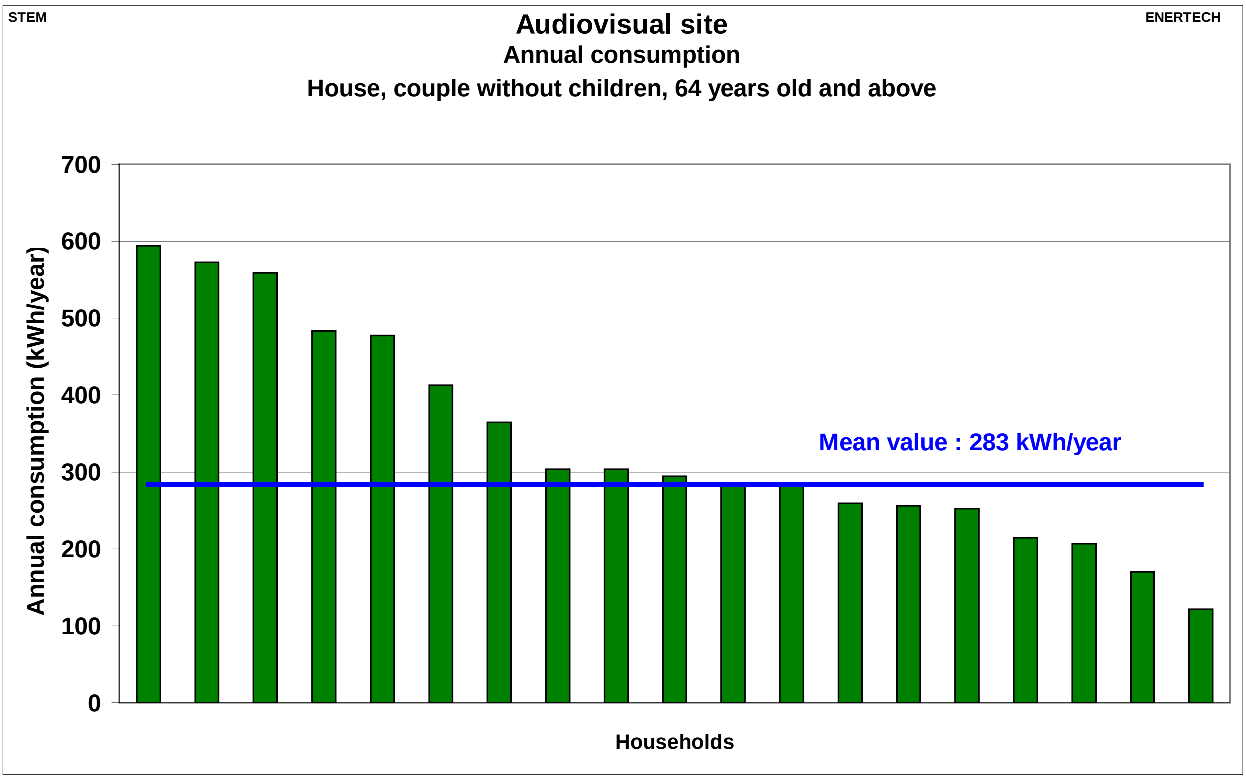


Figure 2.380: Audiovisual site – Annual consumption – House, couples without children, 64 years old and above

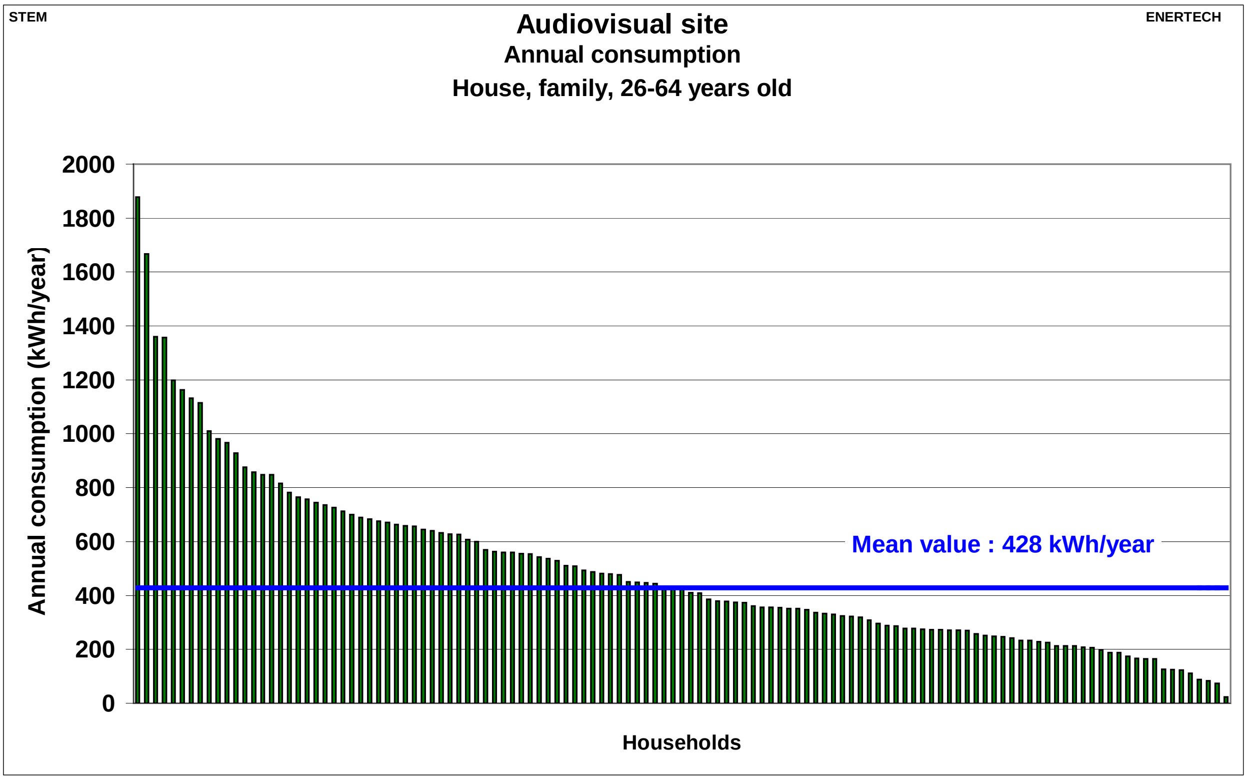


Figure 2.381: Audiovisual site – Annual consumption – House, family, 26-64 years old

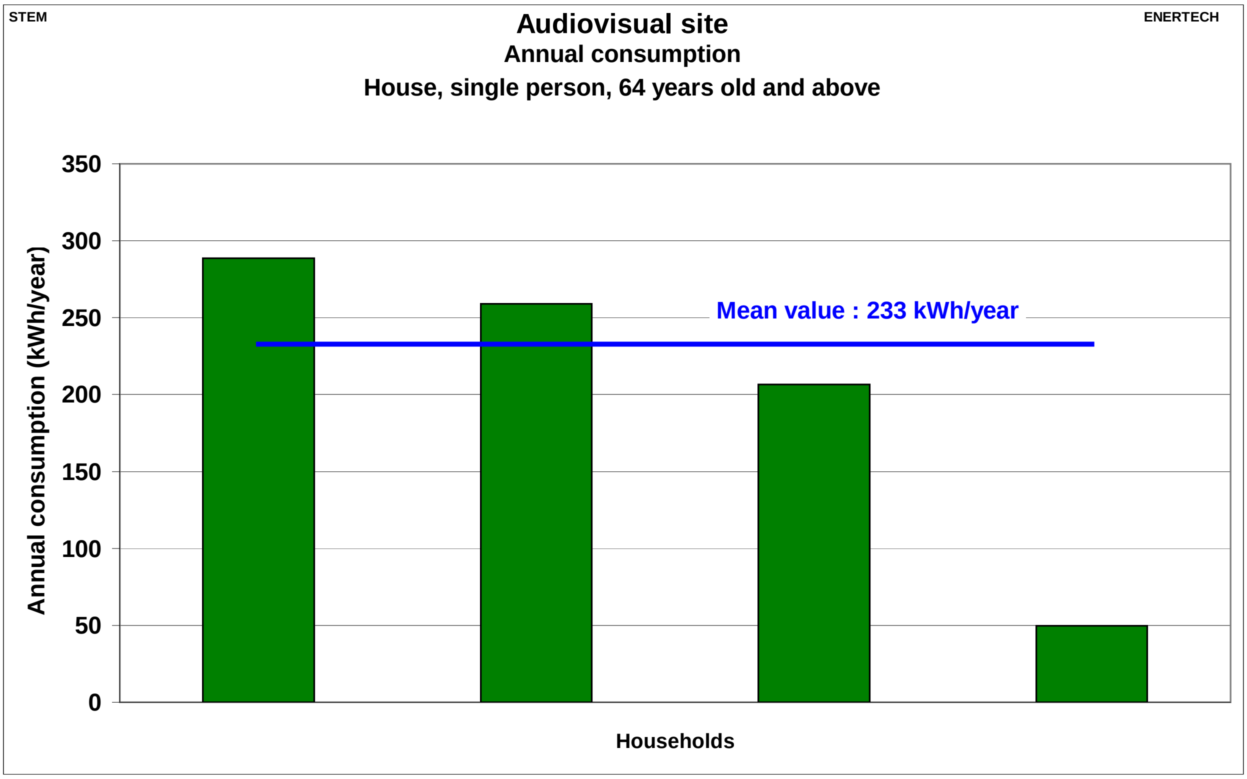


Figure 2.382: Audiovisual site – Annual consumption – House, single person, 64 years old and above

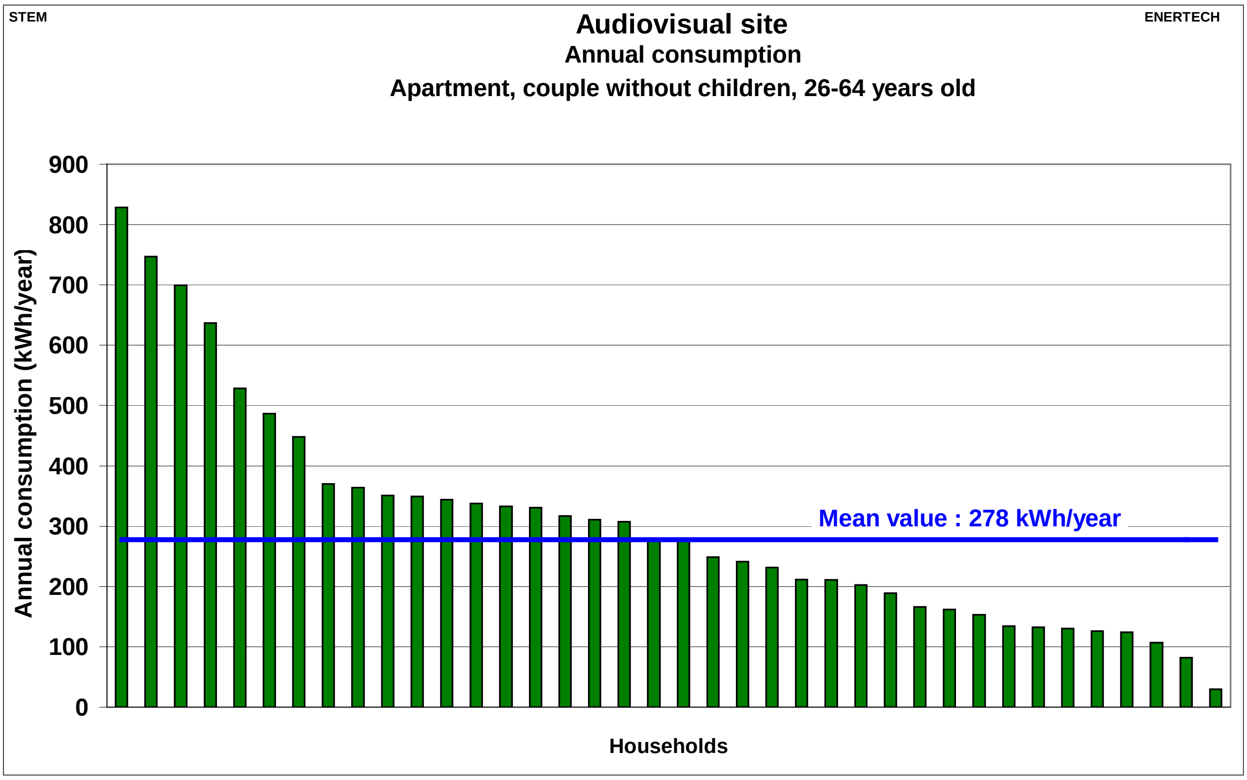


Figure 2.383: Audiovisual site – Annual consumption – Apartment, couples without children, 26-64 years old

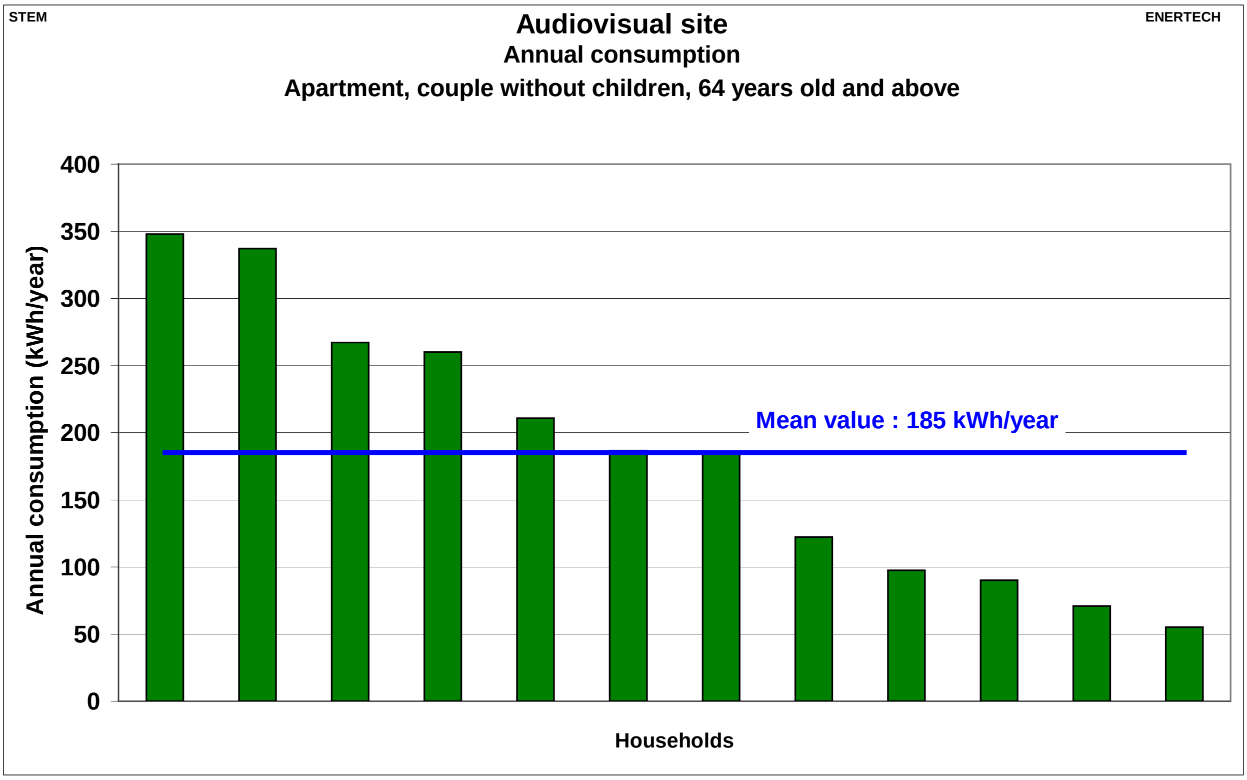


Figure 2.384: Audiovisual site – Annual consumption – Apartment, couples without children, 64 years old and above

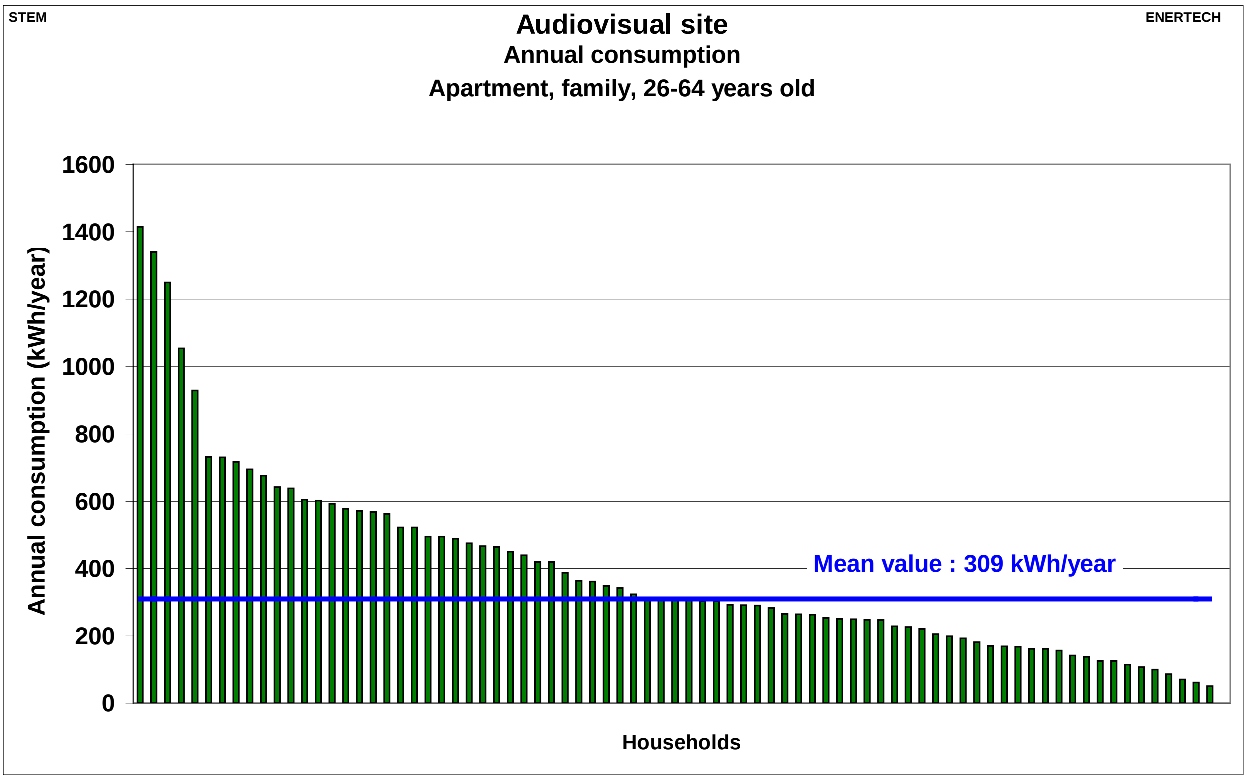


Figure 2.385: Audiovisual site – Annual consumption – Apartment, family, 26-64 years old

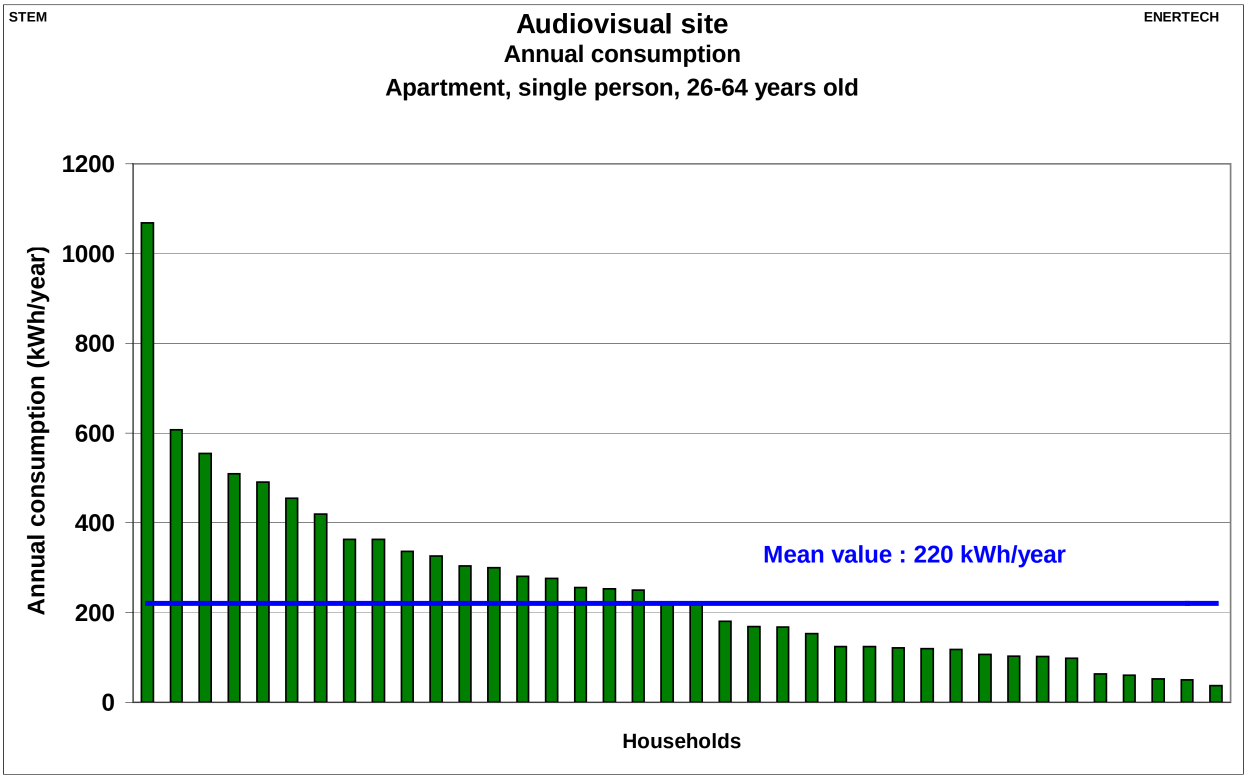


Figure 2.386: Audiovisual site – Annual consumption – Apartment, single person, 26-64 years old

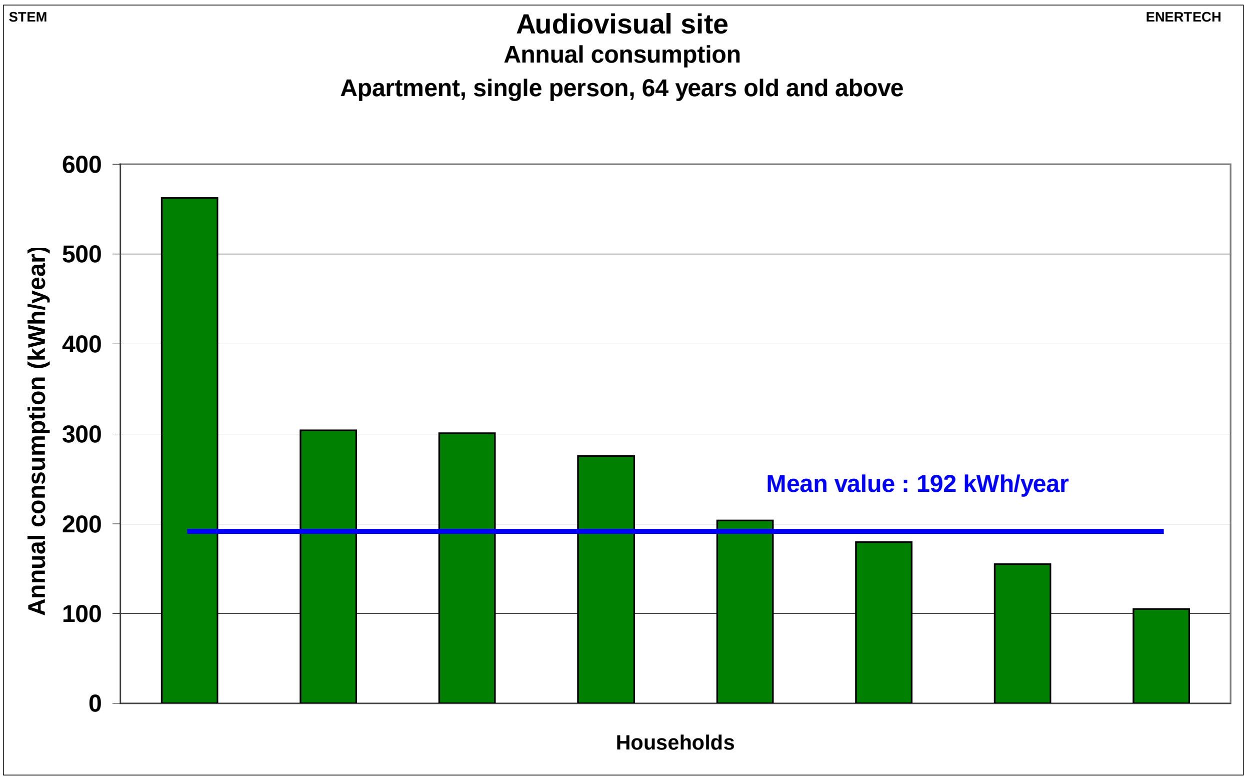


Figure 2.387: Audiovisual site – Annual consumption – Apartment, single person, 64 years old and above

Figure 2.388 shows the annual consumption per person as a function of the number of persons in the household. The values per person should be treated with some care, since the family structure has to be taken into account as well. We can see that the more persons are in the household, the lower is the consumption per person. This indicates that the annual consumption for the audiovisual site is not a direct function of the number of persons. This can be understood easily: the consumption of a TV will remain the same if there is 1 person in front of the TV or 6.

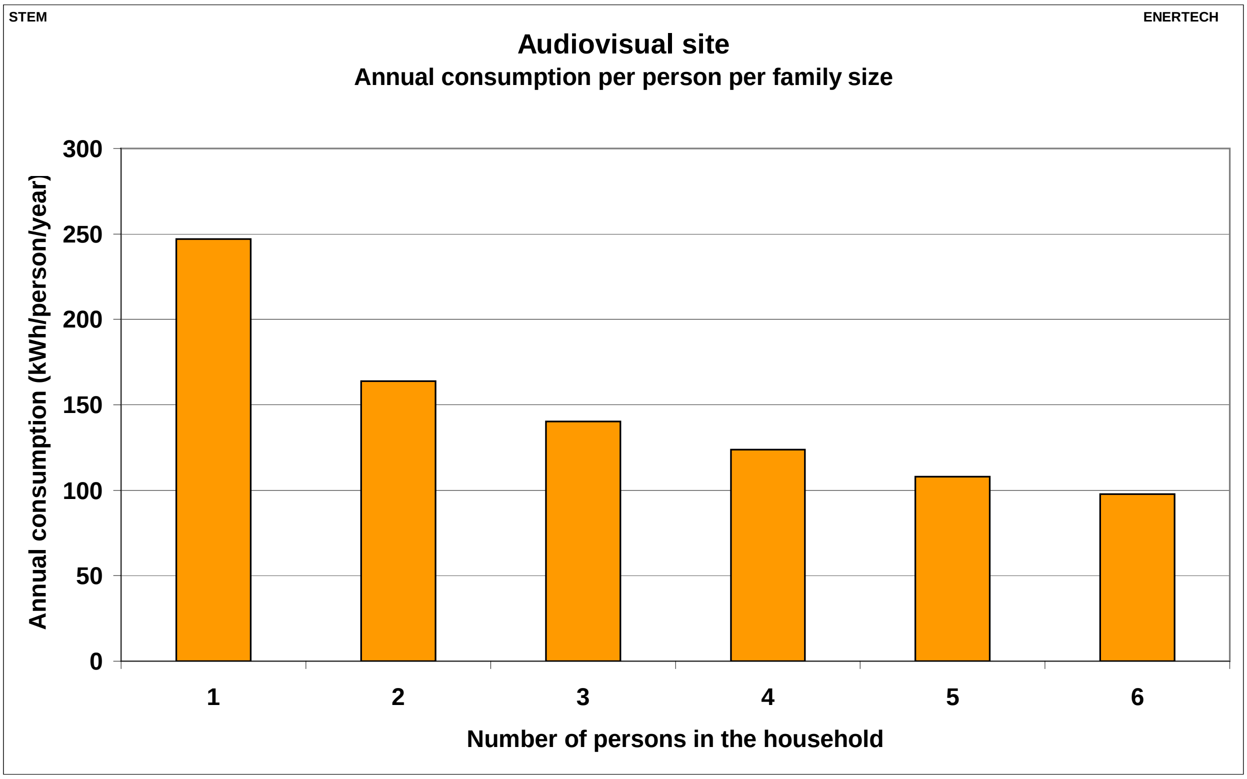


Figure 2.388: Audiovisual site – Annual consumption per person per family size

Hourly load curve per type of household

Figures 2.389 to 2.406 represents the average hourly load curve observed, for each type of household.

It is notable that audiovisual consumption during the night exists in all types of households. It is less than probable that this consumption could be entirely due to night users but more probably due to Standby consumptions. Here is also a potential energy saving that is sometimes significant.

The main peak is always between 20:00 and 22:00. The maximum power demand for the two types of households is always obtained for families.

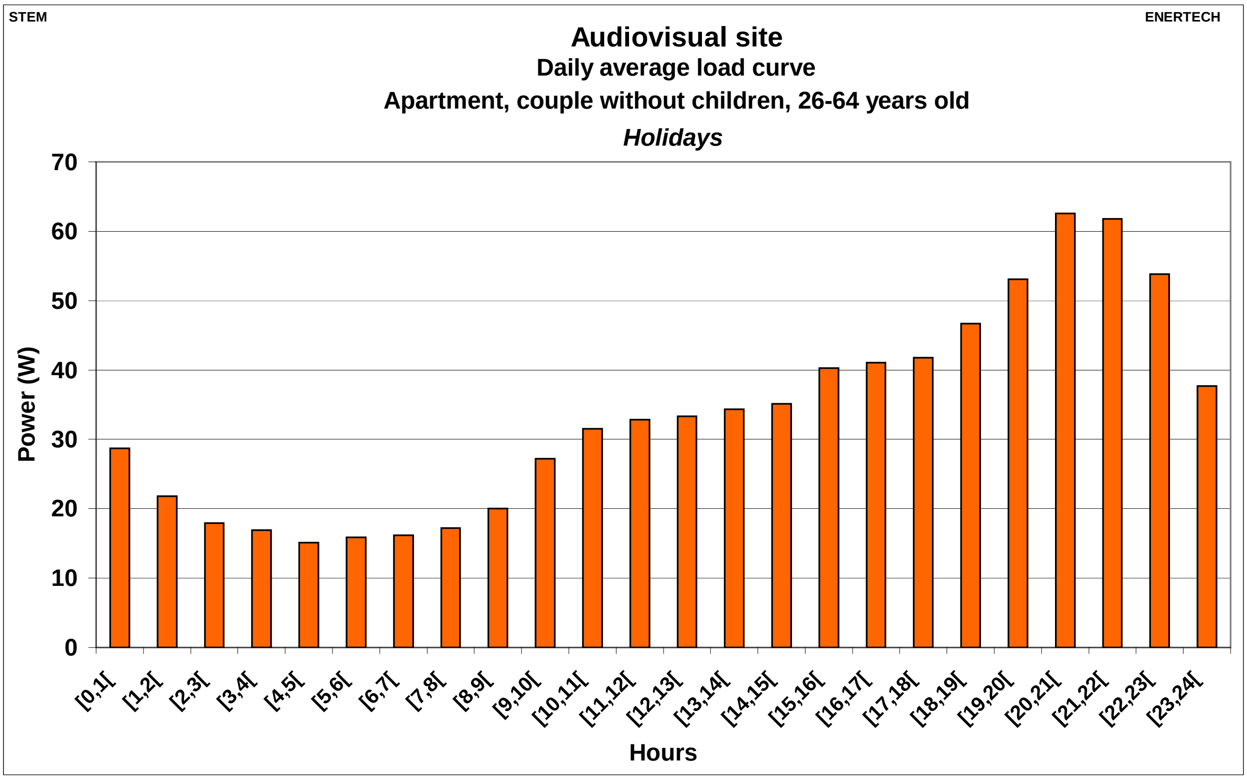


Figure 2.389: Audiovisual site – Daily average load curve – Apartment, couples without children, 26-64 years old – Holidays

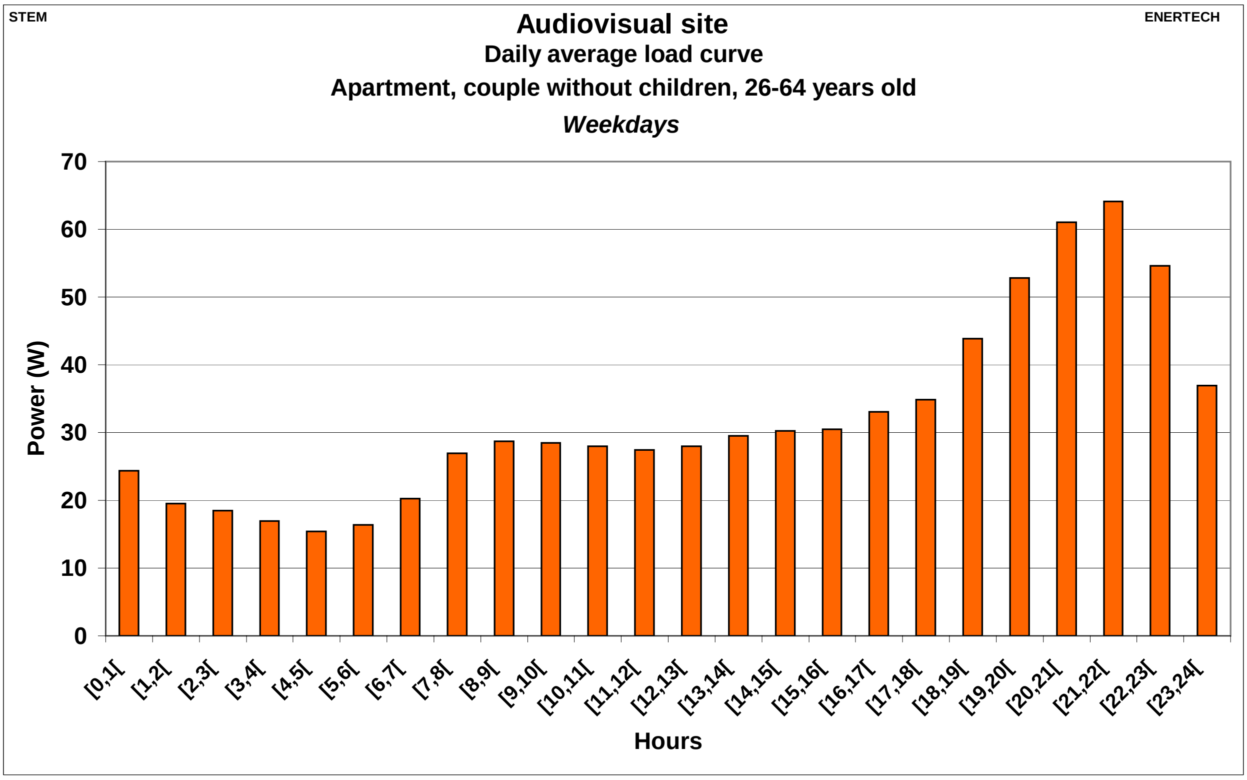


Figure 2.390: Audiovisual site – Daily average load curve – Apartment, couples without children, 26-64 years old – Weekdays

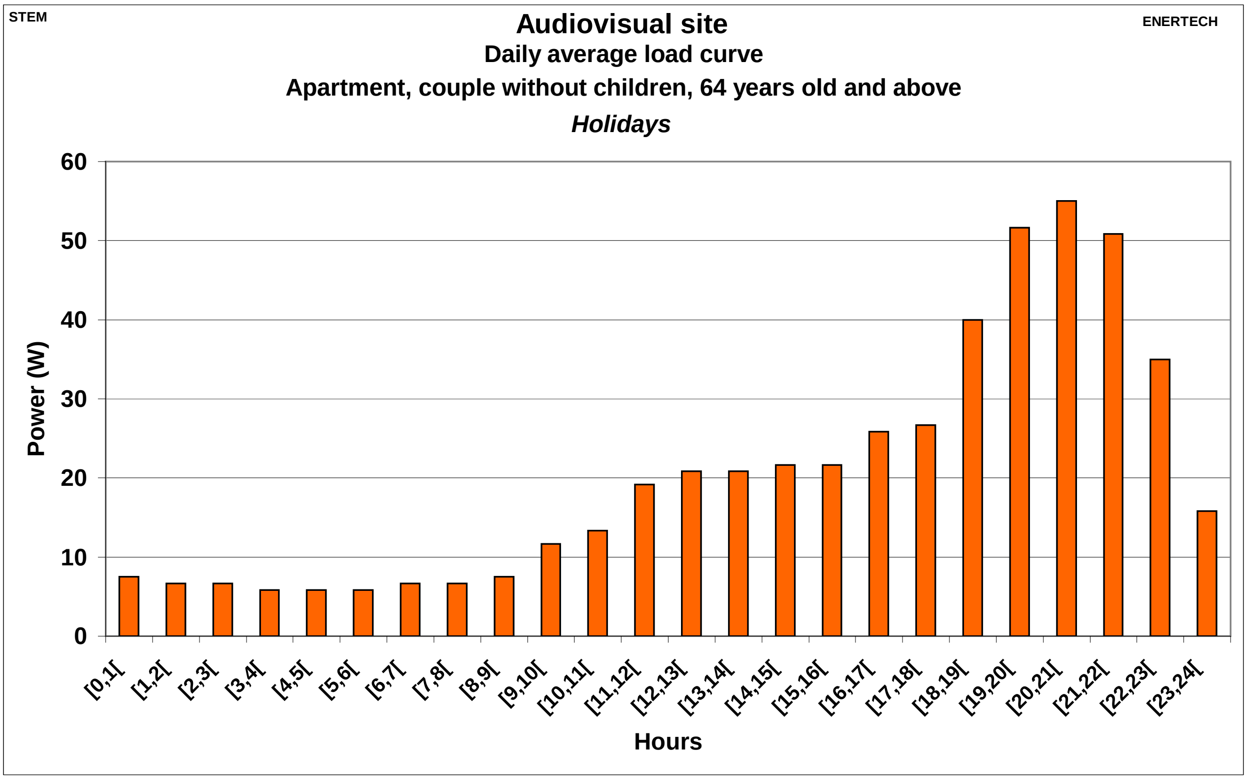


Figure 2.391: Audiovisual site – Daily average load curve – Apartment, couples without children, 64 years old and above – Holidays

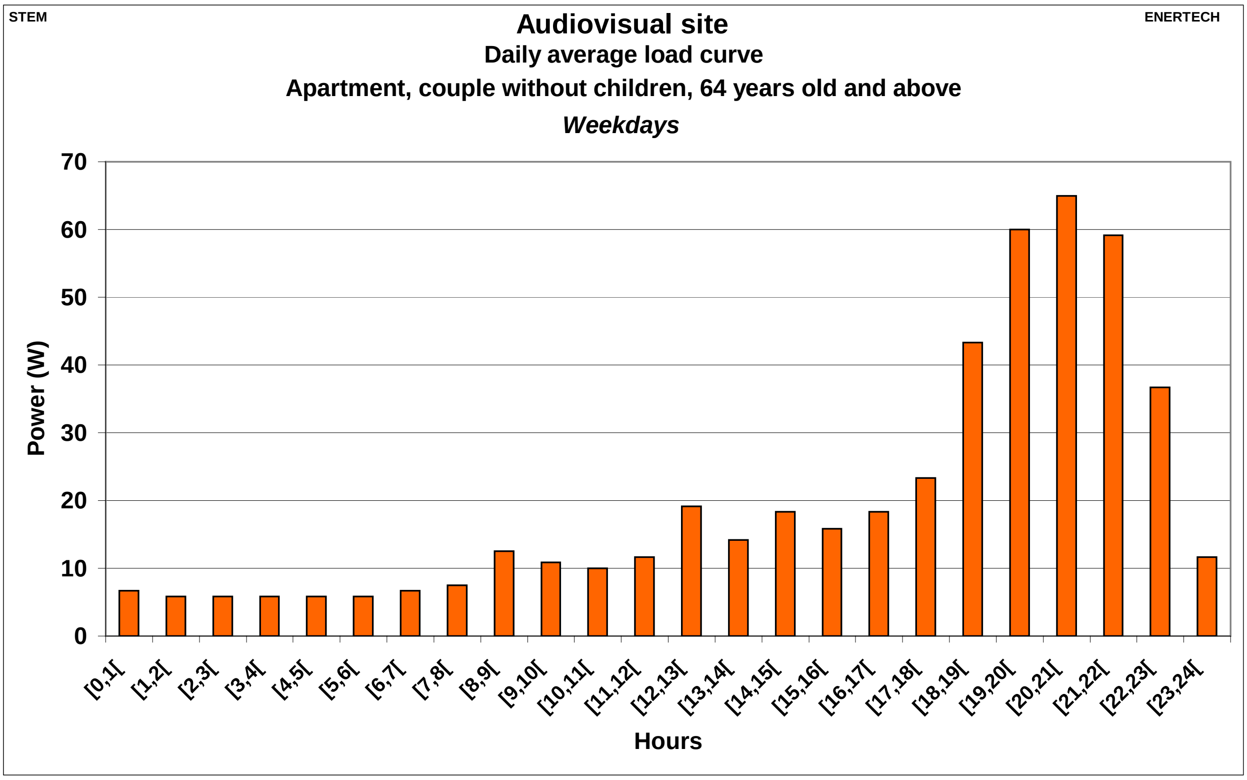


Figure 2.392: Audiovisual site – Daily average load curve – Apartment, couples without children, 64 years old and above – Weekdays

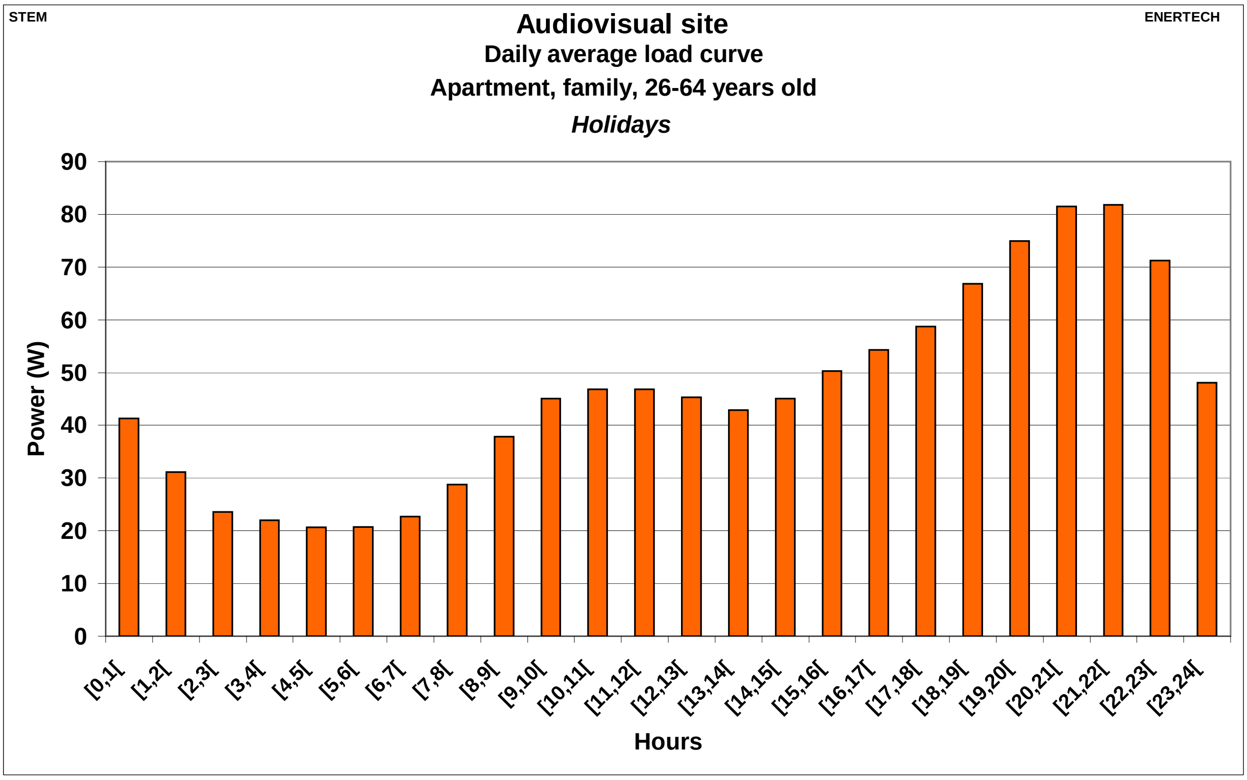


Figure 2.393: Audiovisual site – Daily average load curve – Apartment, family, 26-64 years old – Holidays

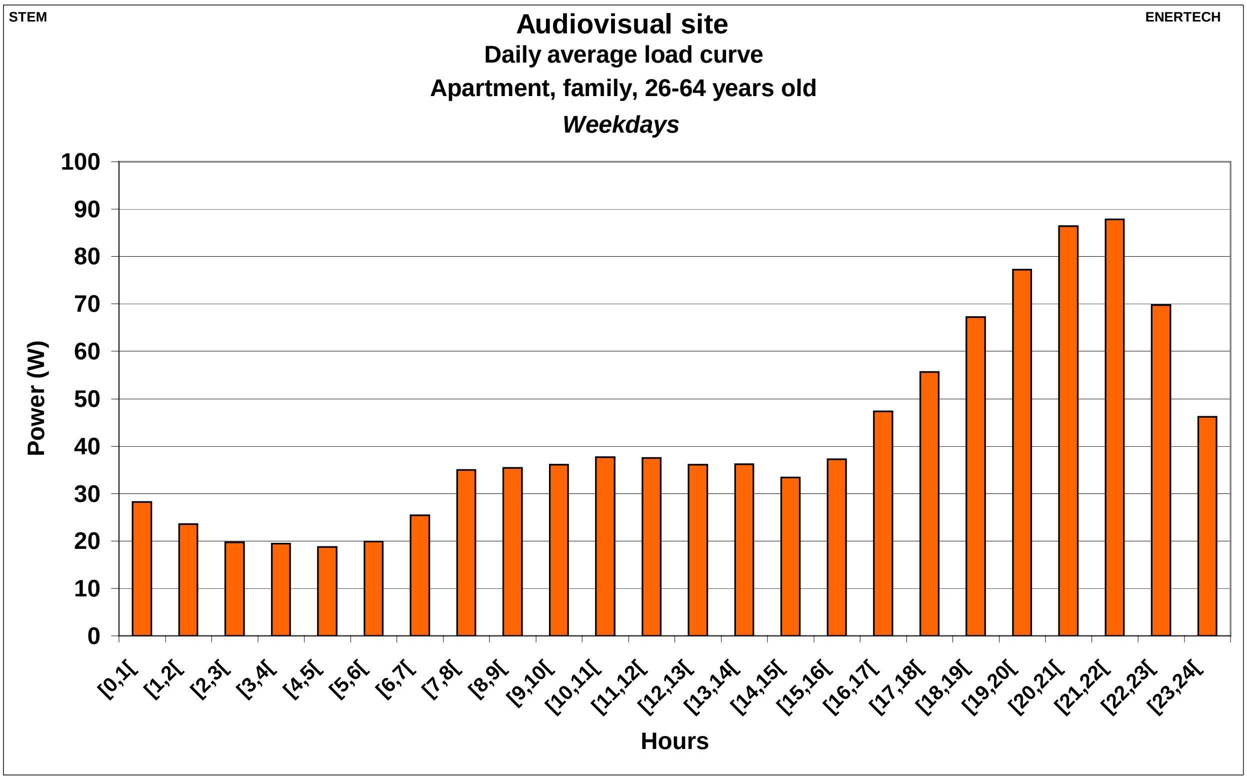


Figure 2.394: Audiovisual site – Daily average load curve – Apartment, family, 26-64 years old – Weekdays

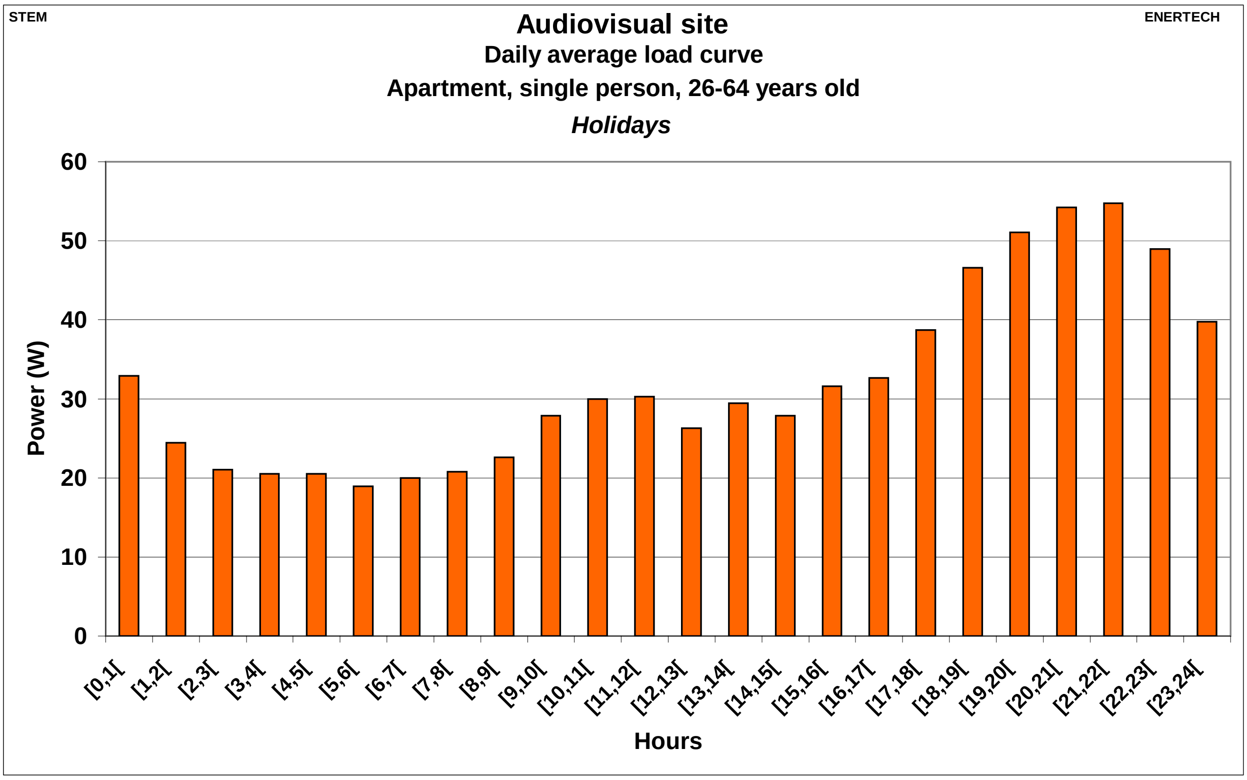


Figure 2.395: Audiovisual site – Daily average load curve – Apartment, single person, 26-64 years old – Holidays

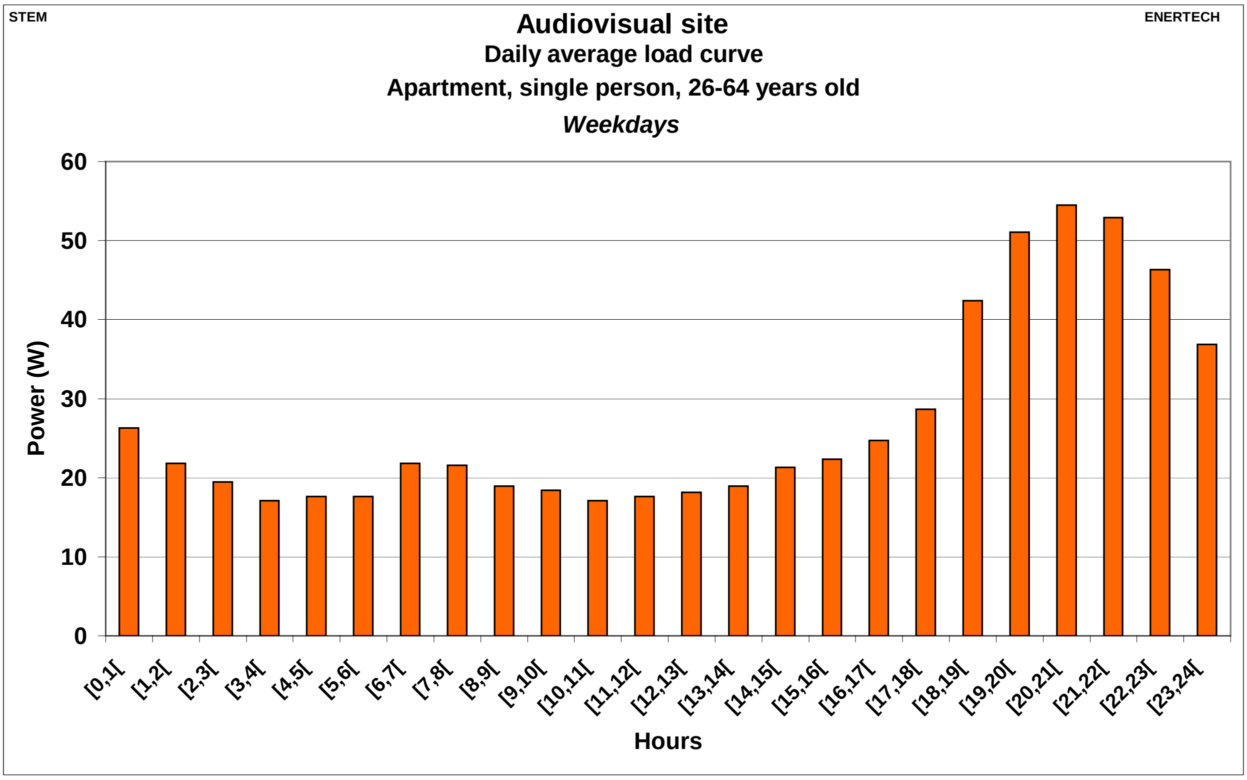


Figure 2.396: Audiovisual site – Daily average load curve – Apartment, single person, 26-64 years old – Weekdays

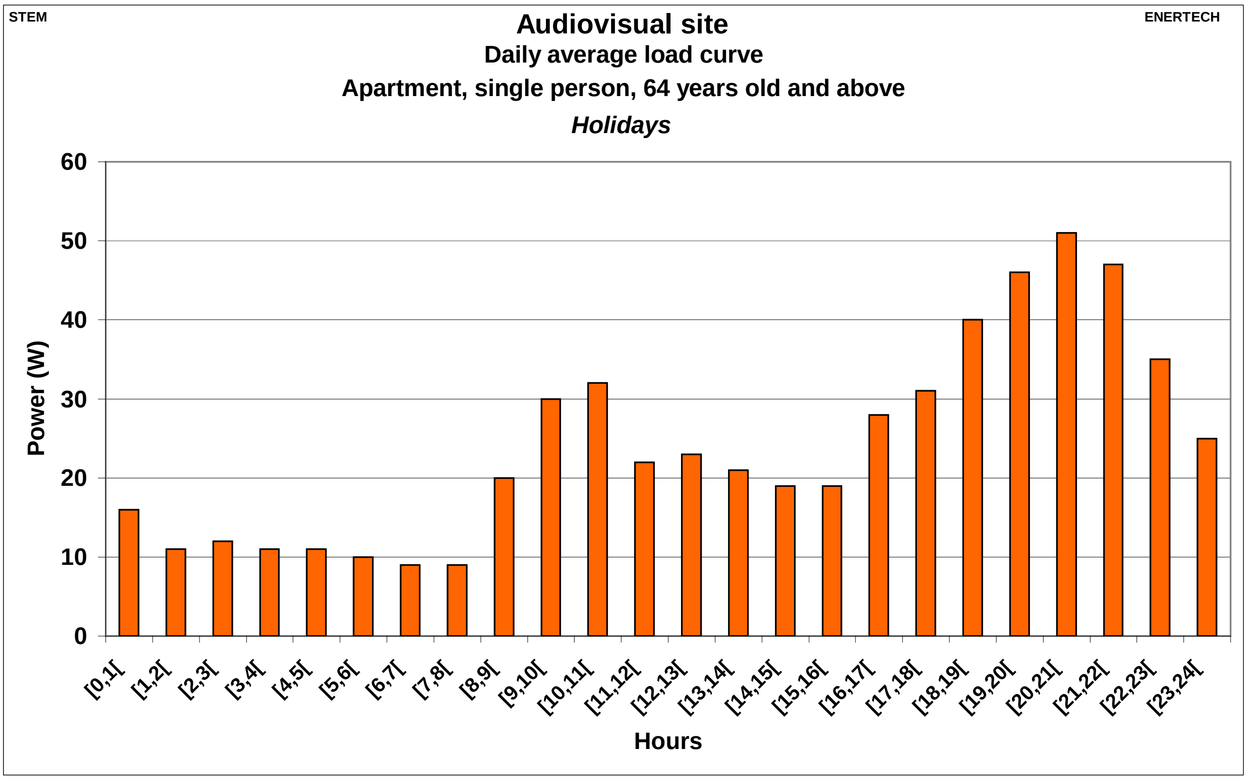


Figure 2.397: Audiovisual site – Daily average load curve – Apartment, single person, 64 years old and above – Holidays

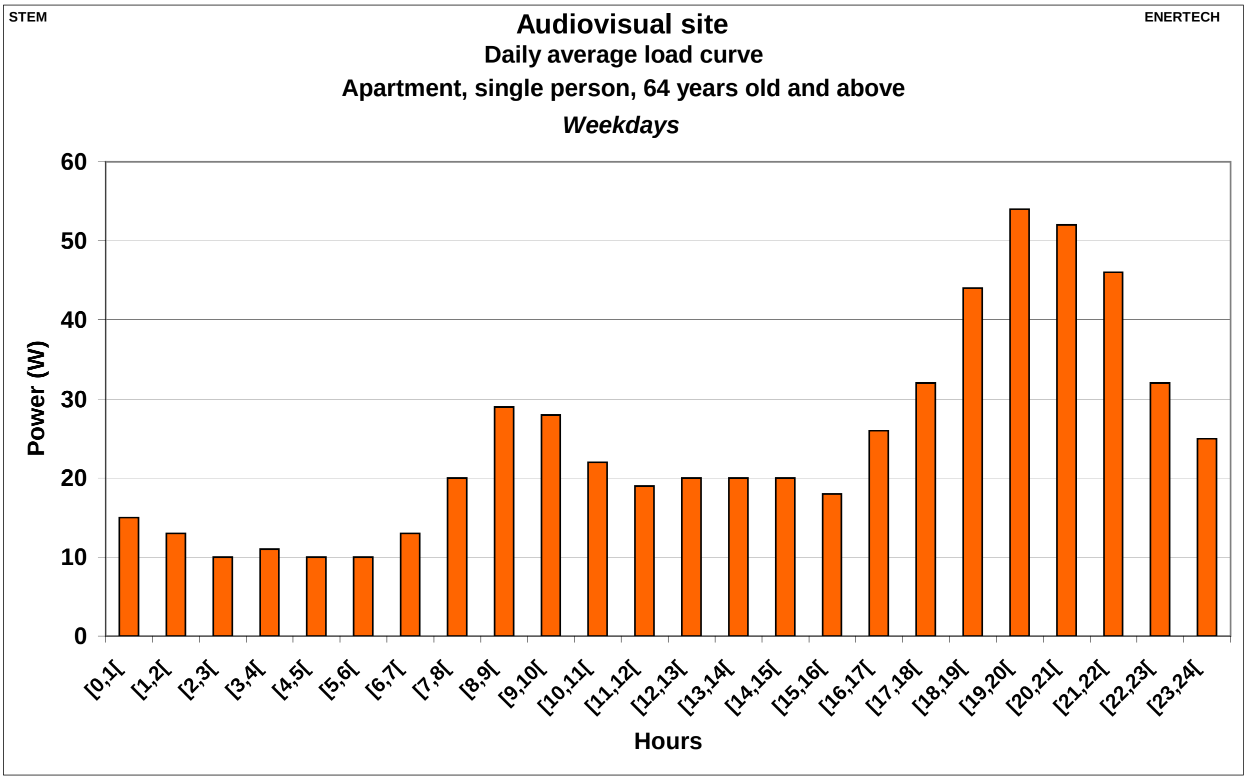


Figure 2.398: Audiovisual site – Daily average load curve – Apartment, single person, 64 years old and above – Weekdays

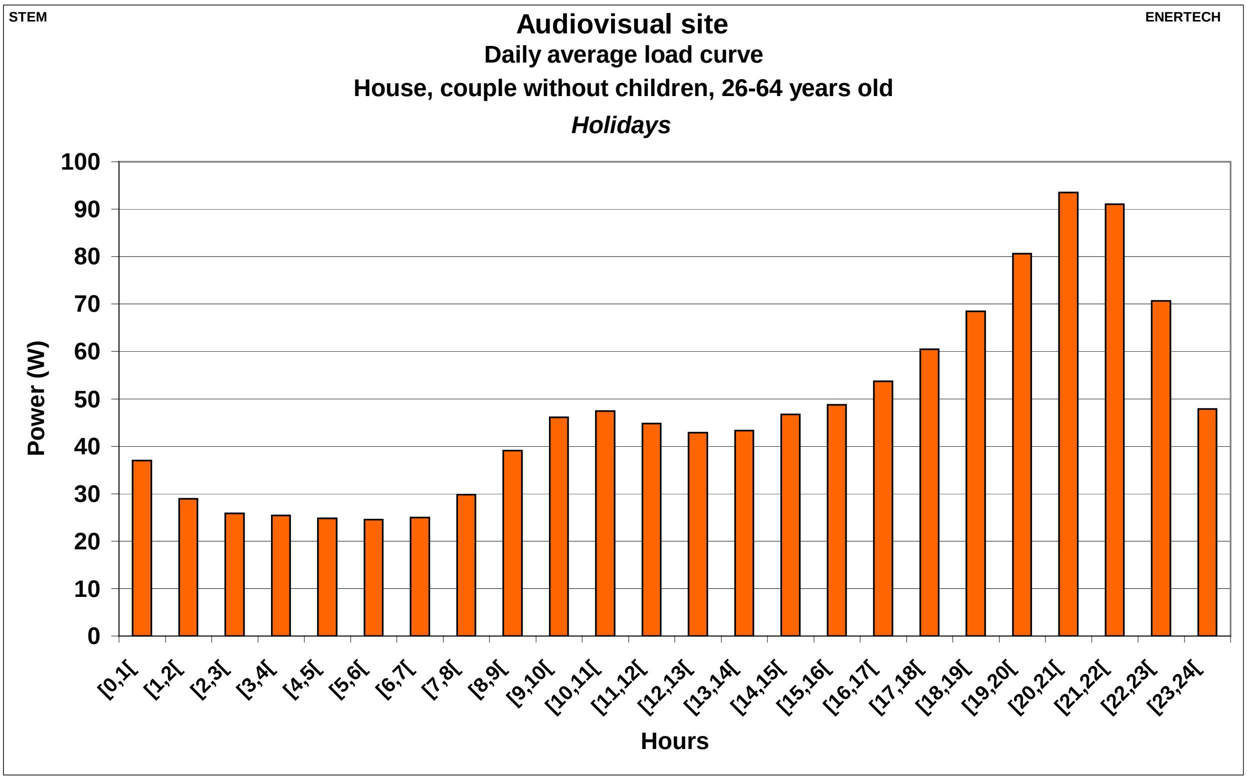


Figure 2.399: Audiovisual site – Daily average load curve – House, couples without children, 26-64 years old – Holidays

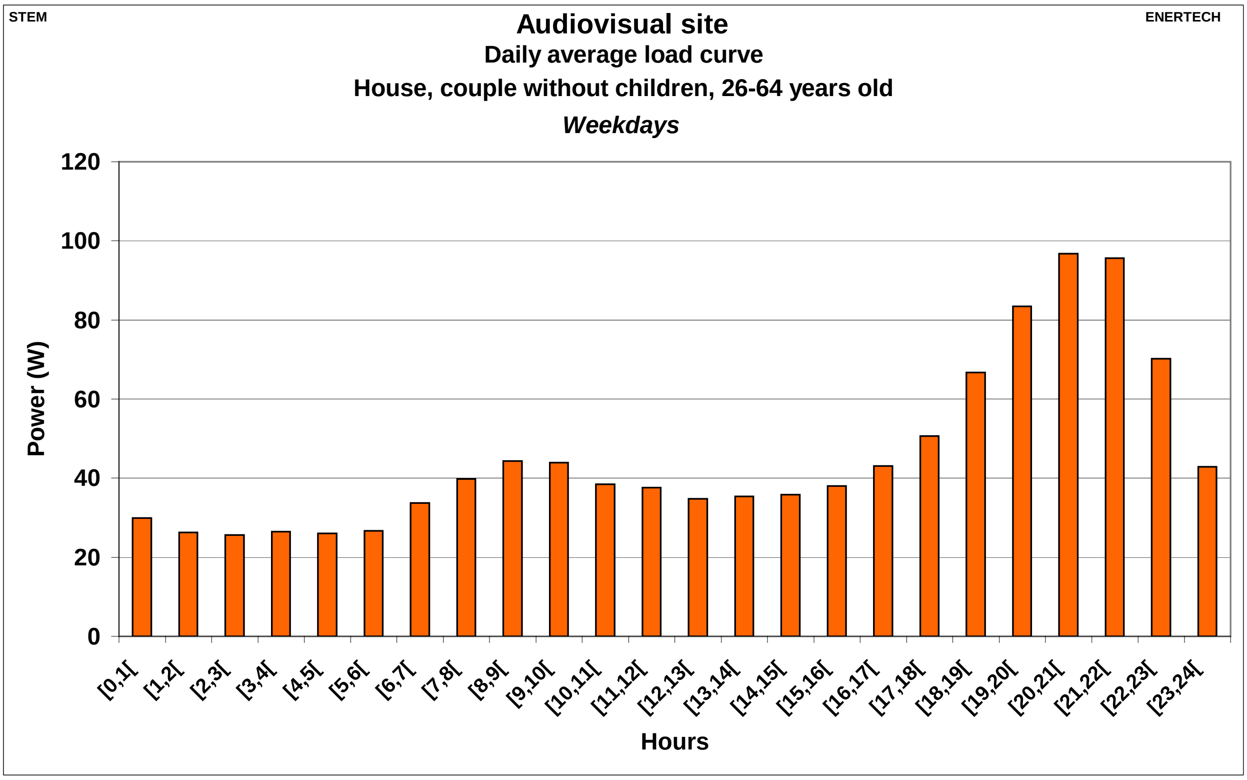


Figure 2.400: Audiovisual site – Daily average load curve – House, couples without children, 26-64 years old – Weekdays

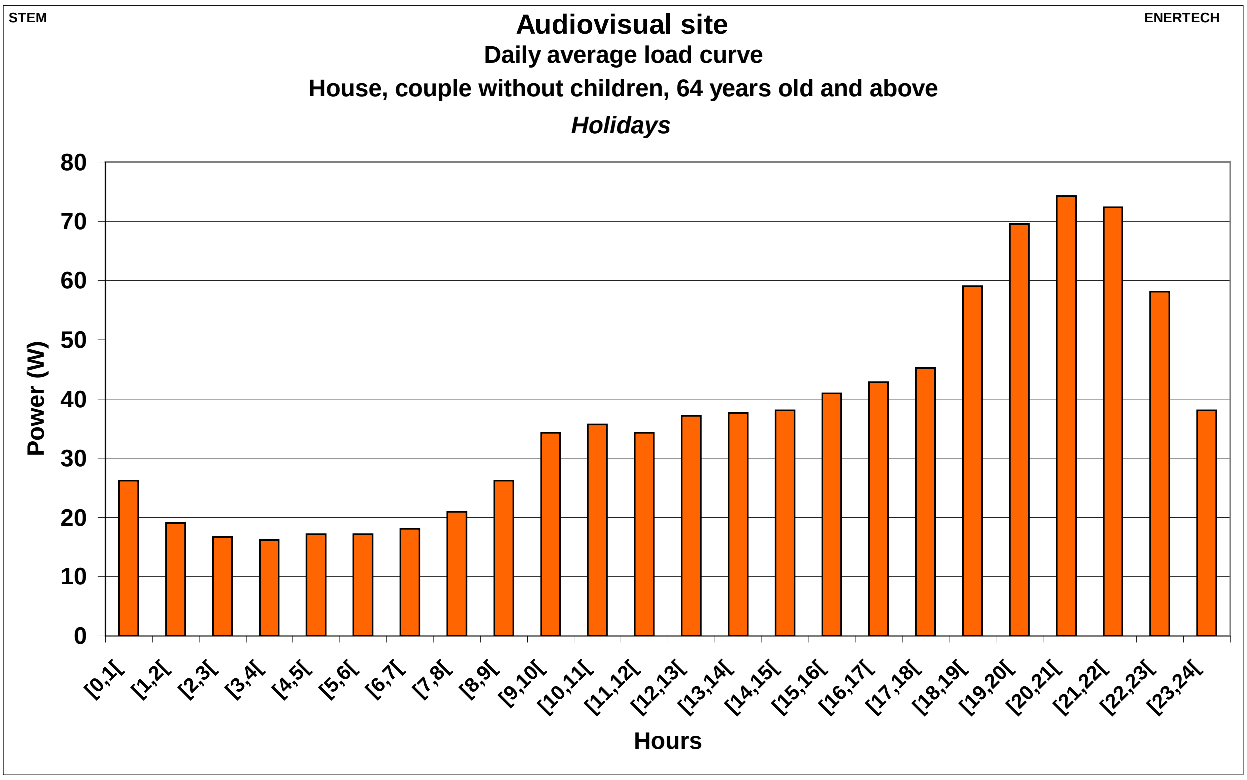


Figure 2.401: Audiovisual site – Daily average load curve – House, couples without children, 64 years old and above – Holidays

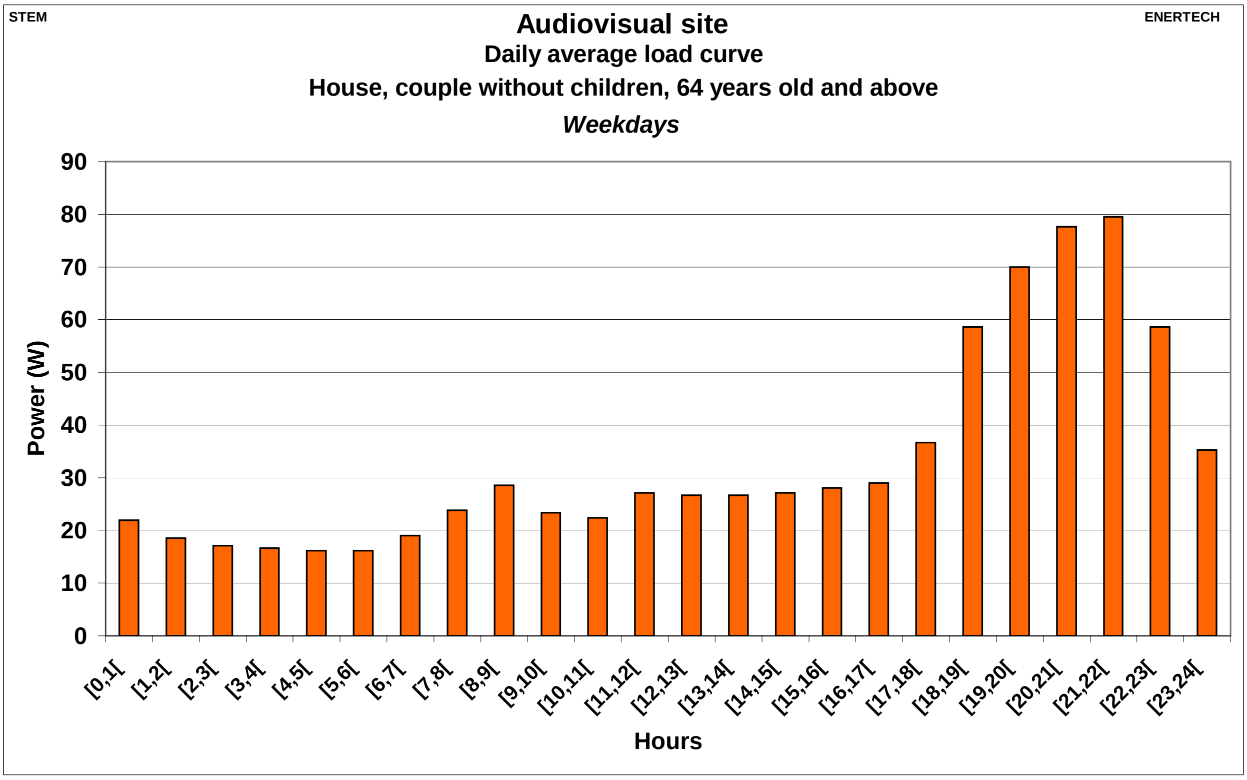


Figure 2.402: Audiovisual site – Daily average load curve – House, couples without children, 64 years old and above – Weekdays

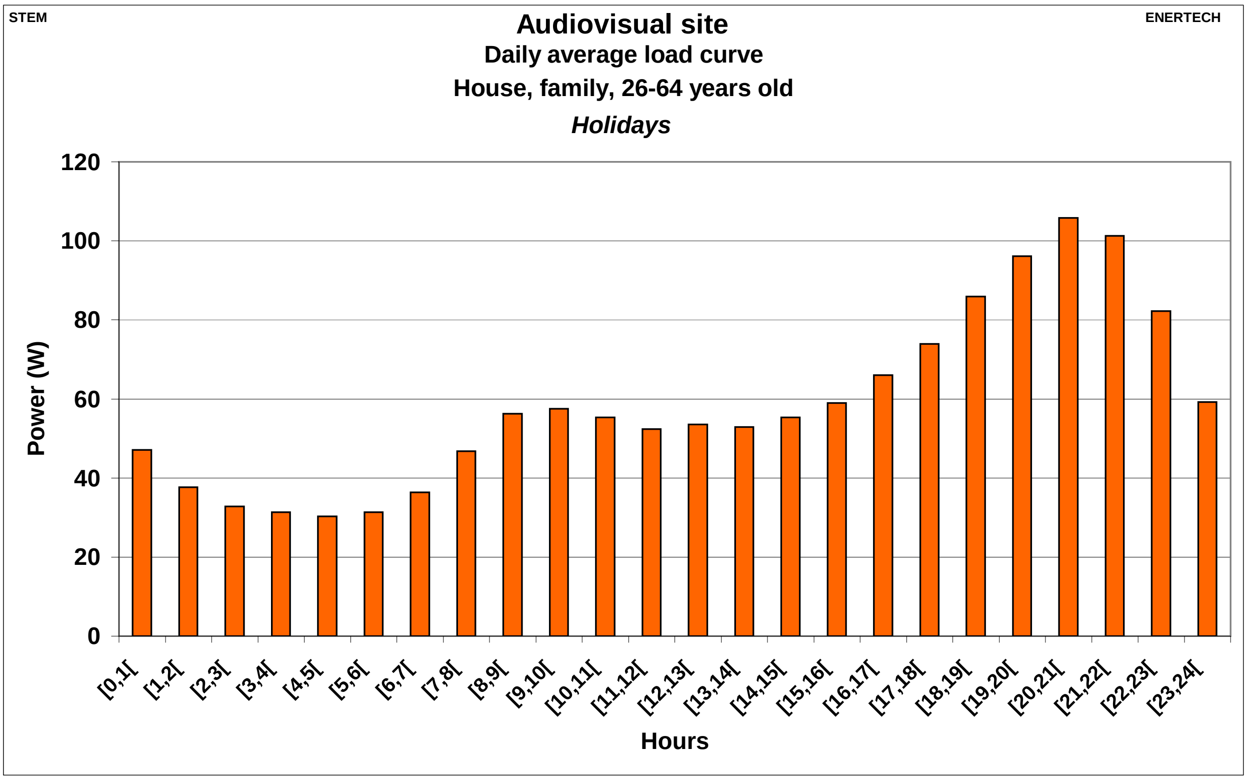


Figure 2.403: Audiovisual site – Daily average load curve – House, family, 26-64 years old – Holidays

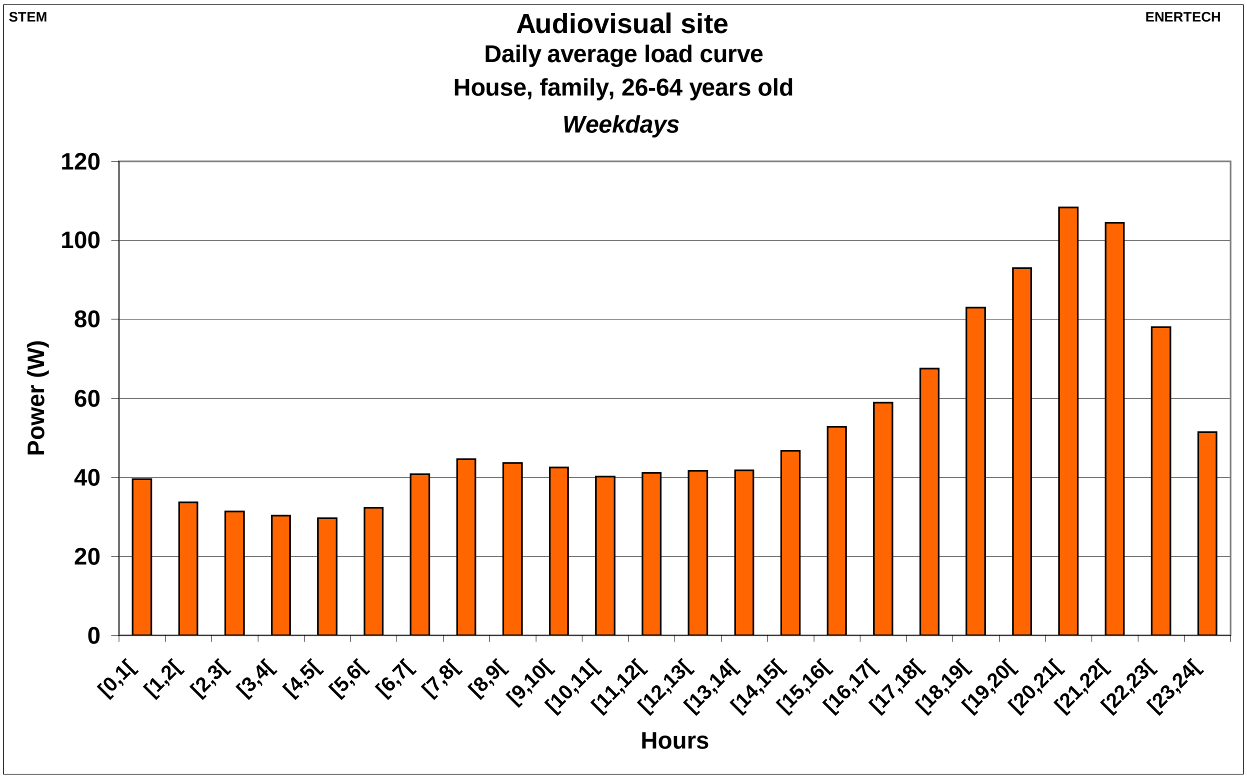


Figure 2.404: Audiovisual site – Daily average load curve – House, family, 26-64 years old – Weekdays

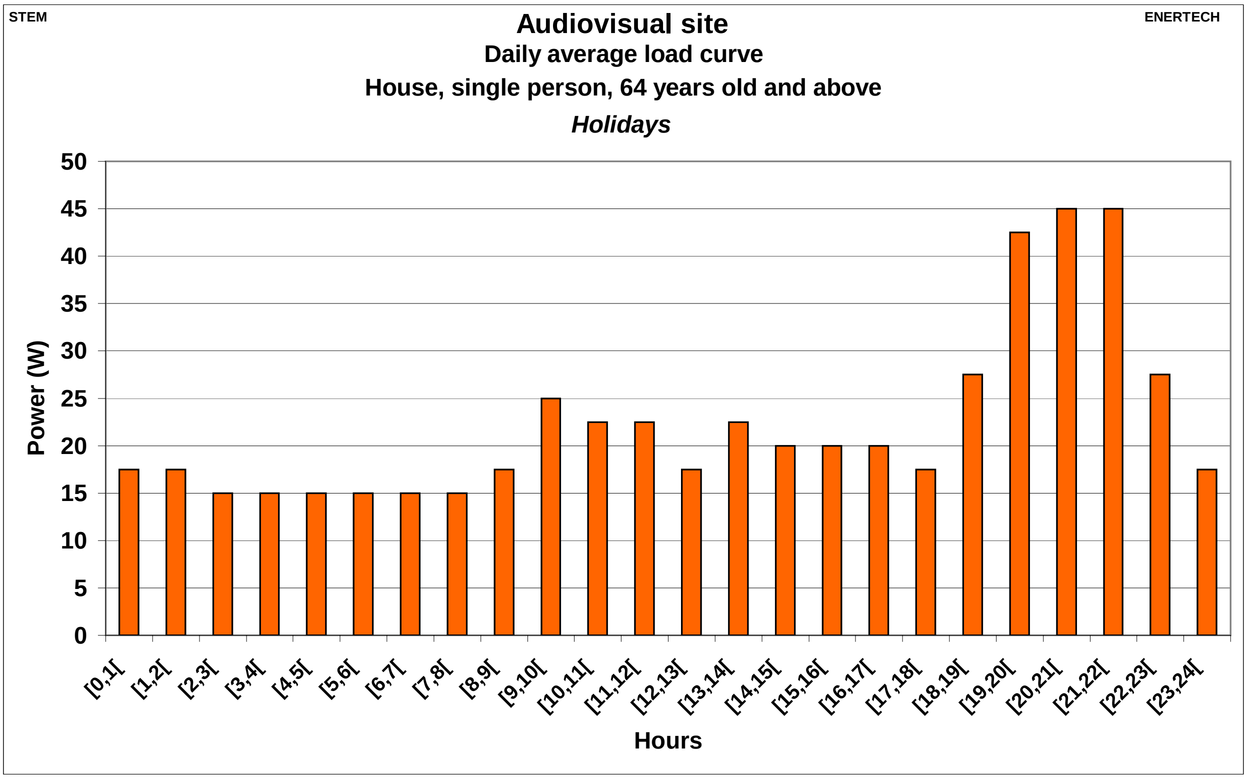


Figure 2.405: Audiovisual site – Daily average load curve – House, single person, 64 years old and above – Holidays

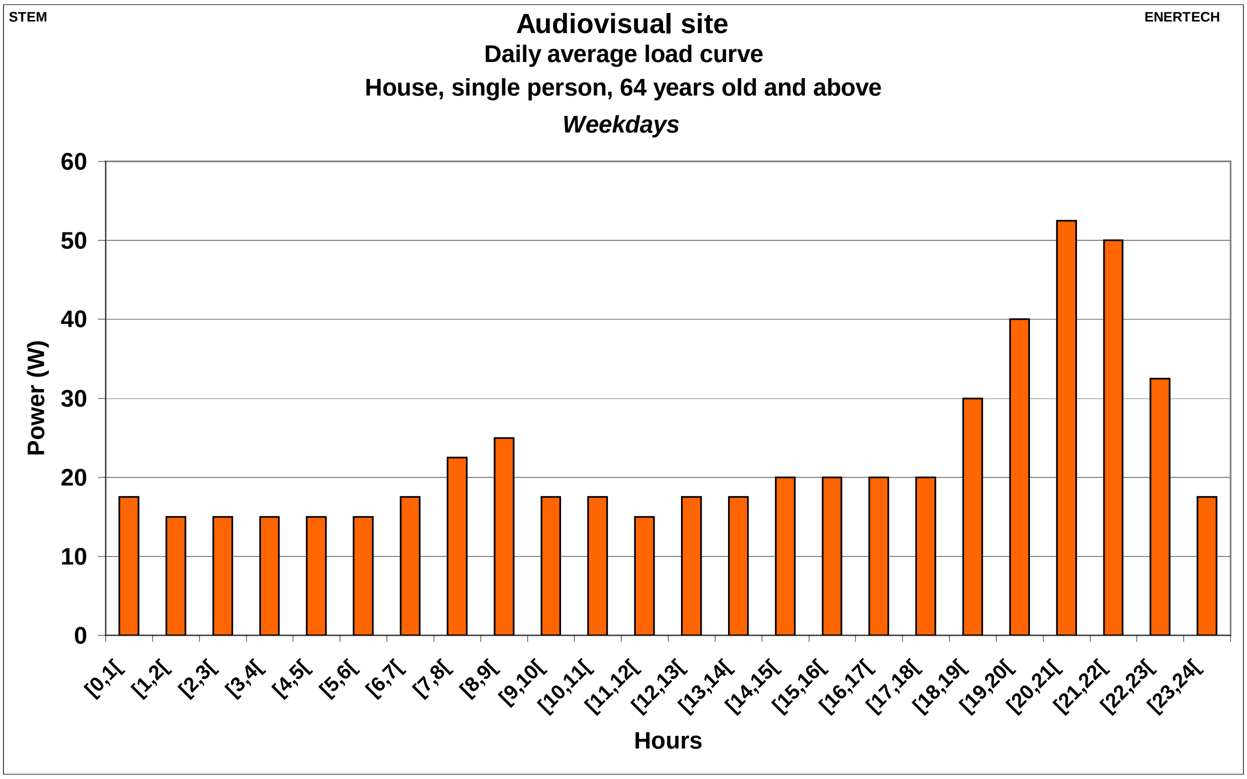


Figure 2.406: Audiovisual site – Daily average load curve – House, single person, 64 years old and above – Weekdays

Standby consumption

Figures 2.407 shows the time distribution between the 3 main states of the audiovisual site: ON mode when used, Stand By mode where the appliances continue to consume energy but are not used and OFF mode when the appliances are disconnected from the plug. These states where calculated for each audiovisual site individually. The sites were analyzed graphically to separate the Standby power from the ON power. The graph was calculated by averaging each state for all the sites. They are in ON mode 32,7 % of the time (2864 hours per year), in Standby mode 60,5 % of the time (5300 hours per year) and in OFF mode the rest of the time (596 hours per year).

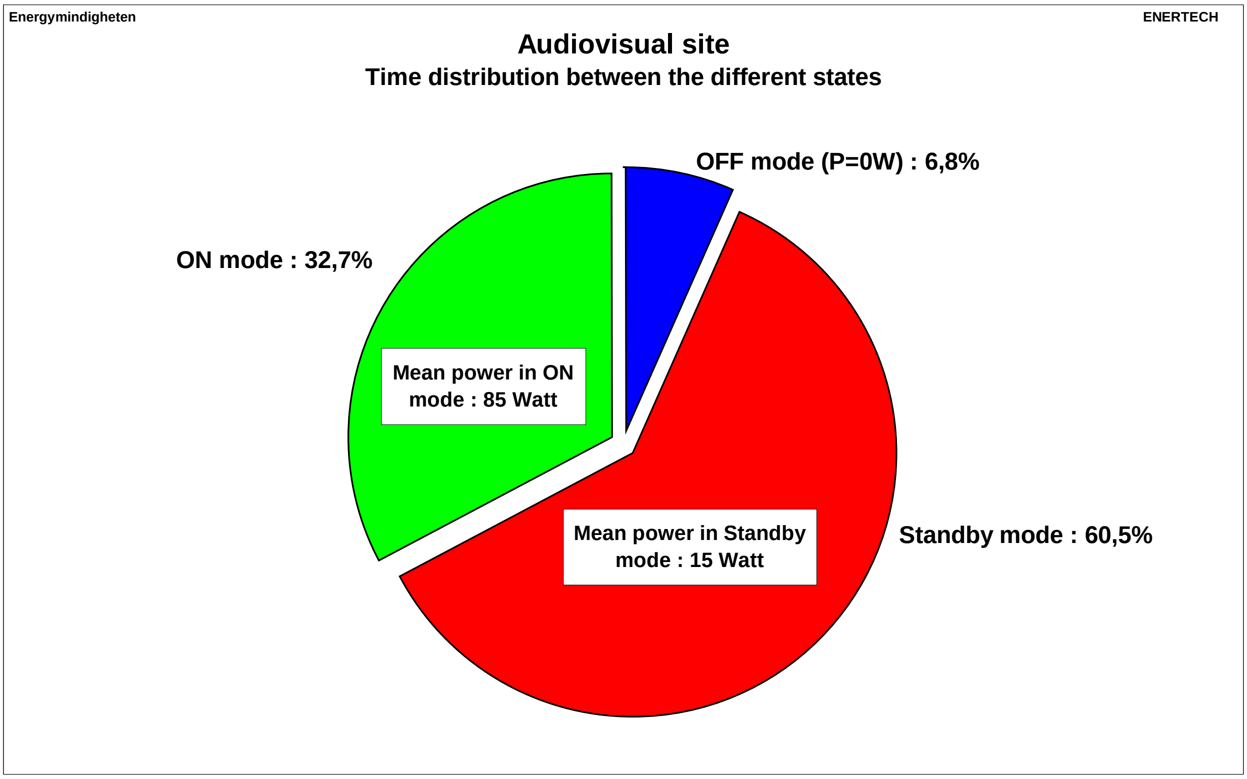


Figure 2.407: Audiovisual site – Consumption distribution between the different states

Figure 2.408 shows the daily average load curve split between ON mode and Standby mode. We can see that most of the night consumption is due to Standby . The Standby is minimal between 20:00 and 22:00, corresponding to the hours where the site is often used.

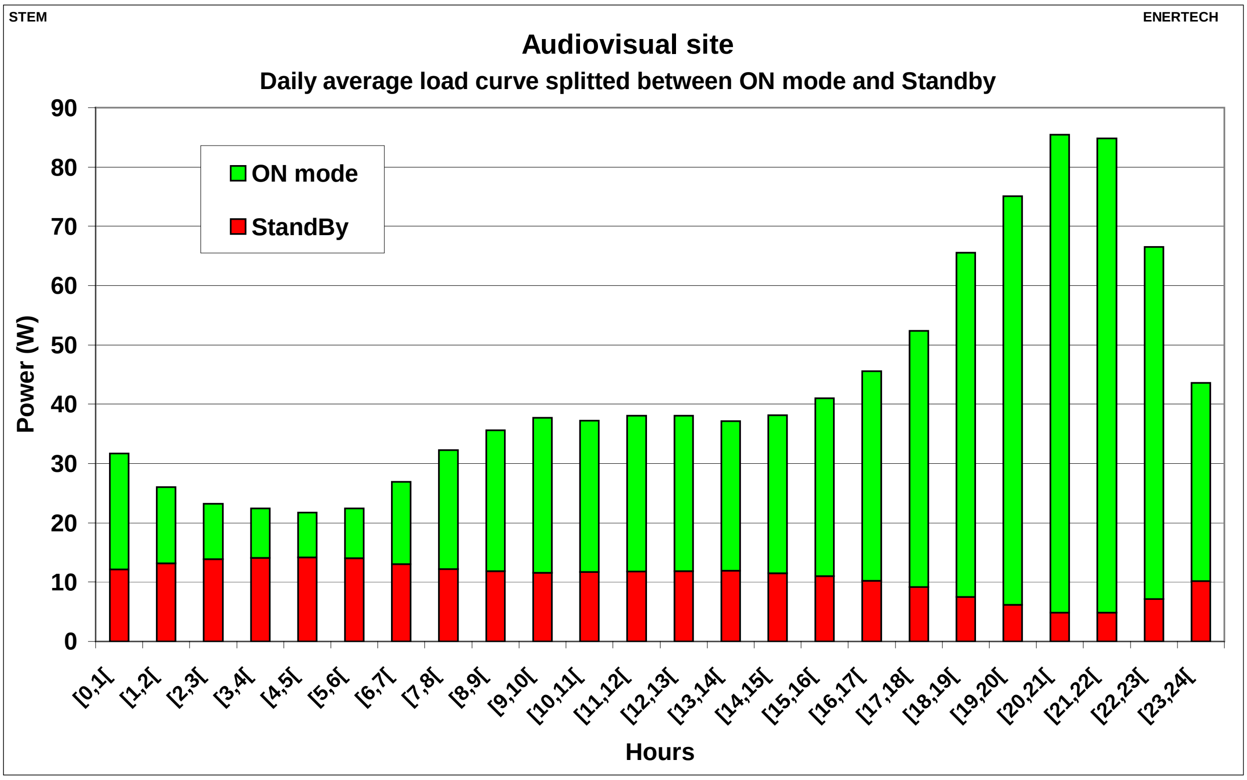


Figure 2.408: Audiovisual site – Daily average load curve split between On mode and Standby

Analysis per type of equipment

TV

Annualized consumptions

Figure 2.409 and 2.410 show the annual consumption for TV for the two types of households. All the TV's present in the households were used to calculate these average values. Figure 2.411 shows the average annual consumption from the most consuming TV to the less consuming one. To obtain these values, we sorted for each household the TV's from the most consuming one to the less consuming one and then averaged all the most consuming ones together, the second most consuming ones together etc.

The main TV has an average annual consumption of 174 kWh/year, the second one has a consumption of 51 kWh/year.

Figure 2.412 shows the annual consumption per person as a function of the number of persons in the household. The values per person should be treated with some care, since the family structure has to be taken into account as well. For household with one person, the annual consumption is near 130 kWh/year. This consumption decreases then with the number of persons in the household. As explained before, the consumption of the TV won't change if there is 1 or more persons who use it.

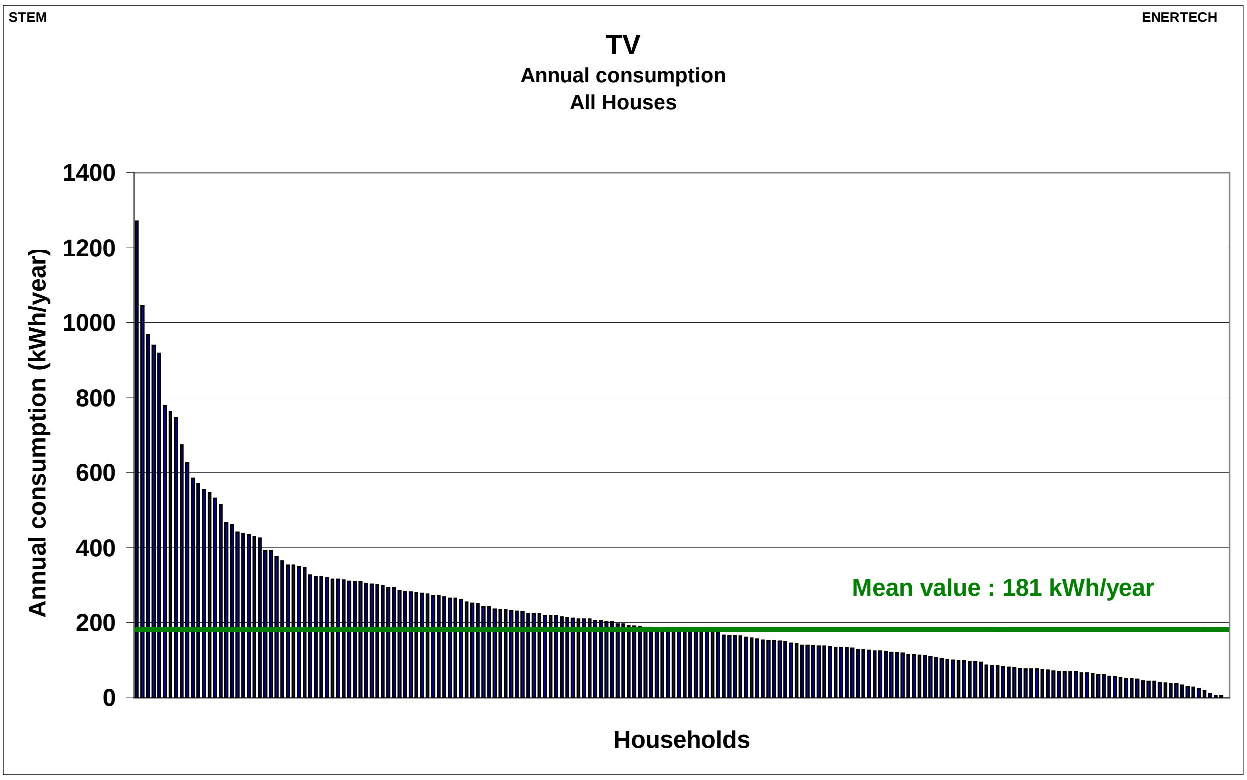


Figure 2.409: TV – Annual consumption – Houses

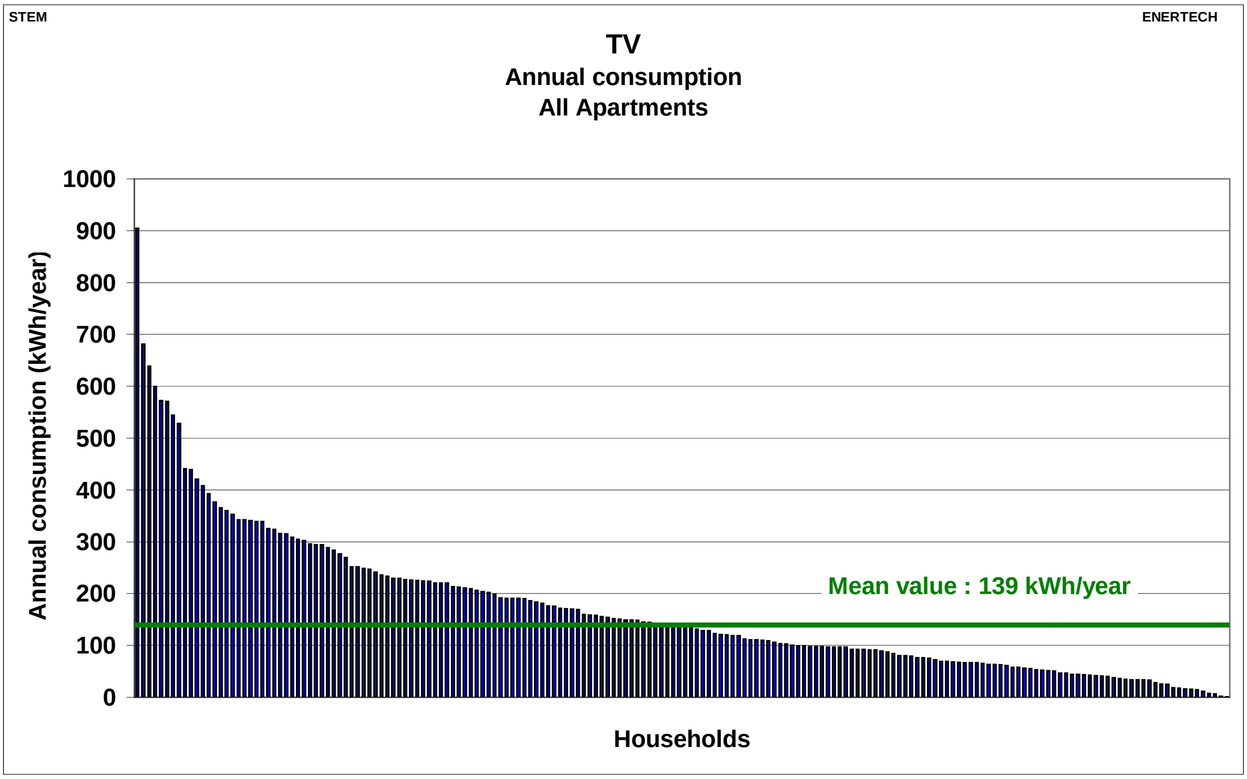


Figure 2.410: TV – Annual consumption – Apartments

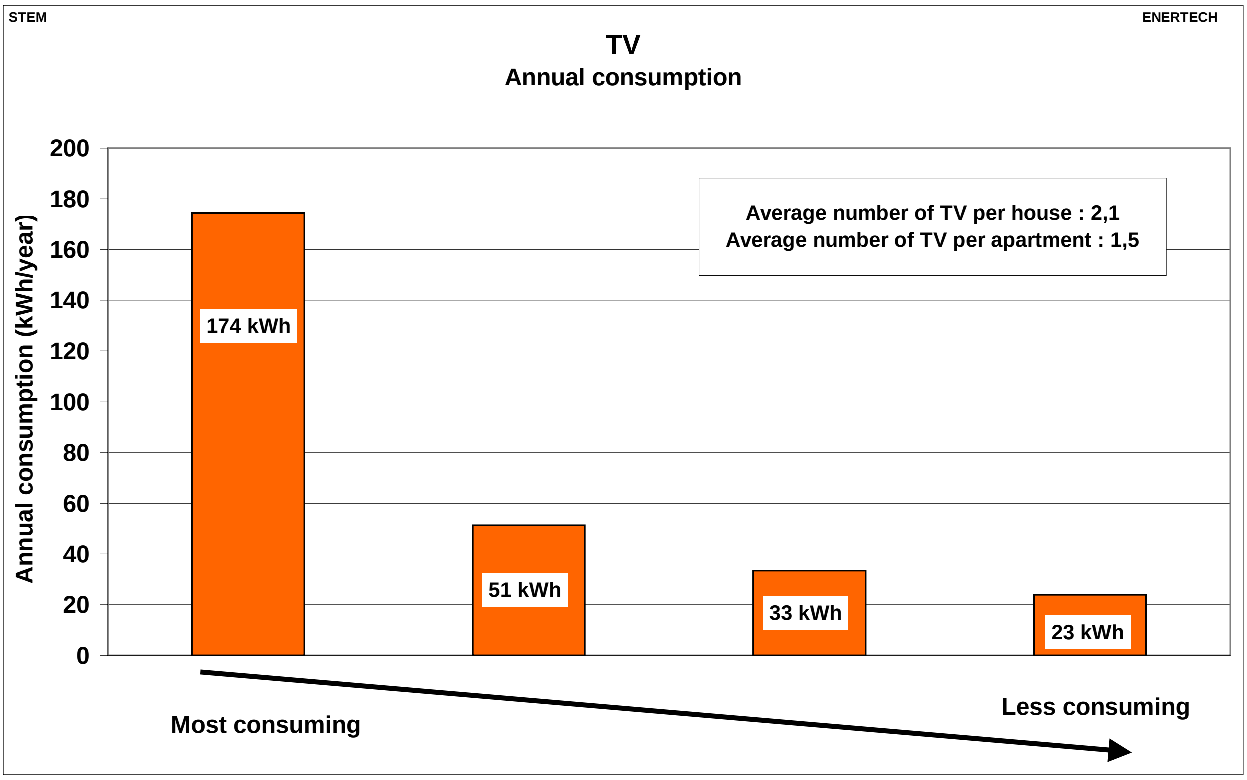


Figure 2.411: TV – Annual consumption

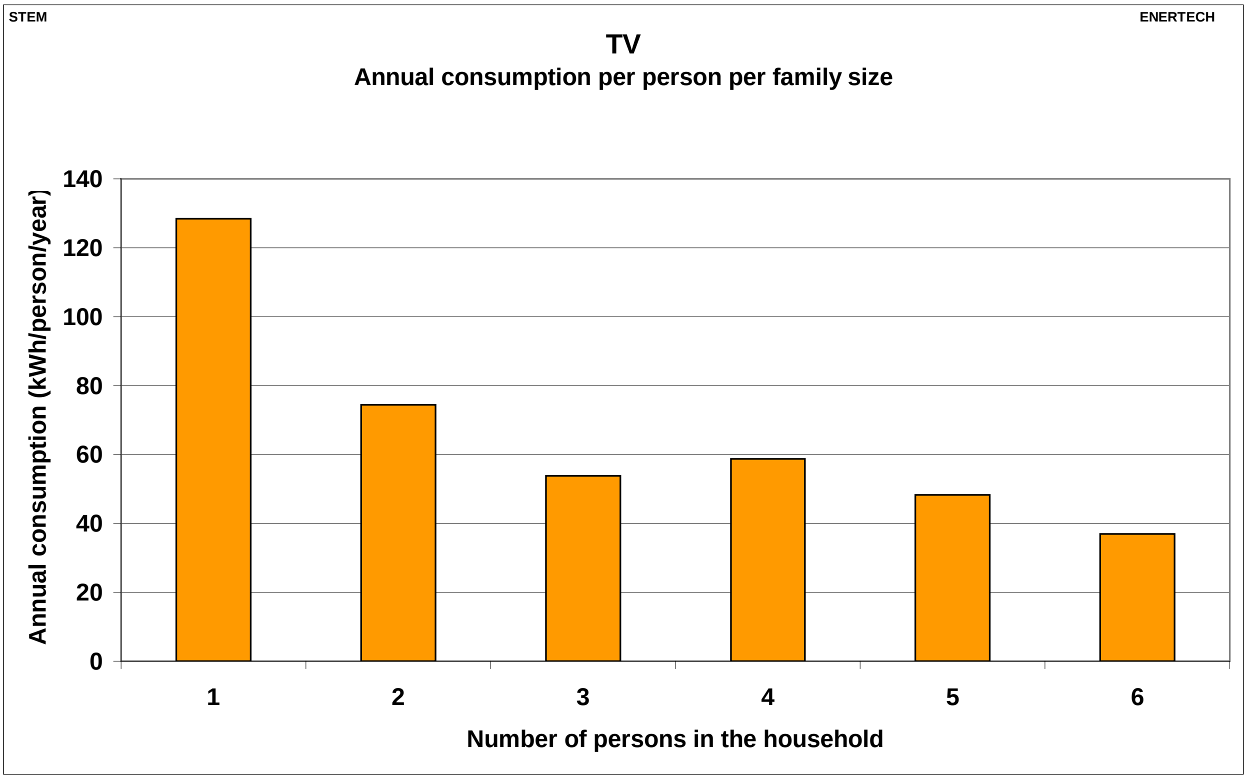


Figure 2.412: TV – Annual consumption per person per family size

Structure of the average hourly load curve

Figures 2.413 to 2.416 represent the average hourly load curve observed, for each type of household split between holidays and workdays.

It is notable that TV consumption during the night exists in all types of households. It is less than probable that this consumption could be entirely due to night users but more probably due to Standby consumption. There is here also a potential energy saving that is sometimes significant.

The main peak is always between 20:00 and 22:00.

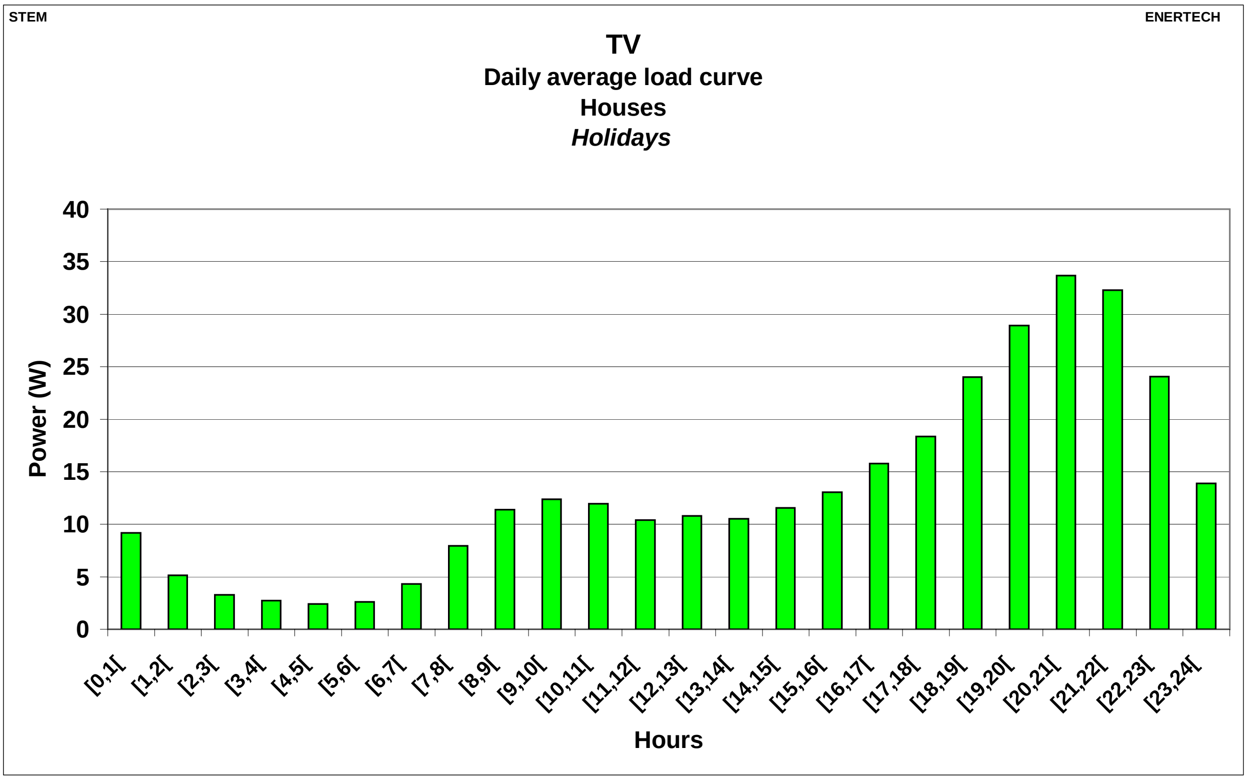


Figure 2.413: TV – Structure of the daily average load curve – Houses – Holidays

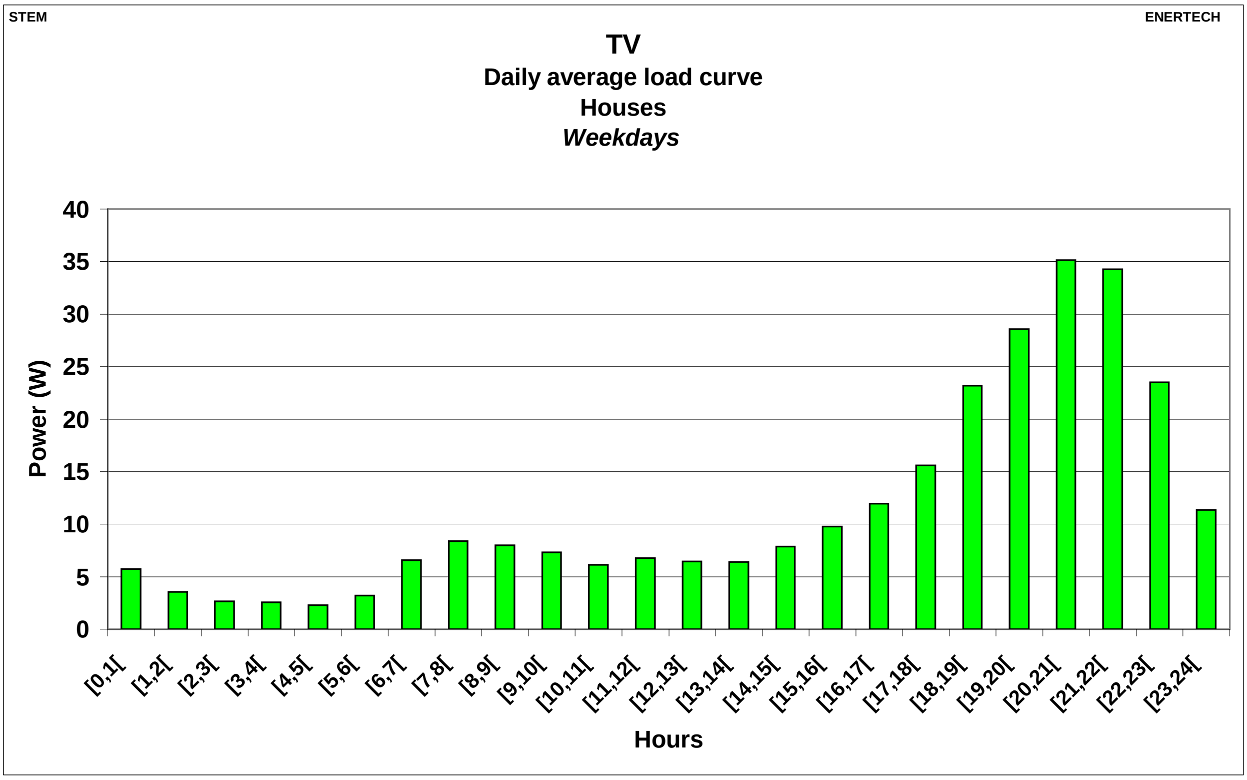


Figure 2.414: TV – Structure of the daily average load curve – Houses – Weekdays

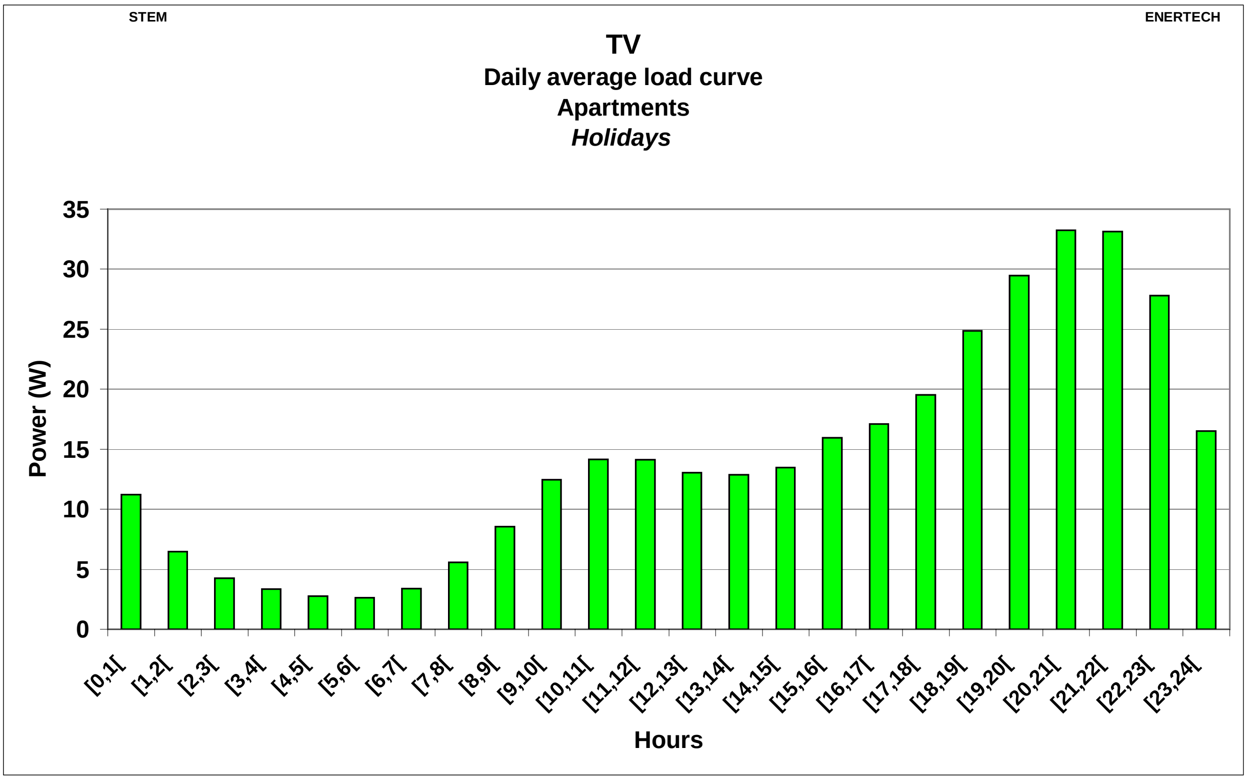


Figure 2.415: TV – Structure of the daily average load curve – Apartments – Holidays

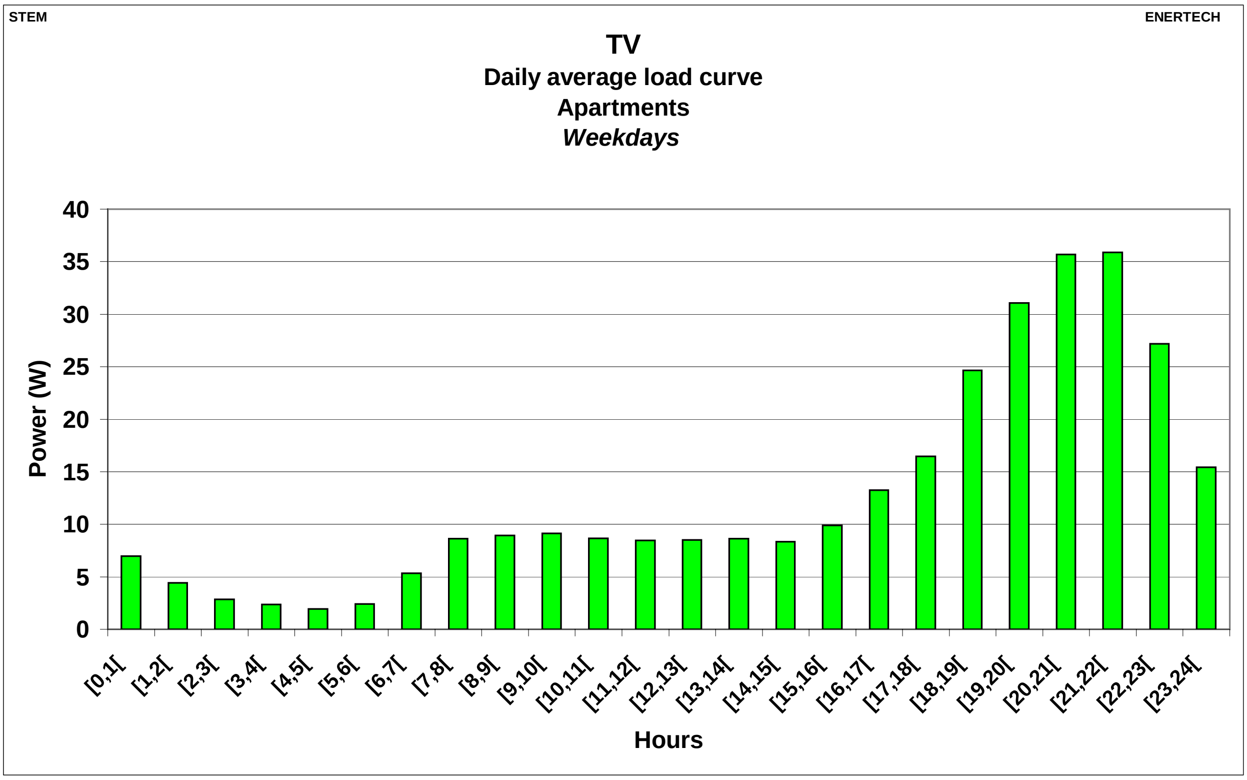


Figure 2.416: TV – Structure of the daily average load curve – Apartments – Weekdays

Standby power analysis

Figures 2.417 shows the time distribution between the 3 main states of the TV's: ON mode when used, Standby mode where the appliances continue to consume energy but are not used and OFF mode when the appliances are disconnected from the plug. These states where calculated for each TV individually. The TV's were analyzed graphically to separate the Standby power from the ON power. The graph was calculated by averaging each state for all the TV's. They are in ON mode 23 % of the time (2015 hours per year), in Standby mode 31 % of the time (2716 hours per year) and in OFF mode the rest of the time (4038 hour per year). TV's are more often in OFF mode than the complete audiovisual site: it is easier and more natural to switch off the TV than the rest of the devices like DVD's, satellite etc.

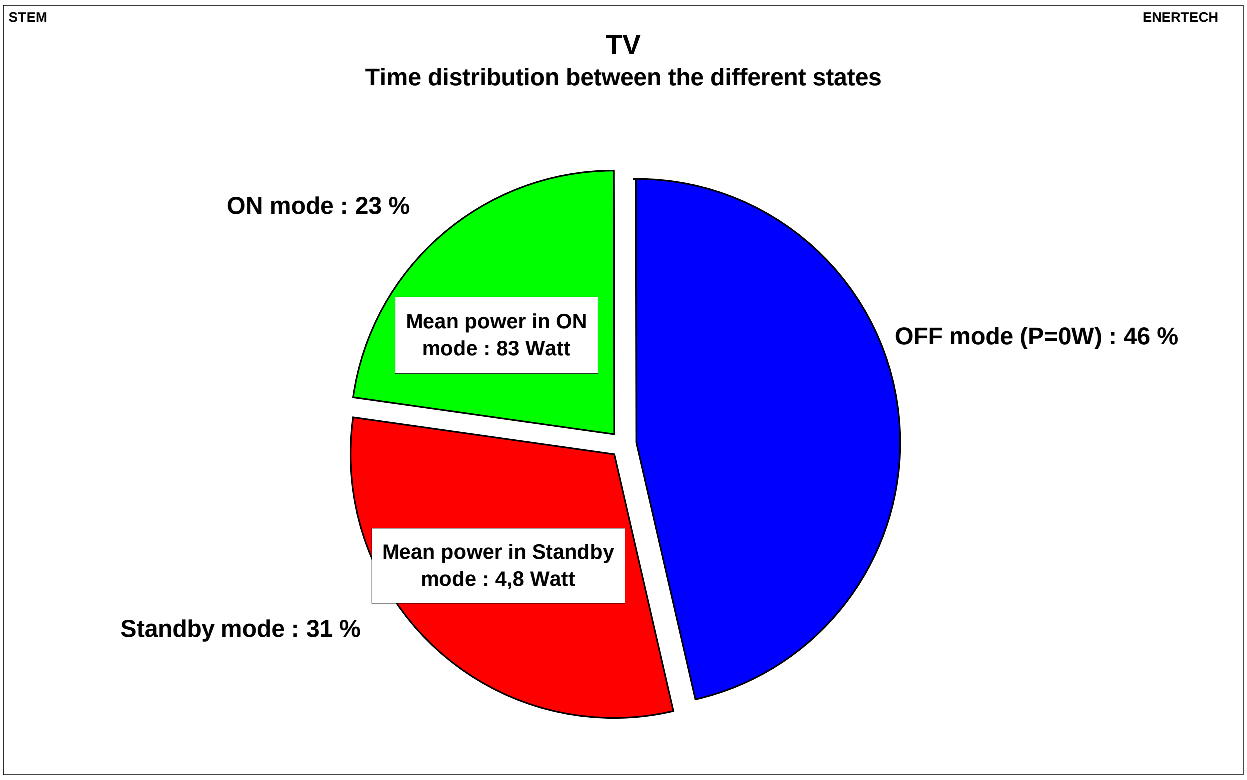


Figure 2.417: TV – Time distribution between the different states

Figure 2.418 shows the daily average load curve split between ON mode and Standby mode. We can see that a large part of the night consumption is due to Standby . The Standby is minimal between 20:00 and 22:00, corresponding to the hours where the TV is often used.

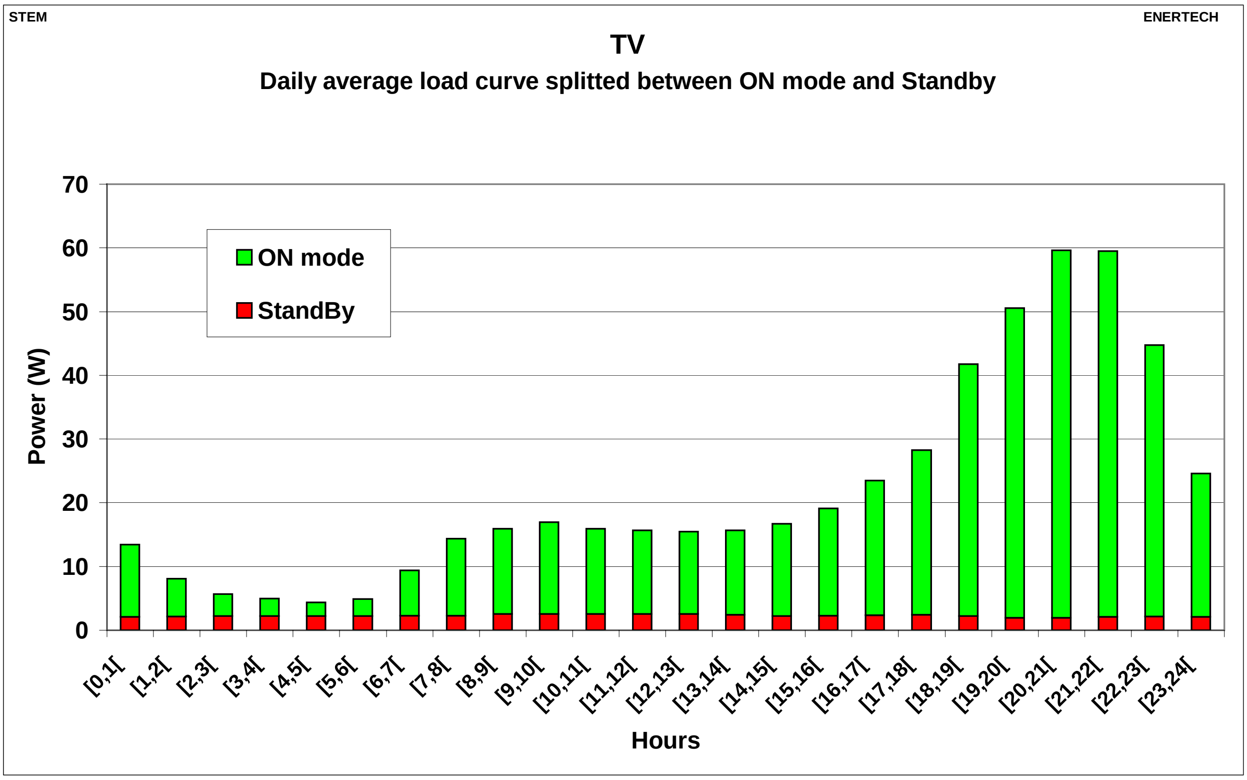


Figure 2.418: TV – Daily average load curve split between ON mode and Standby

Other Audiovisual appliances

Annual consumption

The table from figure 2.419 lists all the appliances or group of appliances that were monitored individually. The audiovisual site was calculated by adding all the individual appliances present in this table.

	Total number of appliances monitored	Average annual consumption (kWh)	Apartment, couples without children, less than 25 years old	Apartment, couples without children, 26-64 years old	Apartment, couples without children, 64 years old and above	Apartment, family, 26-64 years old	Apartment, single person, 26-64 years old	Apartment, single person, 64 years old and above	Apartment, single person, less than 25 years old	House, couples without children, 26-64 years old	House, couples without children, 64 years old and above	House, family, 26-64 years old	House, single person, 26-64 years old	House, single person, 64 years old and above
	All appliances		Annual consumption kWh/year (Number of appliance)											
VCR + DVD + Satellite + Home cinema	15	270		110 (2)		185 (3)	130 (1)			337 (1)		350 (8)		
VCR + DVD + Cable TV Box	2	247		128 (1)								367 (1)		
VCR + DVD + Tuner	2	220				107 (1)						333 (1)		
DVD + Satellite + Home cinema	10	216		115 (1)		183 (3)	379 (2)			253 (1)		162 (3)		
VCR + DVD + Satellite	48	174		178 (4)	150 (2)	203 (4)		177 (1)		147 (10)	154 (2)	183 (25)		
VCR + Satellite + Modem	2	173				139 (1)	207 (1)							
VCR + DVD + PS2	5	151				47 (2)	112 (1)					276 (2)		
Hi-fi + VCR + DVD	3	131				131 (3)								
Home cinema	13	124		392 (1)		14 (1)	10 (1)					120 (10)		
VCR + Satellite	21	123		107 (2)		83 (3)				145 (7)	151 (3)	93 (5)		180 (1)
DVD + Surround system	5	118								15 (1)		144 (4)		
DVD + Satellite	59	101		78 (5)	17 (2)	101 (8)				116 (6)	93 (4)	108 (34)		
Satellite	41	95			158 (1)	79 (6)	108 (3)			96 (9)	74 (2)	97 (20)		
VCR + Xbox	5	84		111 (1)			167 (1)			62 (1)		41 (2)		
Hi-fi + DVD	6	83		18 (1)		112 (1)					157 (1)	71 (3)		
Xbox	8	81		315 (1)		122 (1)						36 (6)		
VCR + DVD	109	65		53 (9)		66 (34)	74 (12)	92 (2)		59 (12)	69 (6)	62 (32)	89 (2)	
VCR	77	57	98 (1)	63 (10)	35 (4)	44 (12)	62 (8)	9 (3)		53 (8)	77 (7)	63 (22)		49 (2)
Hi-fi	370	52	88 (2)	42 (33)	13 (5)	61 (80)	38 (28)	34 (7)	90 (2)	62 (56)	36 (15)	50 (136)	66 (3)	50 (3)
Speaker	6	47				50 (2)						45 (4)		
Subwoofer	8	42		12 (1)		7 (2)				130 (1)	42 (2)	47 (2)		
Projector	5	40		34 (2)		5 (1)						64 (2)		
DVD	66	32		64 (6)	2 (1)	38 (20)	7 (5)	12 (1)		18 (3)		28 (30)		
Playstation	14	30				38 (10)				3 (2)		18 (2)		
Game cube	3	29				36 (2)						13 (1)		
Synthesizer	6	27				52 (2)						15 (4)		
CD Radio	3	23				32 (2)						7 (1)		
Radio	99	14		18 (5)	9 (7)	13 (16)	7 (12)	10 (3)		20 (12)	10 (8)	16 (32)	96 (1)	8 (3)

Figure 2.419: Other audiovisual appliances – Annual consumption

Standby power

The table from figure 2.420 shows the different Standby powers that were measured individually at installation time or extracted from the monitored data. If the number of annual hours in Standby mode is know, it is possible to use the power to calculate the annual Standby consumption: for example, a satellite box that will stay in Standby 90 % of the time will have a consumption of 0,9 * 8760 * 9,1 = 71,7 kWh/year.

Appliance	Number monitored	Power (Watt)
VCR + Satellite	4	33,8
VCR + DVD + Satellite	4	21,6
DVD + Sattelite	5	20,1
VCR + DVD + Satellite + Home cinema	1	16,2
Digital TV Box	9	11,4
Hi-fi + DVD	2	10,9
TV + VCR	3	10,6
Cable TV Box	4	9,6
Satelite	154	9,1
Home cinema	26	7,6
Subwoofer	4	7,4
Projector	2	7,2
Tuner (Audio)	1	6,4
VCR	195	6,4
LCD TV	1	6,1
Hi-fi	291	5,4
VCR + DVD	29	5,3
Cassette player	2	4,5
Surround system	6	3,9
DVD	145	3,8
Synthesizer	1	3,6
CD Player	11	3,2
TV	242	3,1
Antenna amplifier	23	2,8
Wireless headset	9	2,7
Xbox 1	8	2,5
Amplifier (Audio)	6	2,5
Radio	229	2,1
Gramophone	2	1,6
Playstation 2	12	1,4
Digital antenna	2	1,3
Nintendo Gamecube	4	1,0

Figure 2.420: Other audiovisual appliances – Standby power

COMPUTER SITES

Description of the monitored equipment

In about 10 years, the quick development of information technologies deeply modified the household energy landscape. The new equipment leads to new electricity consumption. These latter sometimes represents the biggest consumption sector in the household. This usage draws a big quantity of electricity. All the more so, when this equipment is badly used, or used very intensively, it might become the most important in the household. Computer equipment, as most of the electronic appliances, might draw much Standby power. It looked therefore interesting and justified, in this project, to meter the computer sites, and to explore the behaviours of the appliances they are made up of.

It is probably the first time in Europe that a so important campaign on computers is carried out, **as 451 computer sites and 139 laptops were studied** and metered.

In a « computer site », we included all the appliances that make up a working place. In the great majority, it consists of a CPU, a monitor and a printer, as well as most of the times a modem/ADSL box. The total consumption of this set will be analysed, rather than the consumption of each one of these appliances.

Annualized consumption

No seasonality effect could be observed with the one year household. Therefore the annualized consumption was calculated without seasonality correction.

Figures 2.421 to 2.426 represent the distribution of the total computer site consumption for the different household categories. For houses, the annual consumption is in the range 191-390 kWh/year and 170-287 kWh/year for apartments. The maximum consumption for houses (4846 kWh/year) was measured for an one year house with 4 computer sites that were ON most of the time. The maximum consumption for apartments (2955 kWh/year) was measured for a one month apartment with 3 computer sites that were ON most of the time.

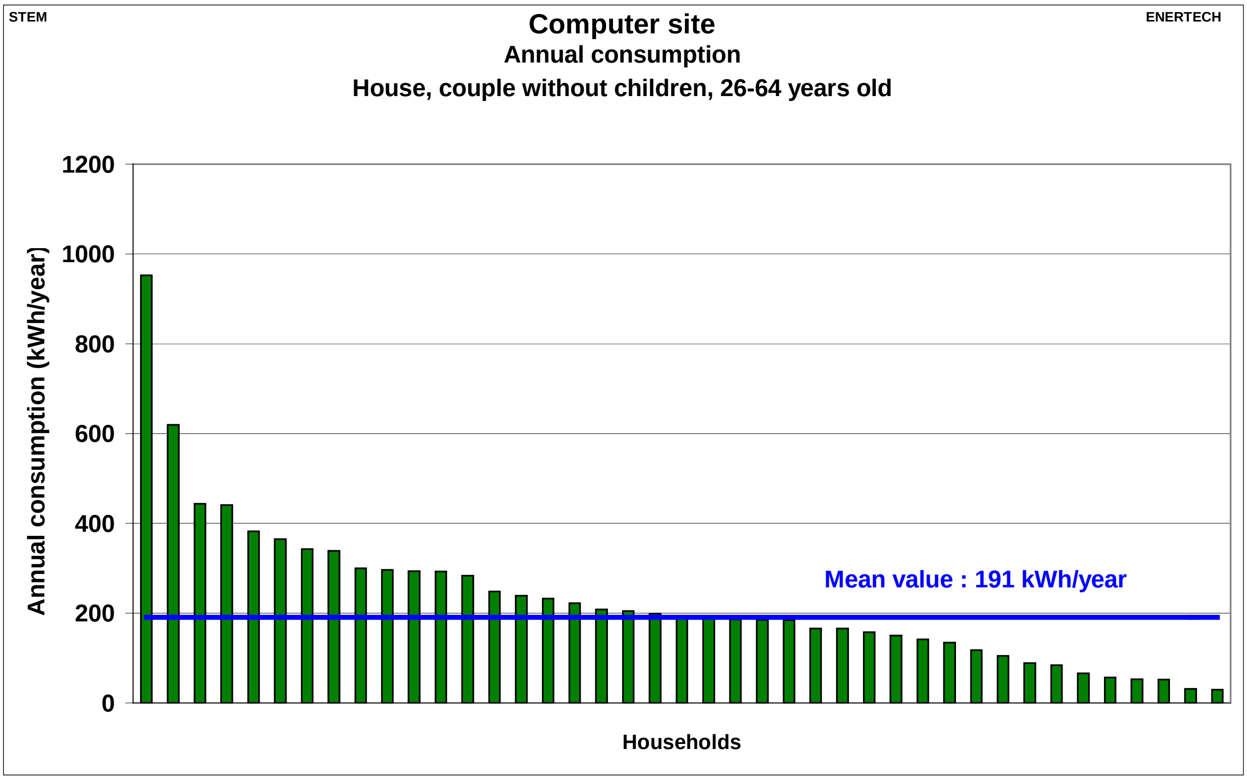


Figure 2.421: Computer site – Annual consumption – House, couples without children, 26-64 years old

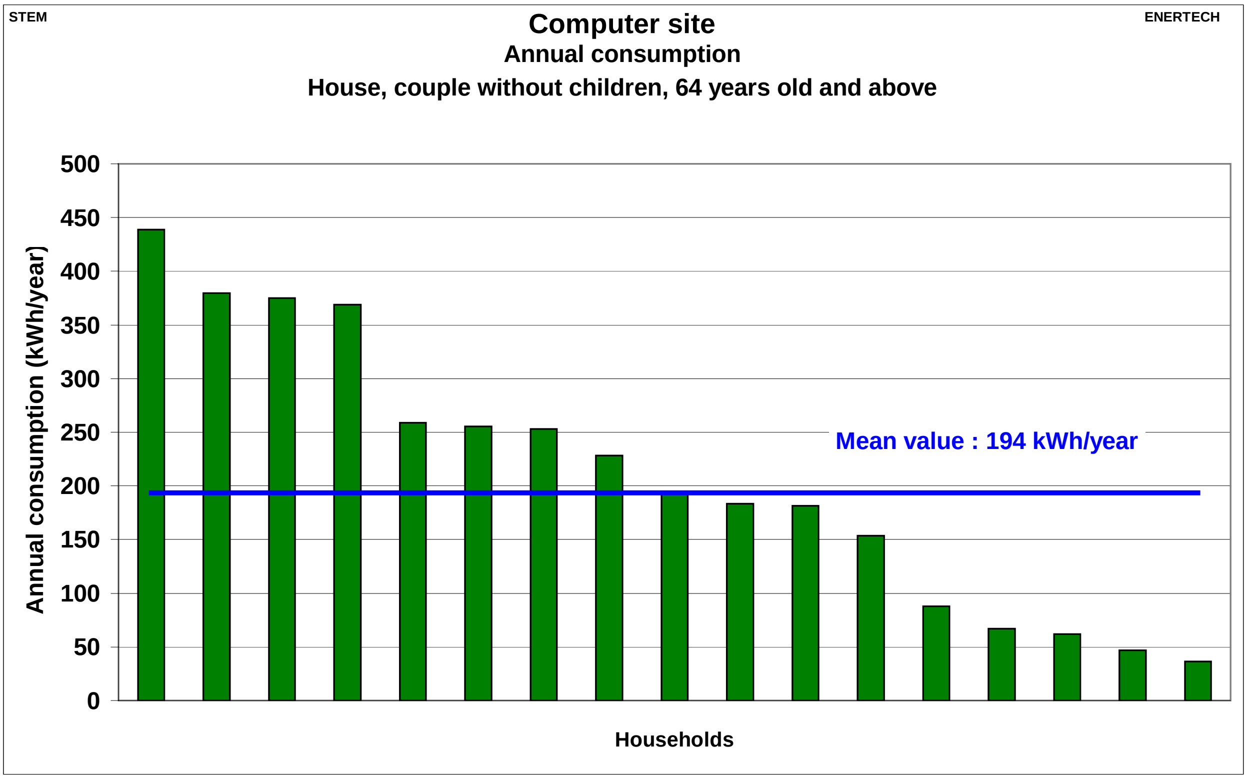


Figure 2.422: Computer site – Annual consumption – House, couples without children, 64 years old and above

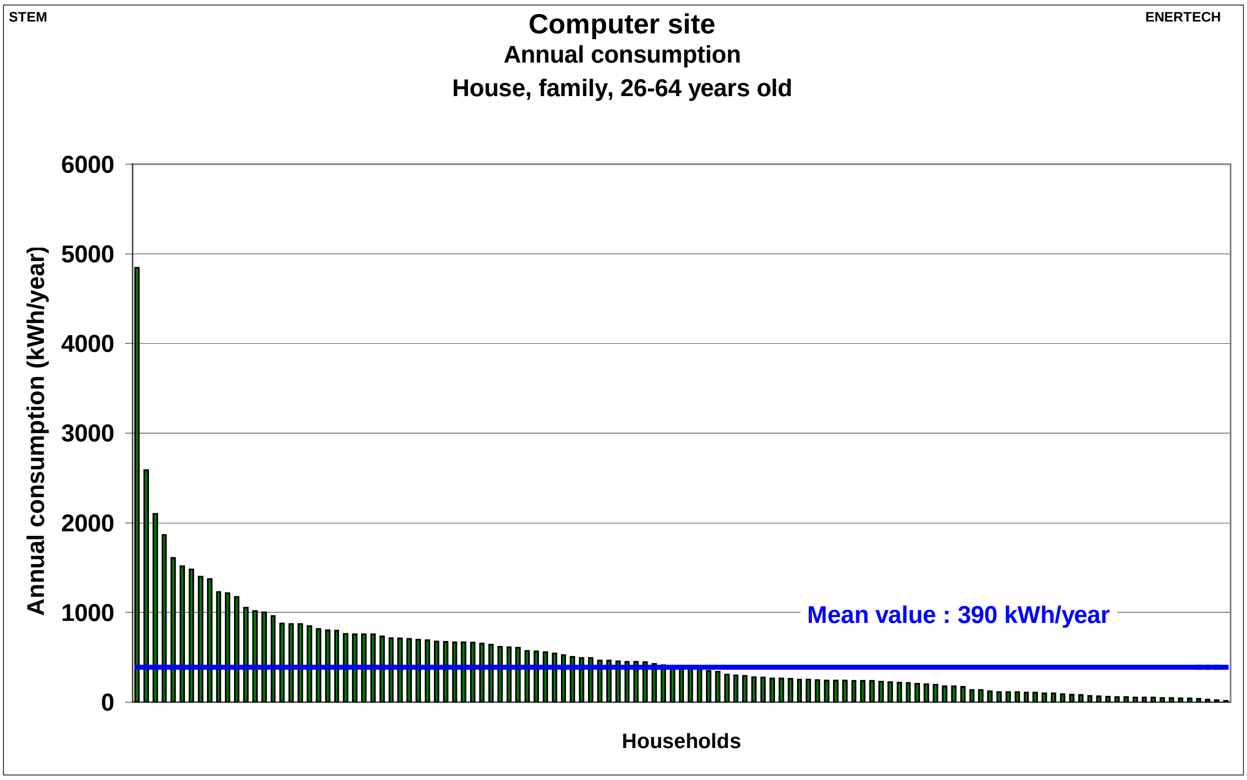


Figure 2.423: Computer site – Annual consumption – House, family, 26-64 years old

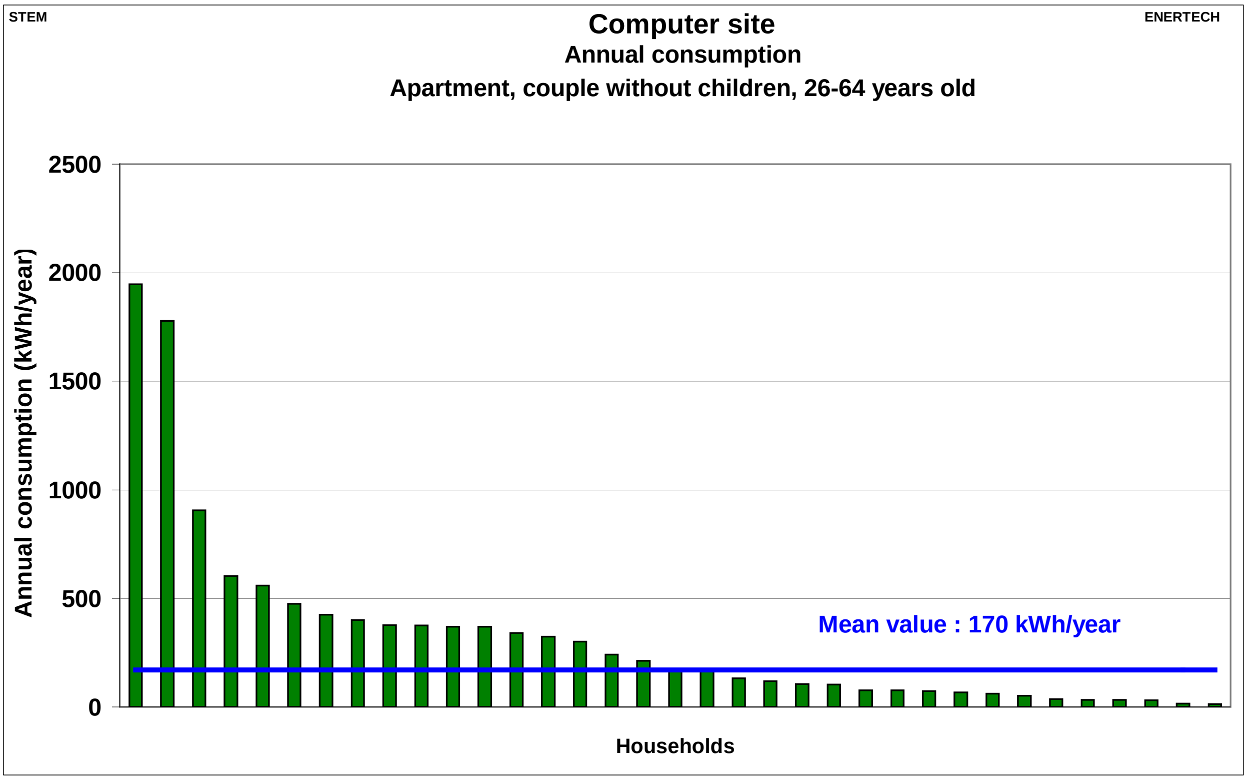


Figure 2.424: Computer site – Annual consumption – Apartment, couples without children, 26-64 years old

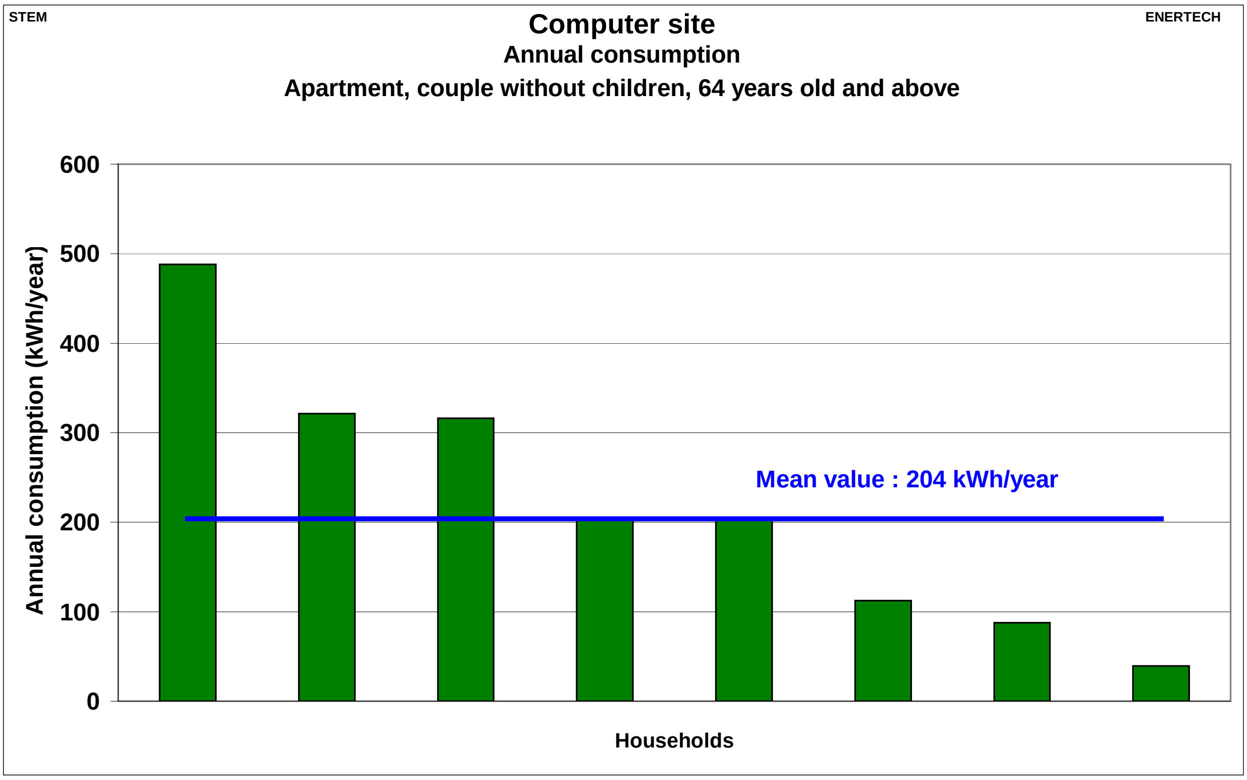


Figure 2.425: Computer site – Annual consumption – Apartment, couples without children, 64 years old and above

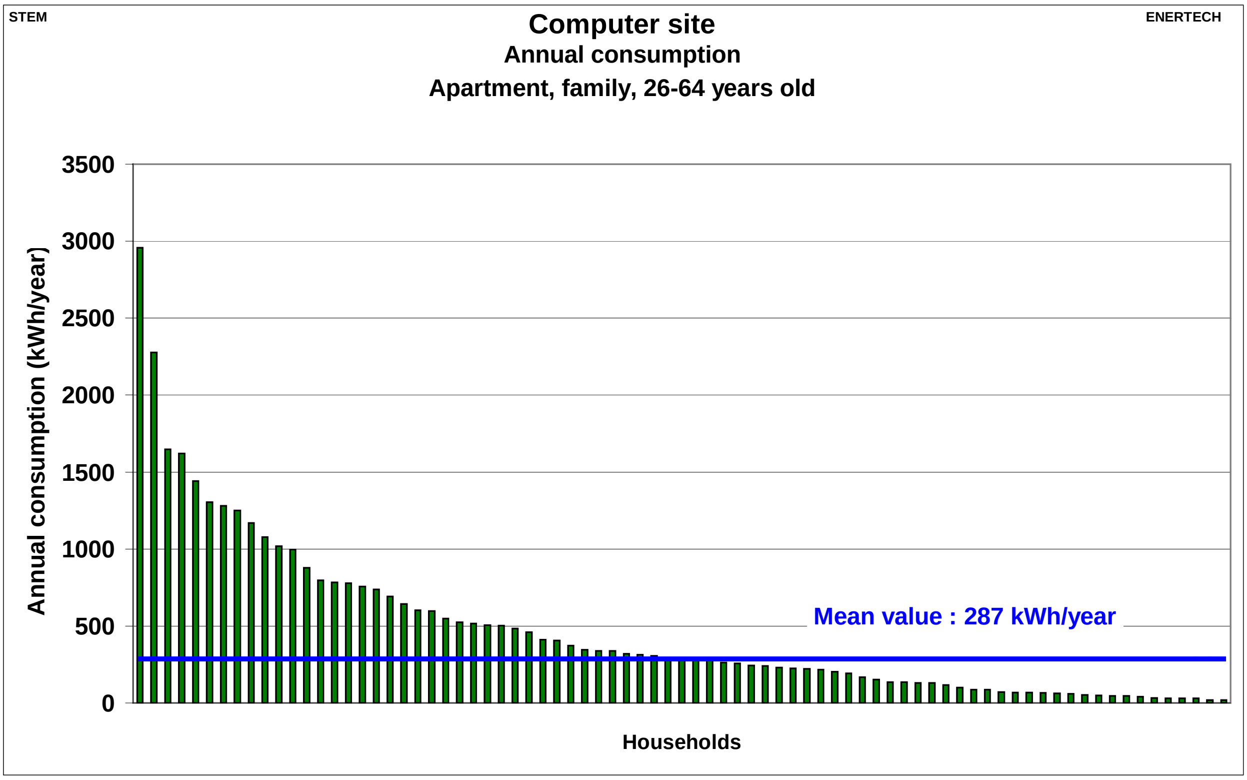


Figure 2.426: Computer site – Annual consumption – Apartment, family, 26-64 years old

Figure 2.427 shows the annual consumption per person as a function of the number of persons in the household. The values per persons should be treated with some care, since the family structure has to be taken into account as well. The annual consumption for a single person is 207 kWh/year, for more than one person this value is in the range 120-160 kWh/person/year. There is no clear pattern that shows that more persons/less consumption per person. It seems that the computer site is very dependant of the number of persons in the household.

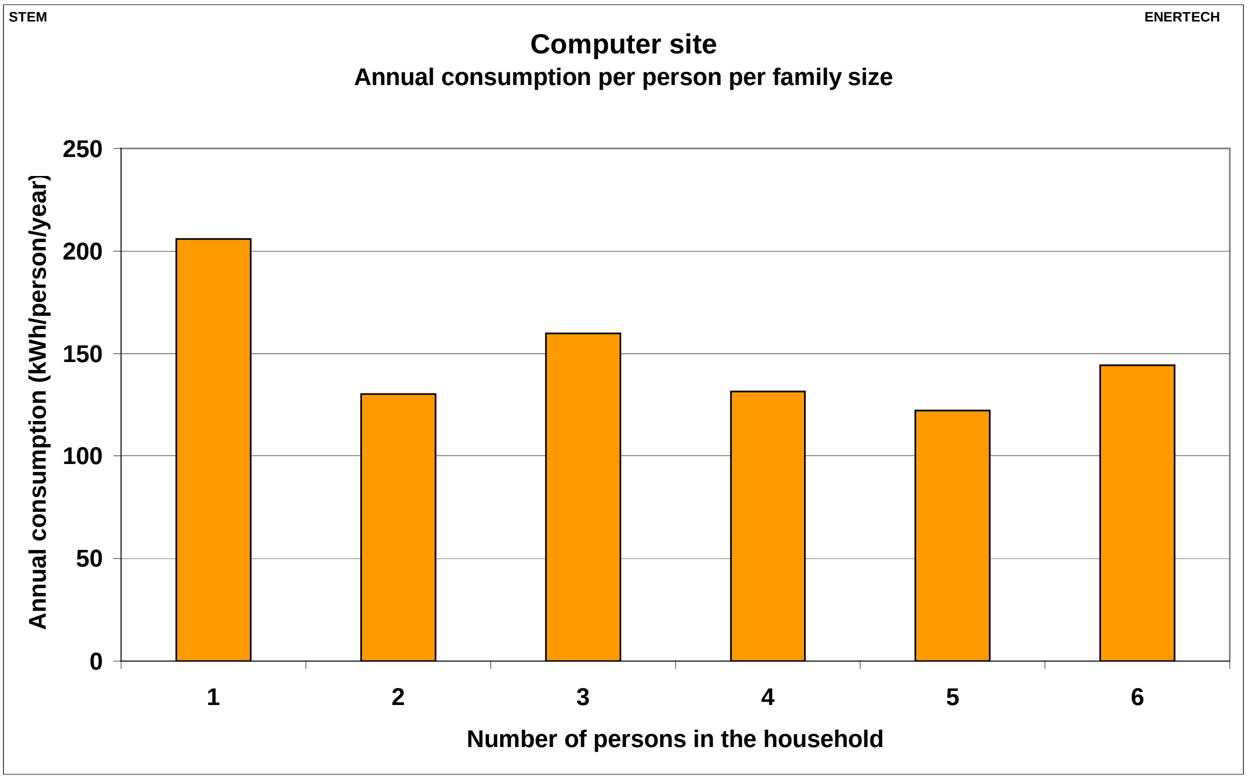


Figure 2.427: Computer site – annual consumption per person per family size

Hourly load curve

The average hourly load curves are shown in figures 2.428 to 2.443.

Computer site consumption grows progressively from a minimum value during the night (consumption is then mostly due to Standby power), to a maximum value in the evening (the peak demand value varies much from one type of household to the other). Then it decreases rather suddenly at the beginning of the night to its lowest level. The consumption of the sites that are ON between 02.00 and 03.00 hours is still very important. Computers are often used during the night, unless users forget to stop their CPUs over the night.

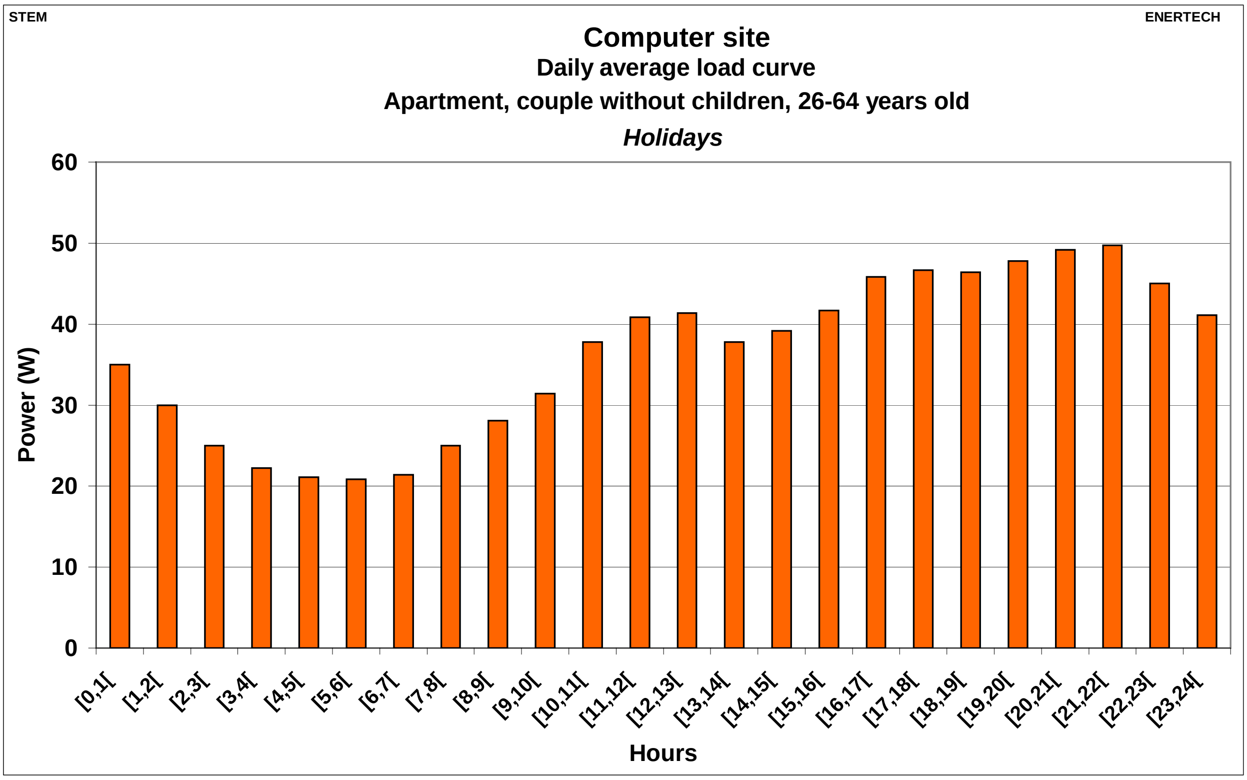


Figure 2.428: Computer site – Daily average load curve – Apartment, couples without children, 26-64 years old – Holidays

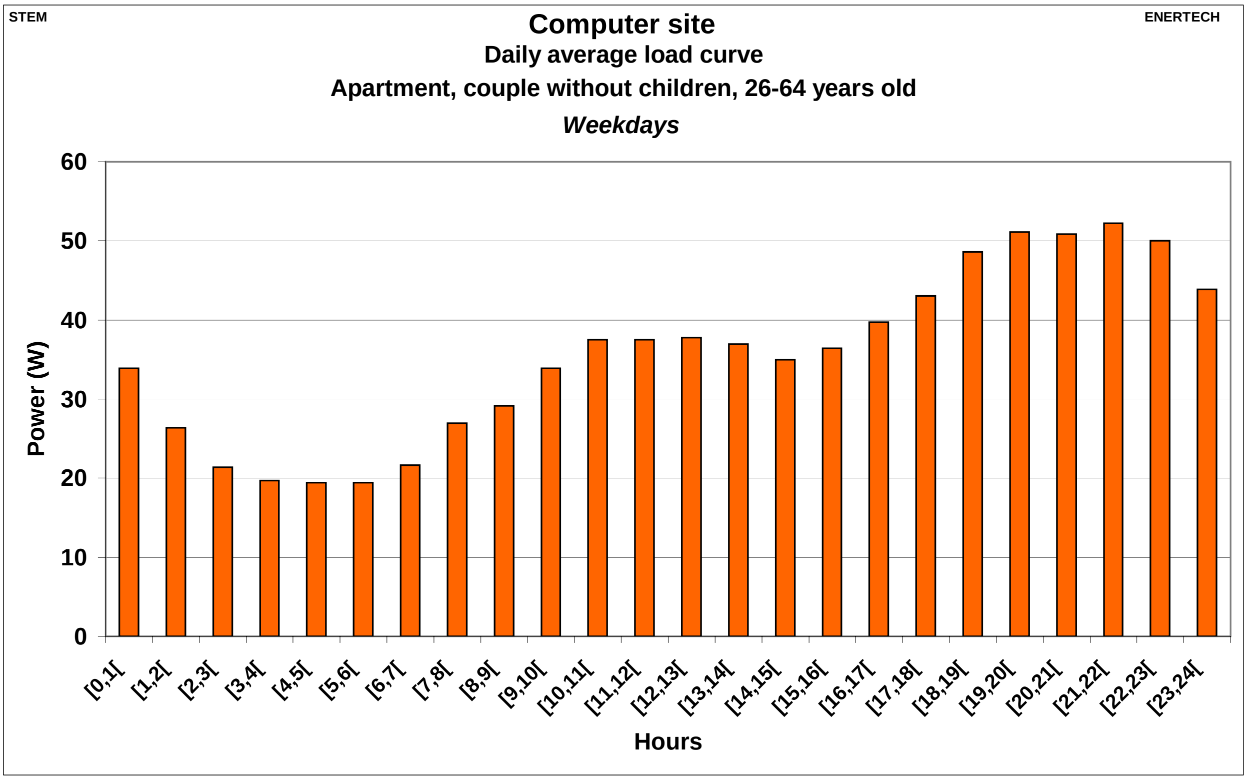


Figure 2.429: Computer site – Daily average load curve – Apartment, couples without children, 26-64 years old – Weekdays

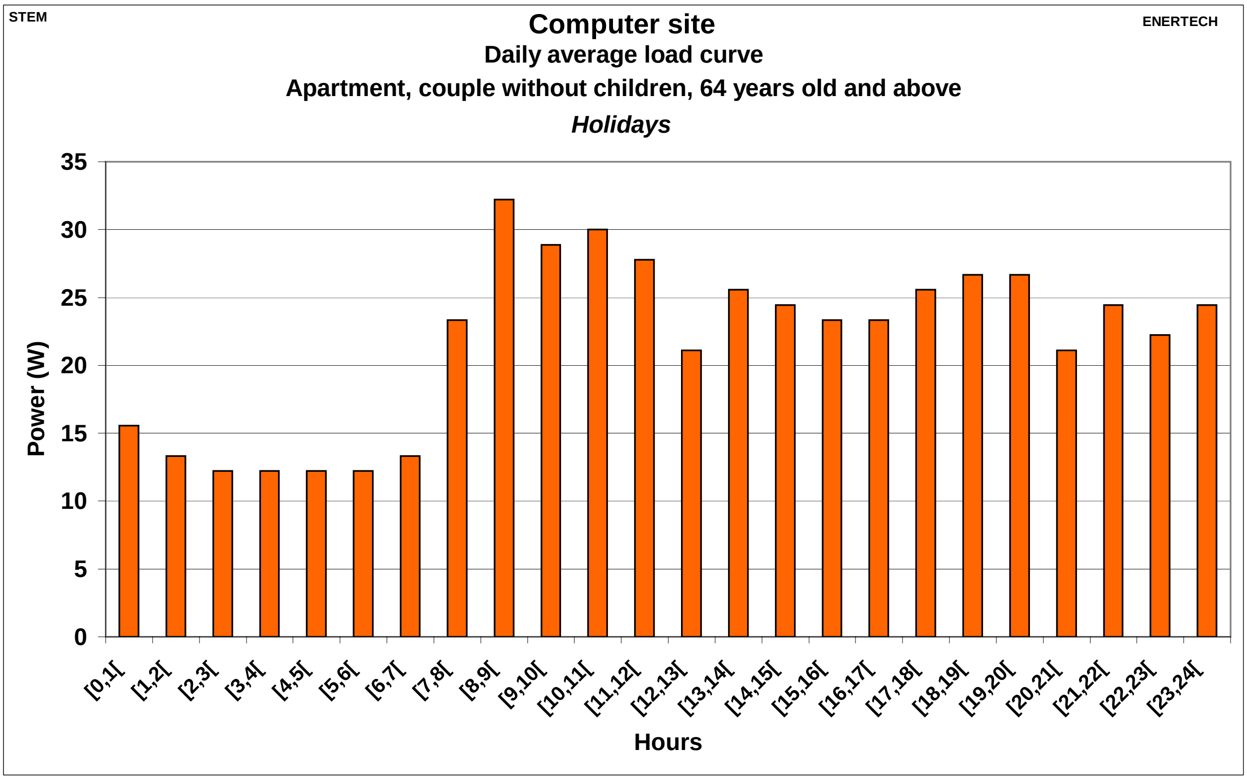


Figure 2.430: Computer site – Daily average load curve – Apartment, couples without children, 64 years old and above – Holidays

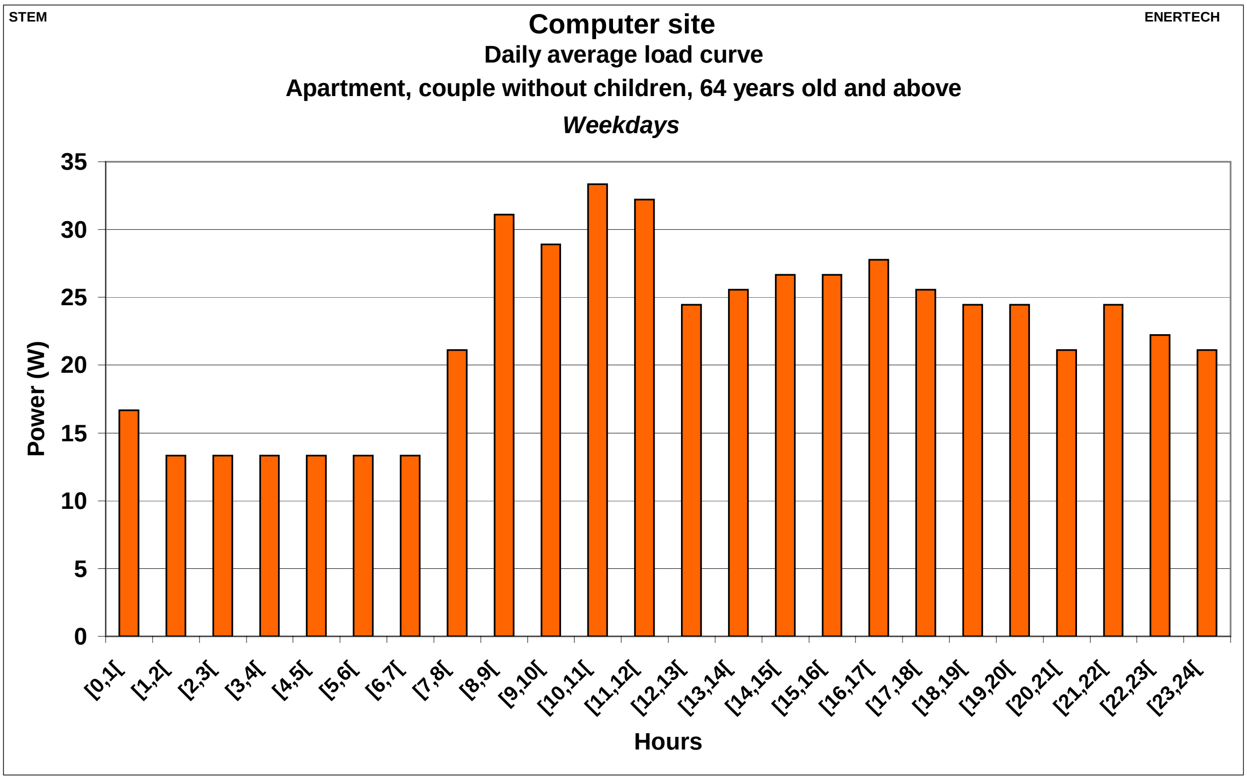


Figure 2.431: Computer site – Daily average load curve – Apartment, couples without children, 64 years old and above – Weekdays

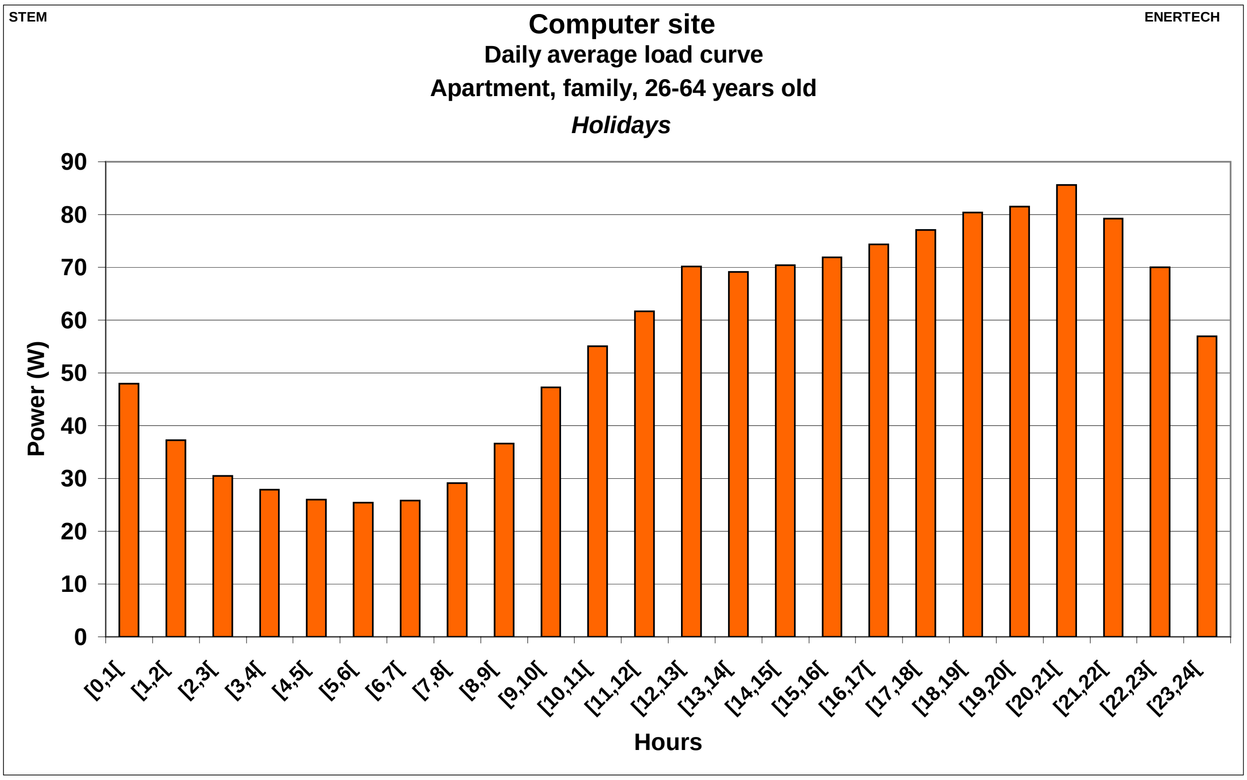


Figure 2.432: Computer site – Daily average load curve – Apartment, family, 26-64 years old – Holidays

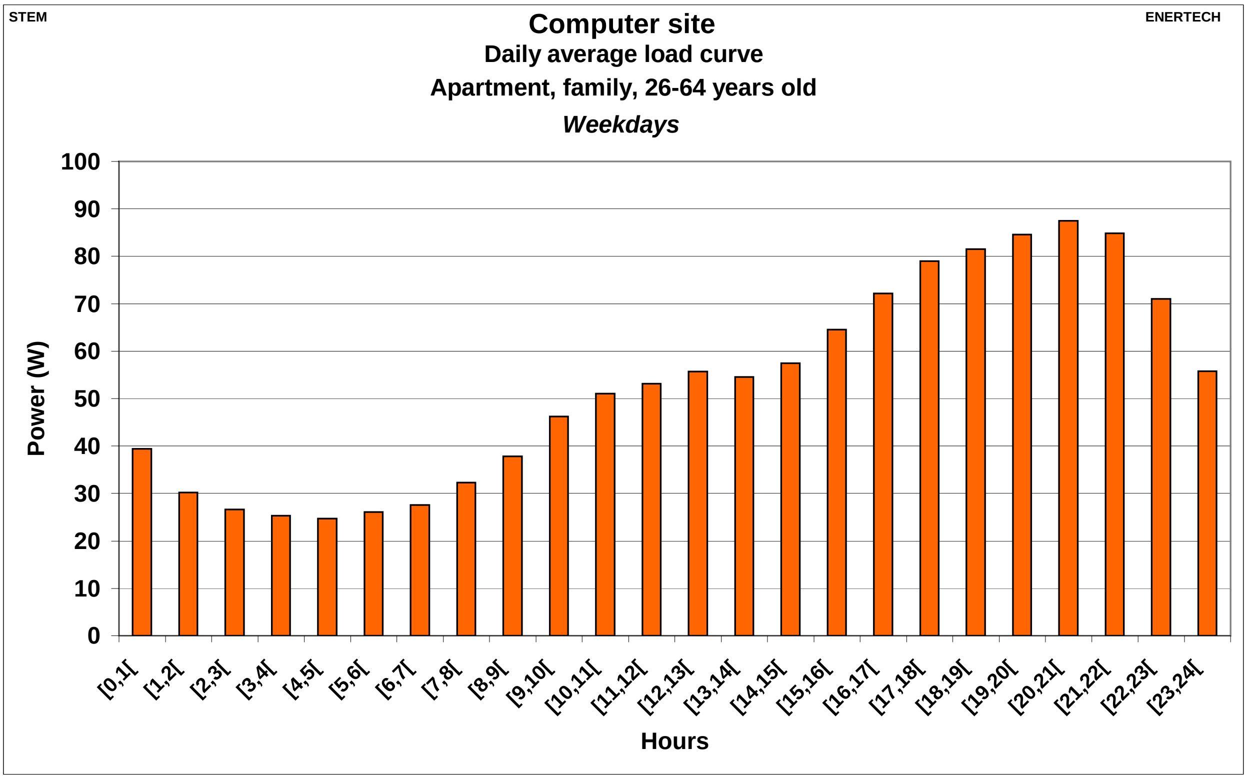


Figure 2.433: Computer site – Daily average load curve – Apartment, family, 26-64 years old – Weekdays

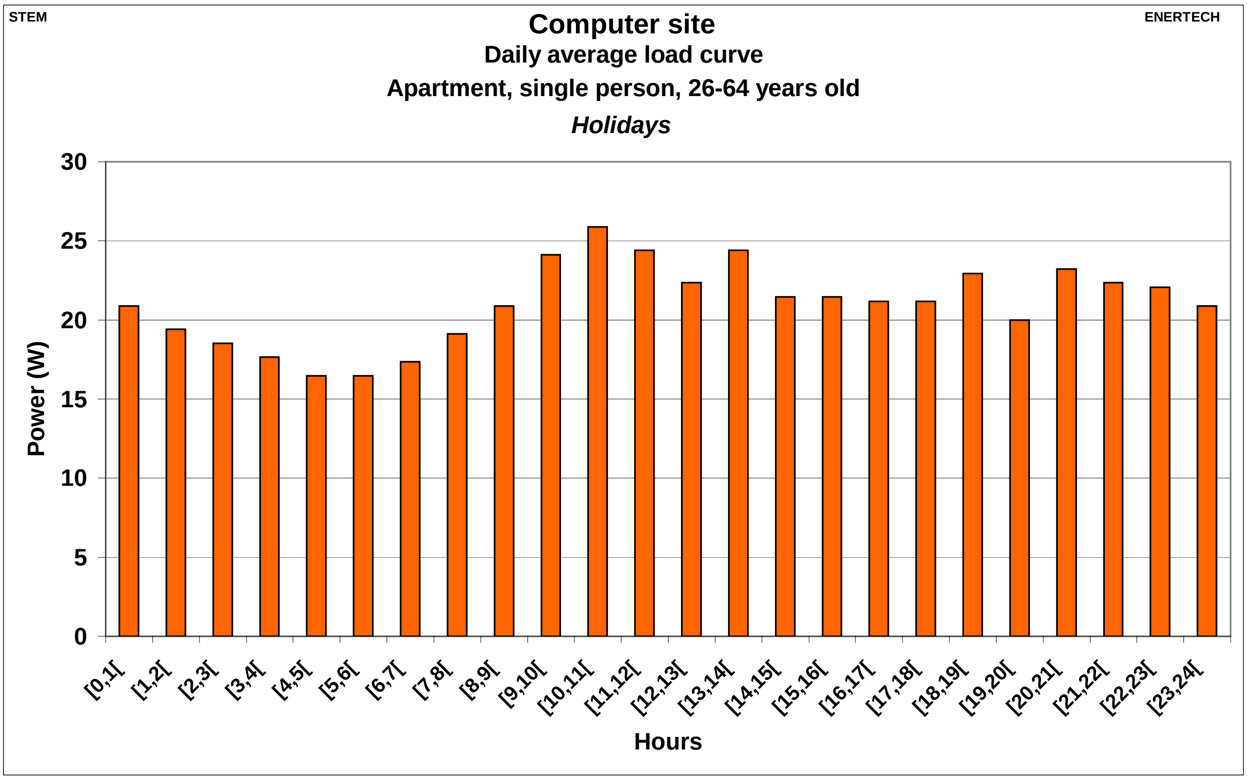


Figure 2.434: Computer site – Daily average load curve – Apartment, single person, 26-64 years old – Holidays

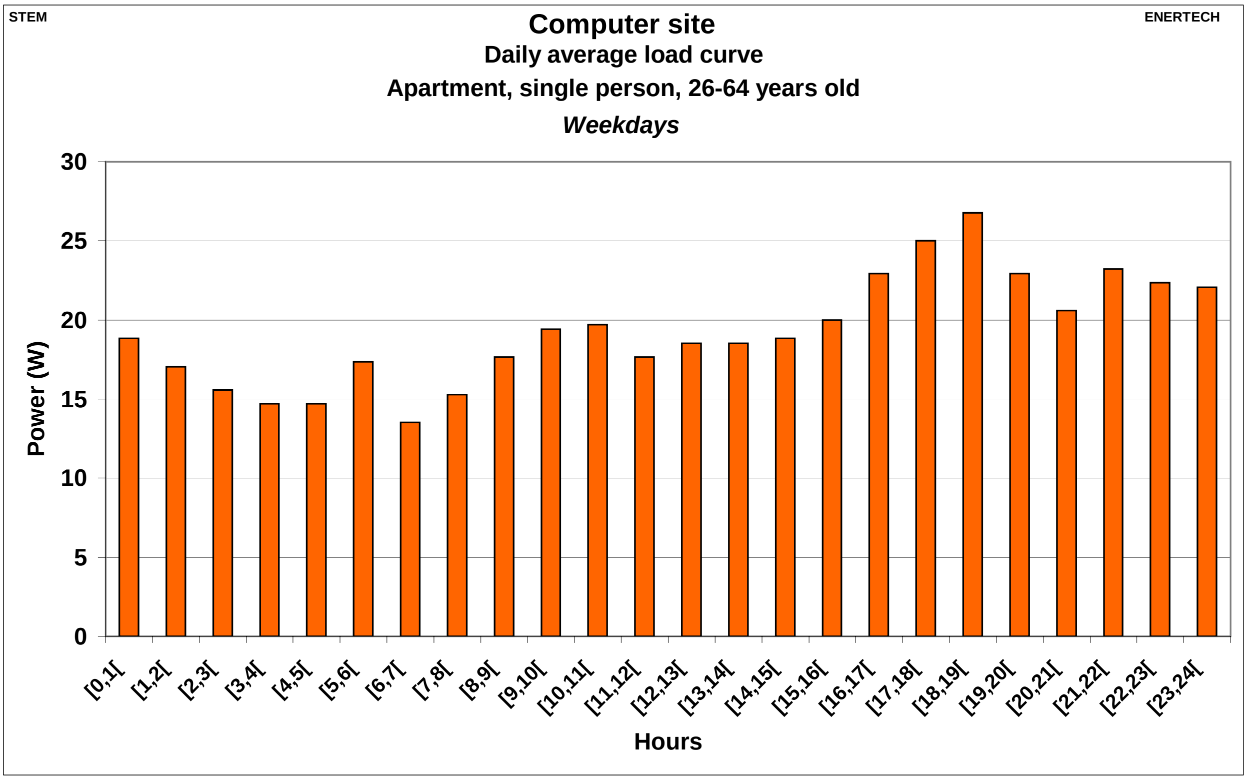


Figure 2.435: Computer site – Daily average load curve – Apartment, single person, 26-64 years old – Weekdays

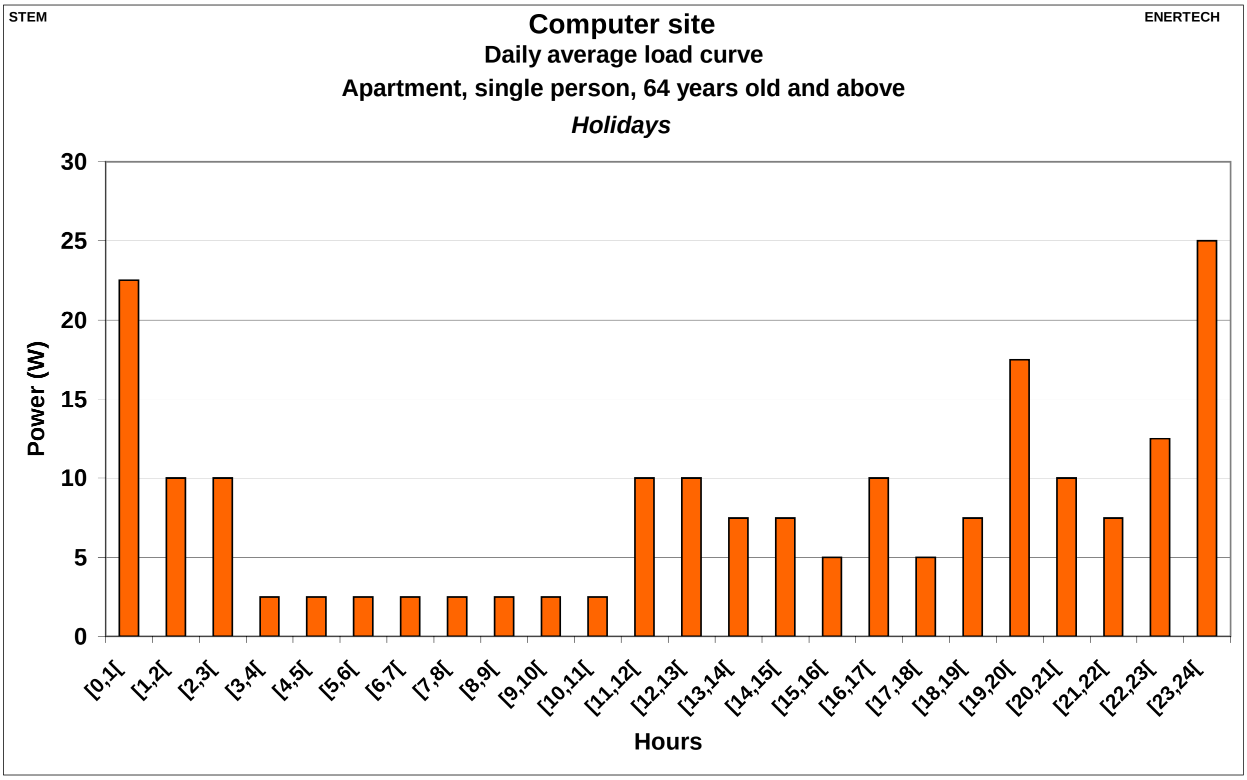


Figure 2.436: Computer site – Daily average load curve – Apartment, single person, 64 years old and above – Holidays

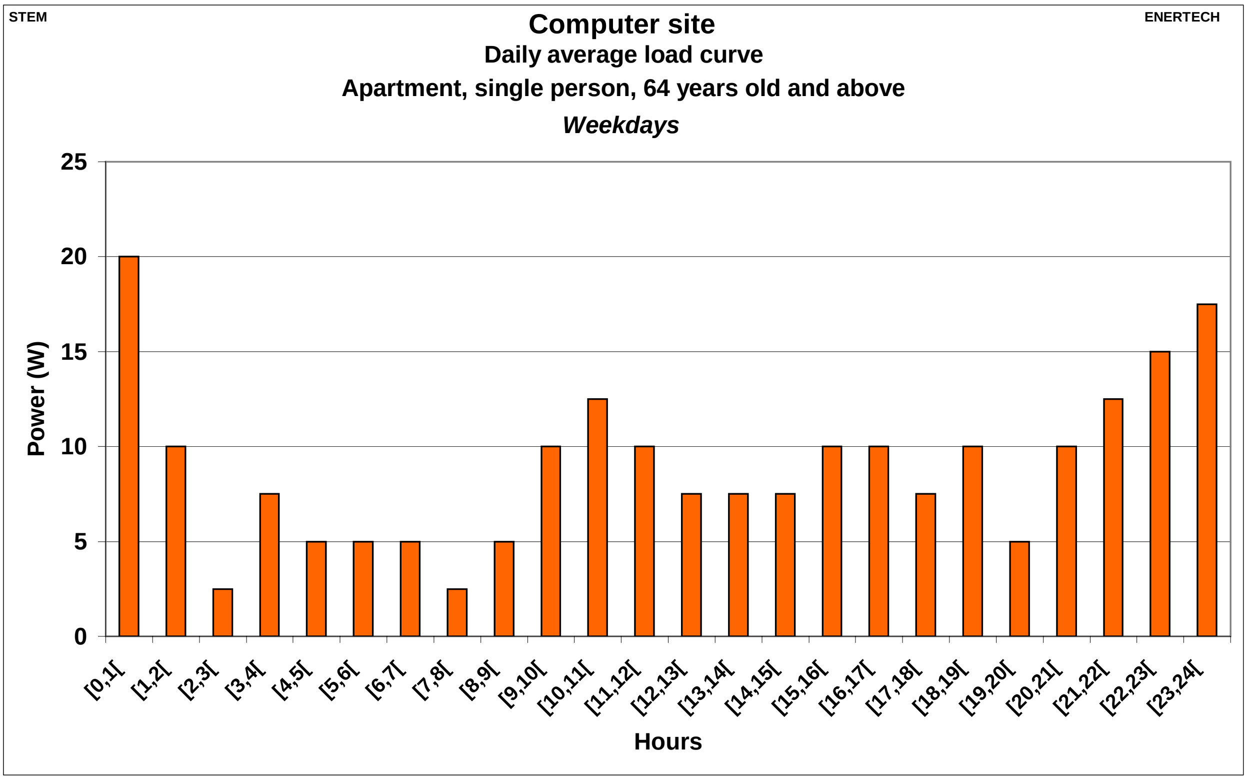


Figure 2.437: Computer site – Daily average load curve – Apartment, single person, 64 years old and above – Weekdays

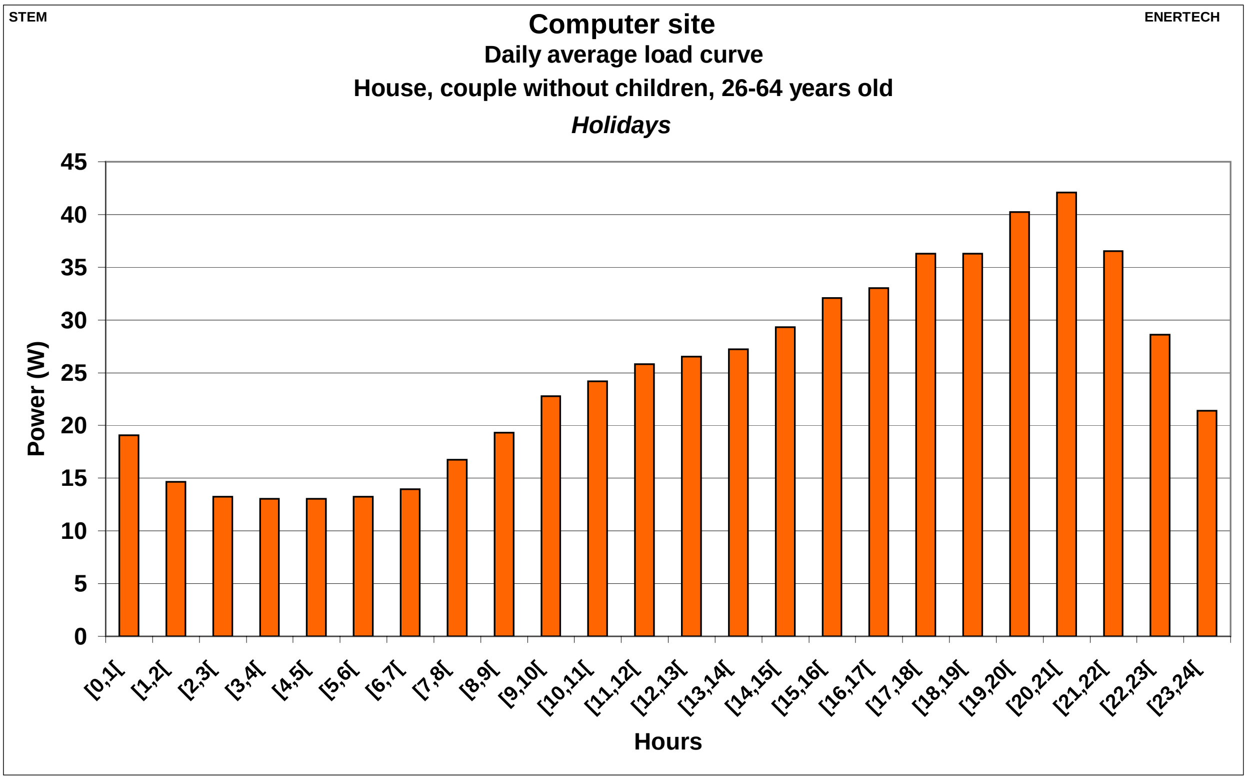


Figure 2.438: Computer site – Daily average load curve – House, couples without children, 26-64 years old – Holidays

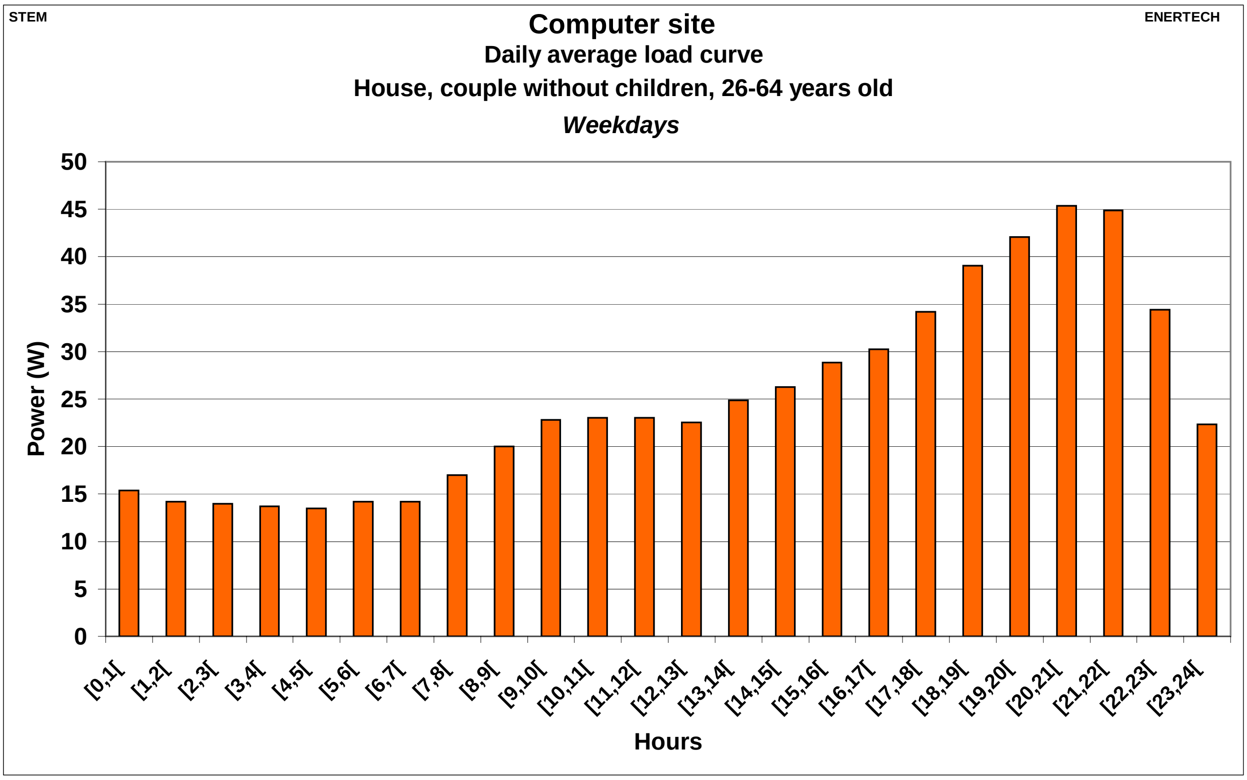


Figure 2.439: Computer site – Daily average load curve – House, couples without children, 26-64 years old – Weekdays

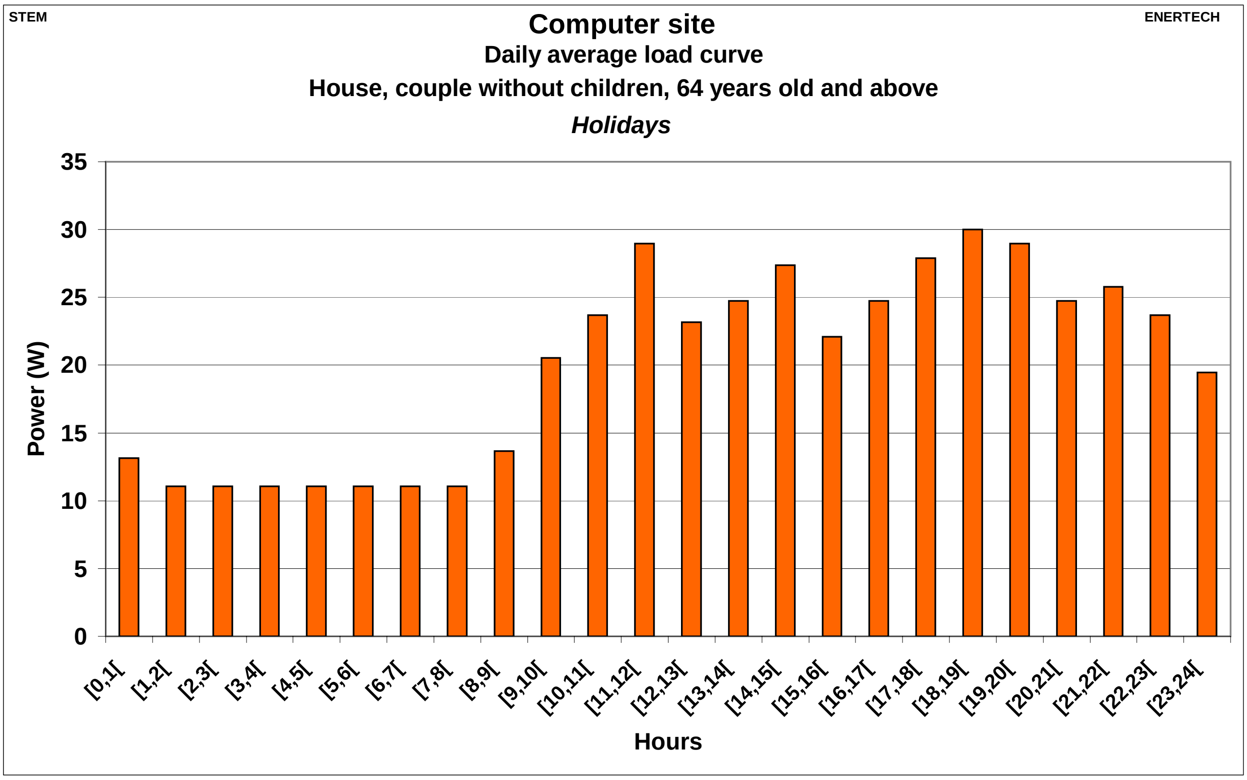


Figure 2.440: Computer site – Daily average load curve – House, couples without children, 64 years old and above – Holidays

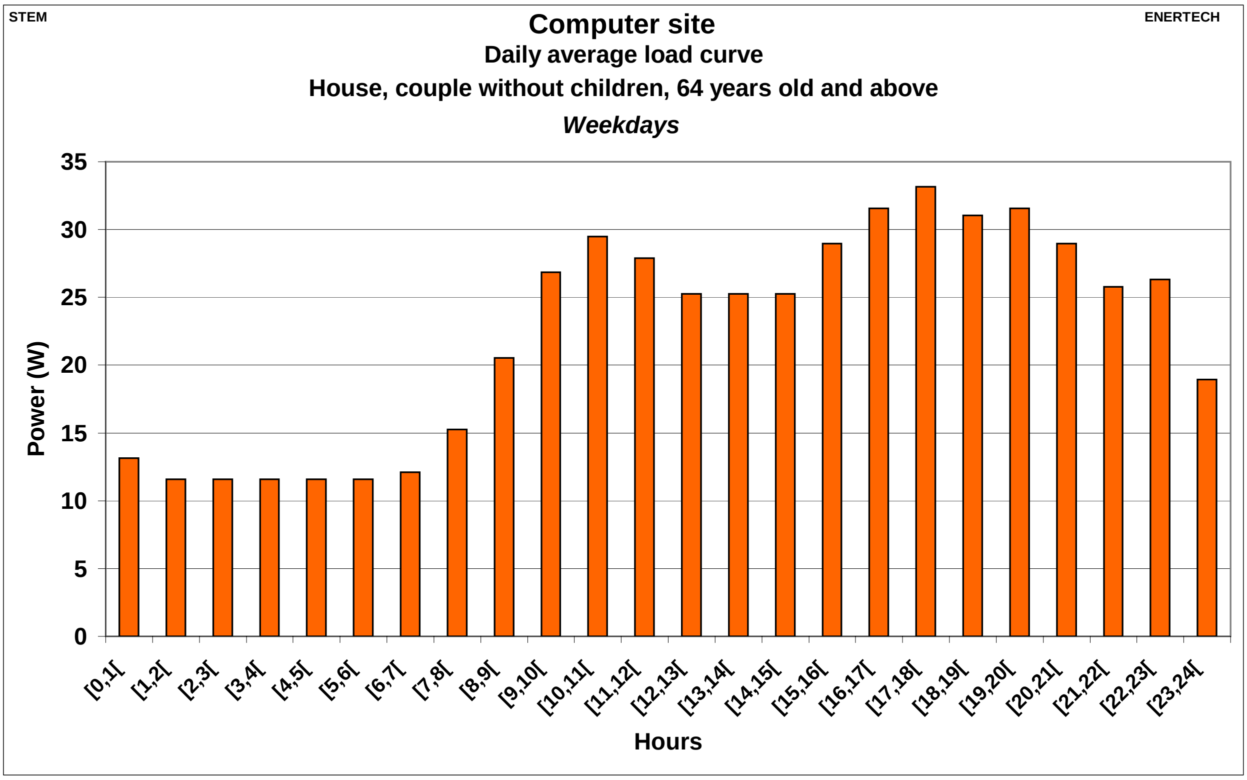


Figure 2.441: Computer site – Daily average load curve – House, couples without children, 64 years old and above – Weekdays

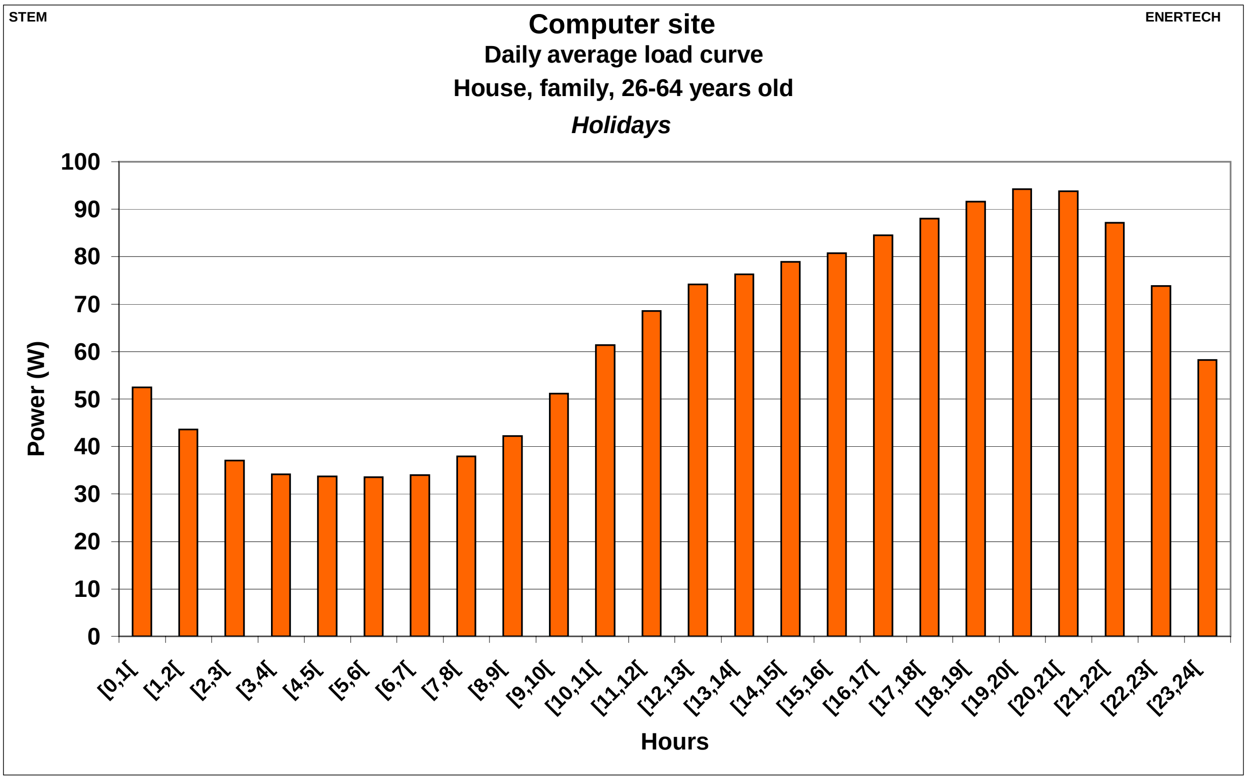


Figure 2.442: Computer site – Daily average load curve – House, family, 26-64 years old – Holidays

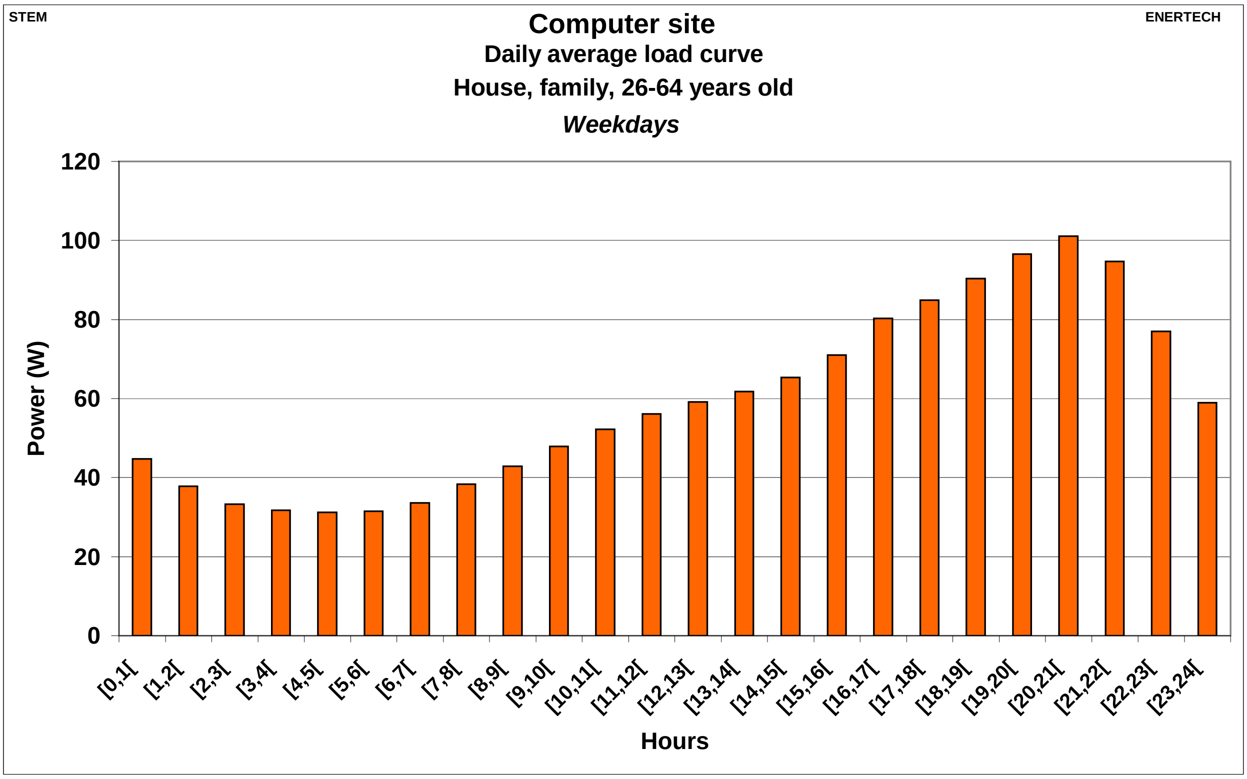


Figure 2.443: Computer site – Daily average load curve – House, family, 26-64 years old – Weekdays

Standby consumption

Figures 2.444 shows the time distribution between the 3 main states for the computer site: ON mode when used, Standby mode where the appliances continue to consume energy but are not used and OFF mode when the appliances are disconnected from the plug. These states where calculated for each computer site individually. The sites were analyzed graphically to separate the Standby power from the ON power. The graph was calculated by averaging each state for all the sites. They are in ON mode 26 % of the time (2278 hours per year), in Standby mode 56 % of the time (4906 hours per year) and in OFF mode the rest of the time (1576 hour per year).

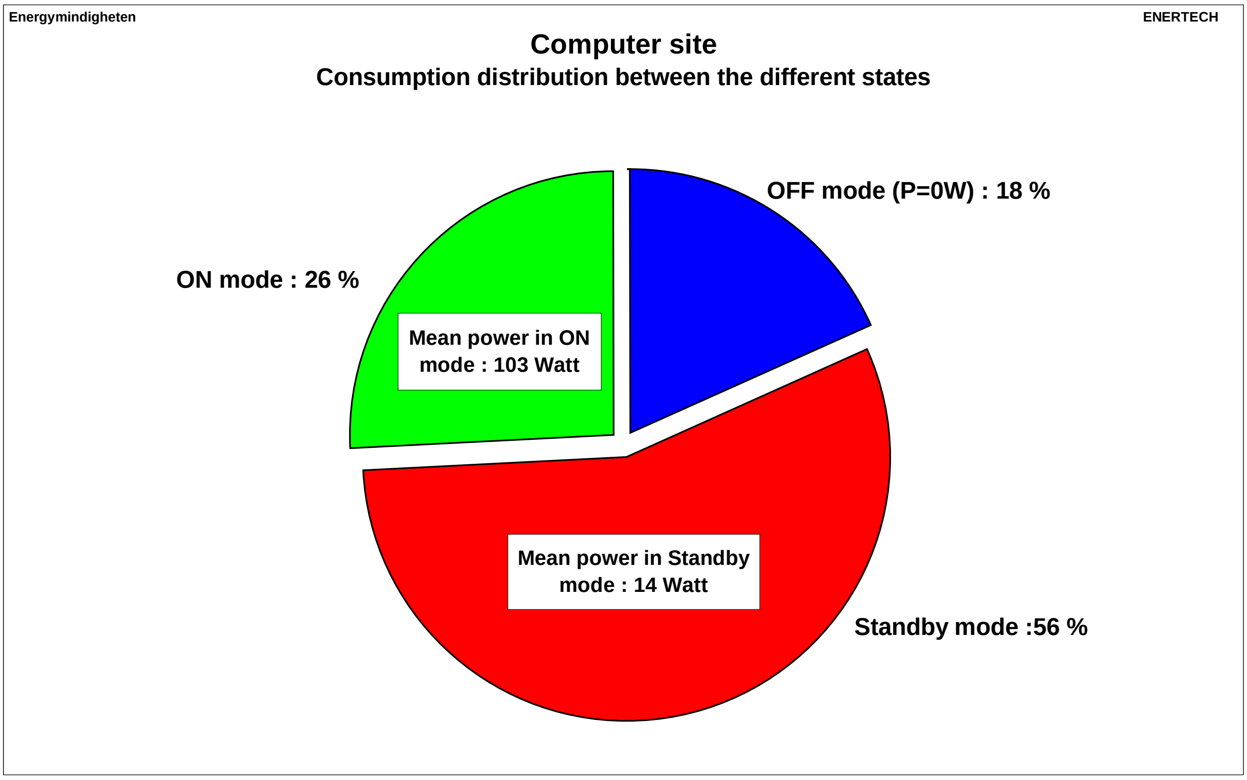


Figure 2.444: Computer site: Consumption distribution between the different states

Figure 2.445 shows the daily average load curve split between ON mode and Standby mode. We can see that a large part of the night consumption is due to Standby (as for the audiovisual site). The Standby is minimal between 19:00 and 22:00, corresponding to the hours where the computer is often used.

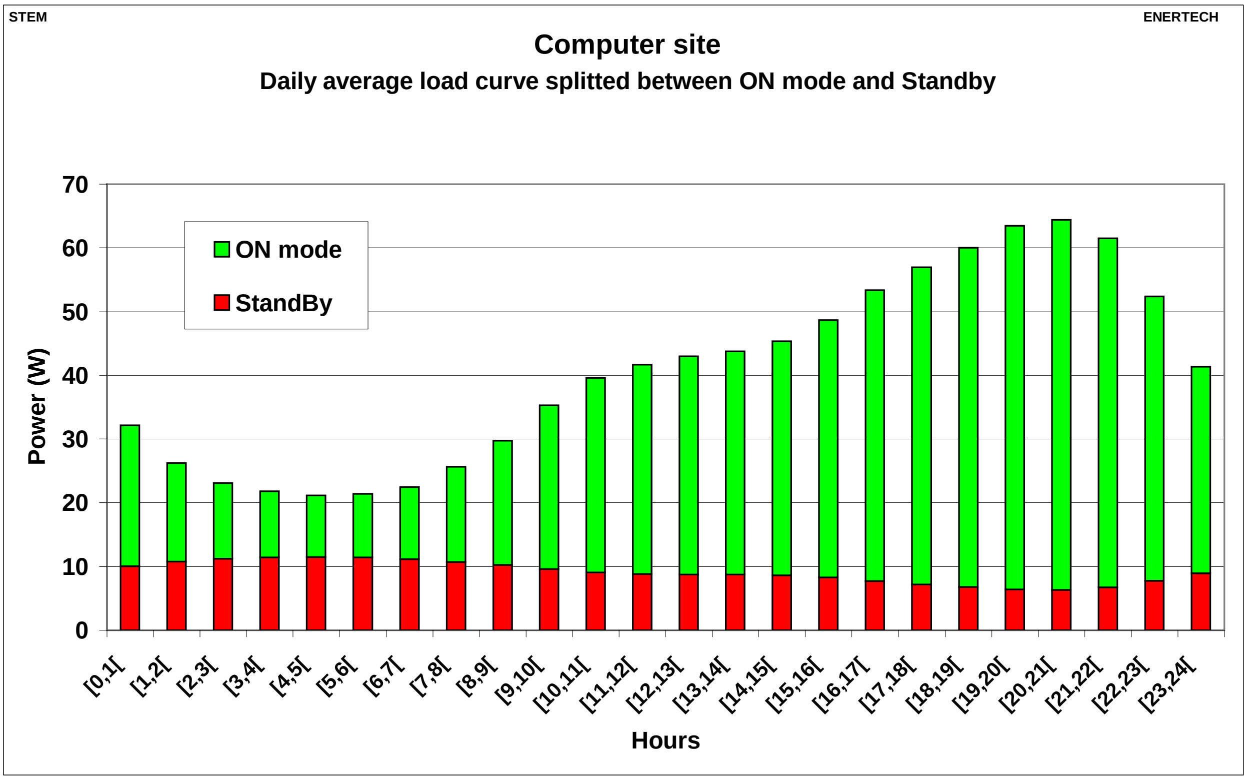


Figure 2.445: Computer site: Daily average load curve split between ON mode and Standby

Analysis per type of equipment

Annualized consumption

The table from figure 2.446 lists all the different devices monitored separately during the campaign. The most interesting part is to compare the annual consumption for a desktop computer with the annual consumption for a laptop: 343 kWh/year to 35 kWh/year! , the ratio is very near to 10-1.

	Total number of appliances monitored	Average annual consumption (kWh)	Apartment, couples without children, less than 25 years old	Apartment, couples without children, 26-64 years old	Apartment, couples without children, 64 years old and above	Apartment, family, 26-64 years old	Apartment, single person, 26-64 years old	Apartment, single person, 64 years old and above	Apartment, single person, less than 25 years old	House, couples without children, 26-64 years old	House, couples without children, 64 years old and above	House, family, 26-64 years old	House, single person, 26-64 years old	House, single person, 64 years old and above
	All appliances		Annual consumption kWh/year (Number of appliance)											
Broadband	3	38				42 (2)						32 (1)		
Computer (desktop/Monitor/modem)	441	343	188 (2)	255 (41)	171 (10)	560 (106)	172 (30)	51 (3)	362 (1)	195 (45)	177 (19)	342 (178)	138 (4)	152 (2)
Harddisk	1	12										12 (1)		
Laptop	139	35		30 (17)		43 (32)	12 (10)	47 (1)	10 (1)	25 (11)	59 (5)	36 (61)		
Modem	5	80		28 (1)			49 (2)			75 (1)		199 (1)		
Printer	34	45		9 (4)	75 (1)	70 (8)	25 (4)	23 (1)		29 (4)		51 (12)		
Monitor + Scanner + Printer + Router	2	214								11 (1)		417 (1)		
Monitor	2	27										27 (2)		
UPC Modem	5	52				19 (1)	86 (1)			58 (2)		39 (1)		

Figure 2.446: Average annual consumption per device

Standby power analysis

The table from figure 2.447 show the different Standby power that were measured individually at installation time or extracted from the monitored data for computer devices. If the number of annual hours in Standby mode is know, it is possible to use the power to calculate the annual Standby consumption: for example, a printer that will stay in Standby 90 % of the time will have a consumption of 0,9 * 8760 * 5,2 = 41 kWh/year.

Appliance	Number monitored	Power (Watt)
Computer site	288	15,5
External harddisk	2	9,6
Laptop	29	2,6
Modem/Router (ADSL)	177	7,2
Printer	35	5,2
Switch	6	5,4

Figure 2.447: Standby power per device

HEATING/WATER HEATER

Description of the monitored equipment

There are different types of heating depending on the energy used: direct electric heating, heat pump, gas, wood, district heating etc. Each type of heating needs different devices to work properly: electric radiators, heat pump, circulation pump for hot water etc. In this monitoring campaign, all the consumption involved in the heating production were monitored, generally directly from the switchboard. According to the questionnaire that each household owner had to fill in, the households were split in two categories: the ones “with direct electric heating” (radiators or electric furnace) and the ones “without direct electric heating” (district heating, heat pump or other types of energy). The table from figure 2.448.1 shows the equipment rate for the different devices monitored during the campaign. This table concerns only the houses, the apartments weren’t split in two categories. It is interesting to note that floor heating is present in the two types of households (and more in the “without electric heating” category!).

The water heater was monitored directly from the switchboard in the case of a three-phased appliance or with a wattmeter in the case of a mono-phased device with standard electric plug.

Heating Device	With direct electric heating	Without direct electric heating
Heating departure in switchboard	1,22	0,4
Floor heating	0,52	0,63
Heater	0,24	0,19
Air heat pump	0,15	0,12
Heat pump	0,11	0,14
Radiator	0,11	0,09
Water pump	0,06	0,03
Circulation pump	0,03	0,12
Air heater	0,02	0,04
Air Water heat pump	0,01	0
Furnace	0,01	0,01
Heat regulation	0,01	0,03
Exhaust air heat pump	0	0,02
Heat exchanger pump	0	0,02

Figure 2.448.1: Heating – Equipment rate for the different heating devices

Seasonality effect

The consumption for the heating site is strongly seasonal, but most of the households were only monitored for one month. The seasonality effect was calculated using the 40 households monitored for one year. For each household, we calculated the weekly consumption by adding all the data per week. The result output consists of 52 values per household corresponding to the number of weeks in one year. This set of values were then normalized to 1 (the average value gives one for each set). An average value per week was then calculated using all the data sets.

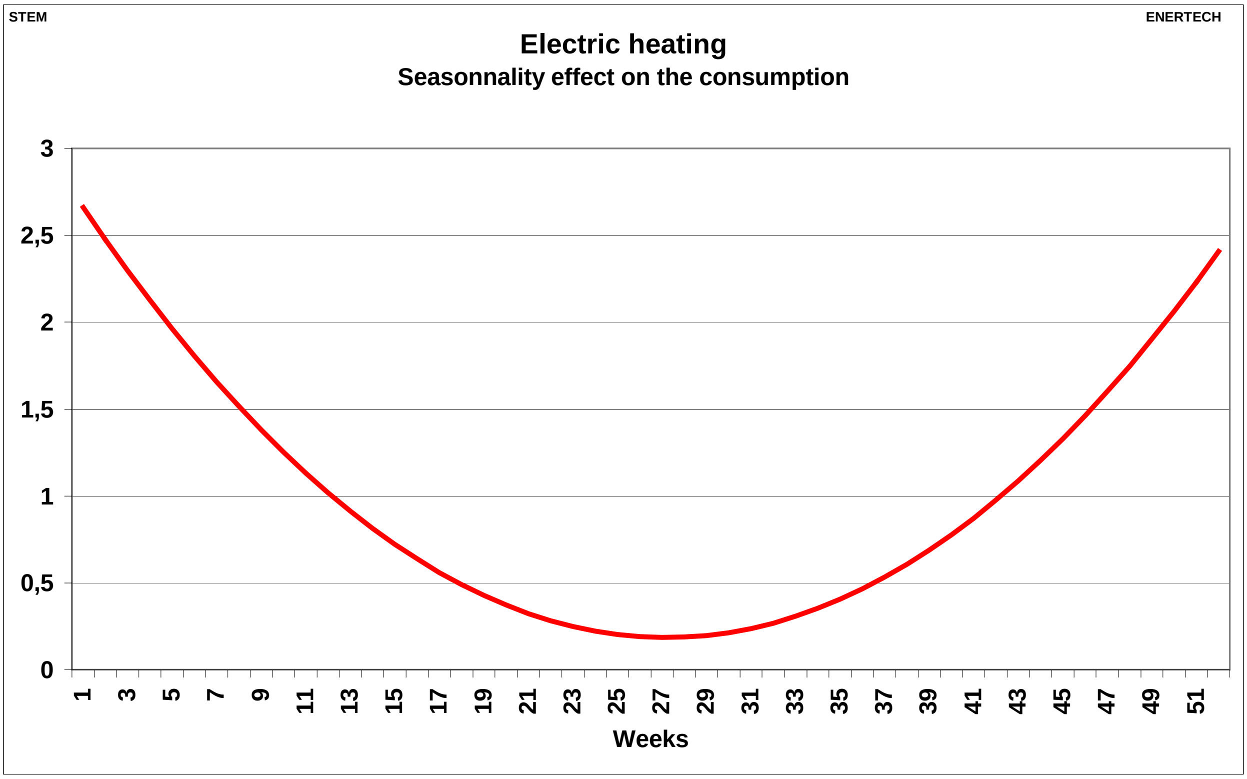


Figure 2.448: Heating – Seasonality effect

Average consumption

Figures 2.449 to 2.481 show the annual consumption, the annual consumption per m² and the annual consumption per person for heating and water heating for the different types of households:

- for the houses with direct electric heating, the total consumption goes from 6804 kWh/year (couples without children, 26-64 years old) to 11217 kWh/year (family). The consumption per m² is in the range 50-81 kWh/m²/year in the same order as for the total annual consumption. Per person, it's the family household which has the lowest consumption with 2904 kWh/person/year and the "couples without children" which has the highest with 4403 kWh/person/year.
- for the houses without direct electric heating, the total consumption goes from 2097 kWh/year (couples without children, 64 years old and above) to 6907 kWh/year (couples without children, 26-64 years old). The consumption per m² is in the range 10-50 kWh/m²/year in the same order as for the total annual consumption. Per person, it's the family household which has the lowest consumption with 768 kWh/person/year and the "couples without children, 26-64 years old" which has the highest with 3453 kWh/person/year.

- the total water heating consumption for the houses with direct electric heating are very close: from 2945 to 3046 kWh/year or 21 to 25 kWh/m²/year,
- the total water heating consumption for the houses without direct electric heating goes from 1850 to 2675 kWh/year or 9 to 20 kWh/m²/year.

Heating

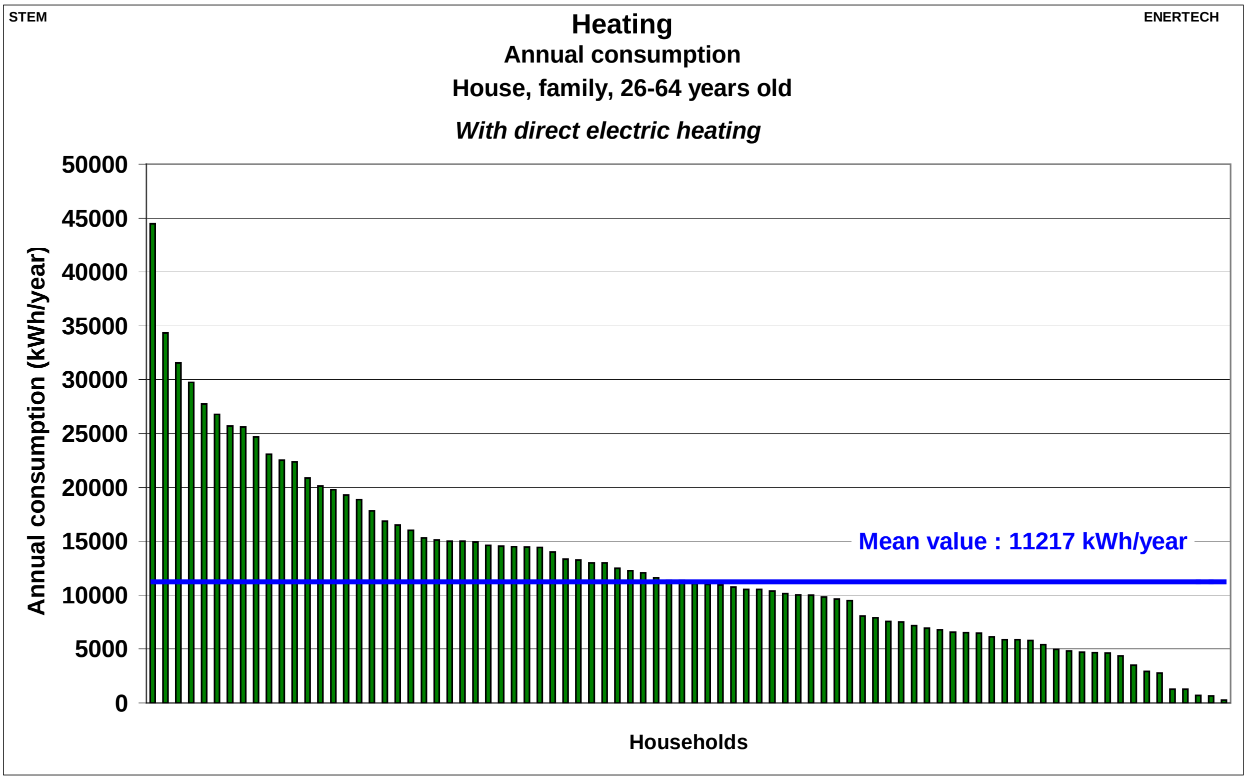


Figure 2.449: Heating – Annual consumption – House, family, 26-64 years old –Direct electric heating

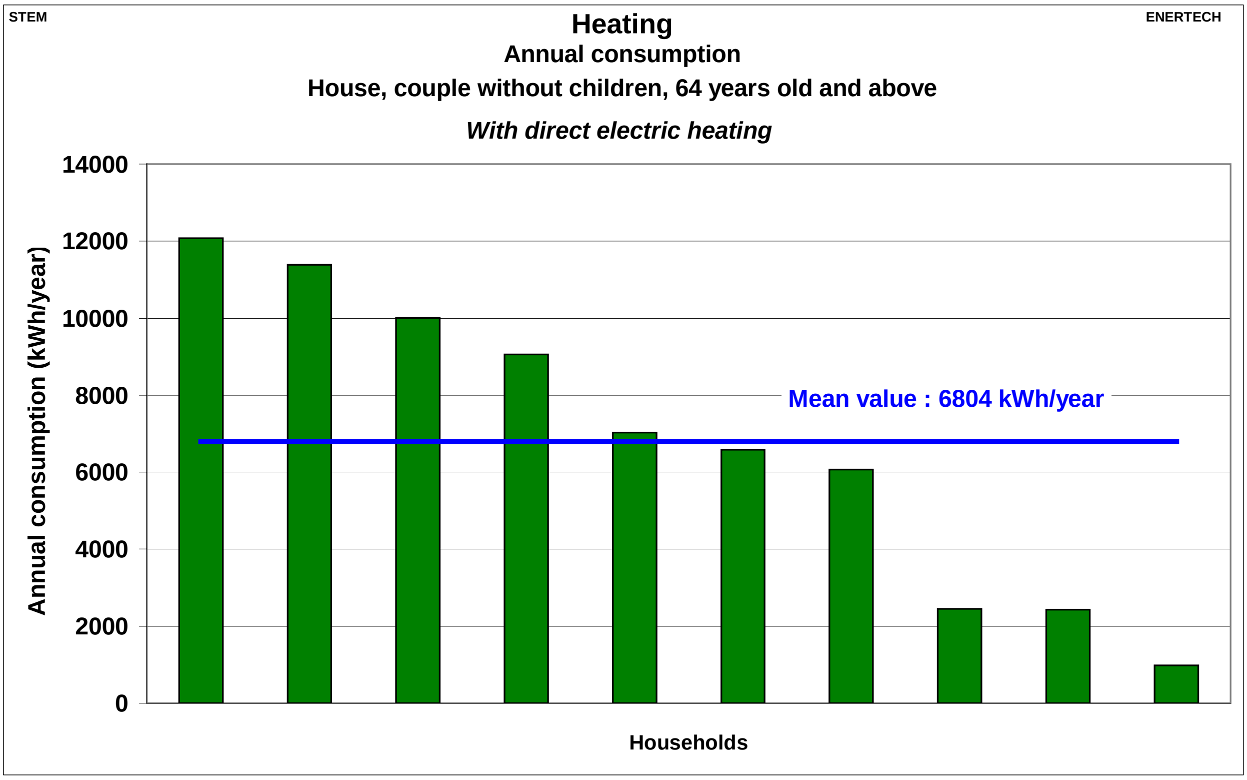


Figure 2.450: Heating – Annual consumption – House, couples without children, 64 years old and above –Direct electric heating

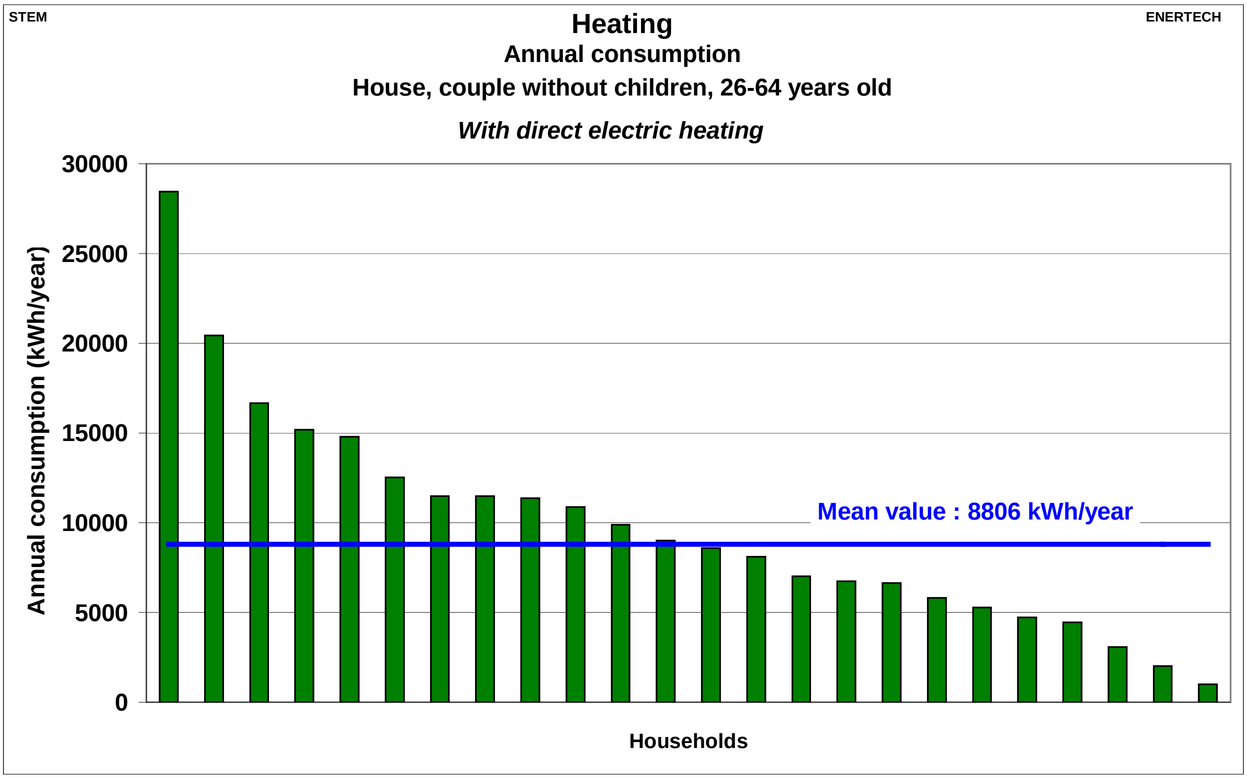


Figure 2.451: Heating – Annual consumption – House, couples without children, 26-64 years old – Direct electric heating

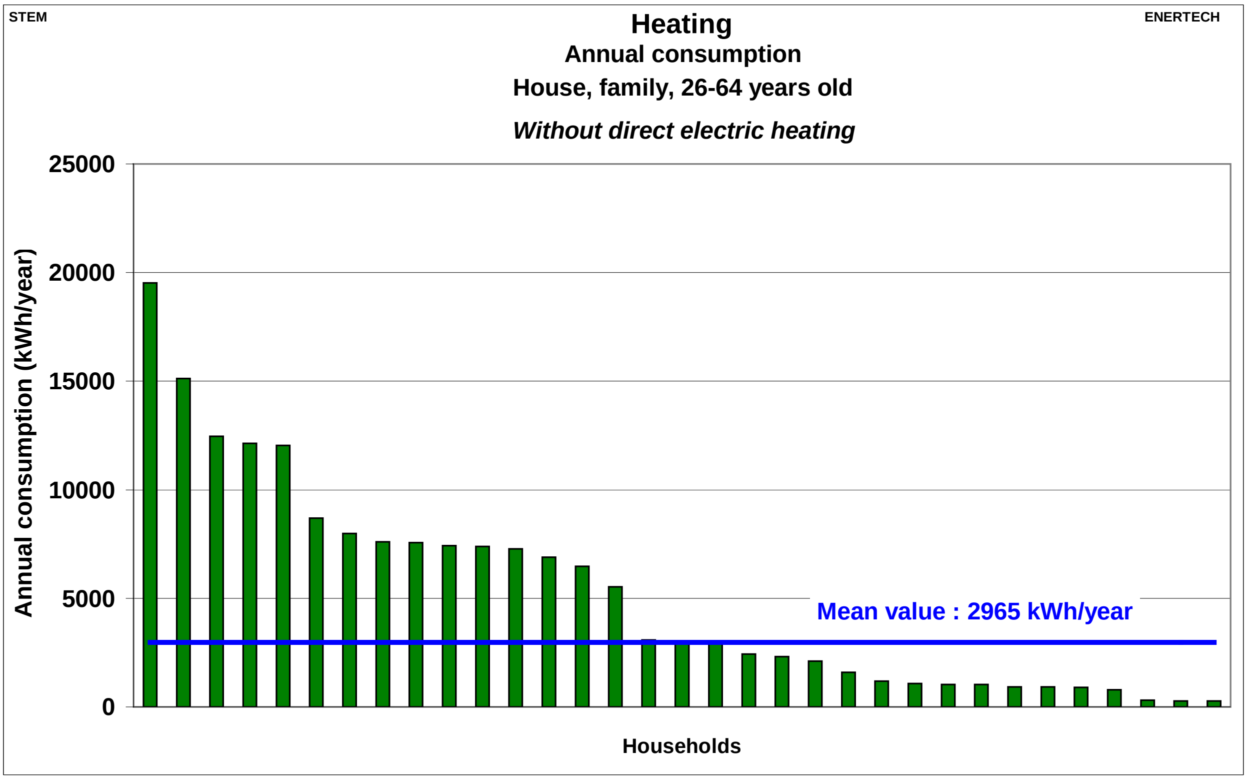


Figure 2.452: Heating – Annual consumption – House, family, 26-64 years old – Without direct electric heating

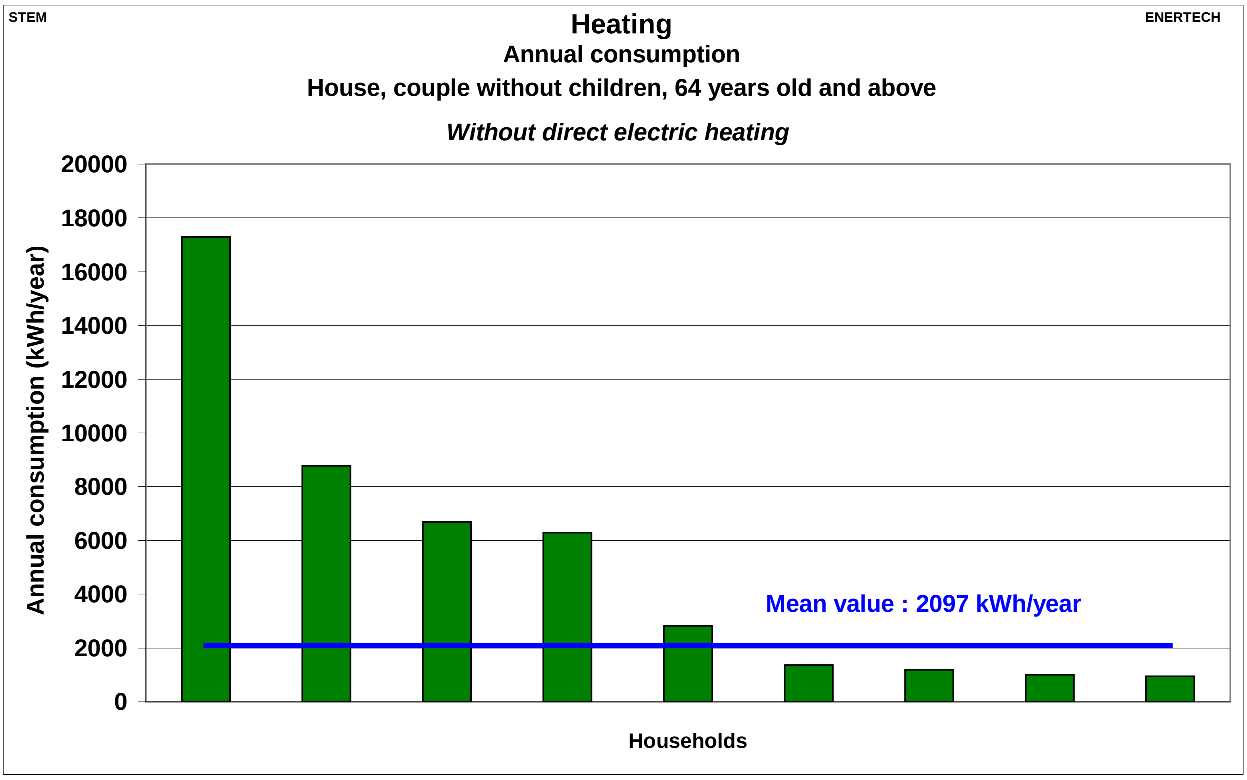


Figure 2.453: Heating – Annual consumption – House, couples without children, 64 years old and above – Without direct electric heating

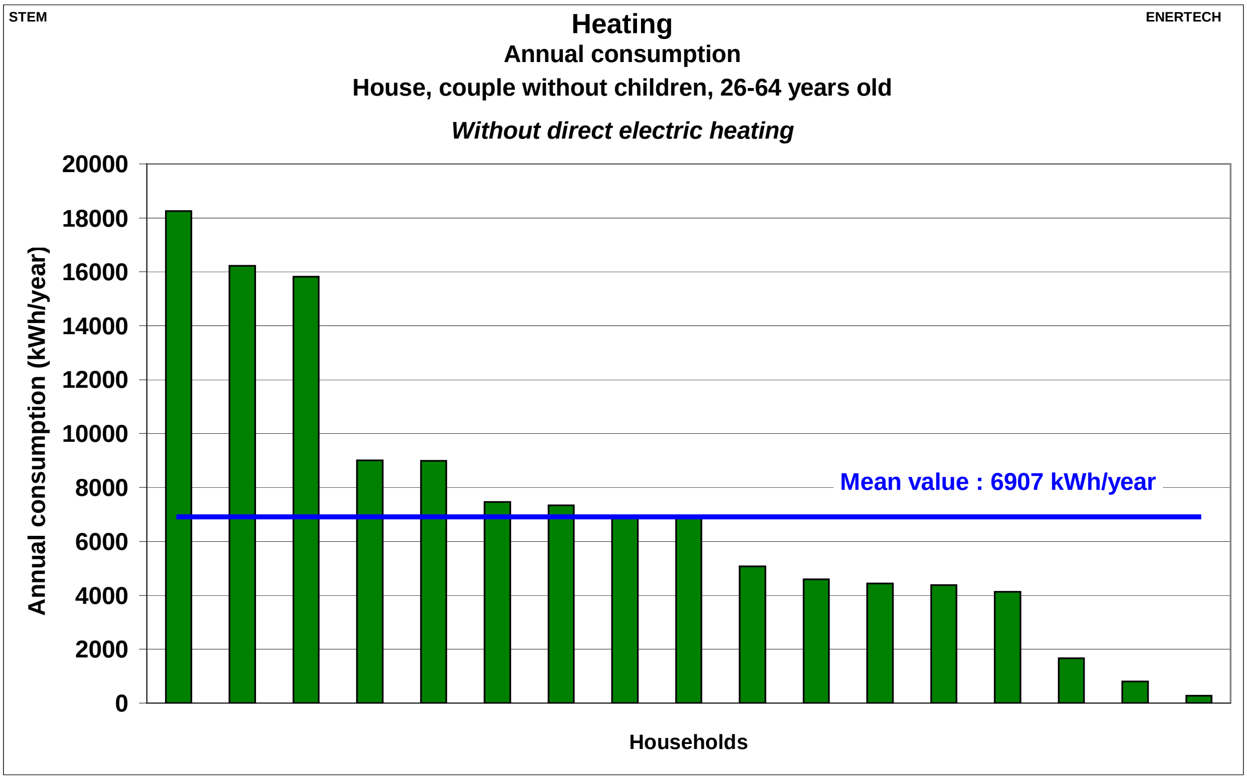


Figure 2.454: Heating – Annual consumption – House, couples without children, 26-64 years old – Without direct electric heating

Water Heating

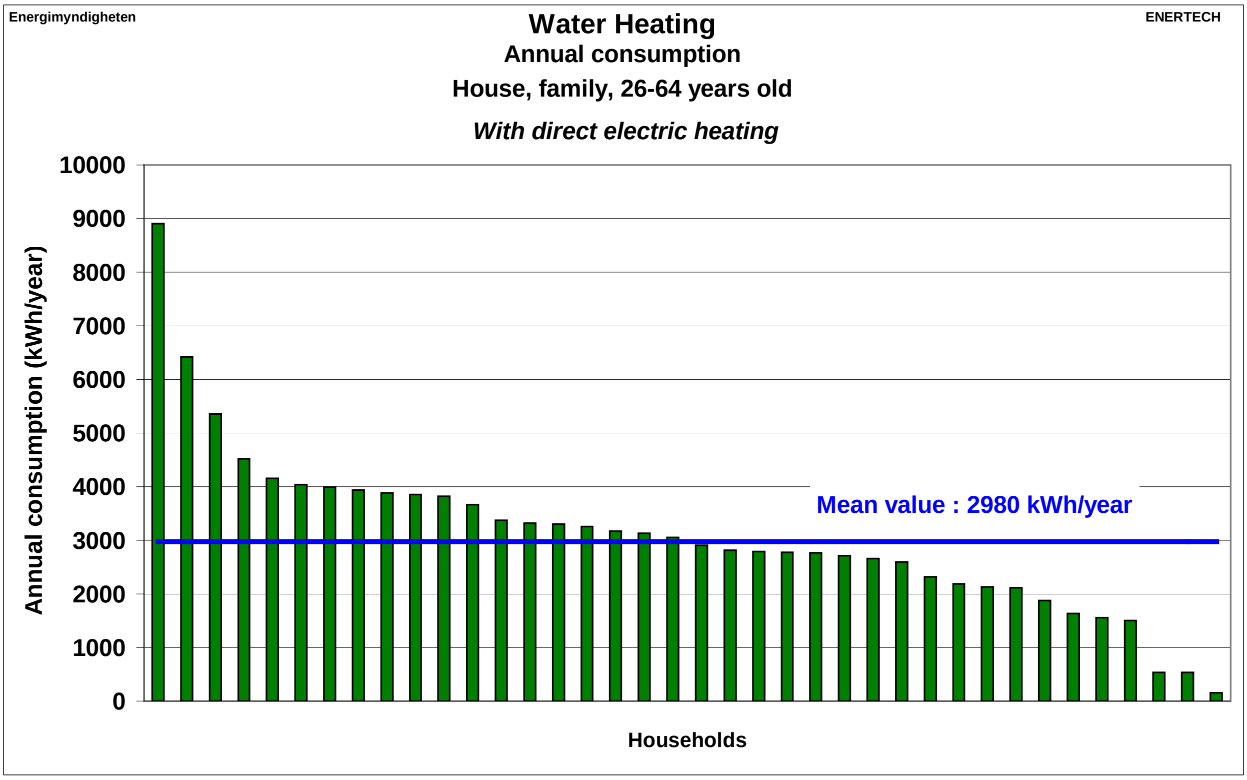


Figure 2.455: Water heating – Annual consumption – House, family, 26-64 years old –Direct electric heating

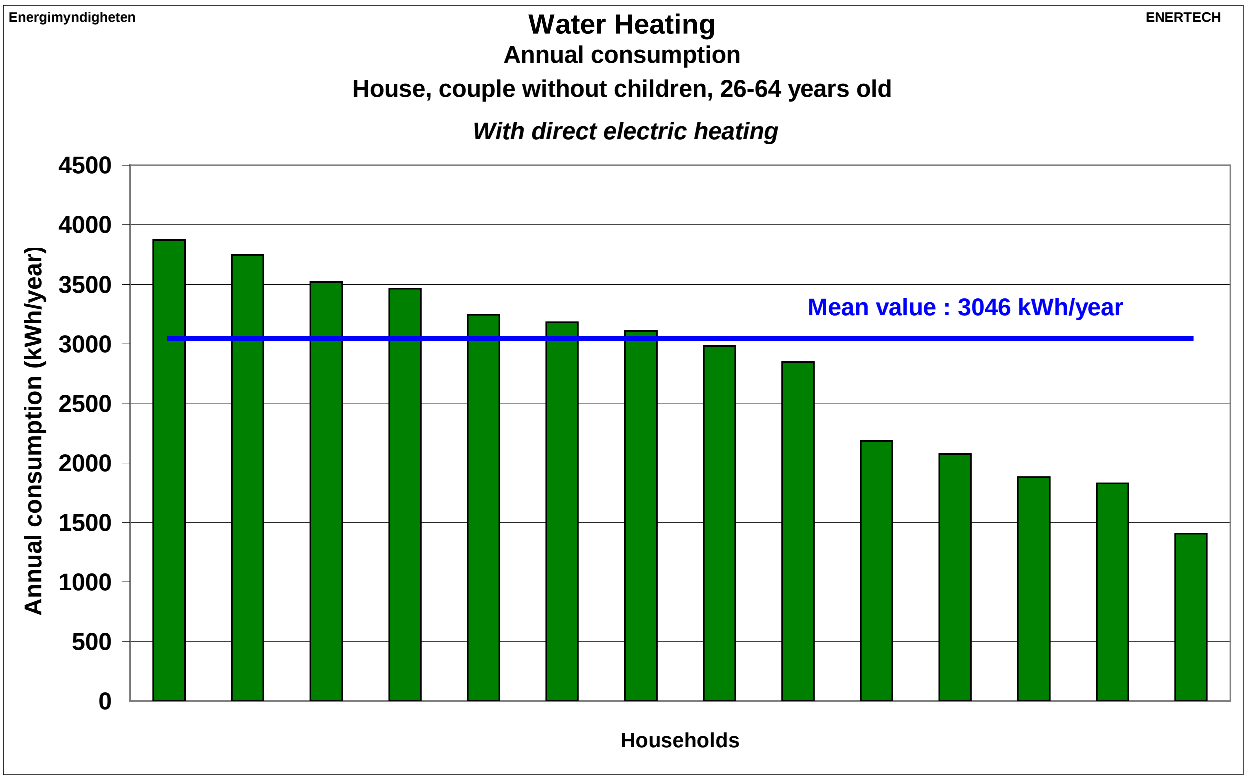


Figure 2.456: Water heating – Annual consumption – House, couples without children, 26-64 years old – Direct electric heating

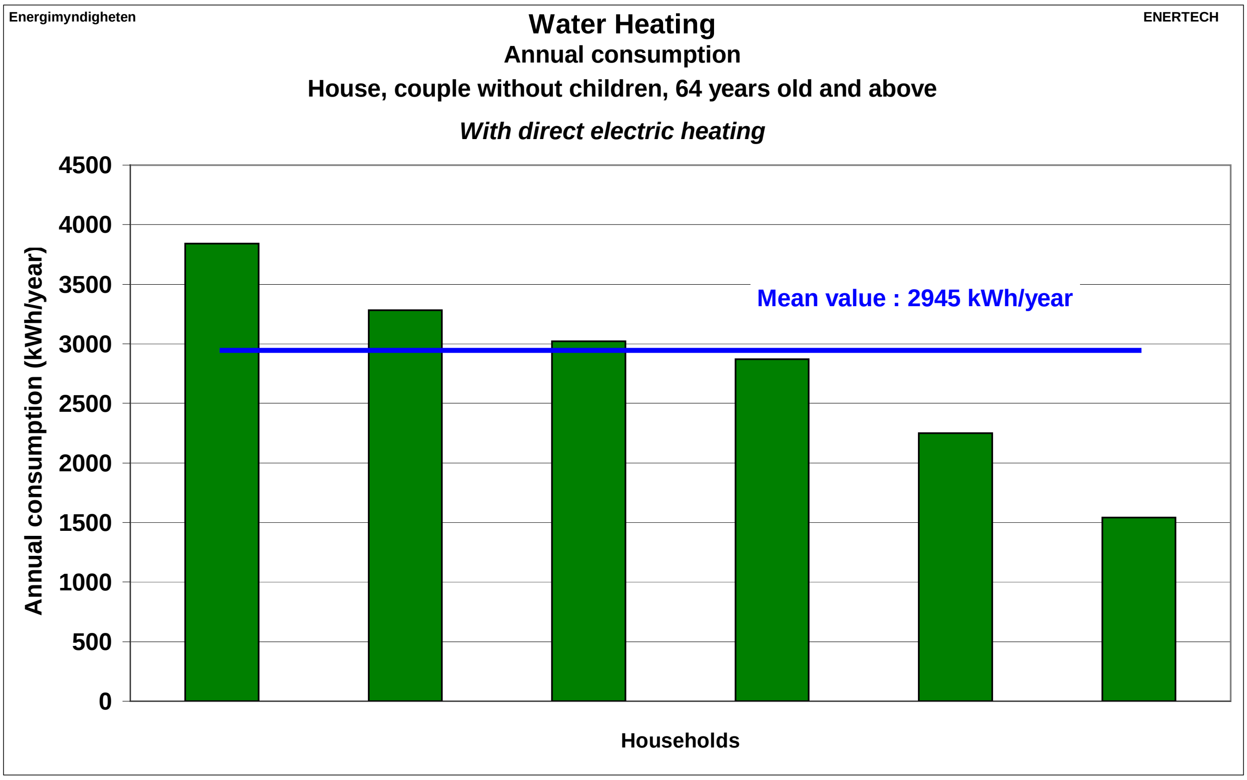


Figure 2.457: Water heating – Annual consumption – House, couples without children, 64 years old and above –Direct electric heating

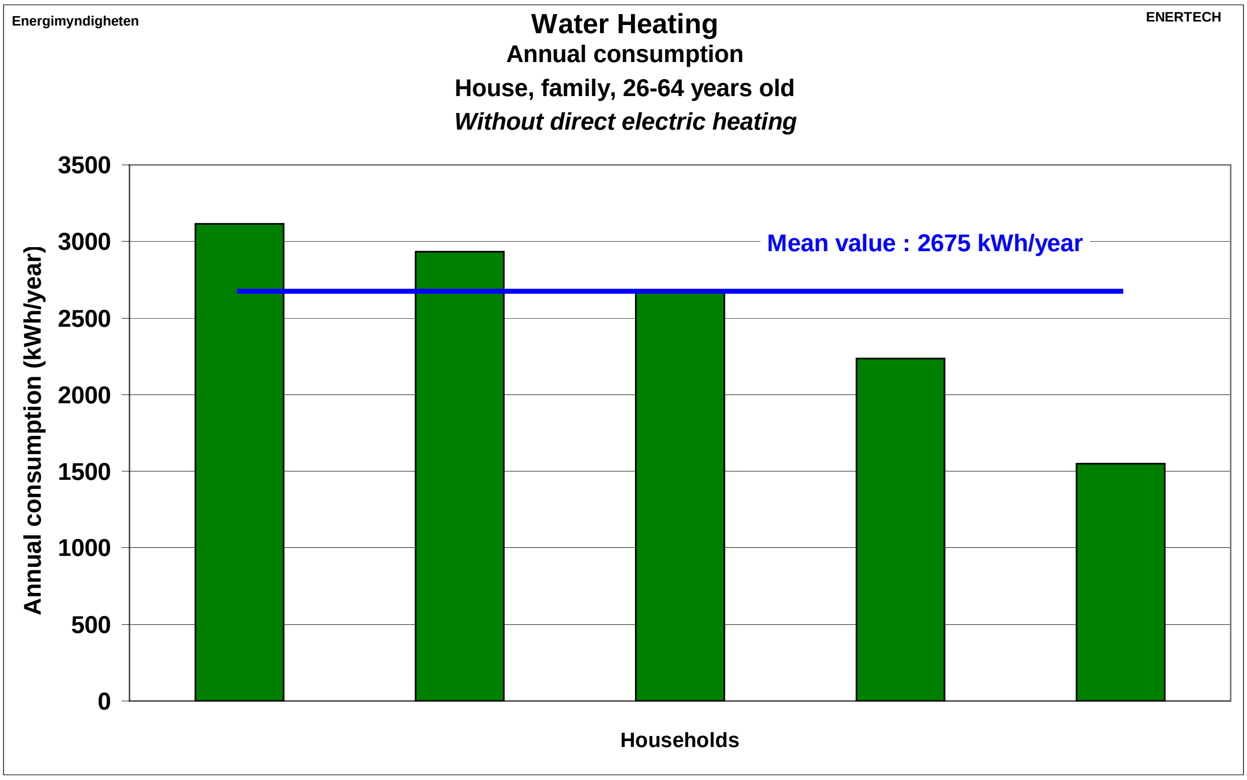


Figure 2.458: Water heating – Annual consumption – House, family, 26-64 years old – Without direct electric heating

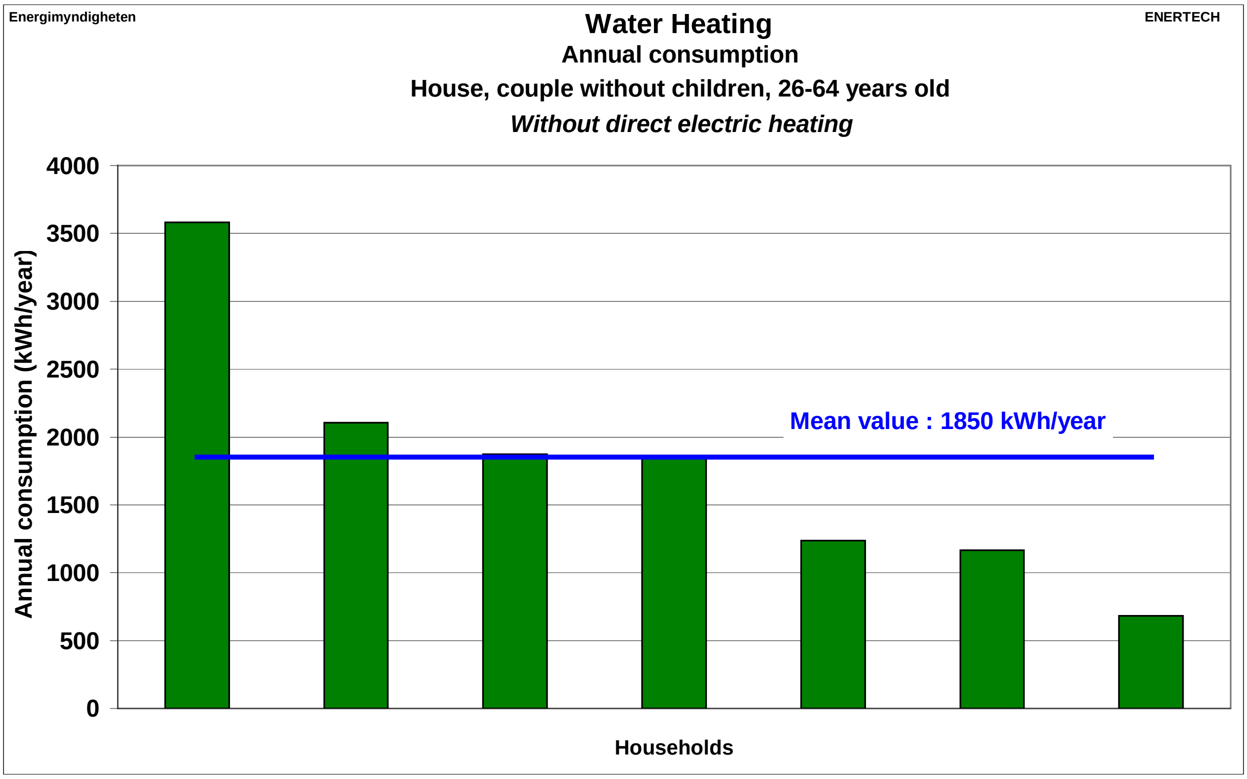


Figure 2.459: Water heating – Annual consumption – House, couples without children, 26-64 years old – Without direct electric heating

Annual consumption per m²

Heating

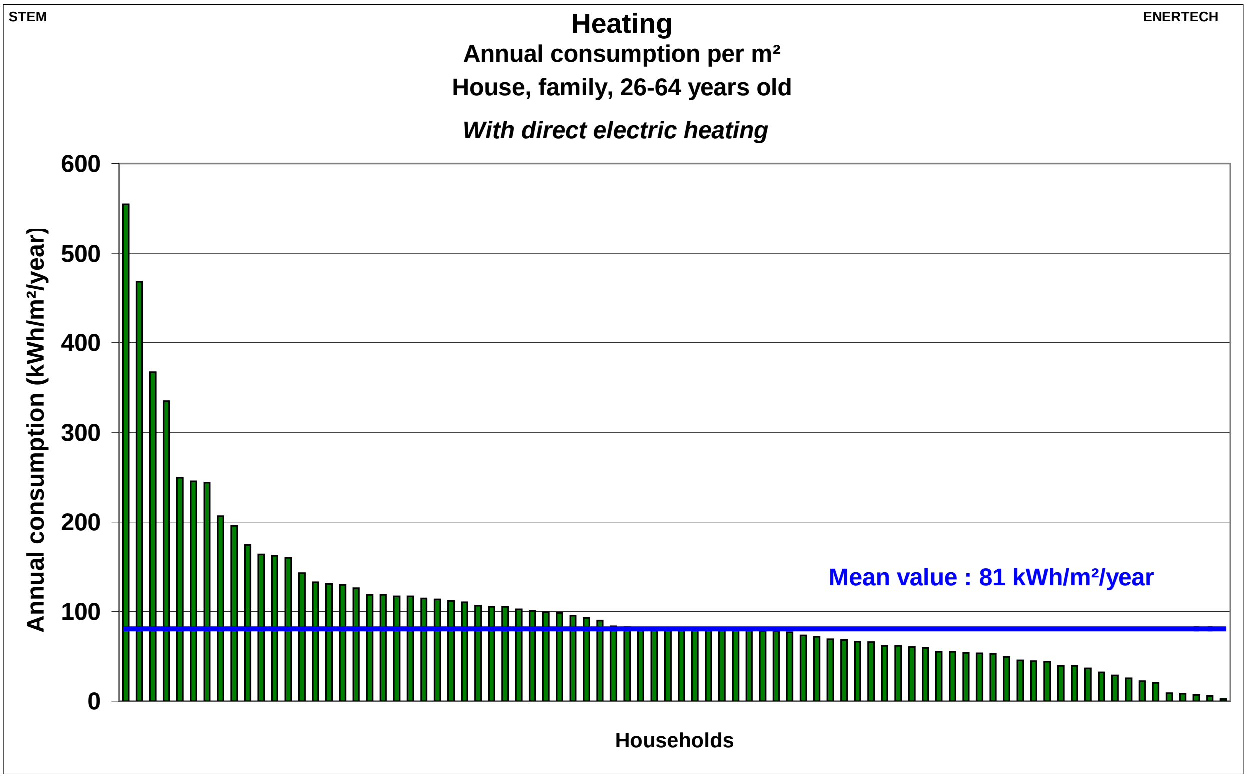


Figure 2.460: Heating – Annual consumption per m² – House, family, 26-64 years old –Direct electric heating

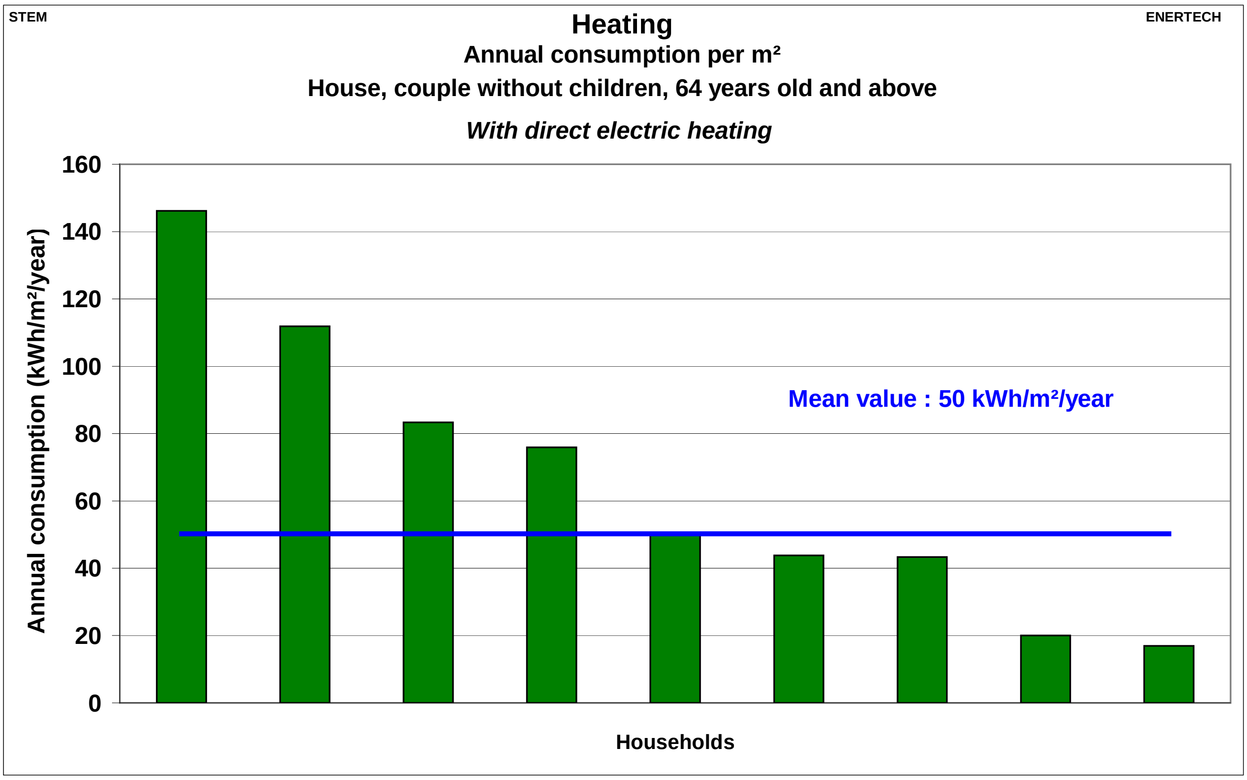


Figure 2.461: Heating – Annual consumption per m² – House, couples without children, 64 years old and above –Direct electric heating

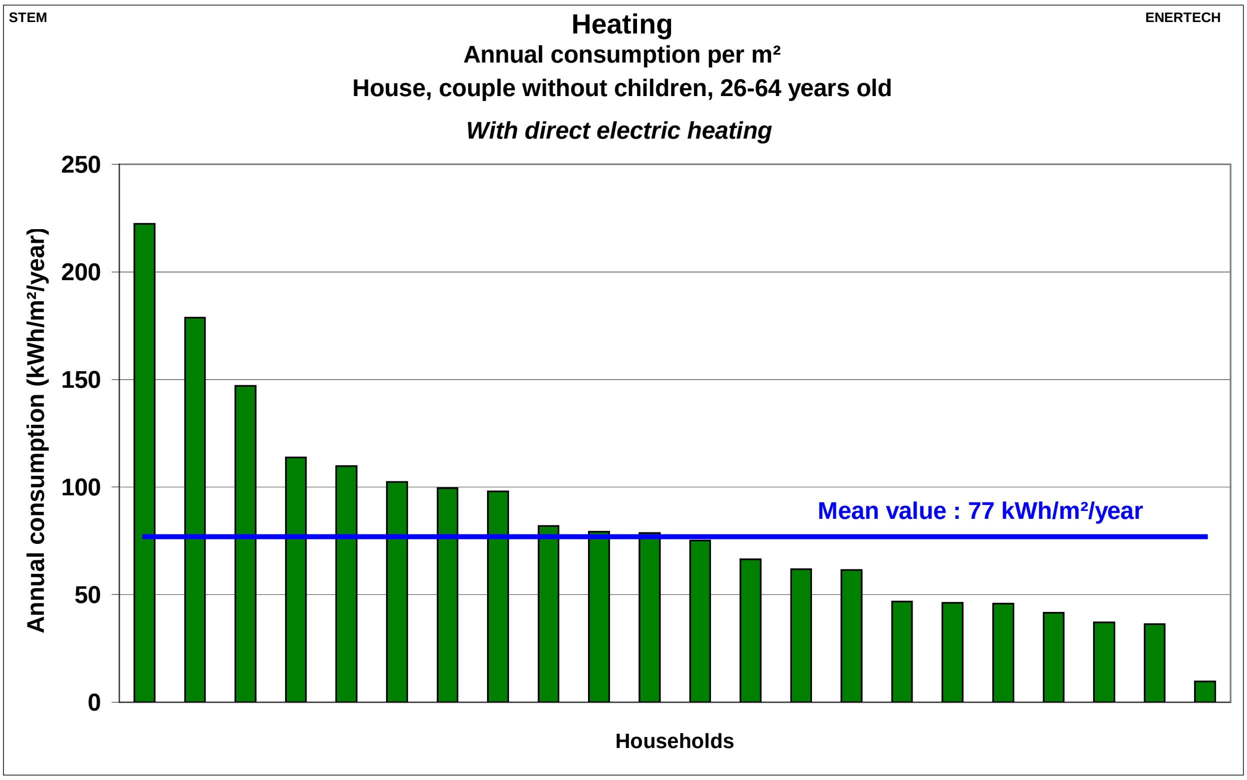


Figure 2.462: Heating – Annual consumption per m² – House, couples without children, 26-64 years old – Direct electric heating

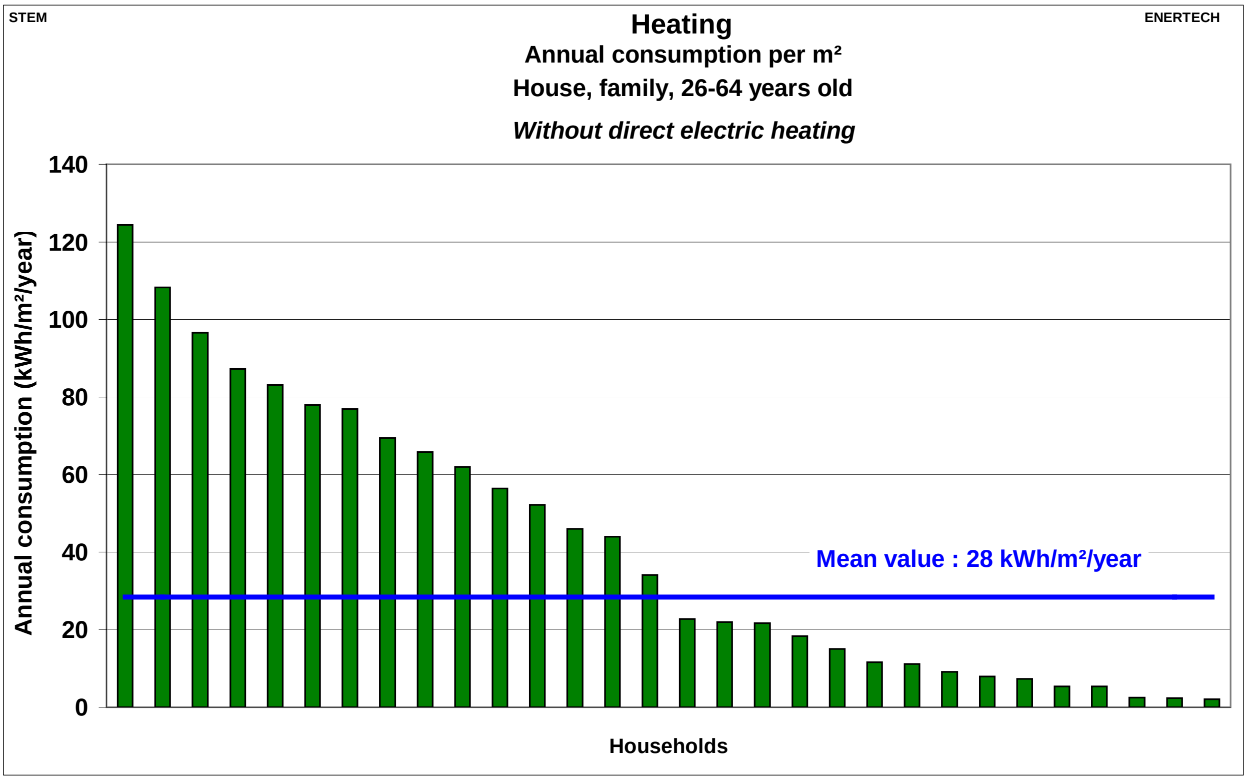


Figure 2.463: Heating – Annual consumption per m² – House, family, 26-64 years old – Without direct electric heating

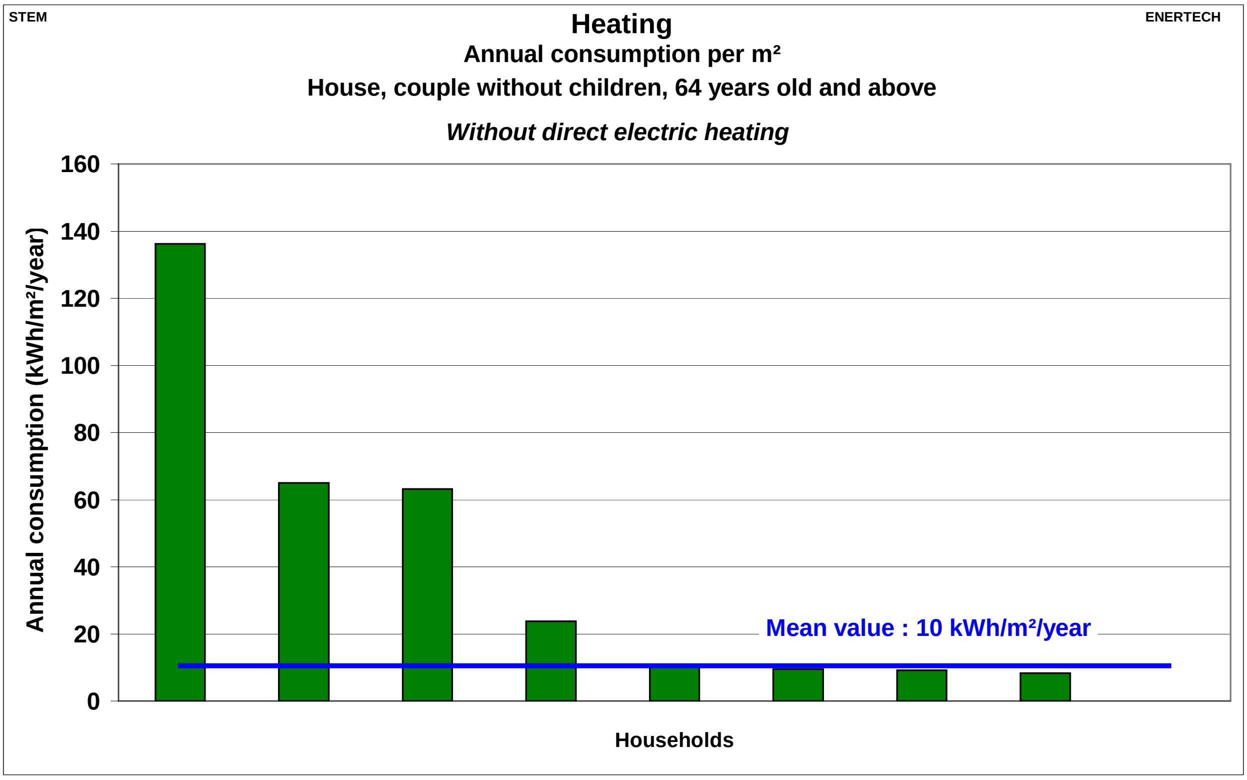


Figure 2.464: Heating – Annual consumption per m² – House, couples without children, 64 years old and above –Without direct electric heating

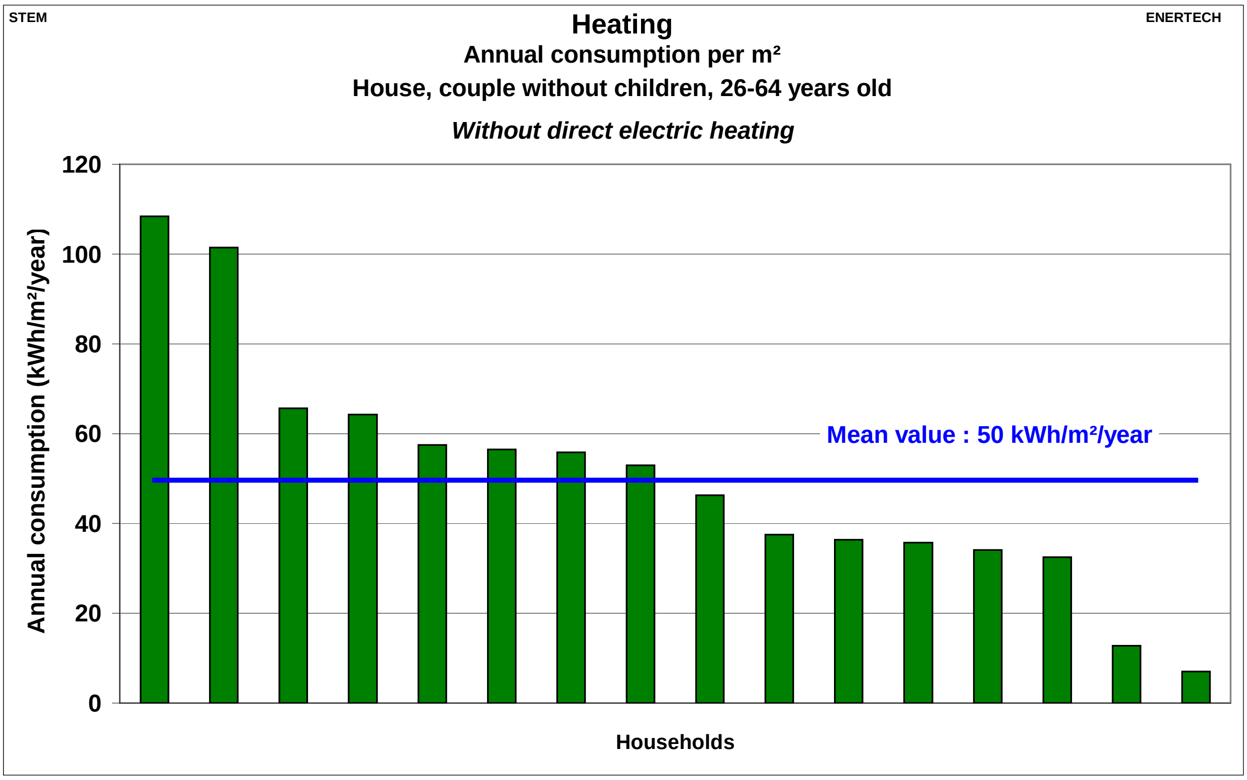


Figure 2.465: Heating – Annual consumption per m² – House, couples without children, 26-64 years old – Without direct electric heating

Water heating

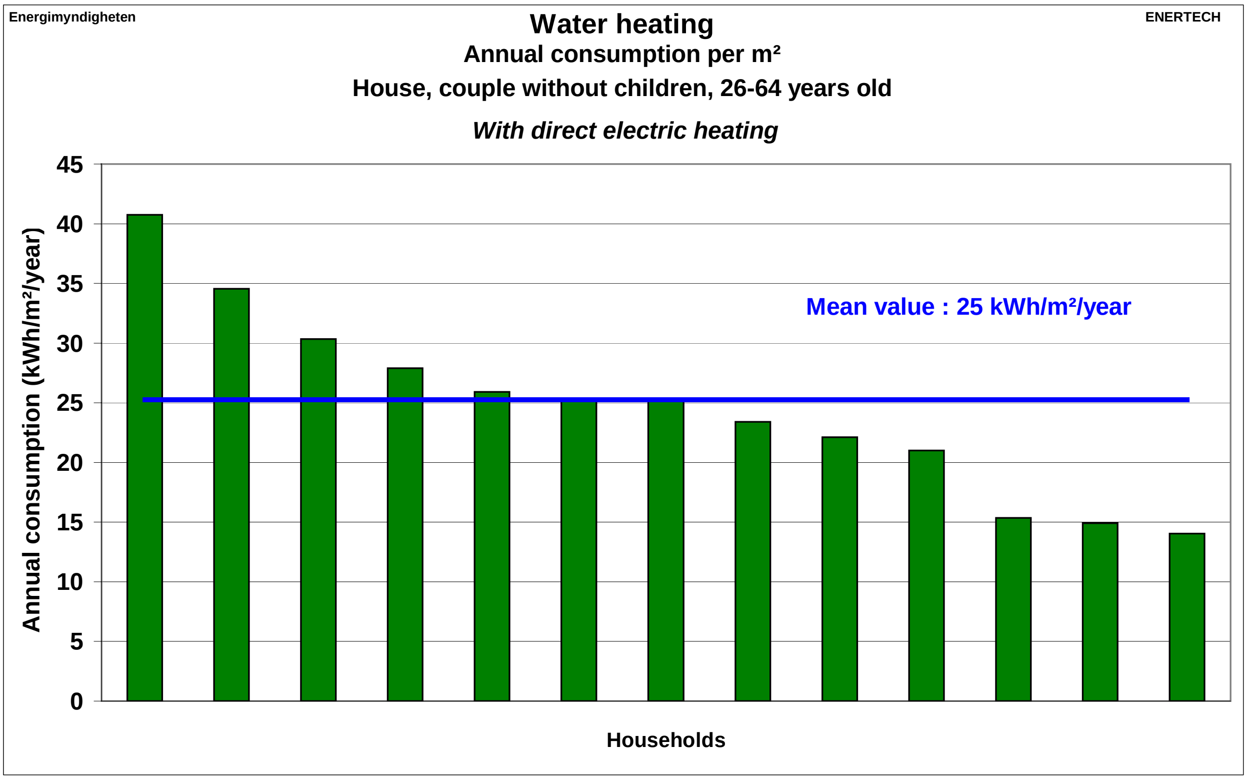


Figure 2.466: Water heating – Annual consumption per m² – House, couples without children, 26-64 years old – Direct electric heating

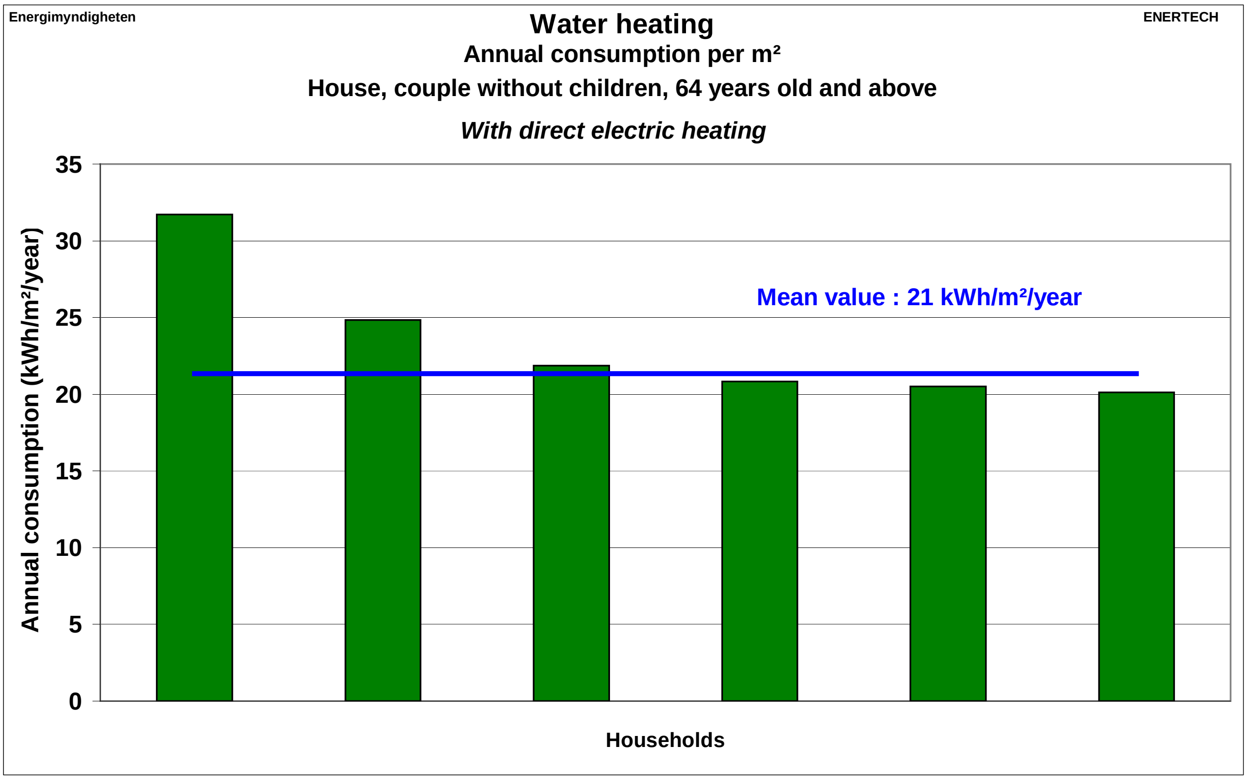


Figure 2.467: Water heating – Annual consumption per m² – House, couples without children, 64 years old and above –Direct electric heating

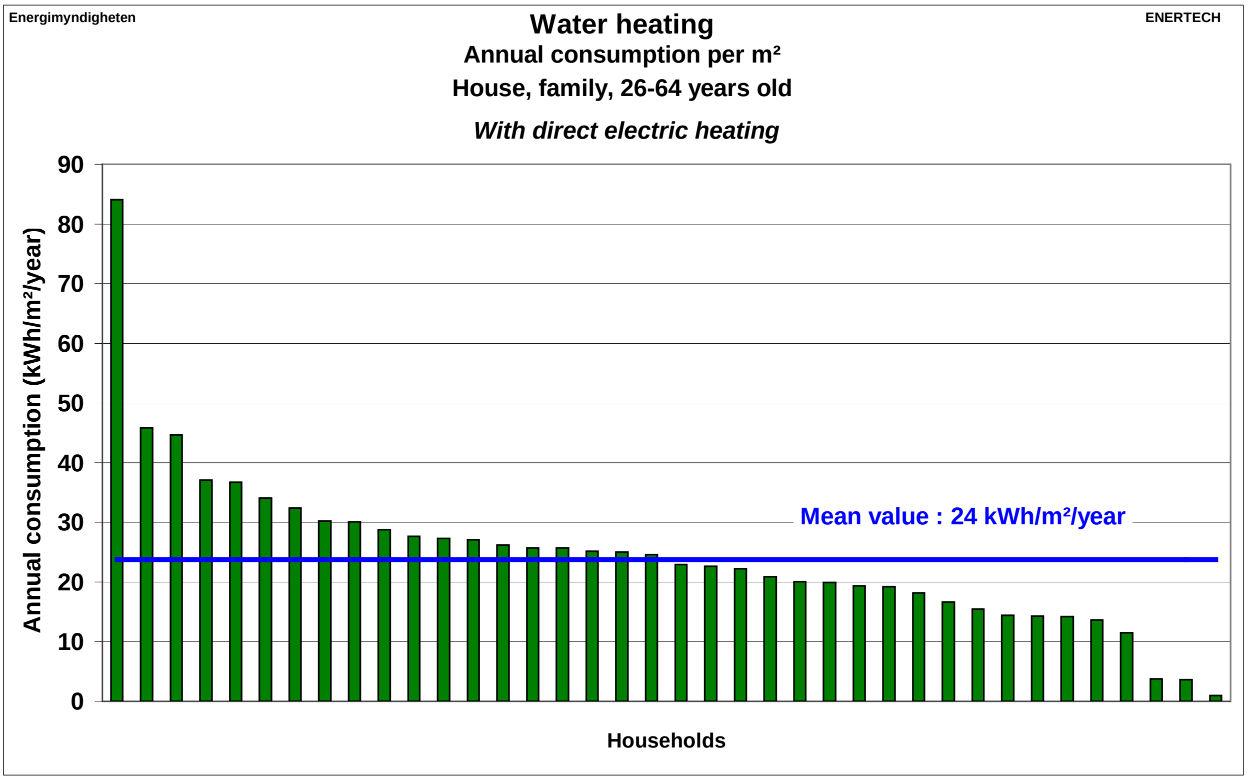


Figure 2.468: Water heating – Annual consumption per m² – House, family, 26-64 years old –Direct electric heating

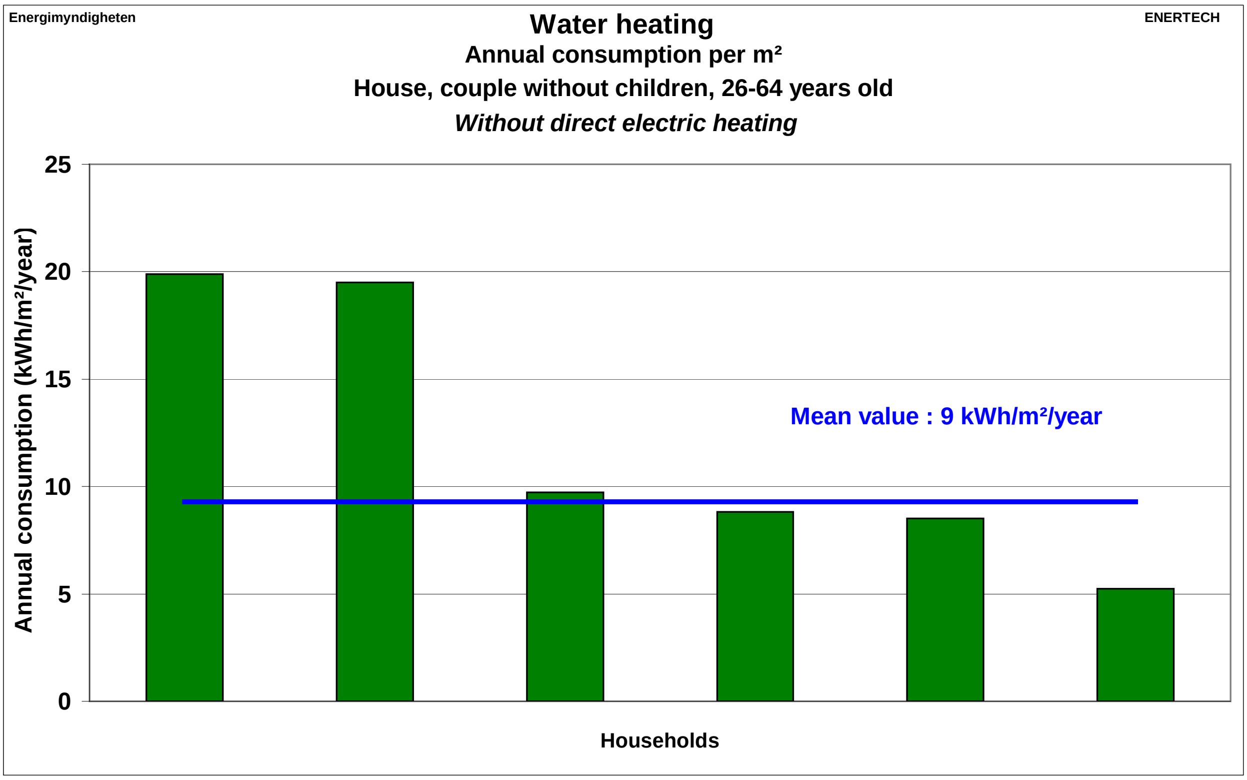


Figure 2.469: Water heating – Annual consumption per m² – House, couples without children, 26-64 years old –Without direct electric heating

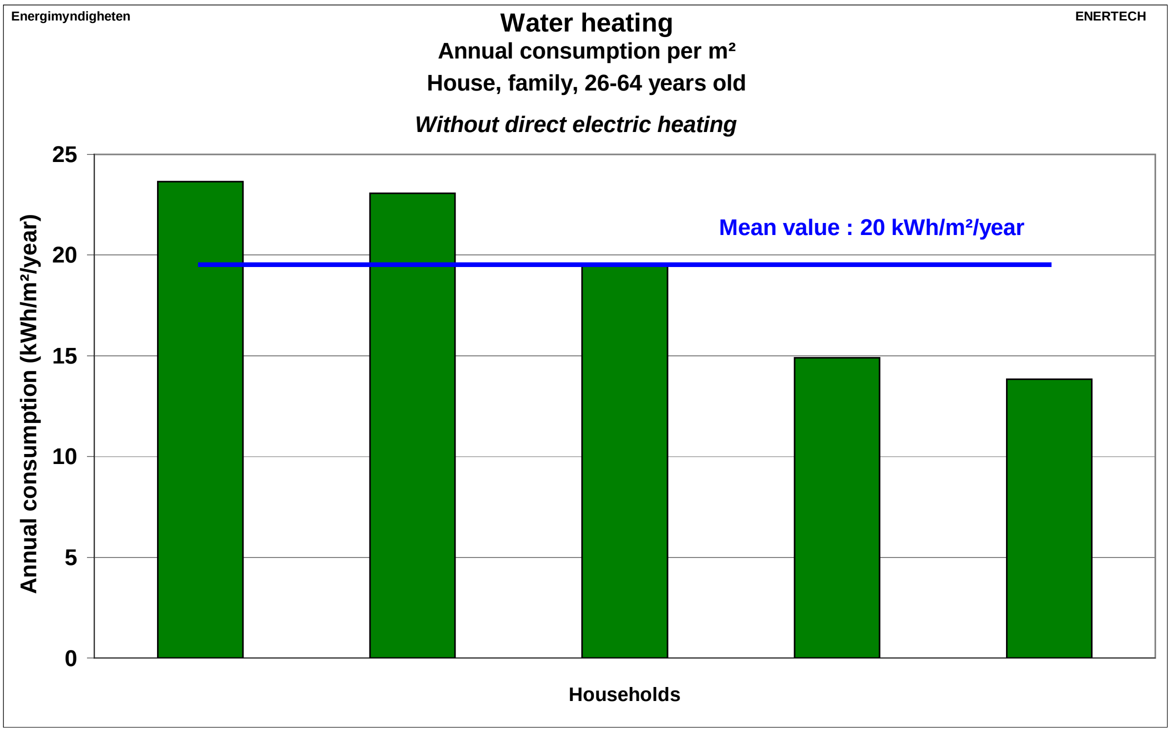


Figure 2.470: Water heating – Annual consumption per m² – House, family, 26-64 years old – Without direct electric heating

Annual consumption per person

Heating

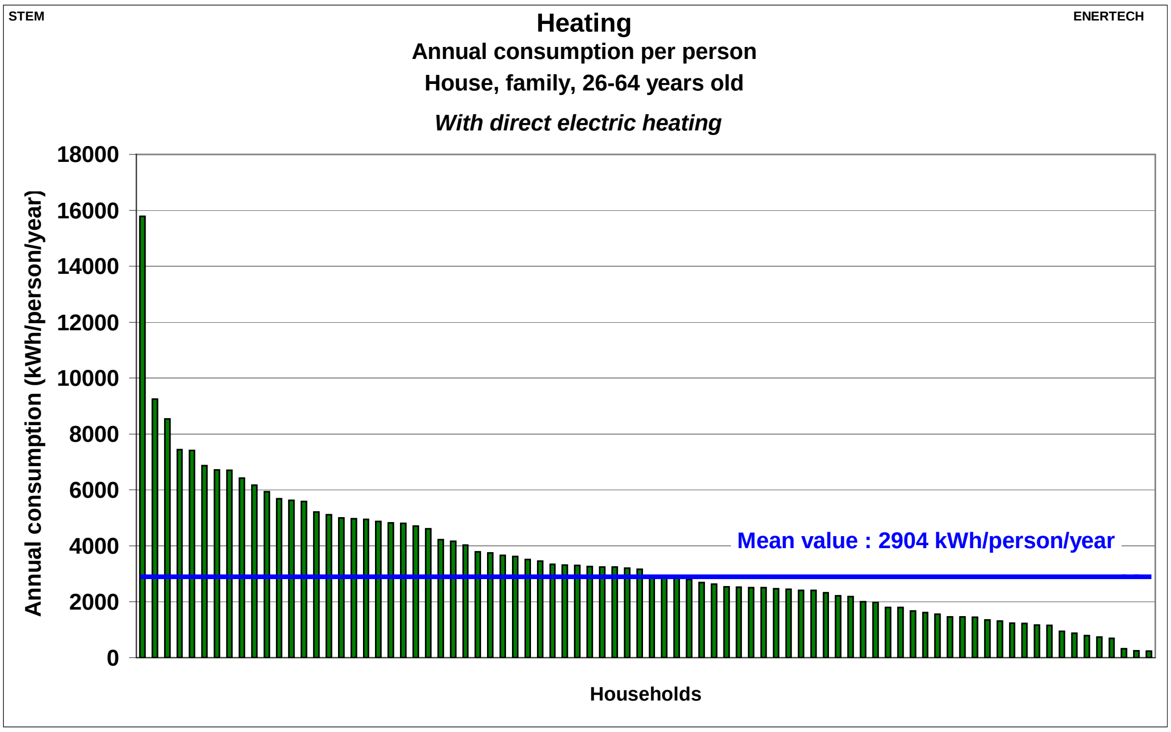


Figure 2.471: Heating – Annual consumption per person – House, family, 26-64 years old –Direct electric heating

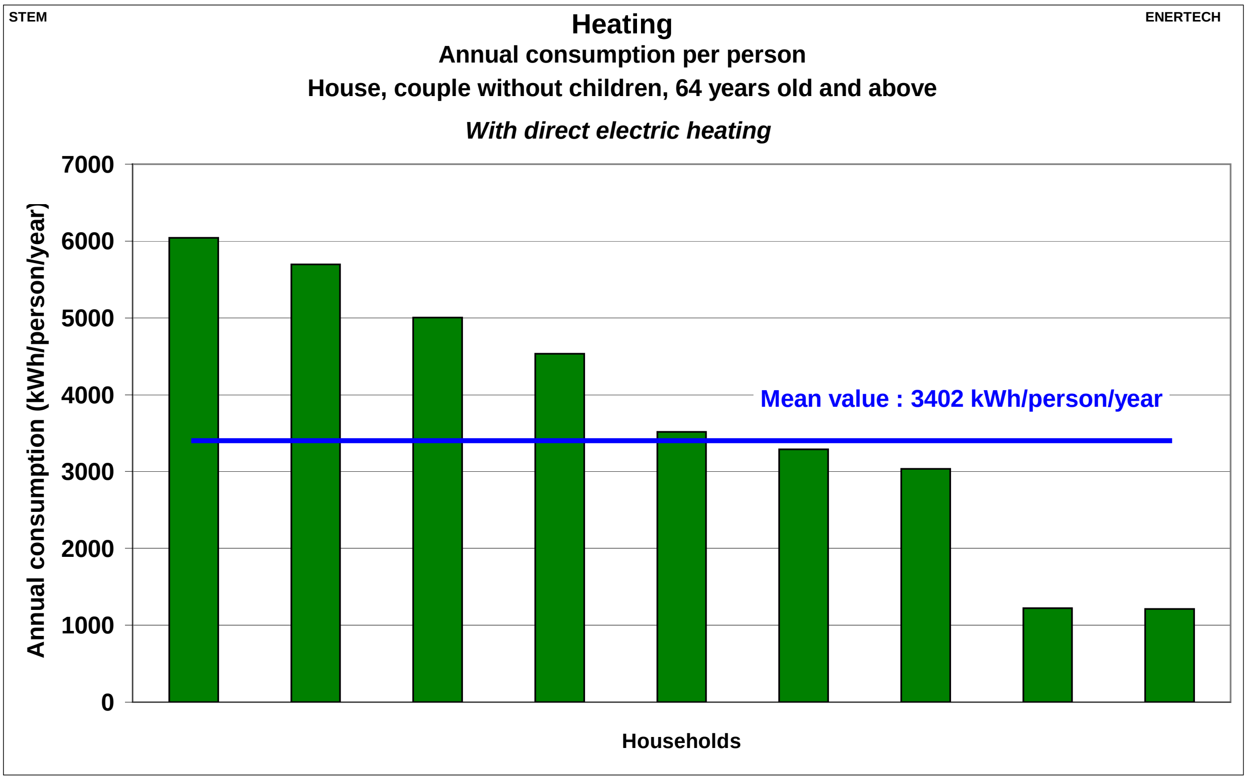


Figure 2.472: Heating – Annual consumption per person – House, couples without children, 64 years old and above –Direct electric heating

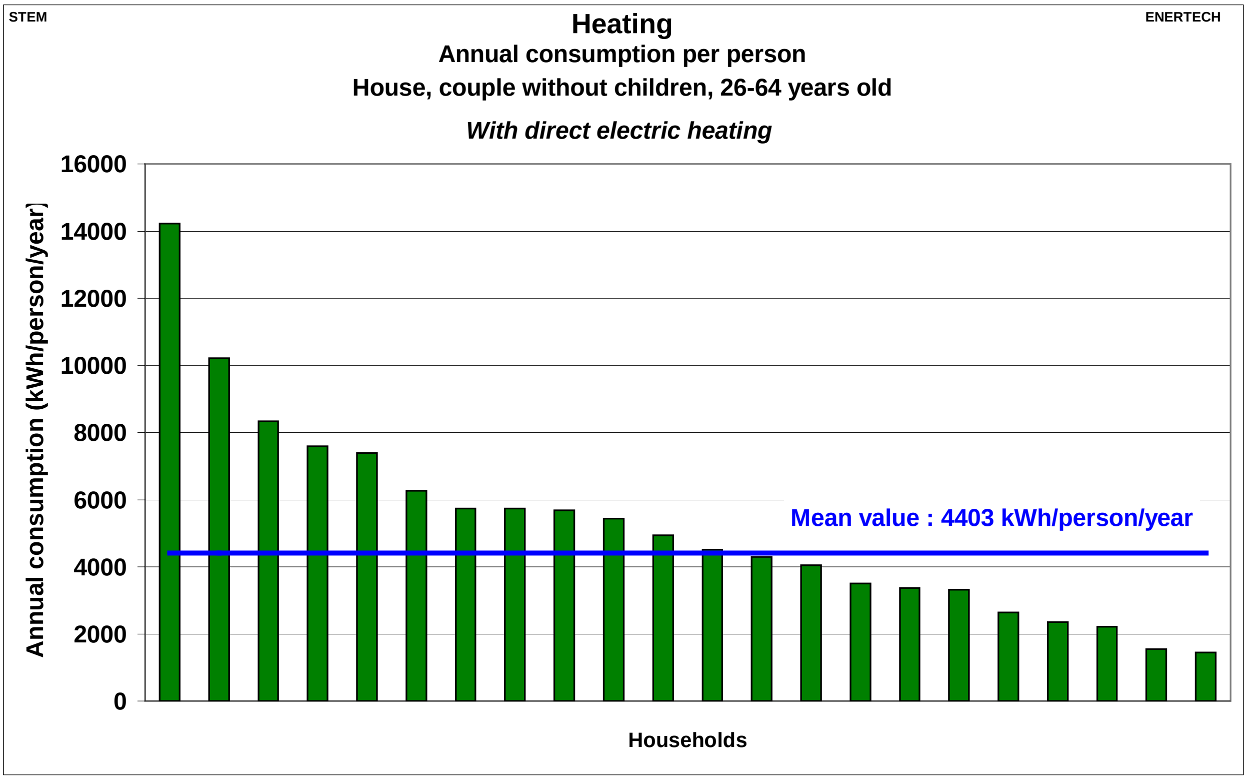


Figure 2.473: Heating – Annual consumption per person – House, couples without children, 26-64 years old – Direct electric heating

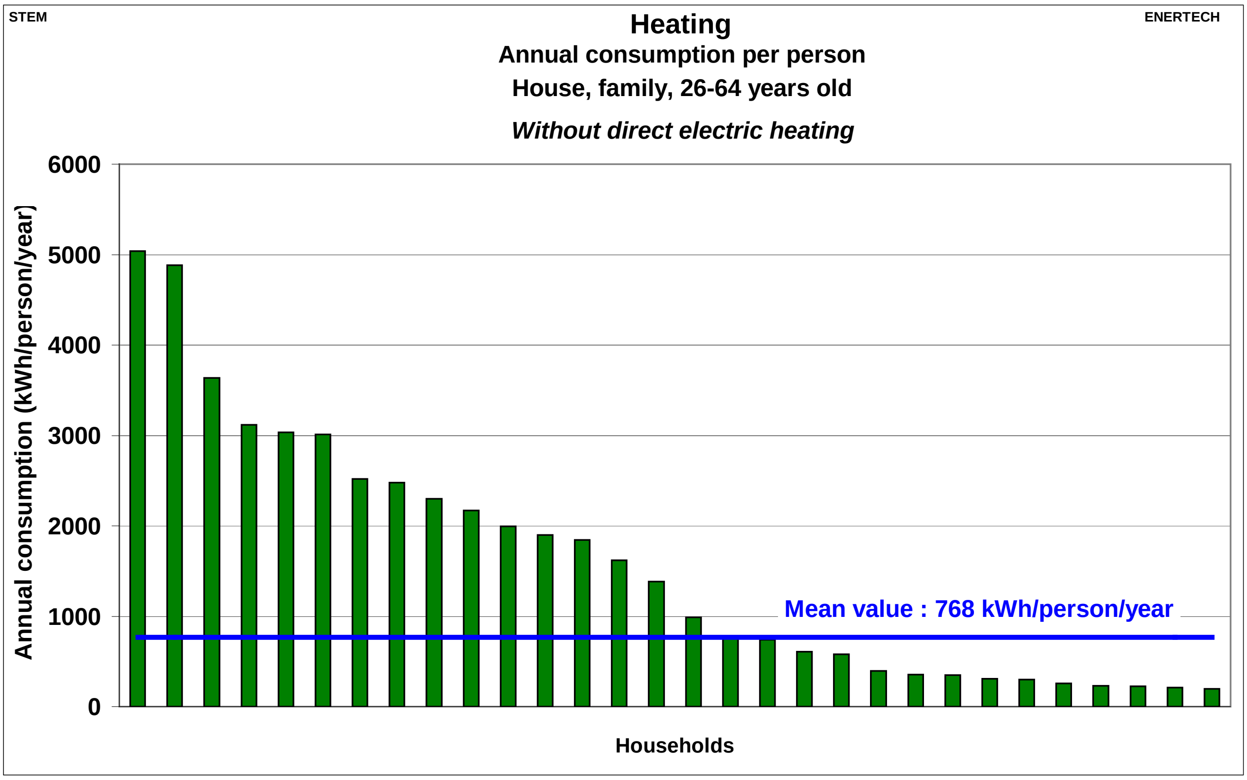


Figure 2.474: Heating – Annual consumption per person – House, family, 26-64 years old – Without direct electric heating

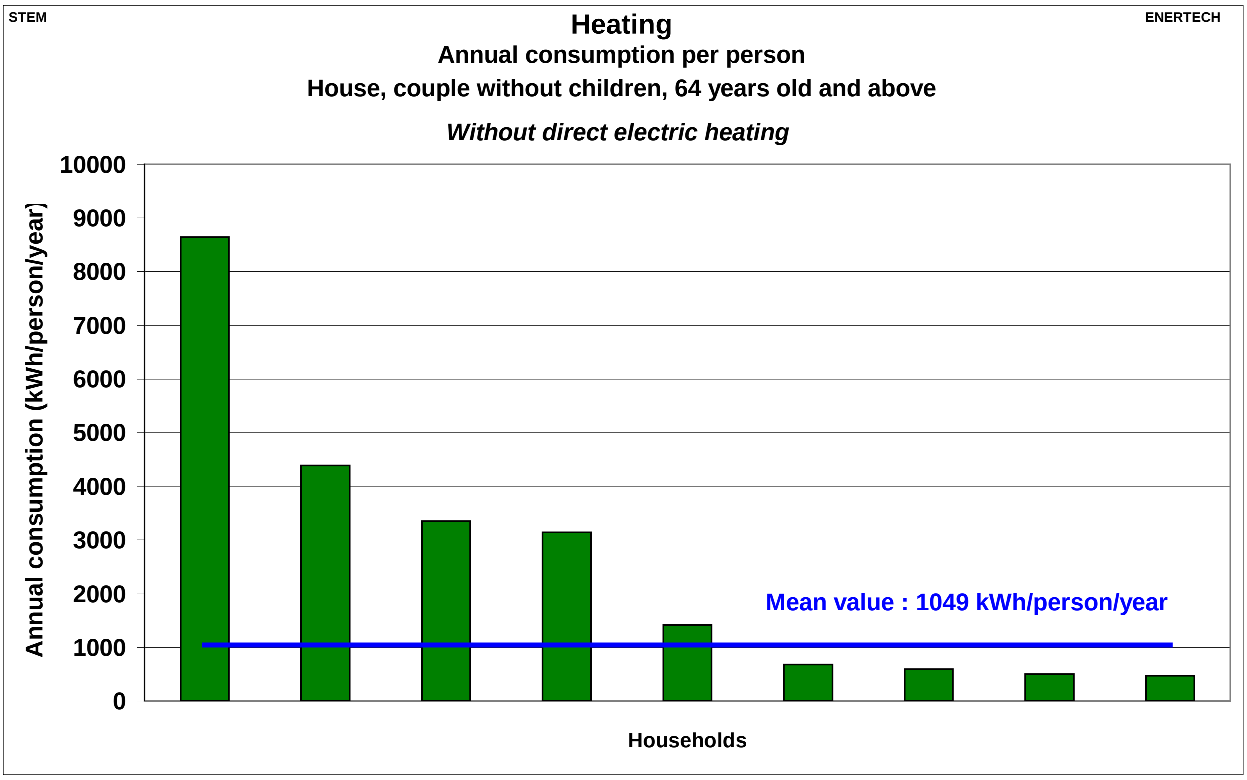


Figure 2.475: Heating – Annual consumption per person – House, couples without children, 64 years old and above –Without direct electric heating

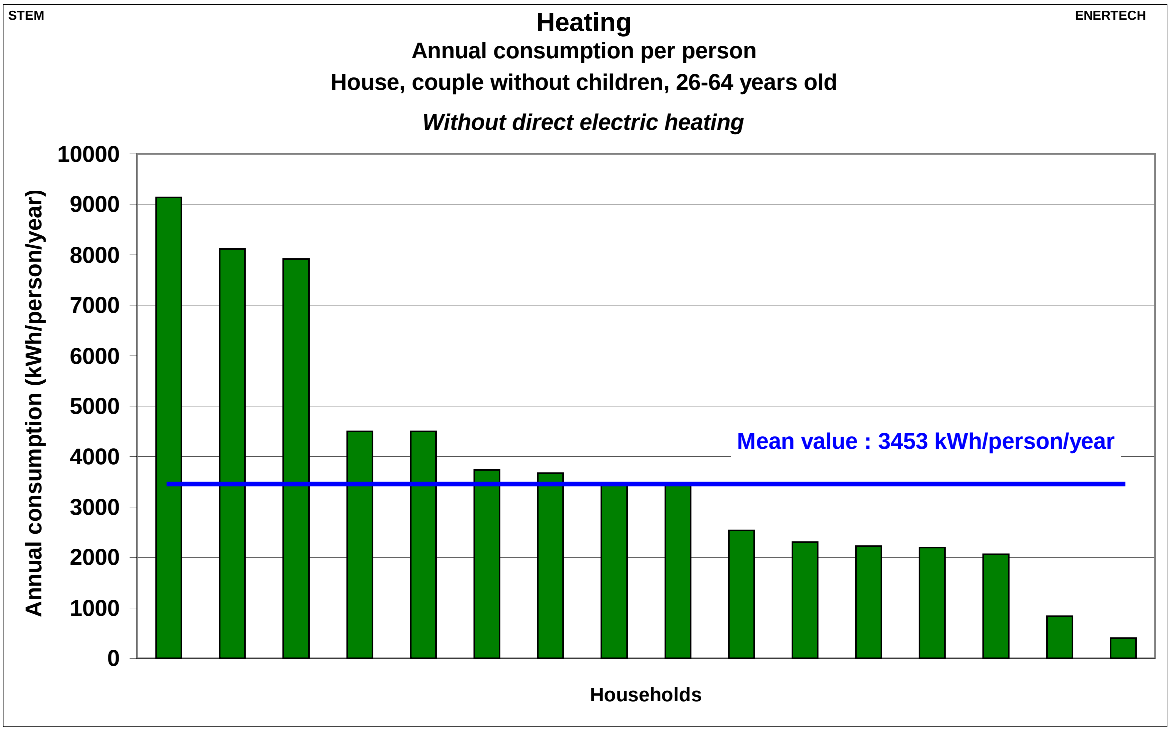


Figure 2.476: Heating – Annual consumption per person – House, couples without children, 26-64 years old –Without direct electric heating

Water heating

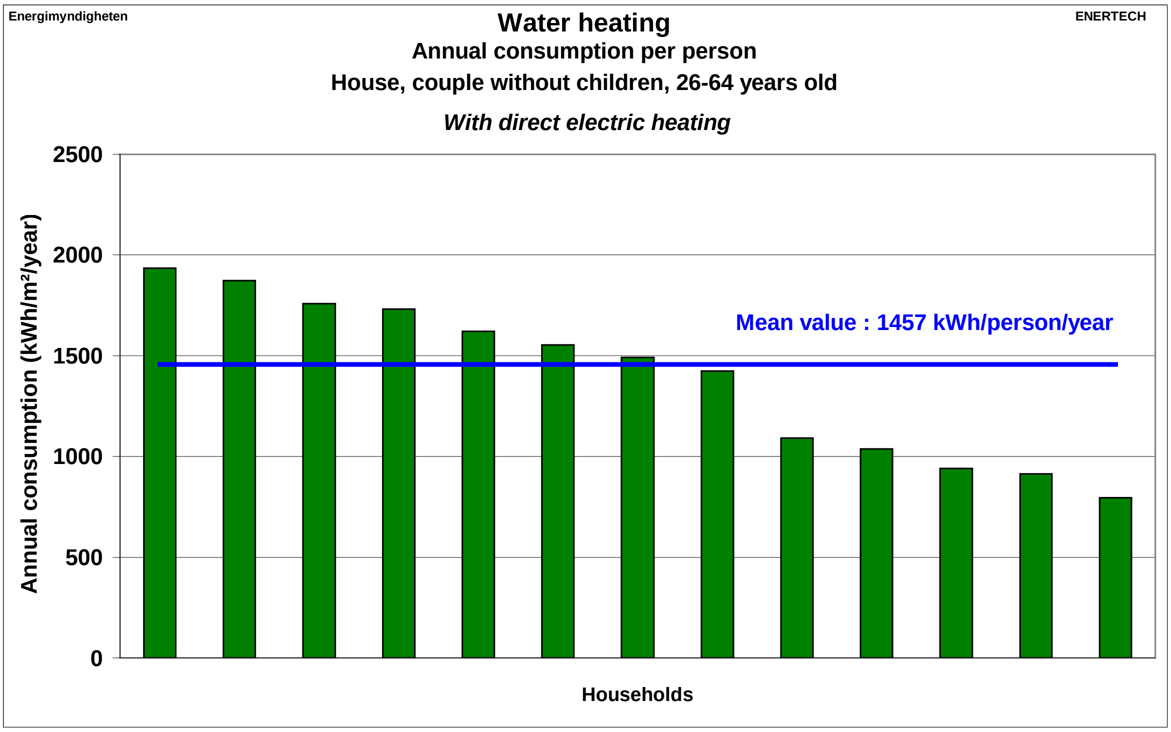


Figure 2.477: Water heating – Annual consumption per person – House, couples without children, 26-64 years old – Direct electric heating

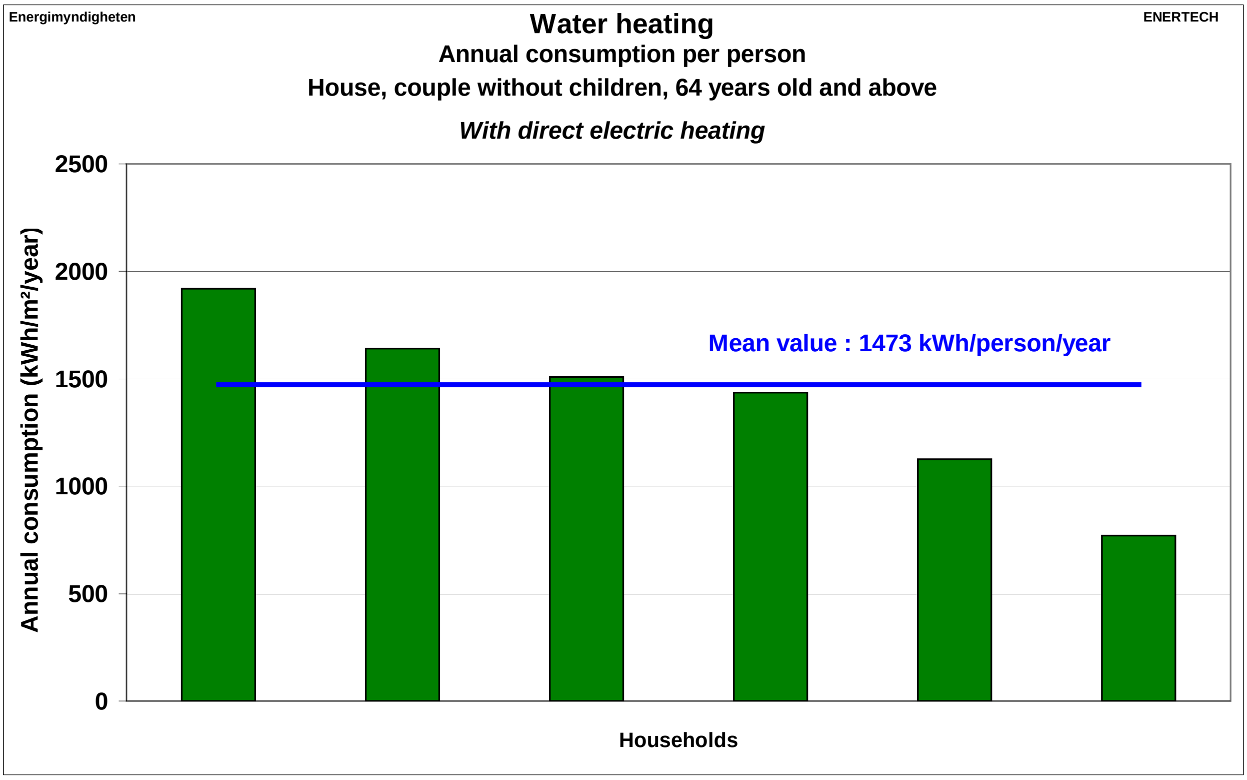


Figure 2.478: Water heating – Annual consumption per person – House, couples without children, 64 years old and above –Direct electric heating

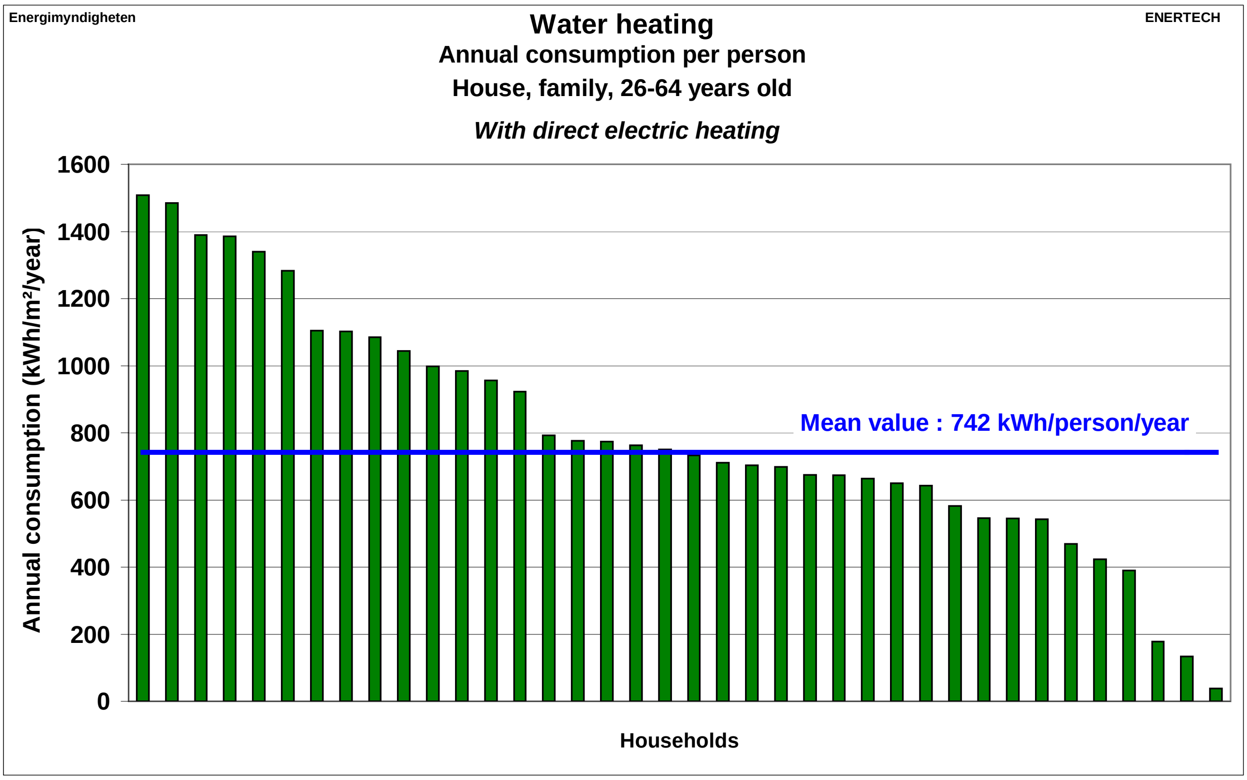


Figure 2.479: Water heating – Annual consumption per person – House, family, 26-64 years old –Direct electric heating

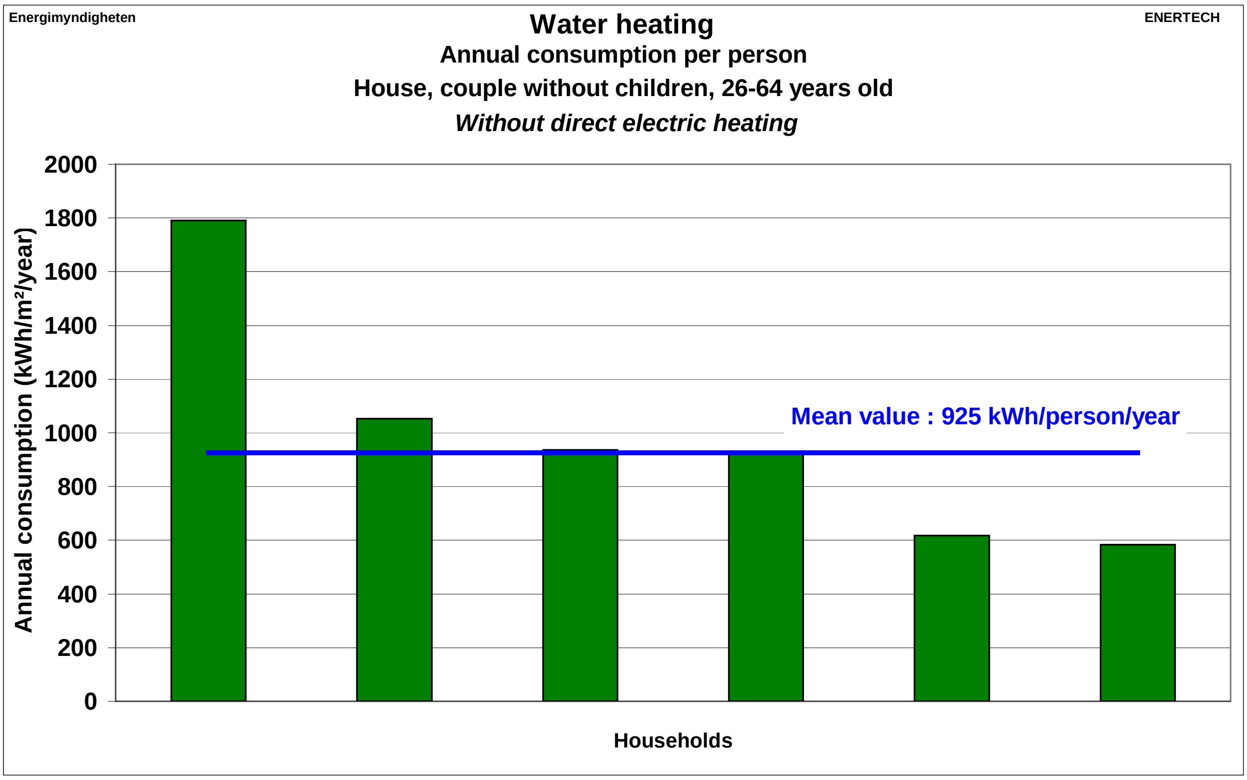


Figure 2.480: Water heating – Annual consumption per person – House, couples without children, 26-64 years old –Without direct electric heating

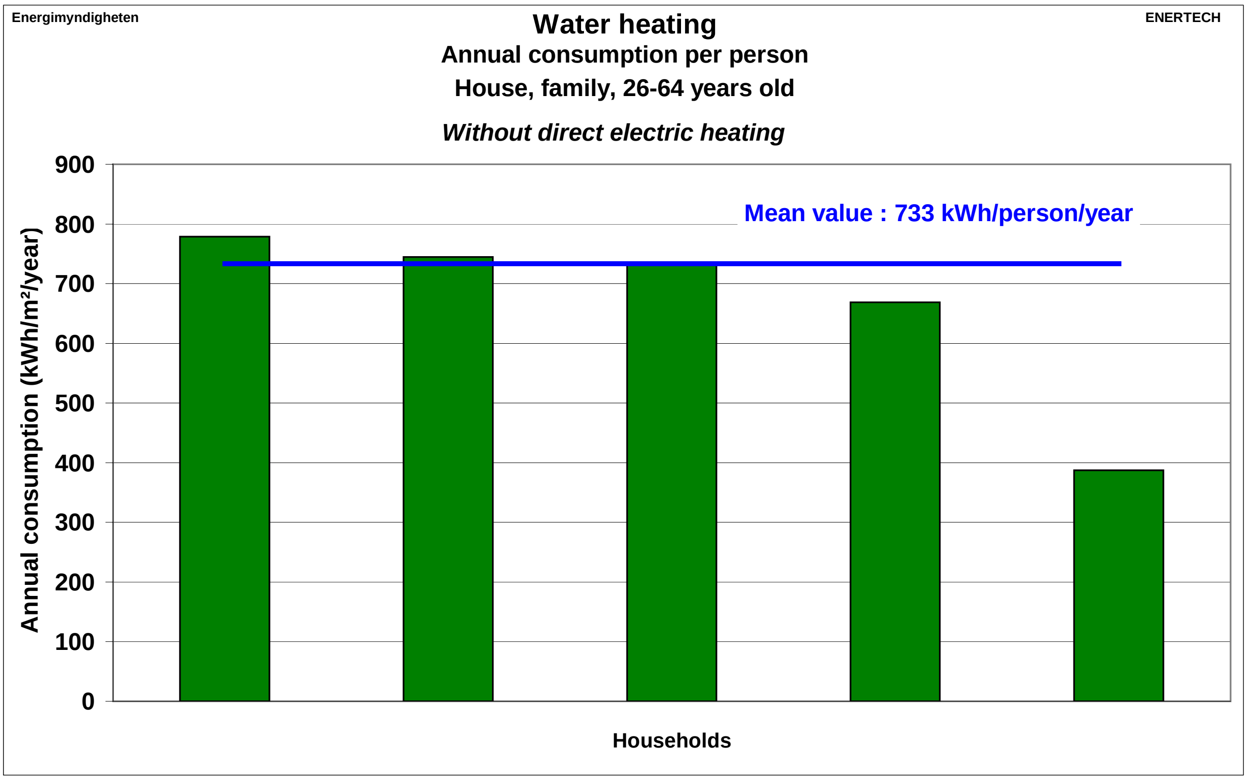


Figure 2.481: Water heating – Annual consumption per person – House, family, 26-64 years old – Without direct electric heating

Part of the electric heating consumption

Figure 2.482 and 2.483 show the distribution between heating and specific consumption for houses with and without direct electric heating. These graphs were calculated with the one year households and represent only 20 monitored houses. It is interesting to note that the heating consumption vary only from 42 % of the total consumption in winter to 25 % in summer for the houses with direct electric heating and from 30 % to 10 % for the houses without electric heating.

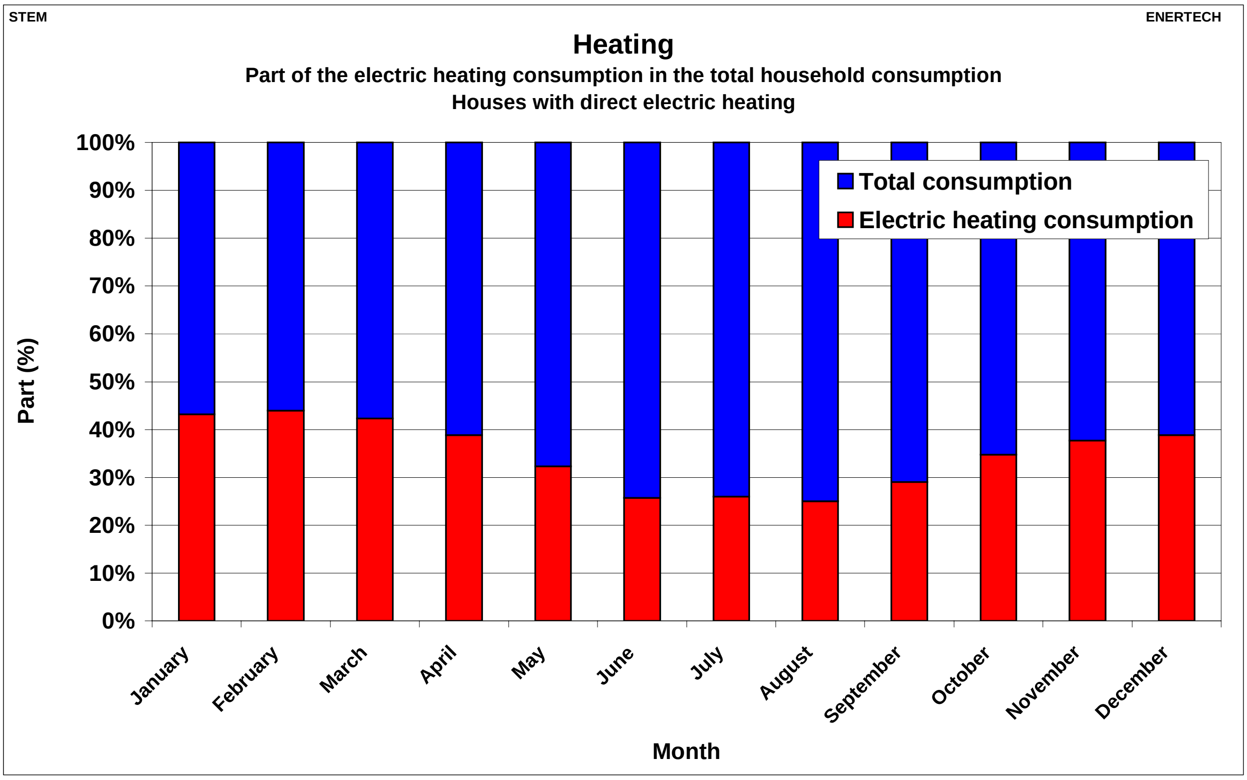


Figure 2.482: Heating – Part of the electric heating consumption in the total household consumption – With direct electric heating

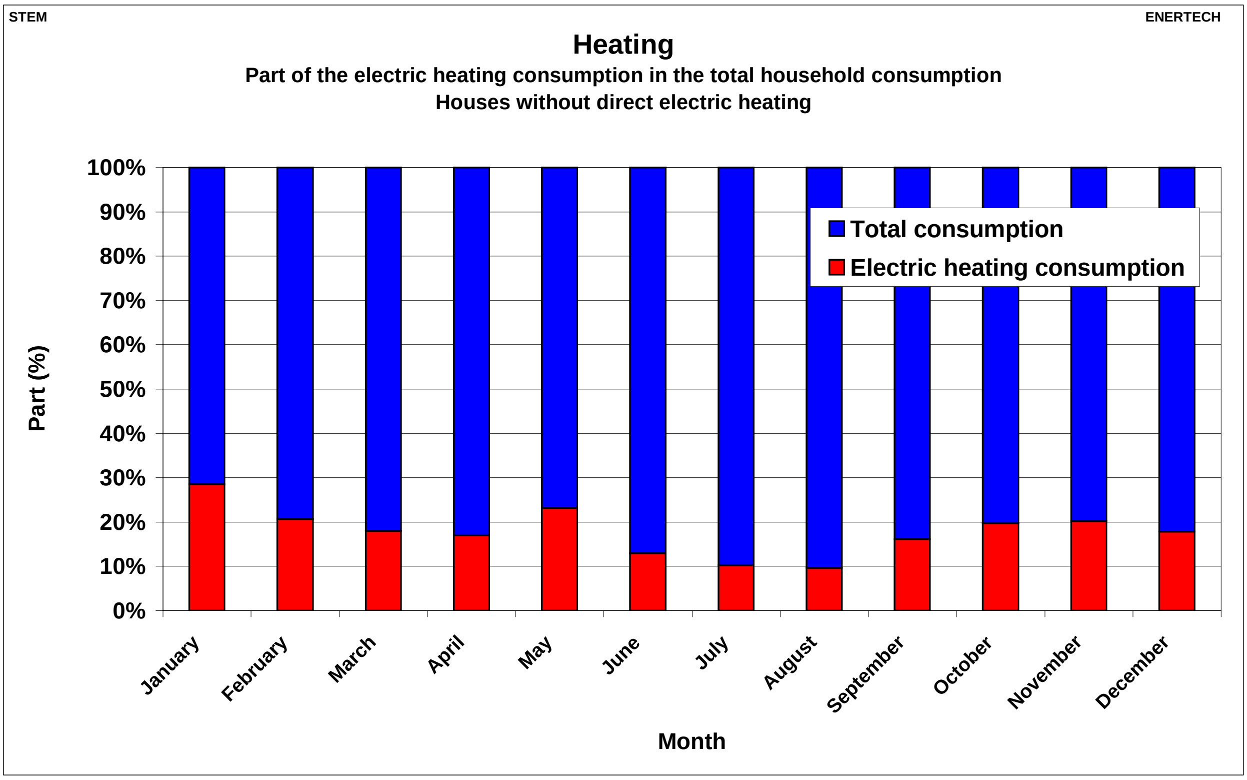


Figure 2.483: Heating – Part of the electric heating consumption in the total household consumption – Without direct electric heating

Analysis per type of equipment

Annualized consumptions

The table from figure 2.484 lists all the different devices that were monitored during the measurement campaign. In most of the houses with electric heating, there were always one or more specific departures from the switchboard concerning heating but the exact devices powered by this departures were not know (radiators, etc.).

It is interesting to note that the second most consuming specific device is the floor heating, considered as a “comfort” heating device and present in the houses with or without electric heating.

Heat pump, air heat pump or air water pump concern the houses without direct electric heating

	Number of devices monitored	Annual consumption (kWh/year)
Heating monitored from switchboard	151	8988
Furnace	2	5202
Heat pump	25	4749
Air heat pump	27	2661
Water heater	79	2646
Floor heating	99	2160
Circulation pump	14	1601
Radiator	15	1264
Heater	28	1197
Air Water pump	1	1145
Air heater	5	1024
Exhaust air heat pump	2	355
Heat exchanger pump	2	354
Water pump	11	284
Heat regulation	4	96

Figure 2.484: annual consumption per type of device

OTHER APPLIANCES

Average consumption

The table from figure 2.485 lists all the other appliances monitored during the campaign that didn't fit in one of the families that we defined in the rest of this report. Six of these appliances have an annual consumption greater than 100 kWh/year, 12 are between 10 and 100 kWh/year and the rest (7 appliances) consume less than 10 kWh/year.

Appliance	Number of monitored appliances	Annual consumption (kWh/year)
Air dryer	4	585
Aquarium	23	230
Roof fan	2	203
Water bed	8	140
Alarm	5	140
Car heater	21	100
Fan	29	97
Solarium	1	88
Sauna	20	82
Air cleaner	5	67
Oxygen mask	3	61
Central vacuum cleaner	26	35
Copier	6	38
Type writer	1	38

Clock radio	1	32
Kitchen ventilation	255	25
Shoes dryer	2	19
Radio	99	11
Hair dryer	1	7
Model train	1	7
Jacuzzi	13	6
High pressure washer	1	4
Calculator	3	3
Lawn mover	3	2
Sewing machine	1	1

Figure 2.485: annual consumption per type of device

ANALYSIS OF STANDBY POWERS IN THE HOUSEHOLDS

It is not possible to deal with domestic electricity consumptions, without an in depth analysis of the Standby power issue. Several times in this report, this aspect was tackled for some appliance types, but the present chapter proposes an overall analysis. Before beginning with the analysis, it is important to define the meaning of the different terms used in this chapter:

OFF mode: the power drawn by an appliance is null in this mode. It might be unplugged, or switched-off on the primary side of the supply transformer.

ON mode: mode in which the appliance realises its principal function. All its components are supplied with their maximum powers. No power management at all is implemented.

Standby mode: mode in which the appliance is neither switched Off, nor in Full-On mode. This mode groups all the Standby and energy management modes that exists in a single appliance together. Depending on the appliance, it might includes the « idle », « energy saving », « doze », « Standby », « delay start » or « suspend » modes.

Average Standby power (W): for a continuously monitored appliance, this is the average power it draws when working in Standby mode. For instance, for a VCR with two different Standby power levels (8 and 12 W) that would be used alternatively in these two modes during the same length, the considered ***average Standby power*** would be 10 W.

Operating Rate (%): this is the ratio of the operating time (in Full-On mode) to the total reference time.

Standby Rate (%): this is the ratio of the time spent in Standby mode, to the sum of the times spent in the Off or Standby modes.

General methodology

The implemented *in situ* measurements included the monitoring of the household general consumptions, as well as the measurements of the different appliances present in the household. In most of the households, audiovisual and computer sites, (which are the main sources of Standby powers in the households) were continuously monitored with wattmeter plugs. Using specific software developed for this campaign, it was possible to extract from the monitoring data all the Standby power and rate. On the other hand, all the other Standby power were directly measured with a portable wattmeter (NZR - ***SEM10***).

The first approach for calculating the Standby power per household consists of adding per household all the directly measured Standby to the ones extracted from the monitored data. This sum will represent the minimum of the Standby power because there are always hidden consumptions that are not measured

The second approach consists in analysing the difference between the total household consumption and the sum of the consumption of all the appliances monitored. This « remnant » consumption is interesting because it removes any appliance that could interfere with our Standby analysis (notably cold appliances, whose regulation resistor is not considered as a Standby power source in this chapter). The aim was to study this remnant part and to investigate the periods during which the remnant power demand was minimum.

Figures 2.486 and 2.87 show us the number of appliances (or group of appliances) that were measured for Standby power. The average numbers are 12 for the houses and 8 for the apartments.

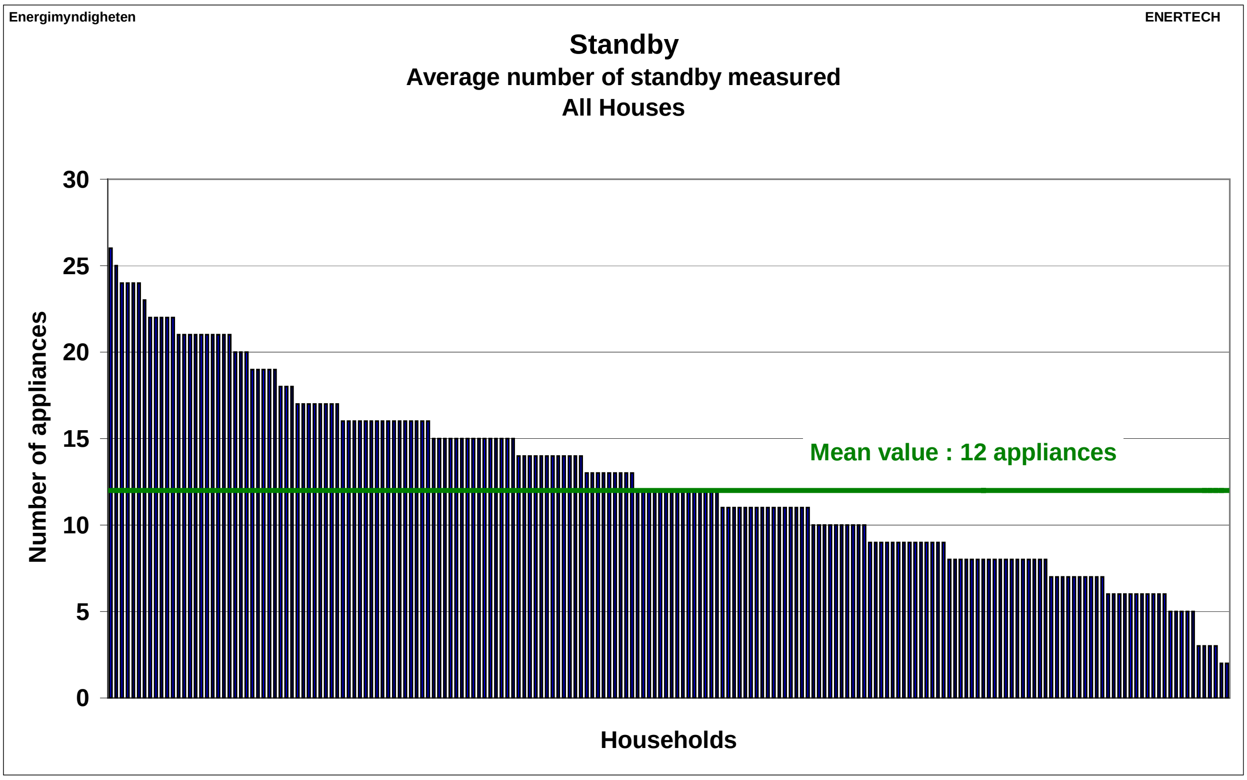


Figure 2.486: Standby – Average number Standby measured per house

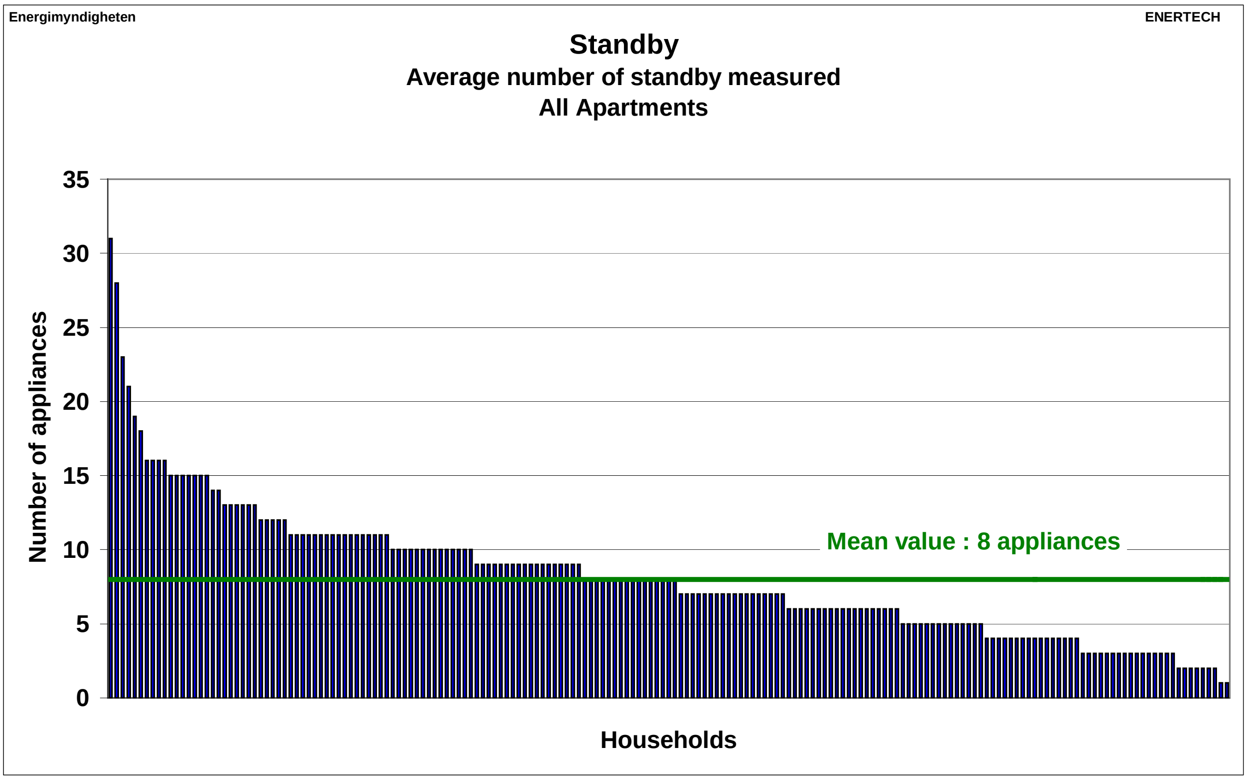


Figure 2.487: Standby – Average number of Standby measured per apartment

Figure 2.488 shows the distribution of the Standby power measured with the wattmeter. 60 % of the Standby power is in the range 0,5 – 5,0 Watt, the rest are going up to 30 Watt. Actually, only 1 % of the Standby measured were lower than 0,5 Watt.

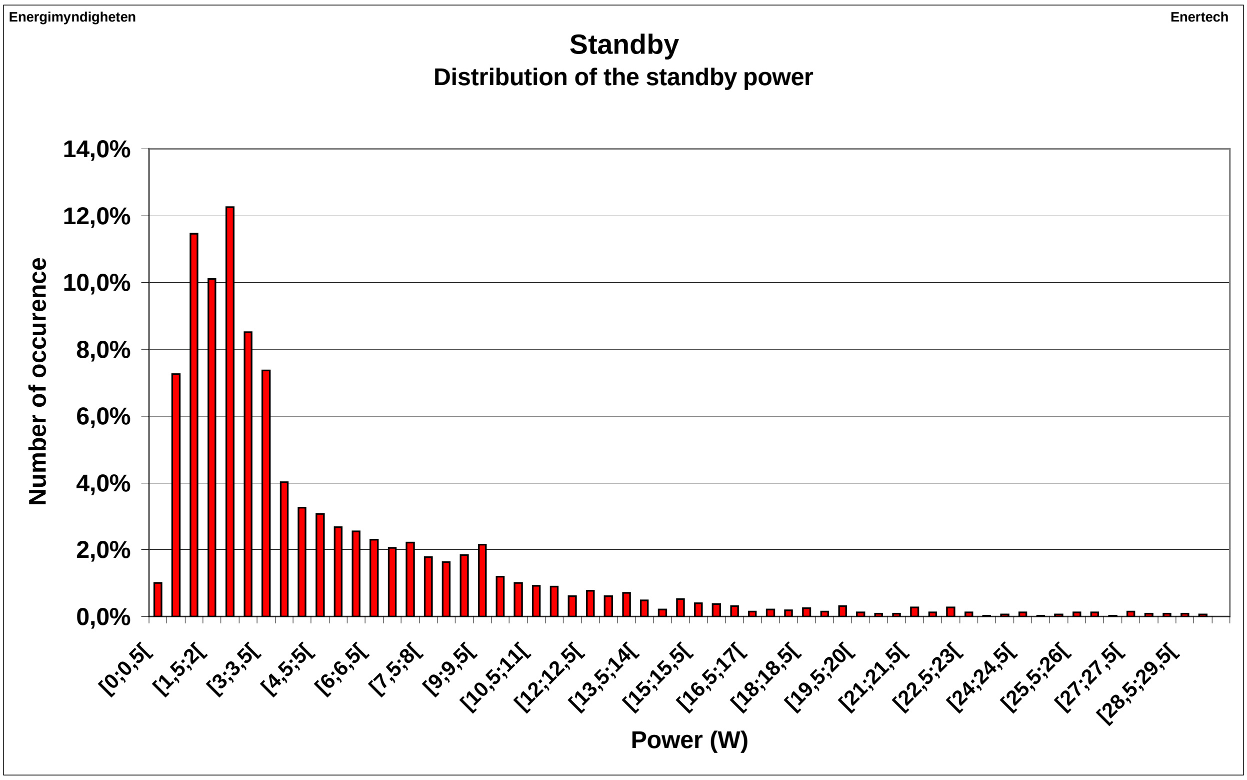


Figure 2.488: Distribution of the Standby power

Standby power demand

Figures 2.489 and 2.490 show the Standby power calculated by adding all the individual Standby powers measured for each appliance in the household. For houses, the average Standby power is 59 Watt and 34 Watt for the apartments. This value can be compared to the 60 Watt that was found in the Eureco project for Denmark, but don't forget that for Denmark 60 Watt was the average value for the *maximum* Standby power demand and this value was calculated for houses and apartments together. For the houses in Sweden, 59 Watt is the *minimum* value due to all of the hidden consumption that we couldn't take into account.

This remark is also valid for the apartments.

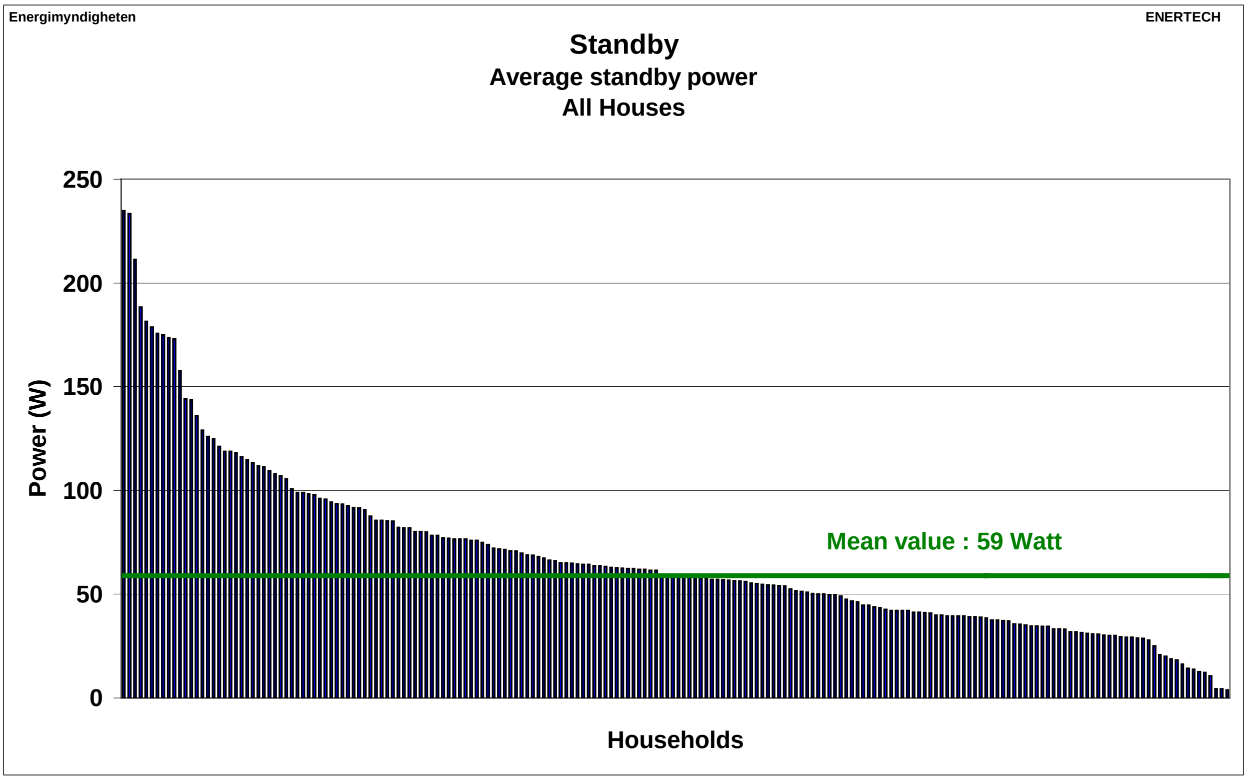


Figure 2.489: Standby – Average Standby power per house

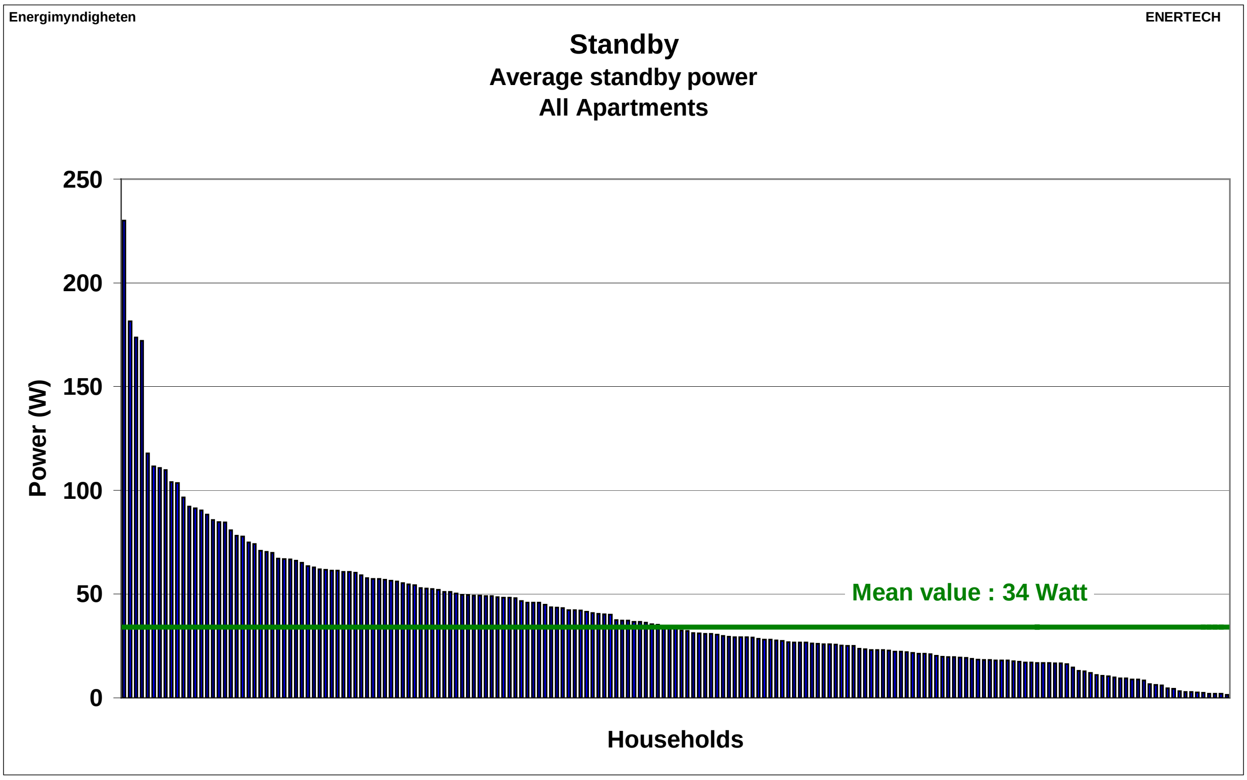


Figure 2.490: Standby – Average Standby power per apartment

Figures 4.491 and 4.492 show the average standby power calculated using the main consumption. An average power between 03:00 and 04:00 was calculated for all the families of appliances and for the main using all the data from the monitoring period. All the families average power (for computer and audiovisual sites) was then subtracted from the main average power. This method gives us a value near the maximum power for Standby for each household. For houses, the maximum average Standby power is 116 Watt and 48 Watt for the apartments. Combined with the results found above, it seems that the average Standby power for houses is in the range [59-116] Watt and for the apartments in the range [34-48] Watt.

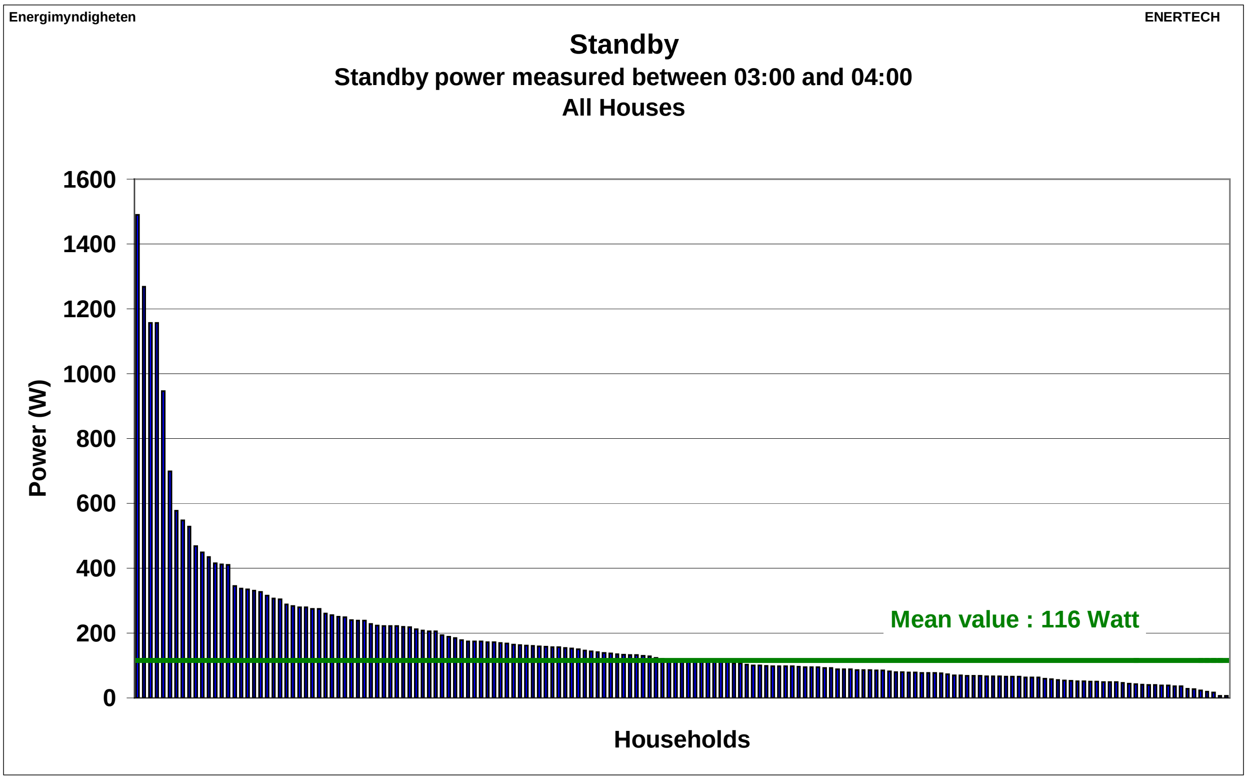


Figure 2.491: Standby – Average Standby power measured from the main for the houses

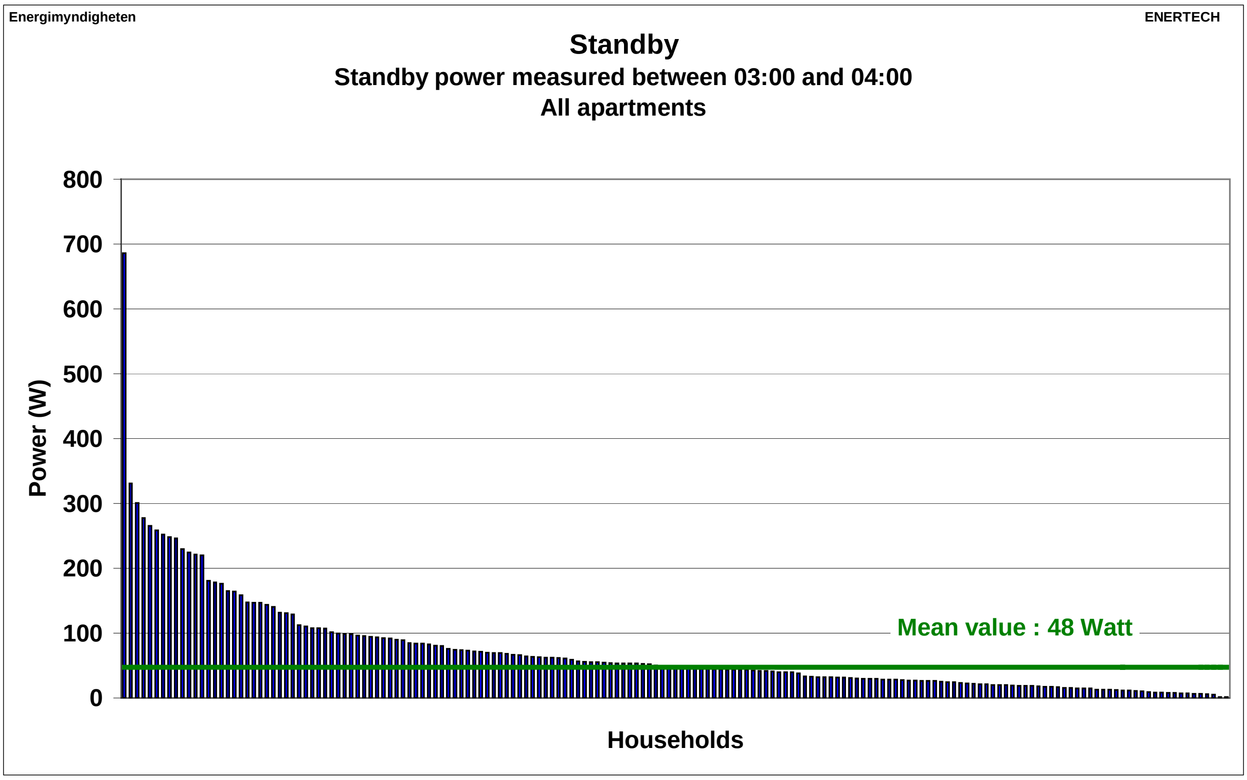


Figure 2.492: Standby – Average Standby power measured from the main for the apartments

SINGLE FAMILY HOUSES VS RESIDENTIAL BUILDINGS

In the previous chapters, the annual consumption for the different appliances were calculated on a “per type of household” basis. The results are very interesting for a detailed analysis when you know exactly the composition of your sample. On the other hand, more general results will be interesting to quickly calculate an approached value. The table of figure 2.493 shows us the annual consumption for all houses and all apartments together. Using the total number of houses and apartments in Sweden, it is possible to use this numbers to calculate a total consumption for a national or for a city point of view.

	All results are in kWh/year except for standby values (Watt)	One Family Houses	Multiple Family Houses
Total consumption	Domestic electricity	6024	3161
Cold appliances	Fridge	275	297
	Fridge-freezers	569	505
	Vertical freezers	489	476
	Table top freezers	489	
	American freezers	454	
	Chest freezers	242	
	Total	*818*	*633*

Washing/Drying	Clothes washers	209	163
	Clothes dryers	194	236
	Dishwasher	193	152
	Total	*525*	*296*
Cooking	Oven	175	205
	Kitchen stove	281	218
	Microwave	38	29
	Water boiler	51	45
	Total	*402*	*320*
Lighting	Total	1021	574
Audiovisual site	TV	181	139
	All	455	311
Computer site	Desktop	298	402
	Laptop	36	34
	Total	374	434
Heating	Heating (with electric heating)	11595	
	Heating (without electric heating)	5547	
	Heating (global)	8378	
	Water Heating	2269	
Standby	Total min/max (Watt)	59-116	34-48

Figure 2.493: Annual consumption for single family houses vs. Residential buildings. Domestic electricity is the sum of all electrical loads except heating and hot water.

ASSESSMENT OF THE POTENTIAL ELECTRICITY SAVINGS

One of the objectives of this report is to assess the potential electricity savings in the residential sector. These savings can be achieved mainly by replacing the existing appliances by energy efficient ones. From the characteristics of the existing equipment, and from the measurements done every 10 minutes, we had the data to simulate the operation of efficient appliances that would be placed in the same conditions.

We took into account the following steps:

- replacement of all the cold appliances with class A+ or A++ equipment,
- replacement of all the incandescent and halogen light bulbs with compact fluorescent light (CFL) bulbs or LEDs,
- reduction of all the Standby powers for the audiovisual and computer site,
- replacement of existing clothes-washers, clothes-dryers and dish washer with energy efficient class A appliances,
- replacement of all the desktops by laptops.

DOMESTIC COLD PRODUCTION

Methods for assessing the savings

The objective here is to determine the potential savings for cold appliances, using the annual consumption calculated with the 10 min values.

The annual consumption of the energy efficiency class A+ or A++ appliances working in the same environment can be found on internet (topten database: http://www.topten.ch/index.php), and this for each type of cold appliance.

The table of figure 3.1 shows the annual consumption used for each type of cold appliance as replacement for the actual consumption. These values were extracted from the Topten.ch database.

	Annual consumption (kWh/year)
Fridge (200-250 liters)	92
Vertical freezer (200-250 liters)	190
Fridge freezer (200 litesr)	157
Table top freezer (height < 85 cm)	127
American freezer (350 liters)	250
Chest freezer (300 liters)	182

Figure 3.1: Cold appliances – annual consumption of the efficient ones

Refrigerator potential electricity saving

Figure 3.2 shows the average annual saving per household for the fridges by replacing all that type of appliance by an efficient one. The average value per household is 132 kWh/year and can be compared to the 148 kWh found for Denmark in the Eureco project. The two projects are separated by 6 years but have more or less the same result: in six years, the numbers of household with efficient fridges increased but the best annual consumption decreased. It is therefore possible to find the same result.

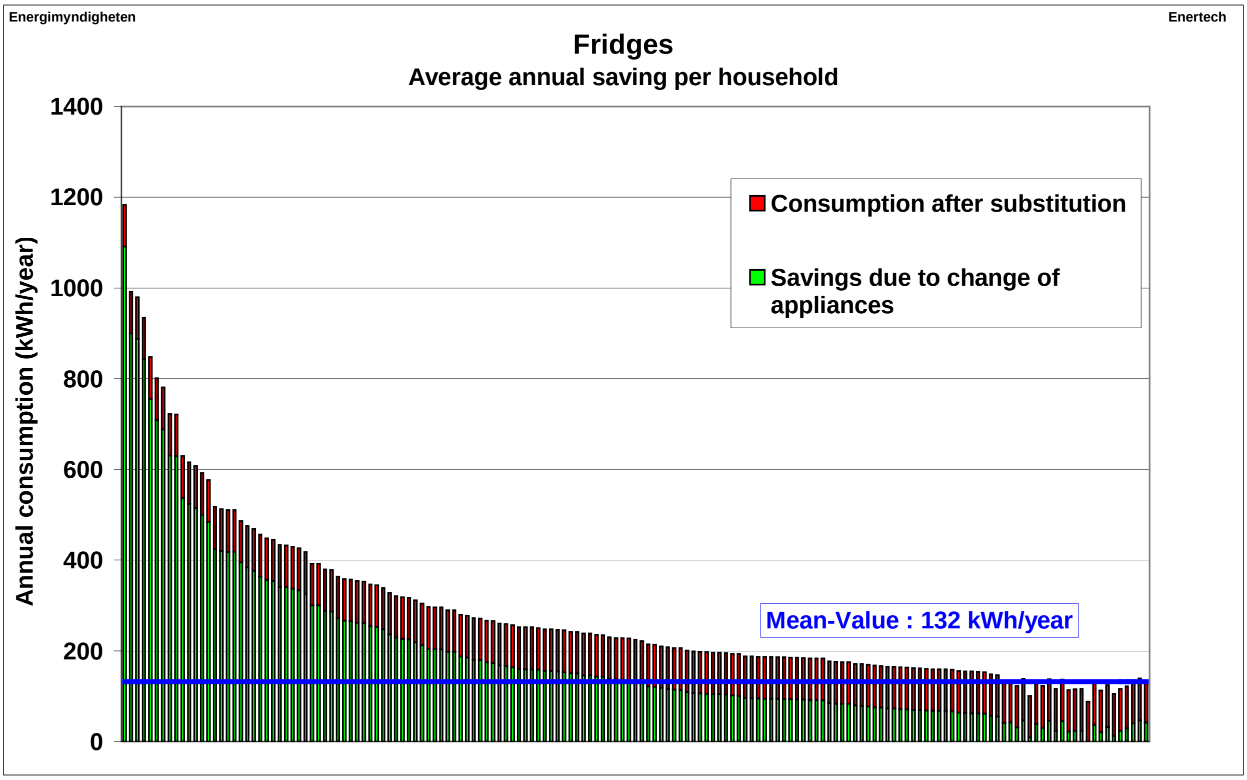


Figure 3.2: Fridges – Average annual savings per household

Vertical freezers potential electricity saving

Figure 3.3 shows the average annual saving per household for the vertical freezers by replacing all that type of appliance by an efficient one. The average value per household is 218 kWh/year and can be compared to the 220 kWh/year calculated for Denmark in the Eureco project. As for the fridges, the two projects are separated by 6 years but have more or less the same result: in six years, the numbers of household with efficient vertical freezers increased but the best annual consumption decreased. It is therefore possible to find the same result.

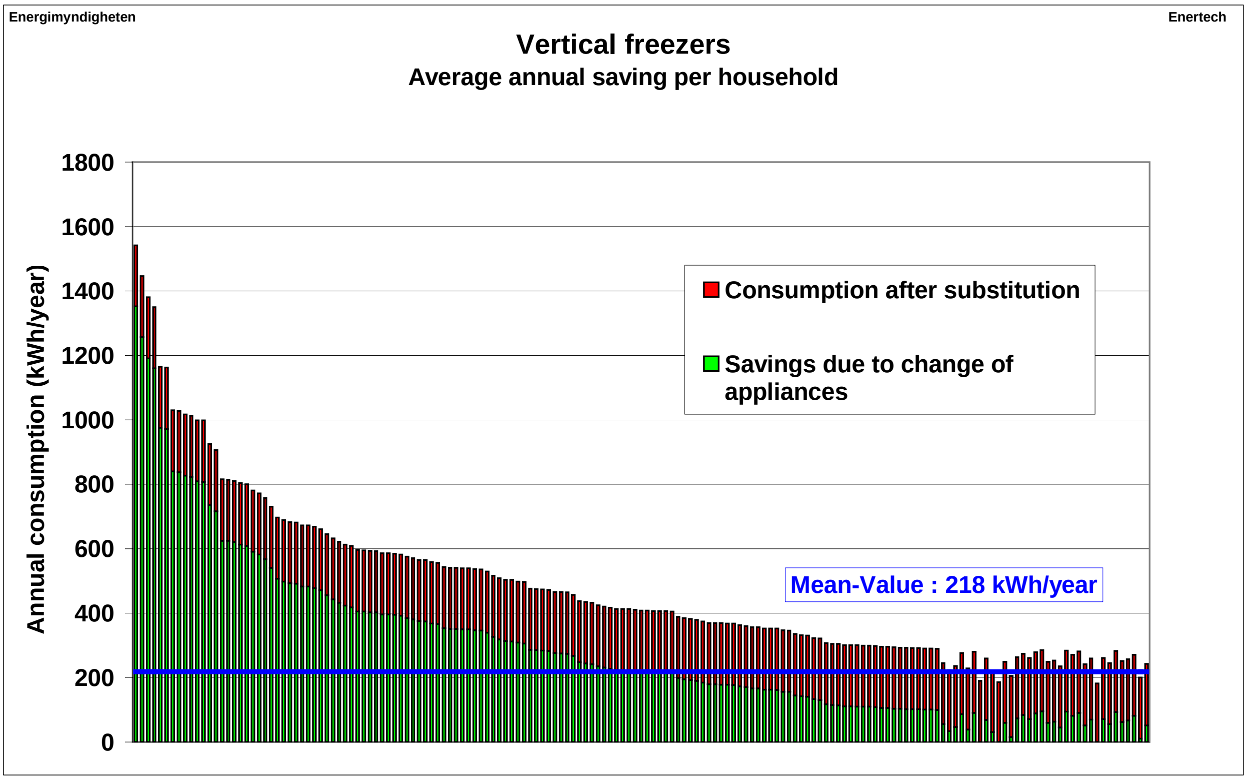


Figure 3.3: Vertical freezers – Average annual savings per household

Fridge freezers potential electricity saving

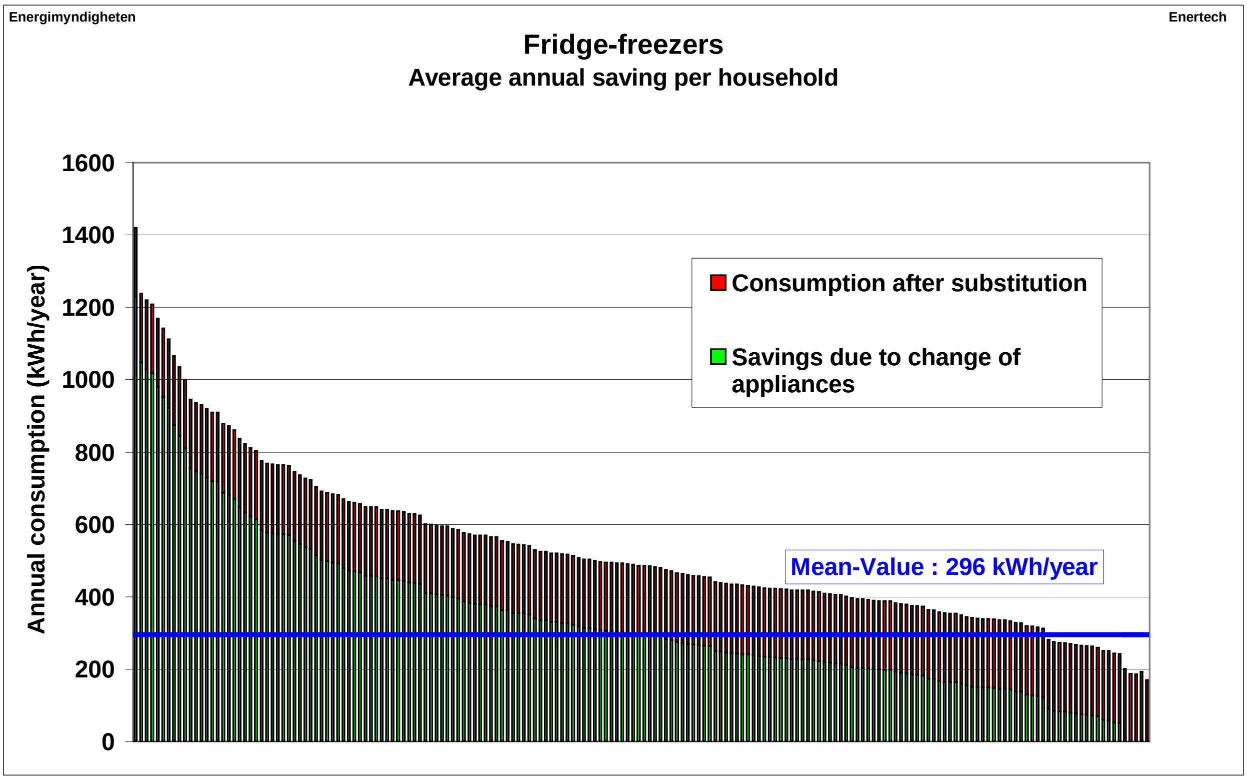


Figure 3.4: Fridge freezers – Average annual savings per household

Table-top freezers potential electricity saving

It is for the tabletop freezers that we find the highest savings for a cold appliance per household with 362 kWh/year.

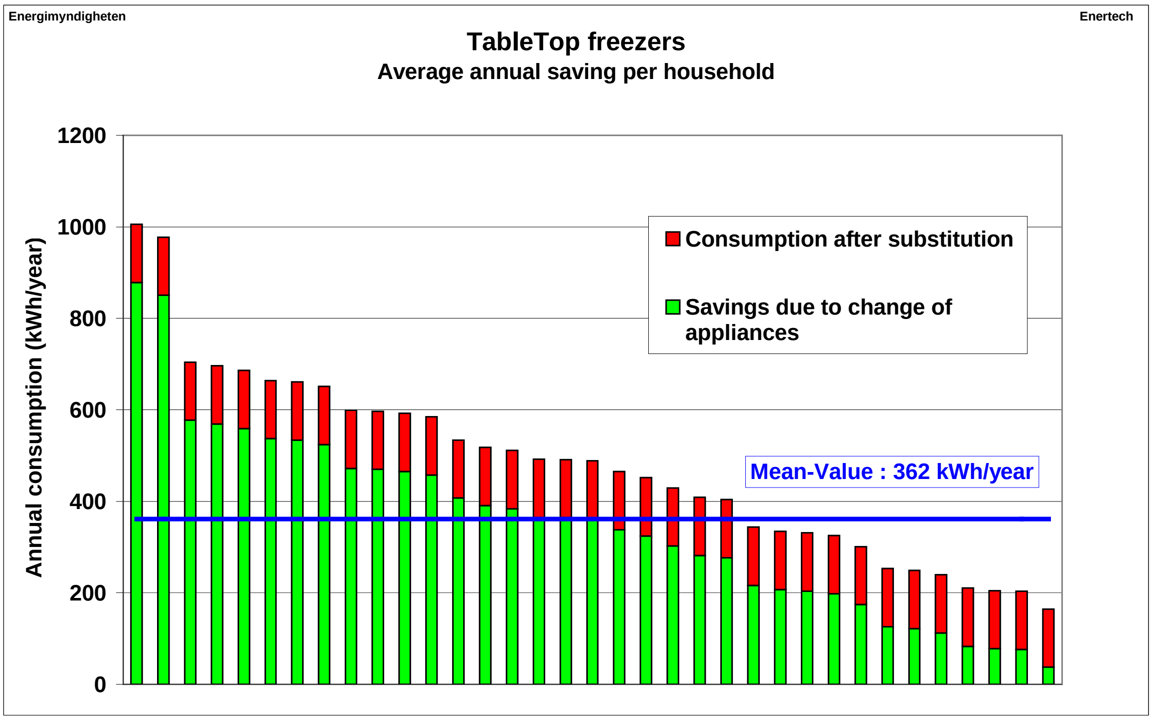


Figure 3.5: Tabletop freezers – Average annual savings per household

American freezers potential electricity saving

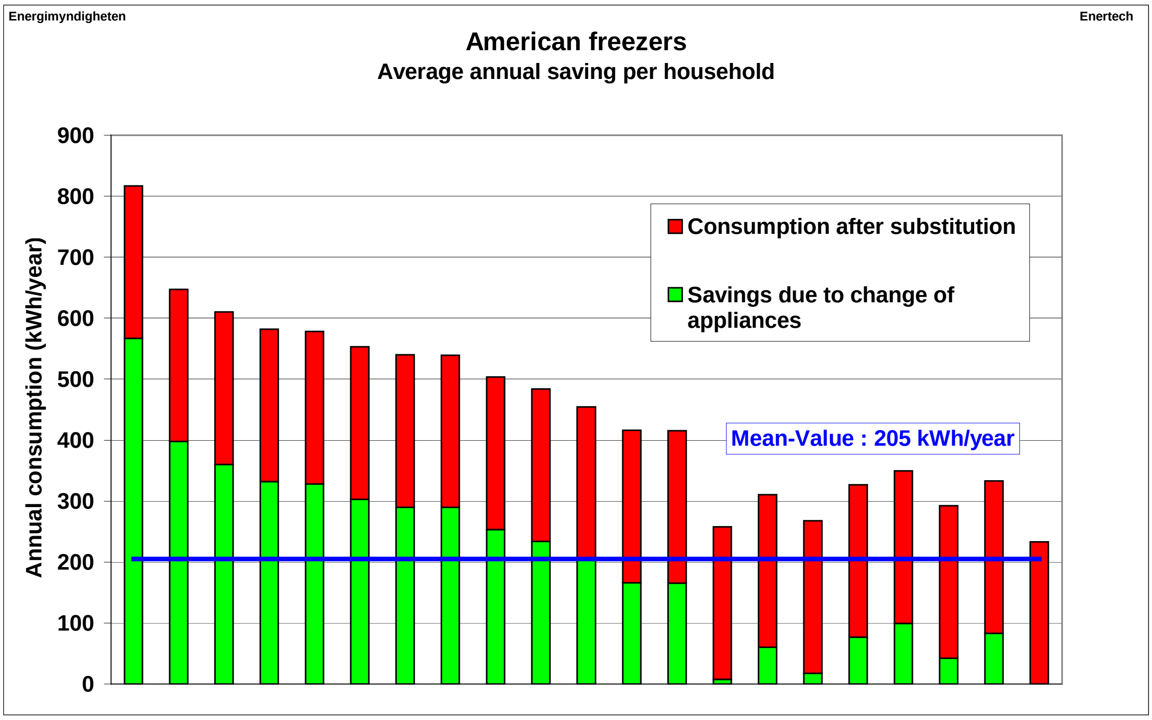


Figure 3.6: American freezers – Average annual savings per household

Chest freezers potential electricity saving

There were only 4 chest freezers monitored in the whole campaign. The estimation of 60 kWh/year has to be confirmed with a larger panel.

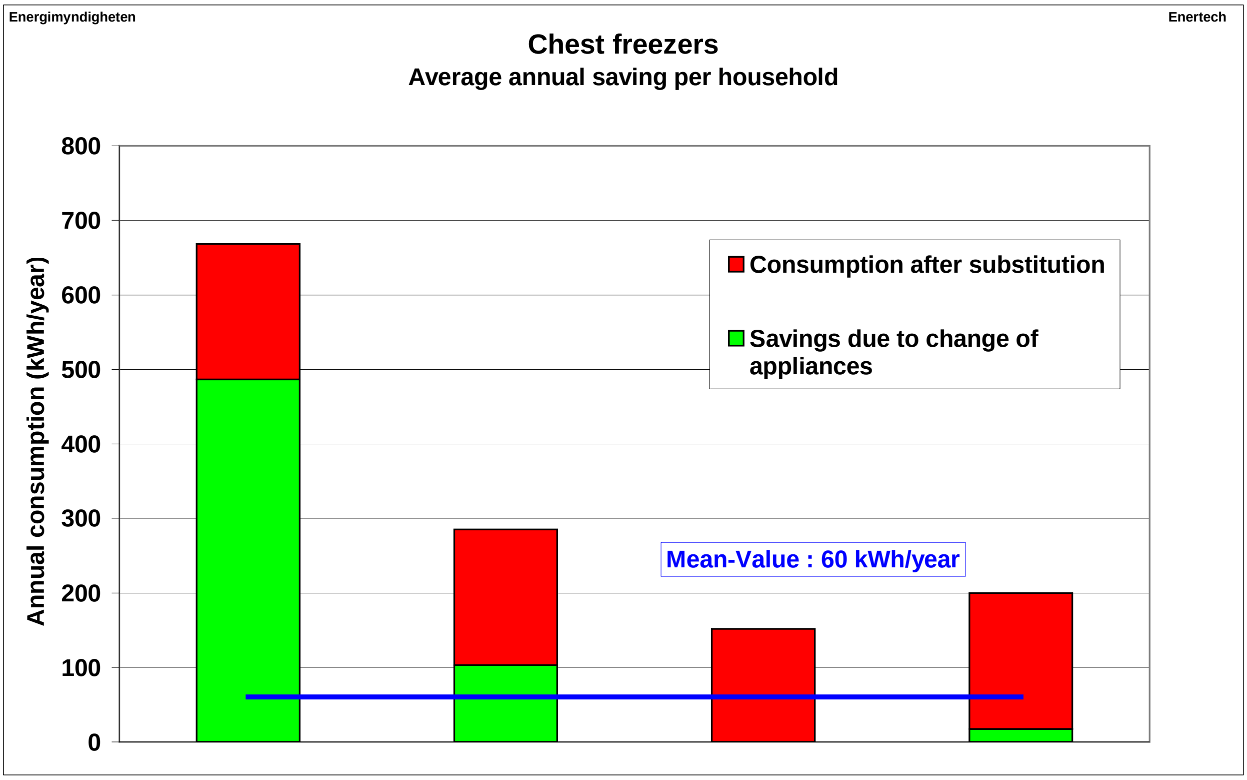


Figure 3.7: Chest freezers – Average annual savings per household

Cold appliances potential electricity saving

Figure 3.8 shows the total savings for the cold appliances site. This value was calculated by replacing individually each appliance with an efficient one and then calculating the annual consumption after replacement. The difference between the actual consumption and the new one gives the annual savings possible per household. In the Eureco project for Denmark, the value found was 385 kWh/year/household: the value for this campaign is very close with 390 kWh/year/household !

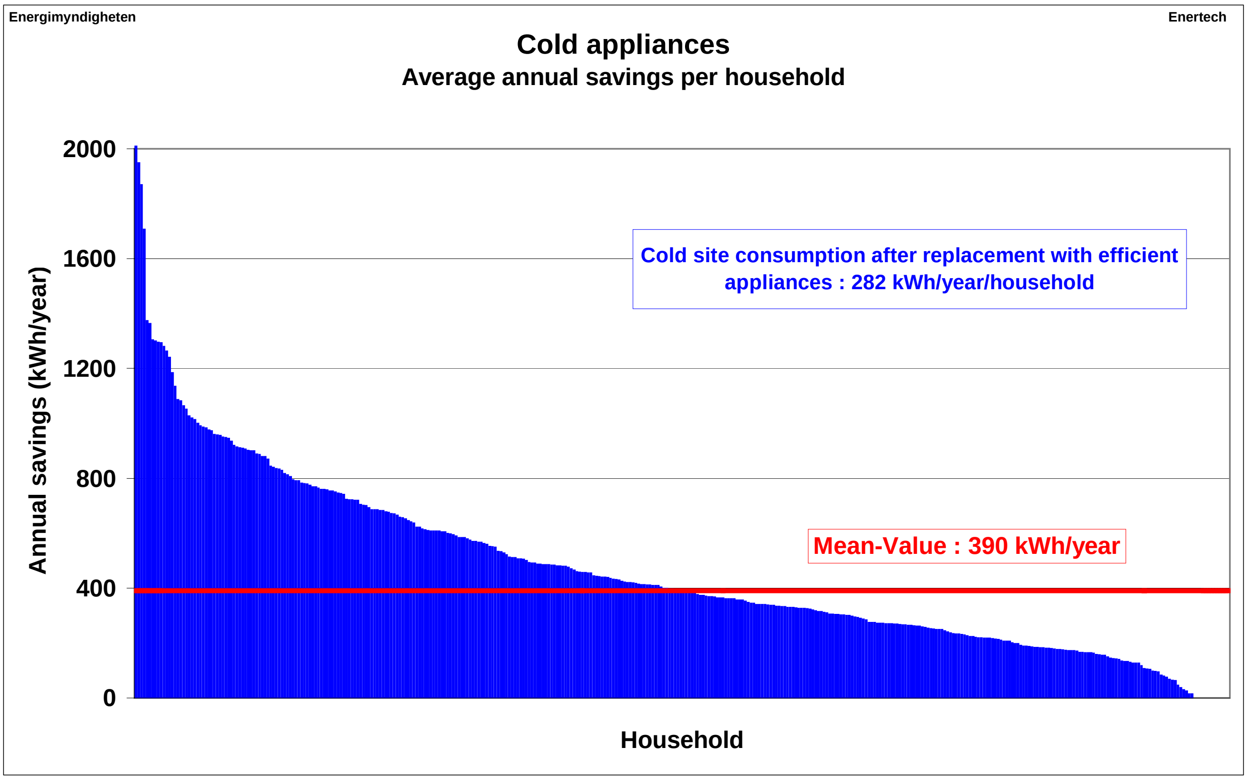


Figure 3.8: All cold appliances – Average annual savings per household

LIGHTING

Methods for assessing the savings

The only method for saving lighting energy in the household that was considered in this study, was the replacement of all the incandescent or halogen lights of the households by compact fluorescent light bulbs (CFLs) or LED.

Practically, the assessment of the energy saving was calculated by modifying the bulb wattages in the lighting database. The bulb wattages were divided by 4 which seems a good ratio between incandescent and CFL and LED technologies. As it contains every 10 minutes records, this database also provides the operating periods of each light source. It was therefore easy to deduce by comparison the potential electricity savings.

Lightning potential electricity saving

Figure 3.9 and 3.10 show the annual average saving per household for houses and apartments. The value is higher in the houses with 517 kWh/years than in apartments (305 kWh/year) but we saw in the lighting chapter that the installed wattage is higher for houses than apartments. This values can be compared to the 265 kWh/year that was found in the Eureco project for Denmark. This time, the savings are higher in Sweden.

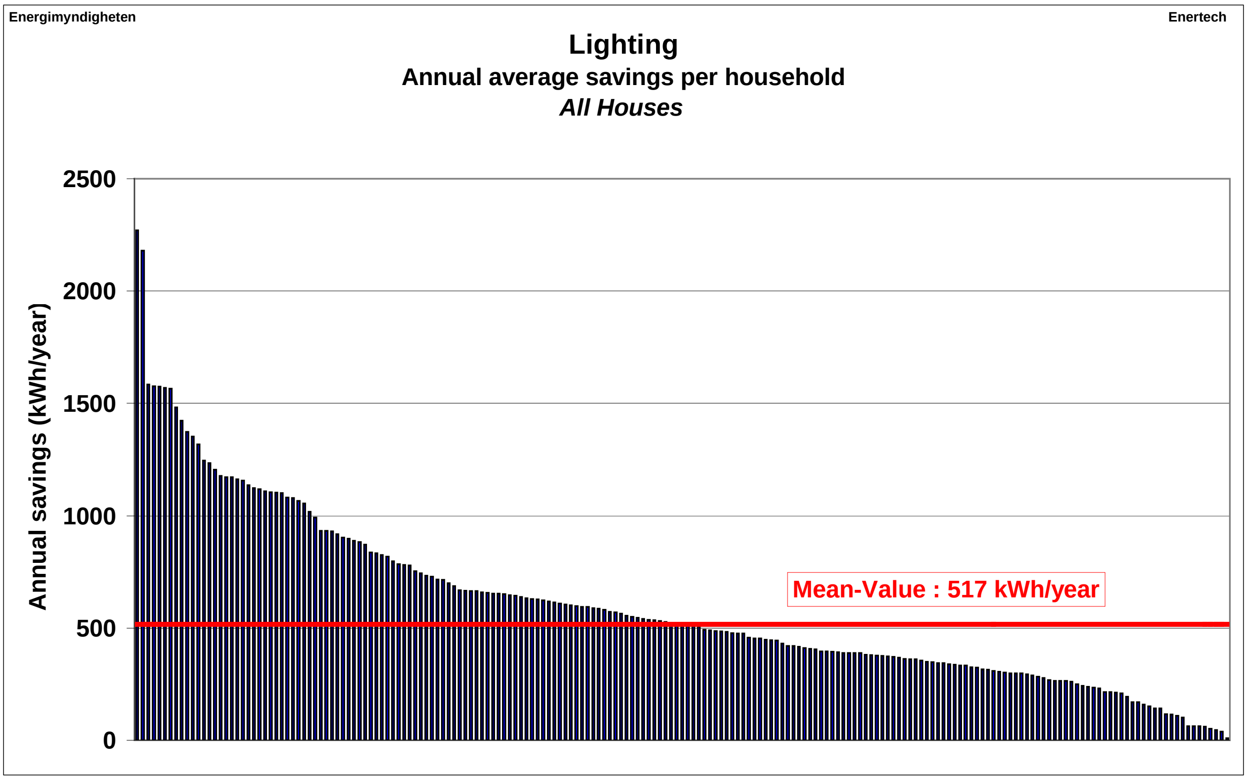


Figure 3.9: Lighting – Average annual savings per houses

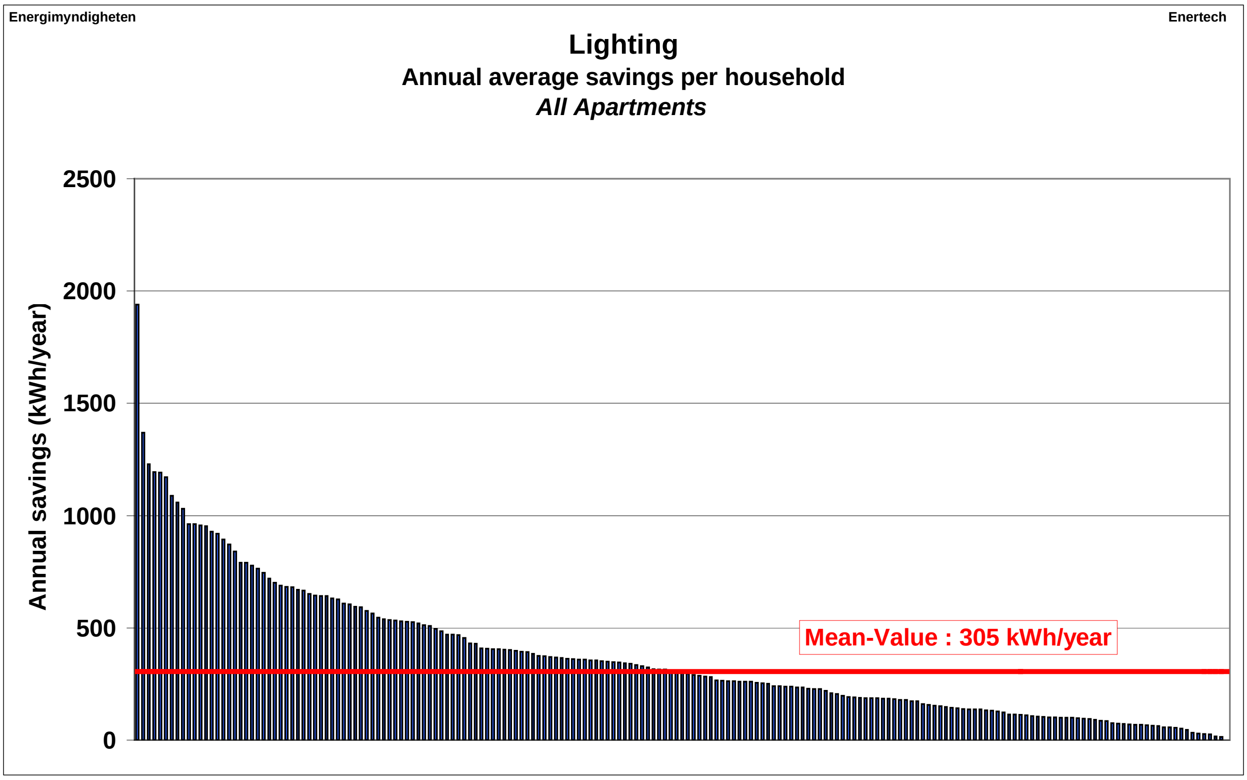


Figure 3.10: Lighting – Average annual savings per apartments

WASHING/DRYING

Methods for assessing the savings

The consumption of each efficient clothes-washer, clothes dryer and dish washer was estimated as a function of the annual number of cycles of the existing appliance. For each type of appliance, we extracted individually the different working cycles and compared the consumption with the cycle consumption of an efficient appliance. If the actual consumption was higher than the efficient one, we replaced it with this consumption. At the end of the cycle analysis we calculated a new annual consumption: the difference between the actual and the new one gives us the annual savings for the appliance. The table from figure 3.11 shows the different consumption per cycle used to calculate the savings.

	Consumption per cycle (kWh)
Clothes washer	0,93
Clothes dryer	1,35
Dish washer	0,98

Figure 3.11: Washing: consumption per cycle for efficient appliances

Clothes-washer potential electricity saving

During the calculation of the savings, we saw that consumption of the washing cycles in many cases were lower than the value for the efficient one. Therefore the average saving represents only 10 kWh/year/household.

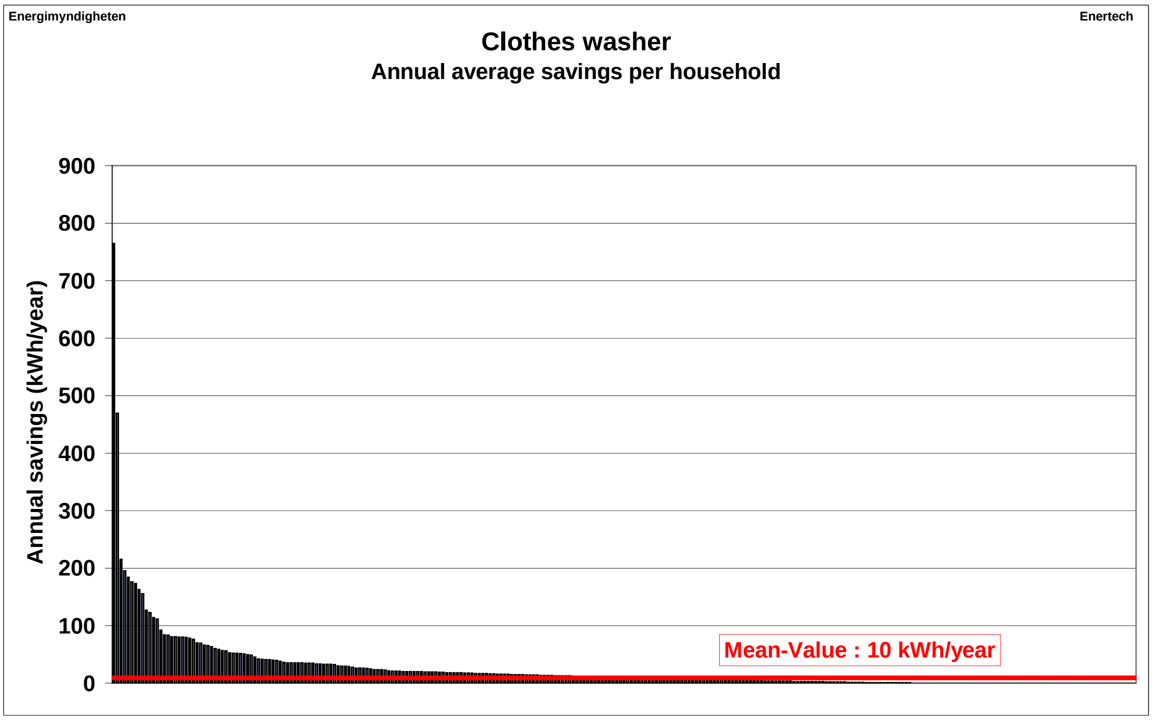


Figure 3.12: Washing machine: Annual average savings per household

Clothes dryers potential electricity saving

During the calculation of the savings, we saw that the consumption of the drying cycles in many cases were lower than the value for the efficient one. Therefore the average savings represent only 45 kWh/year/household.

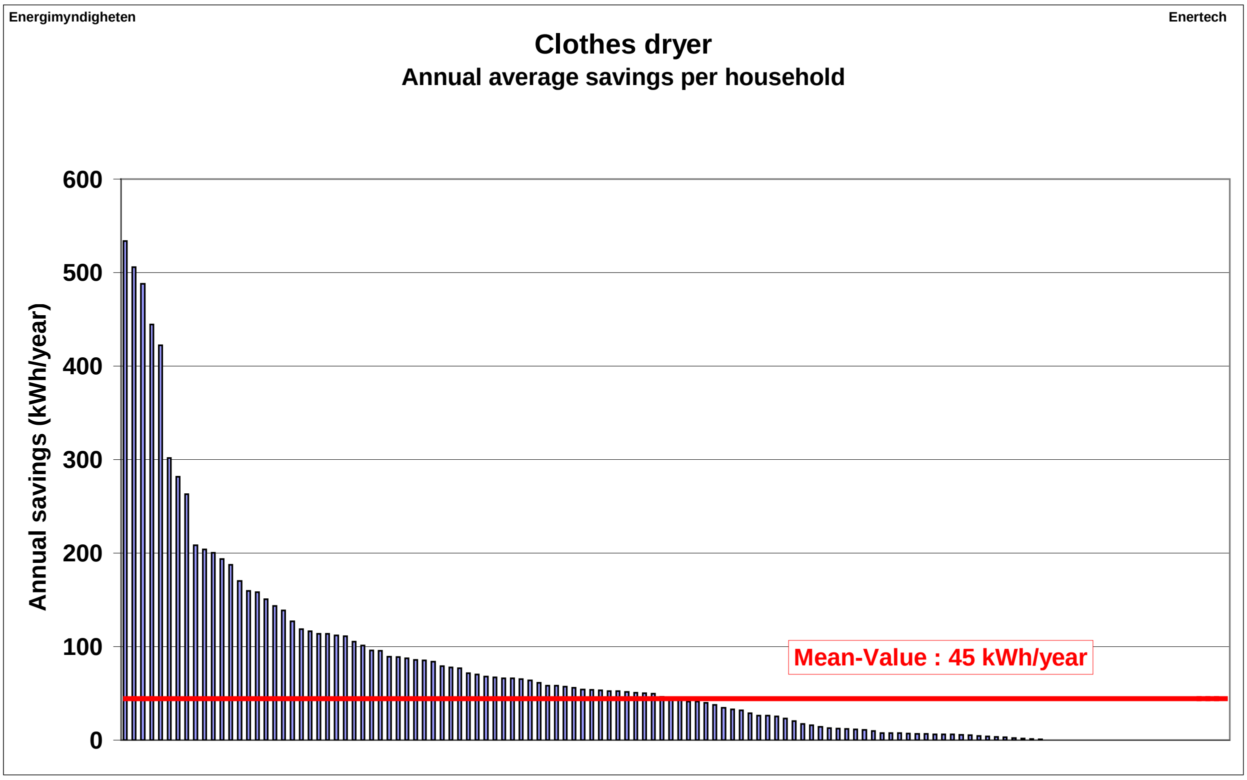


Figure 3.13: Clothes dryer: Annual average savings per household

Dishwasher potential electricity saving

During the calculation of the savings, we saw that the consumption of the washing cycles in many cases were lower than the value for the efficient one. Therefore the average saving represents only 11 kWh/year/household.

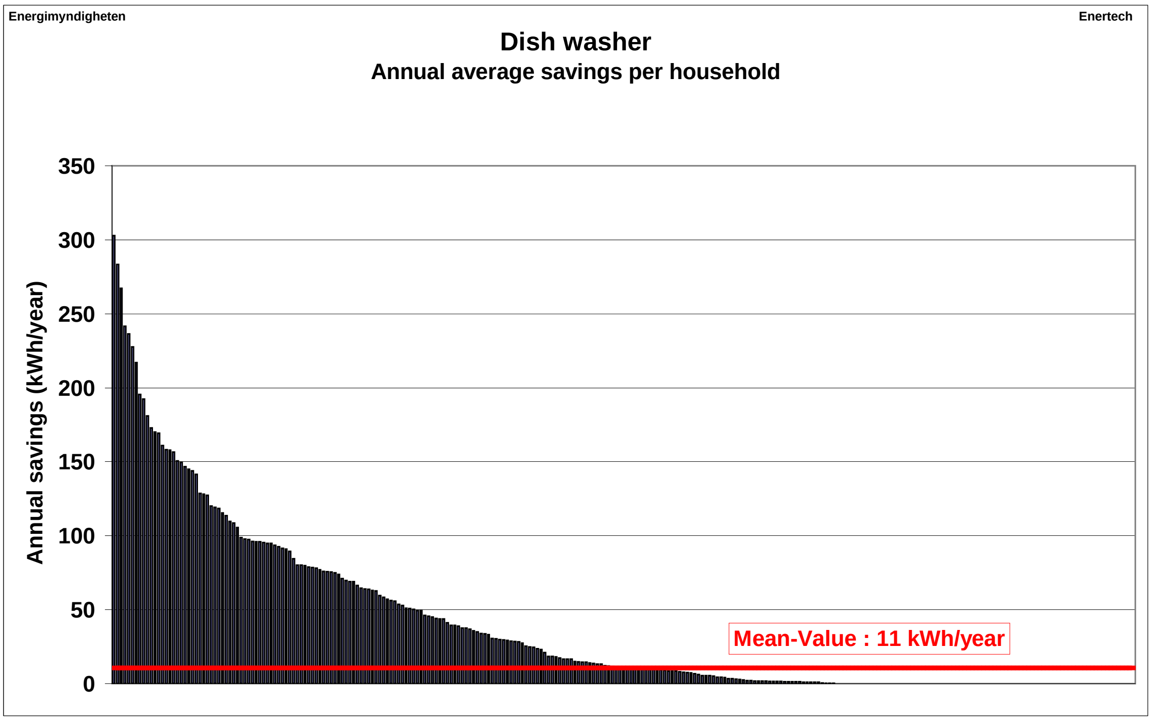


Figure 3.14: Dish washer: Annual average savings per household

AUDIOVISUAL SITE

Methods for assessing the savings

The audiovisual site was analyzed as a whole. The main work was to recalculate the Standby consumption using appliances with less than 0,5 Watt Standby power. The ON mode power was not modified because recent studies, such as the Remodece+ study in France, indicates that customers, when they change their TV for example, will buy a bigger one and that, despite of the fact that recent appliances will have their ON mode power minimized, the ON mode power will remain the same. The distribution between Standby and ON mode were used to recalculate the annual consumption by replacing the Standby power by 0,5 Watt. At the same time, the night consumption(between 00:00 and 06:00) were deleted because this consumptions is due to Standby and there are possibilities to switch the entire site OFF when not used.

Potential electricity saving

Figure 3.15 shows the annual savings per household for the audiovisual site. It is possible to save 84 kWh/year/household only by reducing the Standby power and by switching the site OFF when not used.

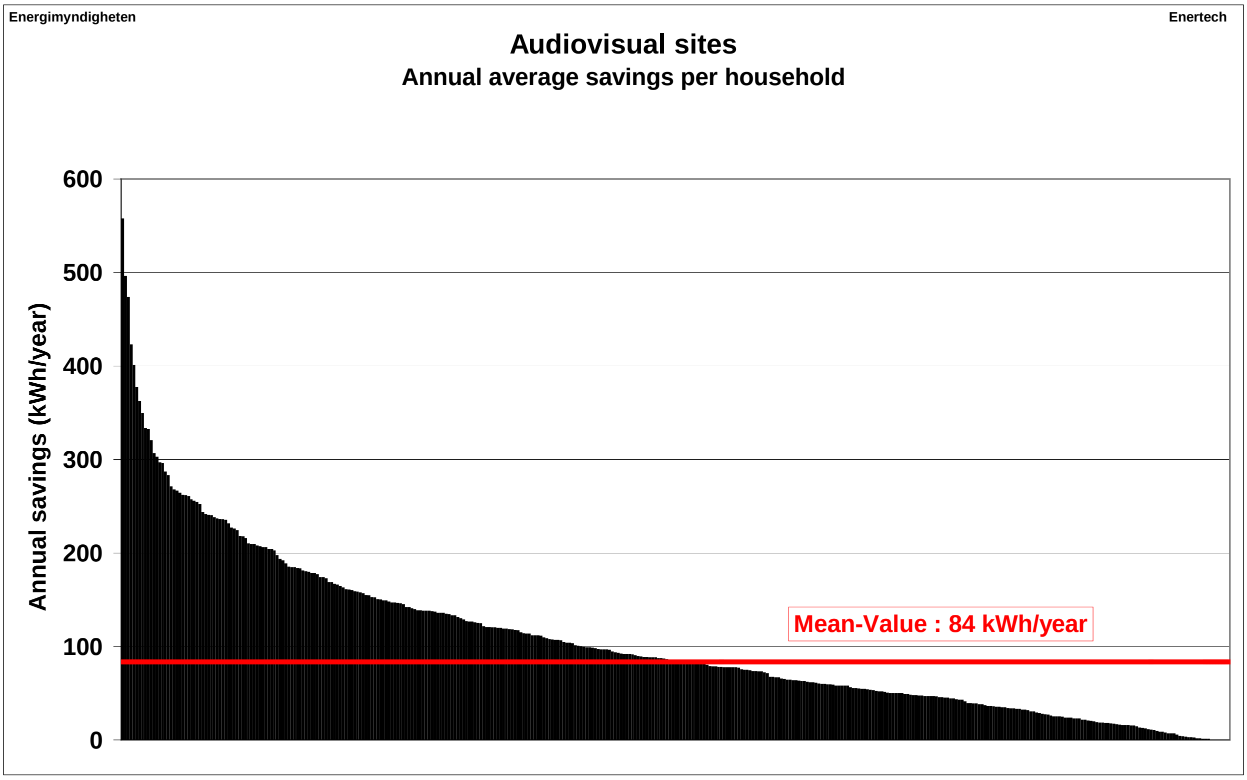


Figure 3.15: Audiovisual site: Annual average savings per household

COMPUTER SITE

Methods for assessing the savings

The savings for the computer site were calculated by analyzing each device separately:

- the laptops were replaced with the same type of device using 20 Watt ON mode power, Standby power: 0,5 Watt
- the desktops computers were replaced with laptops: ON mode power 20 Watt, Standby power: 0,5 Watt
- the computer sites with desktop computer were replaced with laptops: ON mode power 20 W, Standby power: 0,5 Watt and an average of 8 Watt ON mode for the rest of the devices (modem/printer/scanner etc.)

Using the distribution between Standby mode and ON mode, it was possible to re-calculate an annual consumption. The difference between this new consumption and the actual one will give the annual savings per household.

Potential electricity saving

Figure 3.16 and 3.17 show the annual savings for houses and apartments. This value is higher for houses.

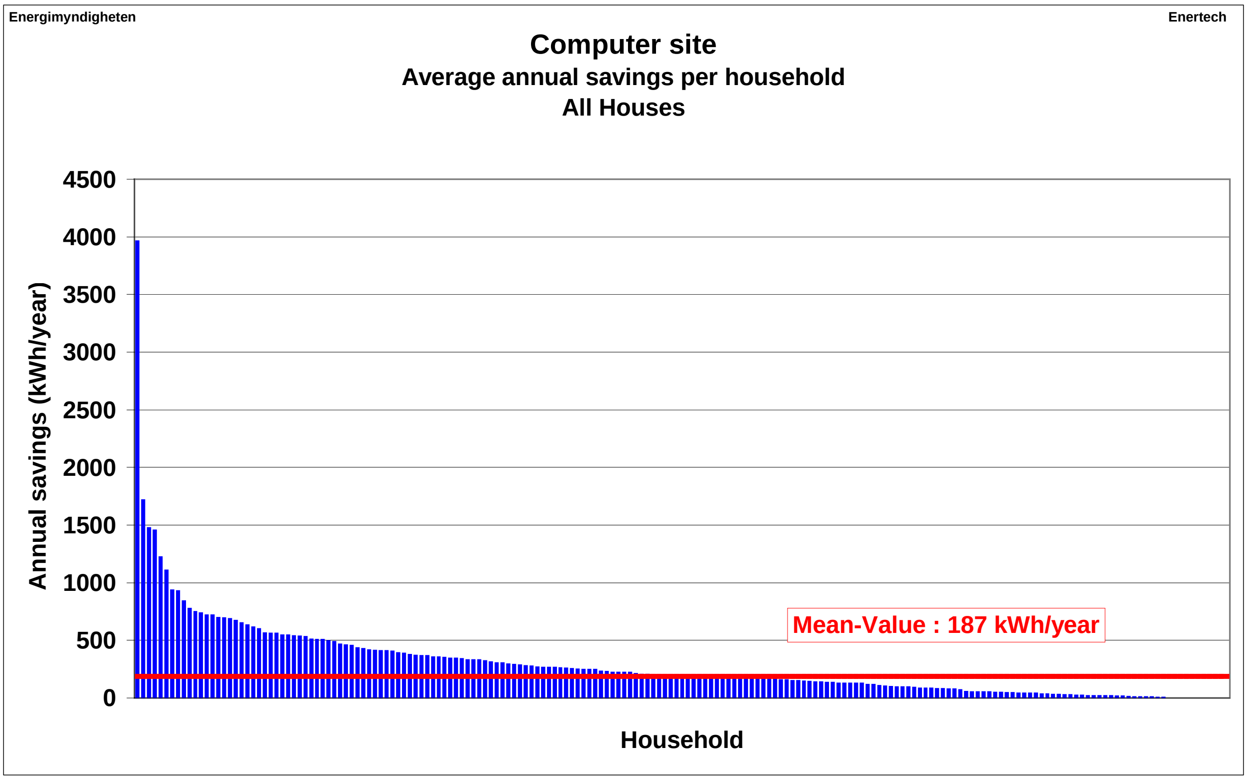


Figure 3.16: Computer site: Annual average savings per houses

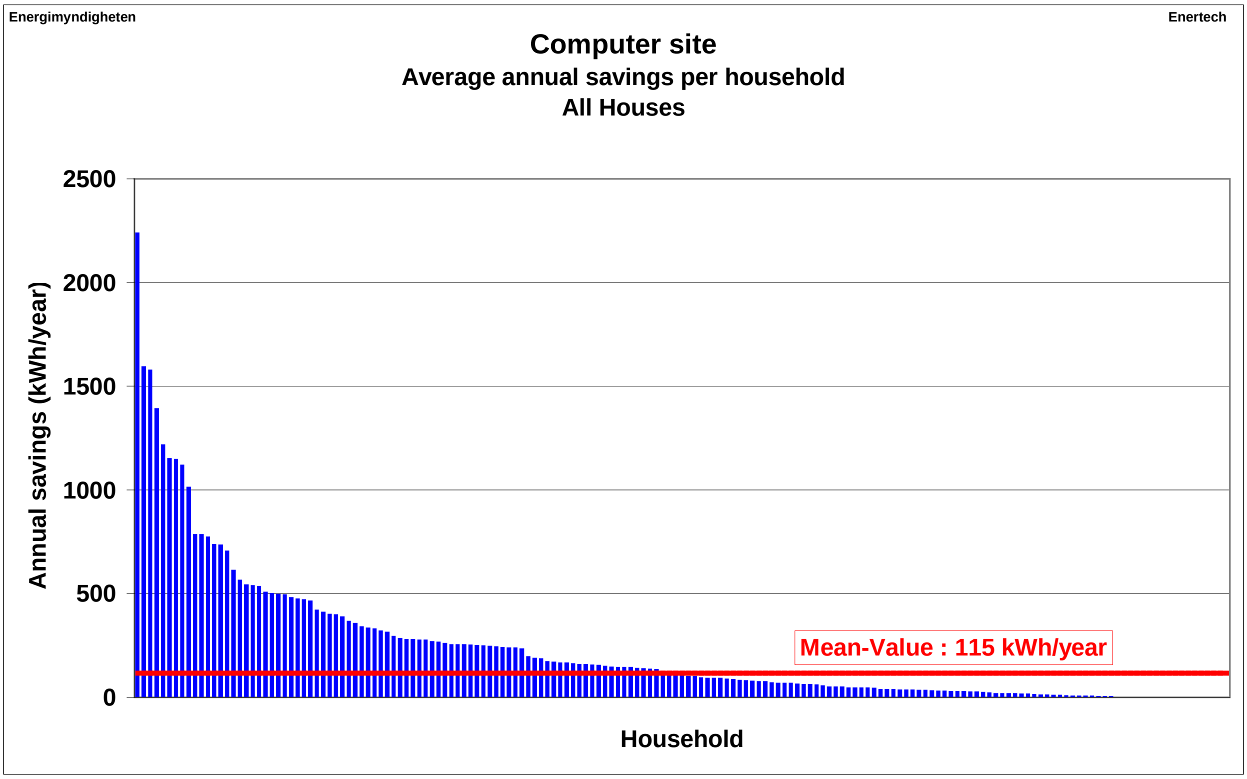


Figure 3.17: Audiovisual site: Annual average savings per apartments

POTENTIAL ENERGY SAVING PER TYPE OF HOUSEHOLD

Figures 3.18 to 3.31 show the annual savings for the different types of household and the distribution of this savings between the different families of appliances.

- for the two types of households (Houses and apartments), the maximum saving is achieved for families: 1815 kWh/year for houses and 1366 kWh/year for apartments,
- for the two types of household (houses and apartments), the minimum saving is achieved for persons older than 65 year old: 1344 kWh/year for houses and 632 kWh/year for apartments,
- for the same type of persons, the savings are always higher in the houses as in the apartments,
- the sum of the savings for cold appliances, lighting and computer sites represent always more than 75 % of the total savings.

Apartment, family, 26-64 years old

Annual savings

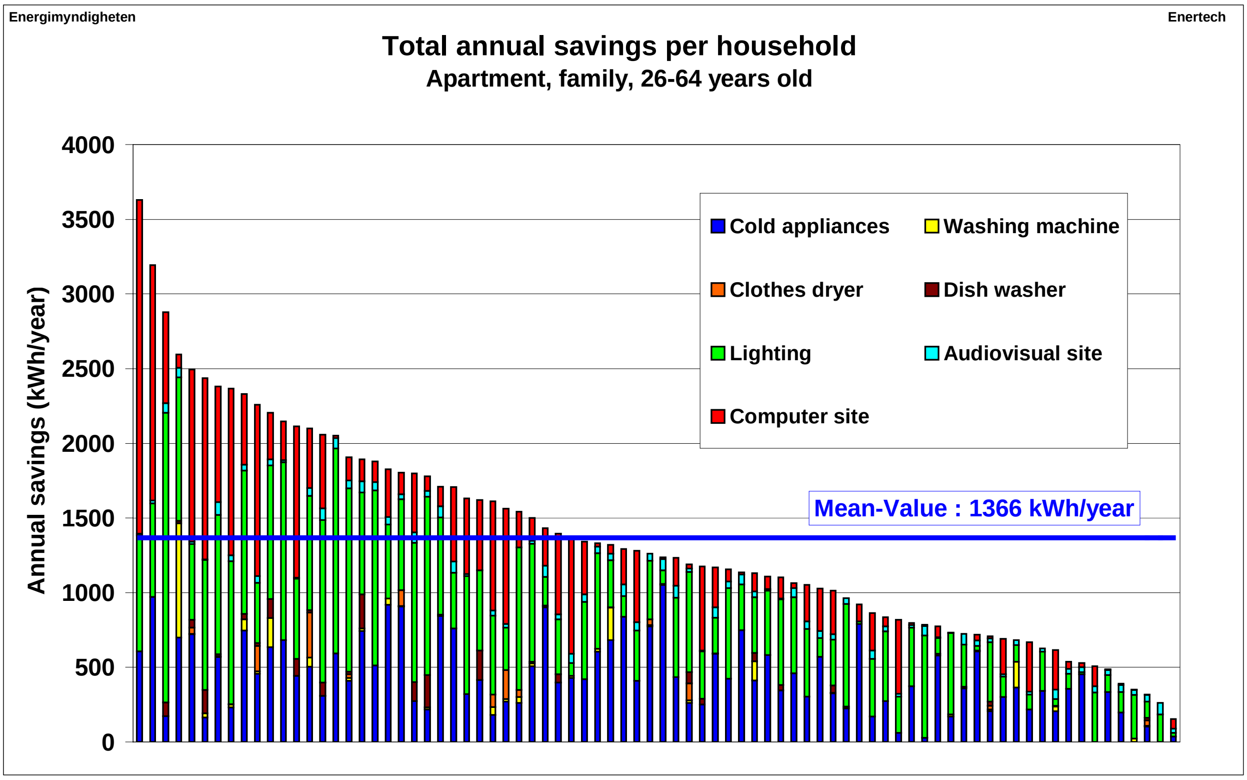


Figure 3.18: Total annual savings per household – Apartment, family, 26-64 years old

Distribution of the savings between the different families of appliances

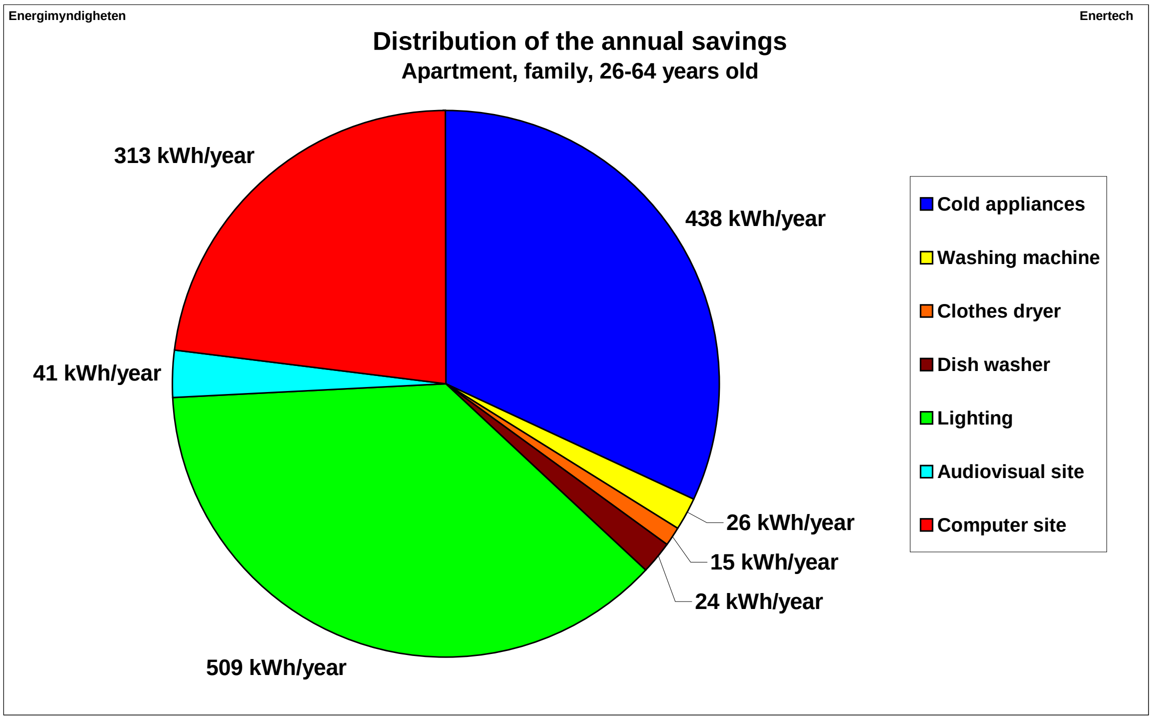


Figure 3.19: Distribution of the annual savings – Apartment, family, 26-64 years old

Apartment, single person, 26-64 years old

Annual savings

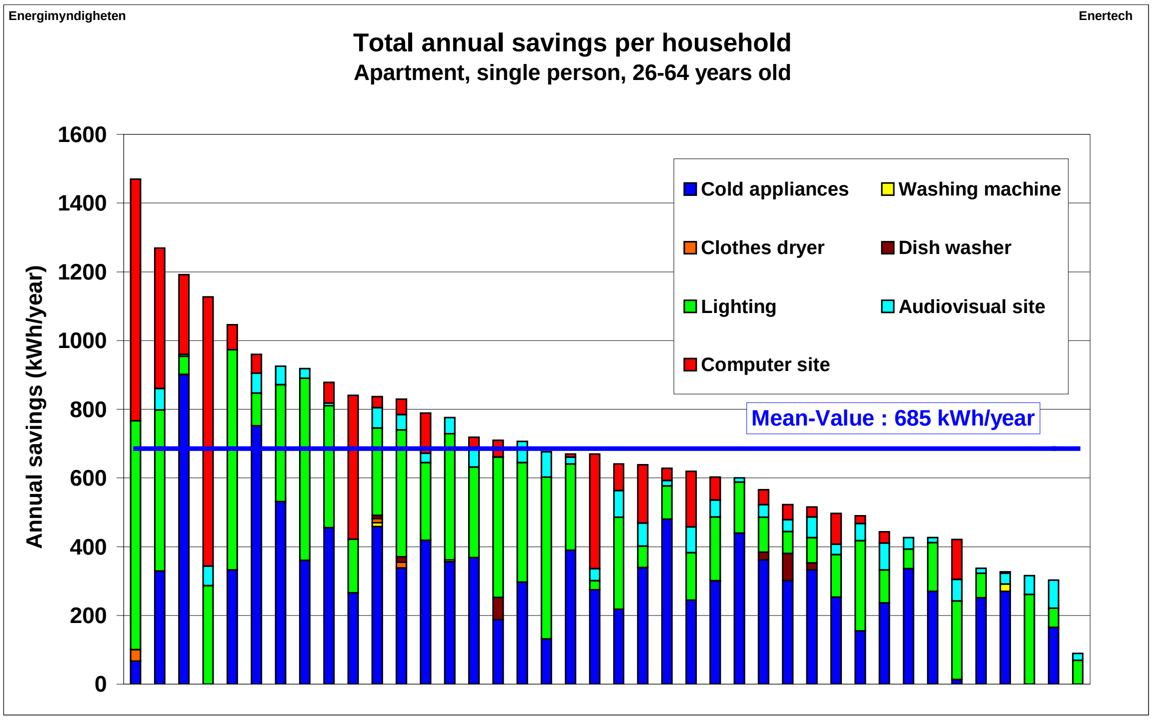


Figure 3.20: Total annual savings per household – Apartment, single person, 26-64 years old

Distribution of the savings between the different families of appliances

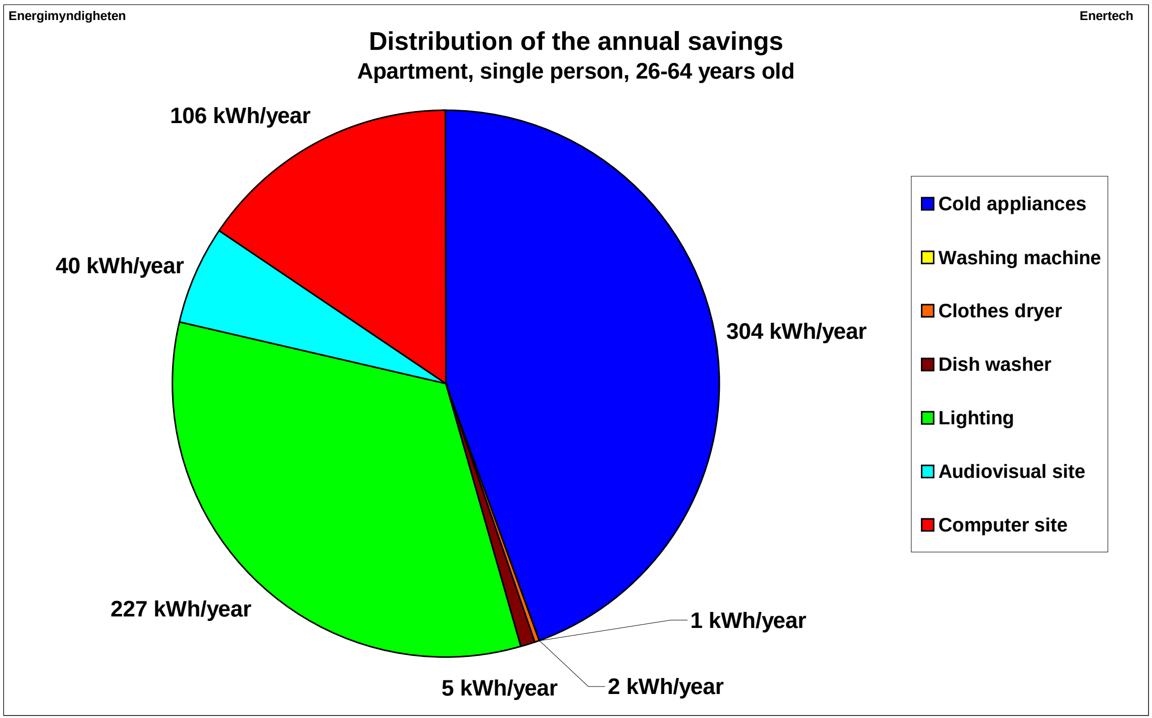


Figure 3.21: Distribution of the annual savings – Apartment, single person, 26-64 years old

Apartment, couples without children, 26-64 years old

Annual savings

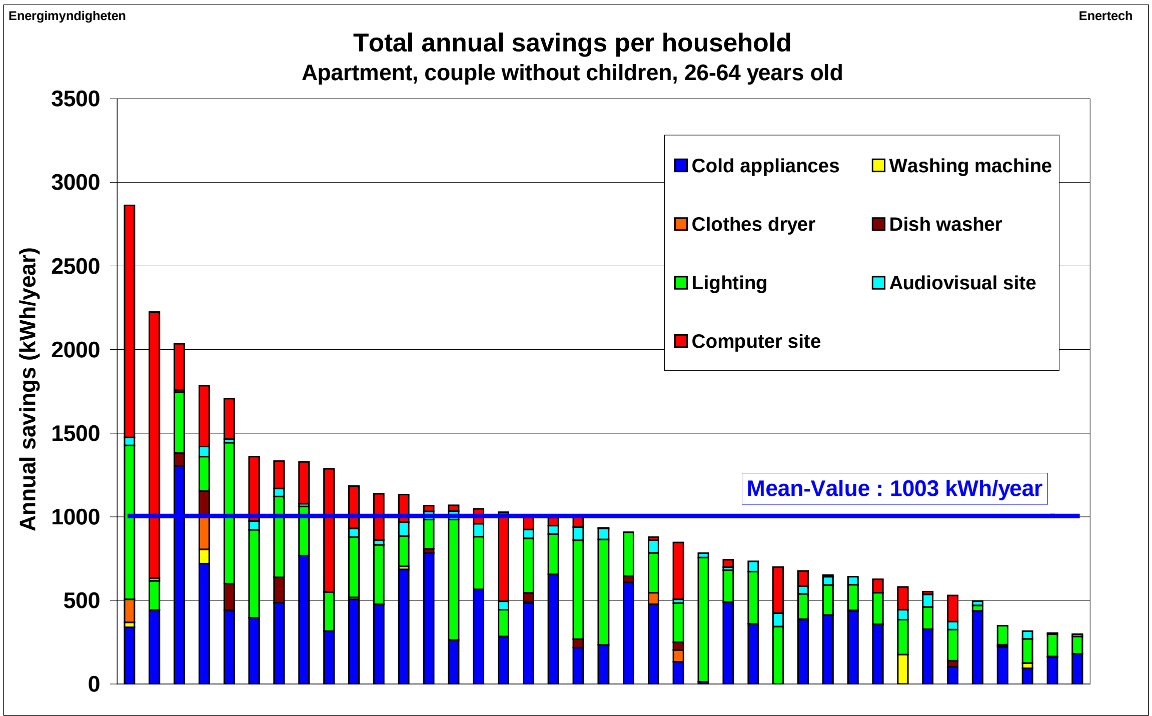


Figure 3.22: Total annual savings per household – Apartment, couples without children, 26-64 years old

Distribution of the savings between the different families of appliances

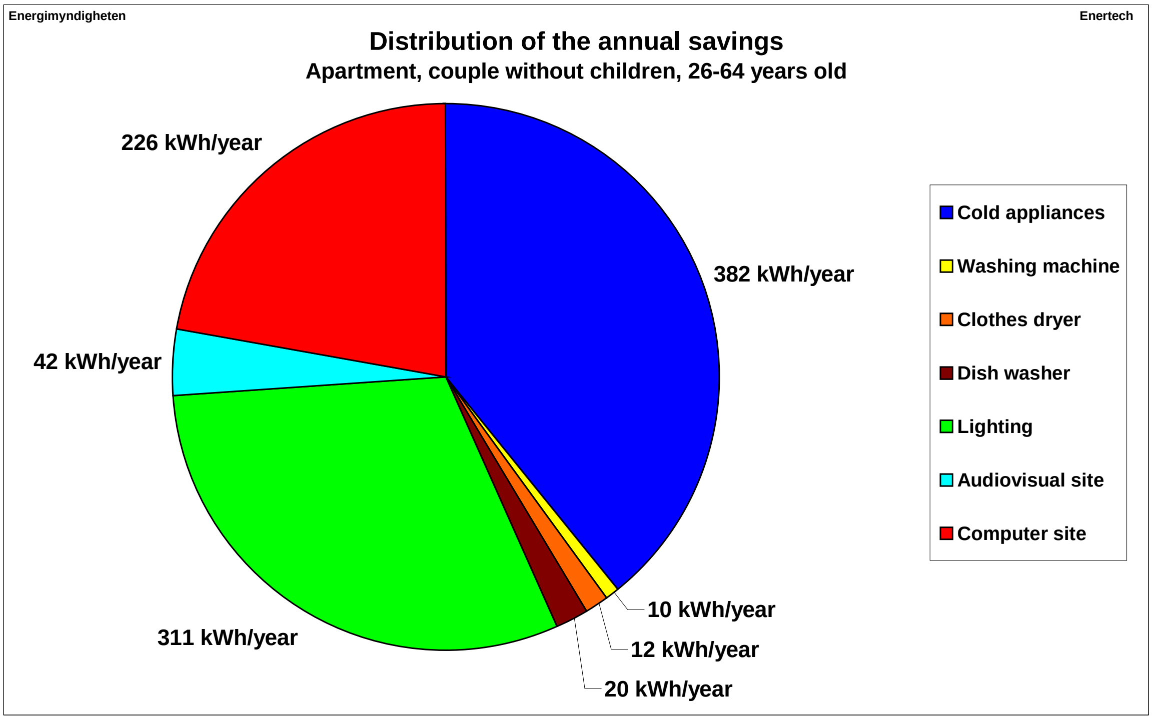


Figure 3.23: Distribution of the annual savings – Apartment, couples without children, 26-64 years old

Apartment, couples without children, 64 years old and above

Annual savings

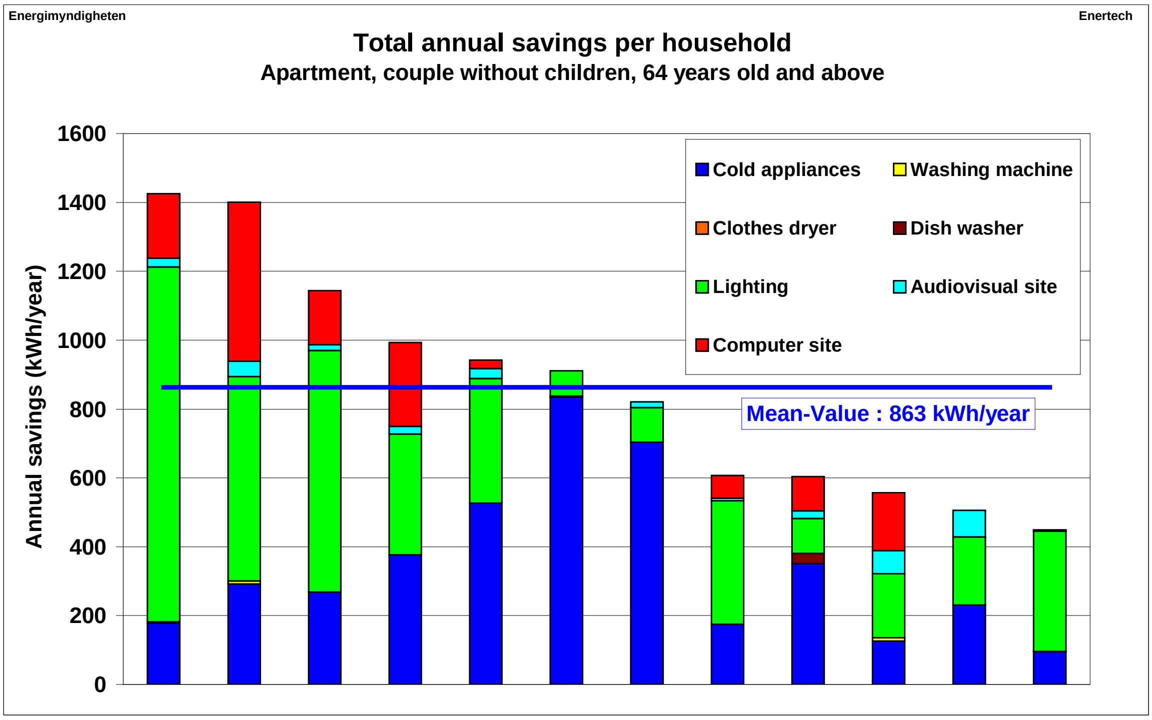


Figure 3.24: Total annual savings per household – Apartment, couples without children, 64 years old and above

Distribution of the savings between the different families of appliances

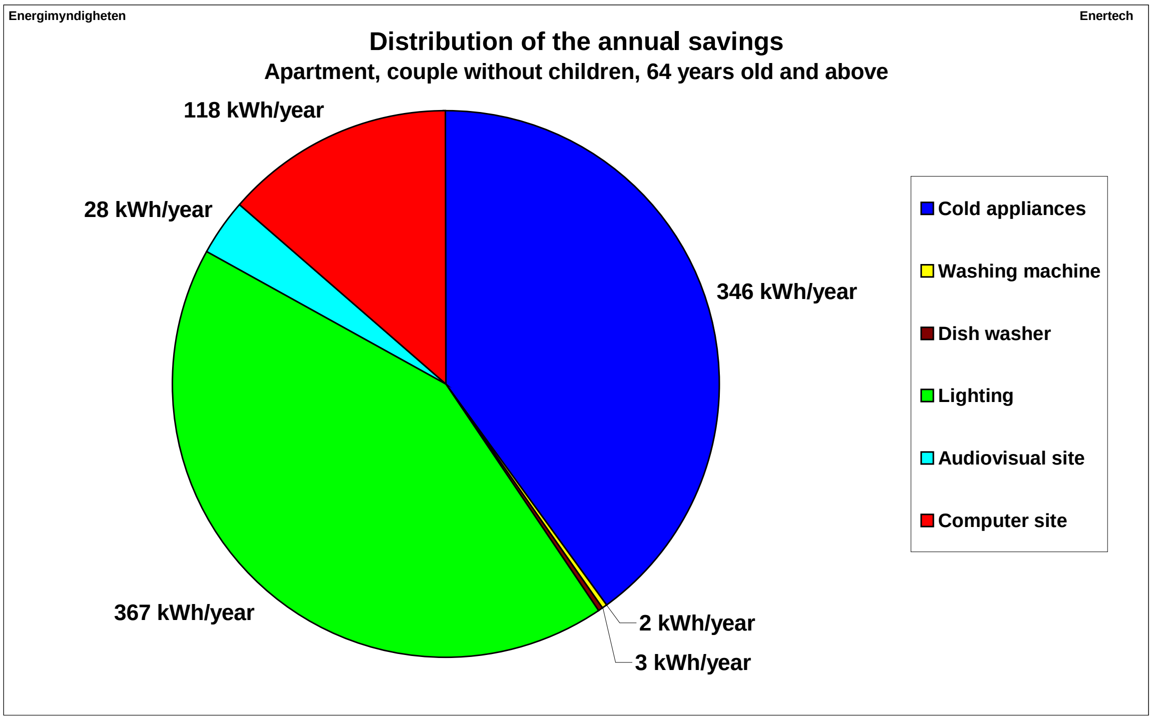


Figure 3.25: Distribution of the annual savings – Apartment, couples without children, 64 years old and above

Apartment, single person, 64 years old and above

Annual savings

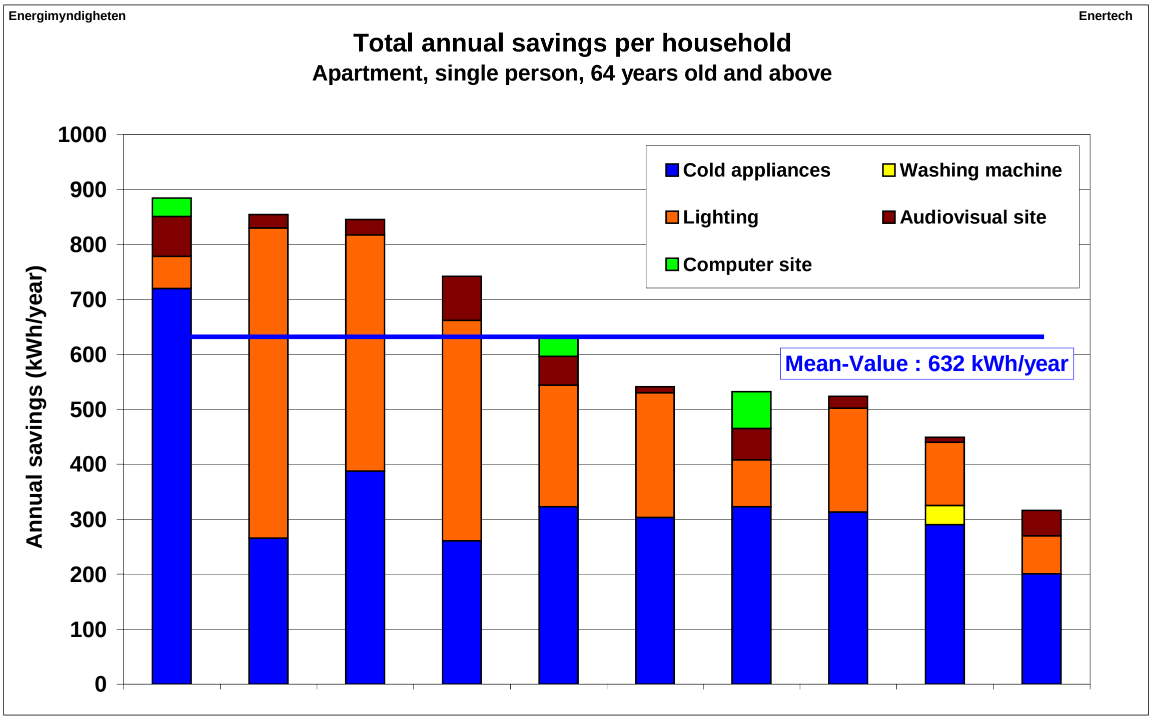


Figure 3.24: Total annual savings per household – Apartment, single person, 64 years old and above

Distribution of the savings between the different families of appliances

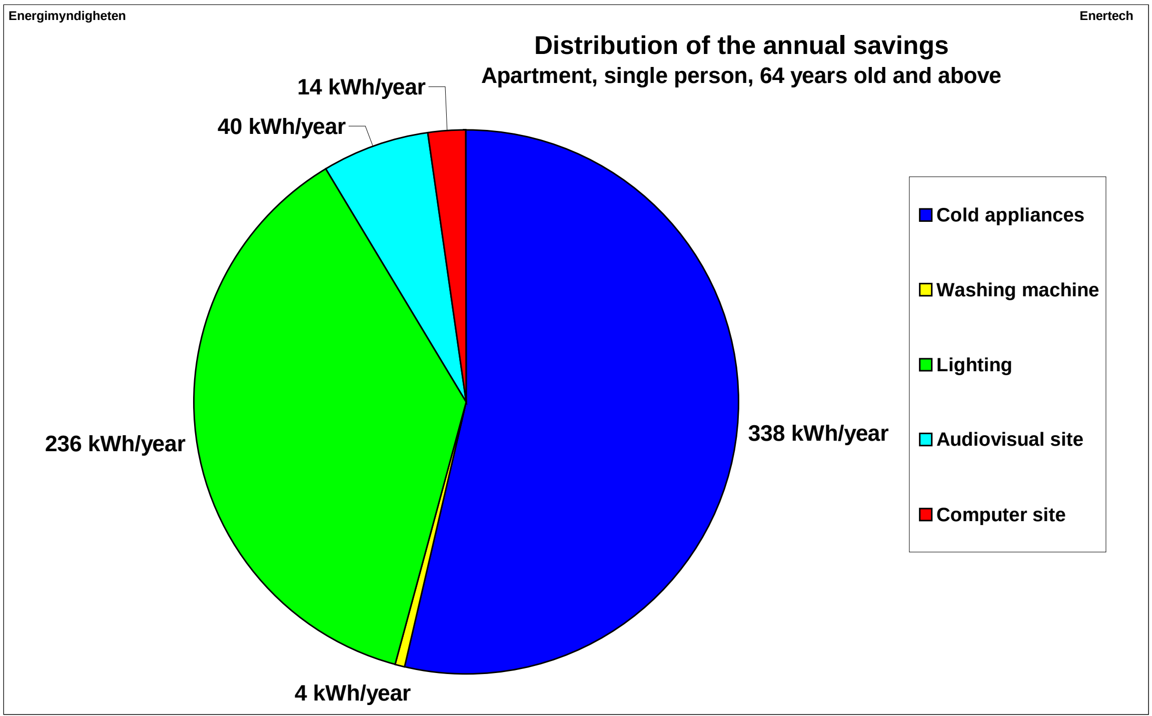


Figure 3.25: Distribution of the annual savings – Apartment, single person, 64 years old and above

House, family, 26-64 years old

Annual savings

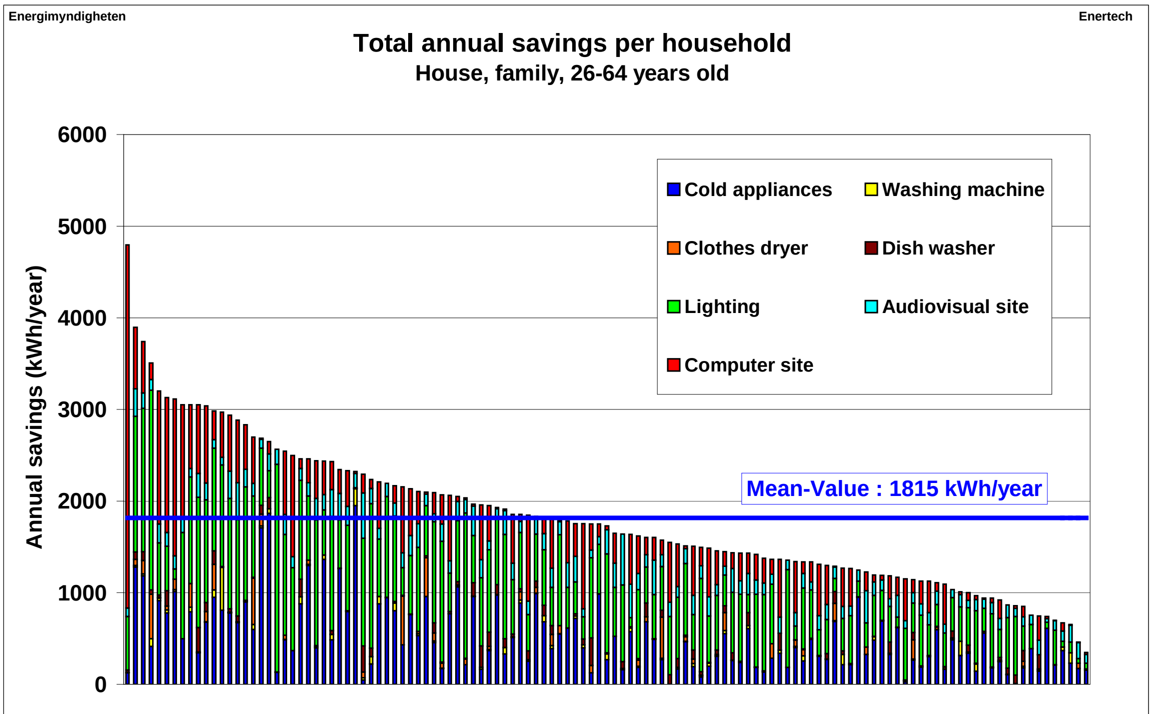


Figure 3.26: Total annual savings per household – House, family, 26-64 years old

Distribution of the savings between the different families of appliances

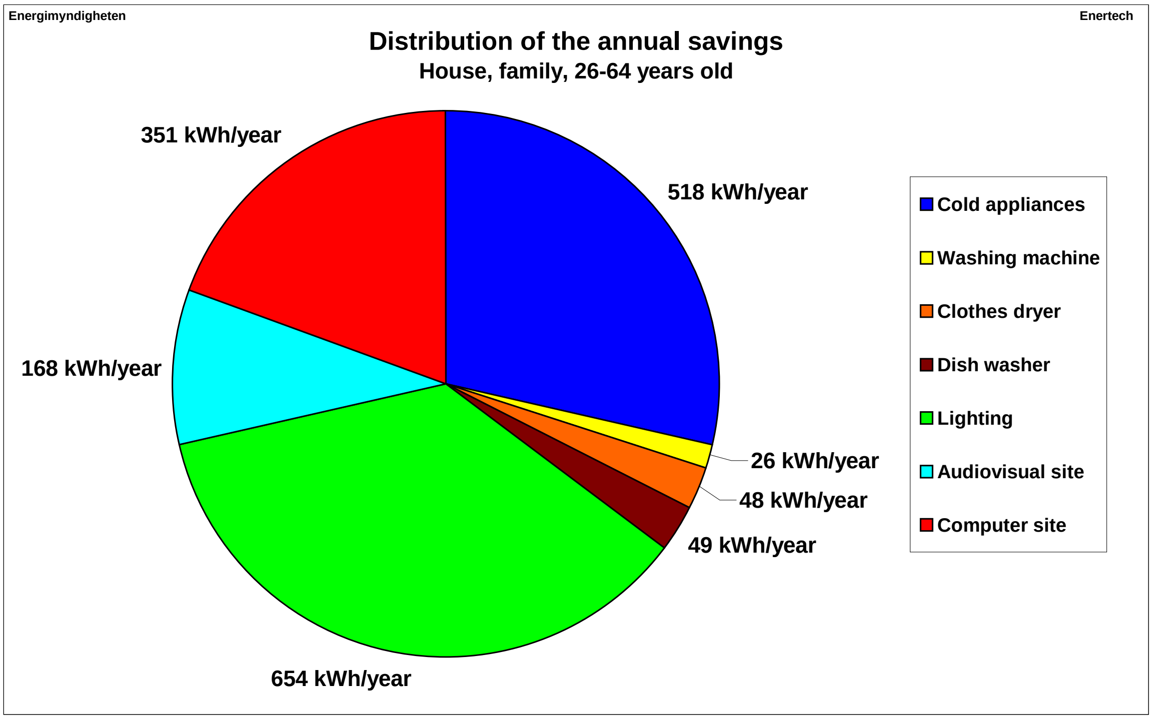


Figure 3.27: Distribution of the annual savings – House, family, 26-64 years old

House, couples without children, 26-64 years old

Annual savings

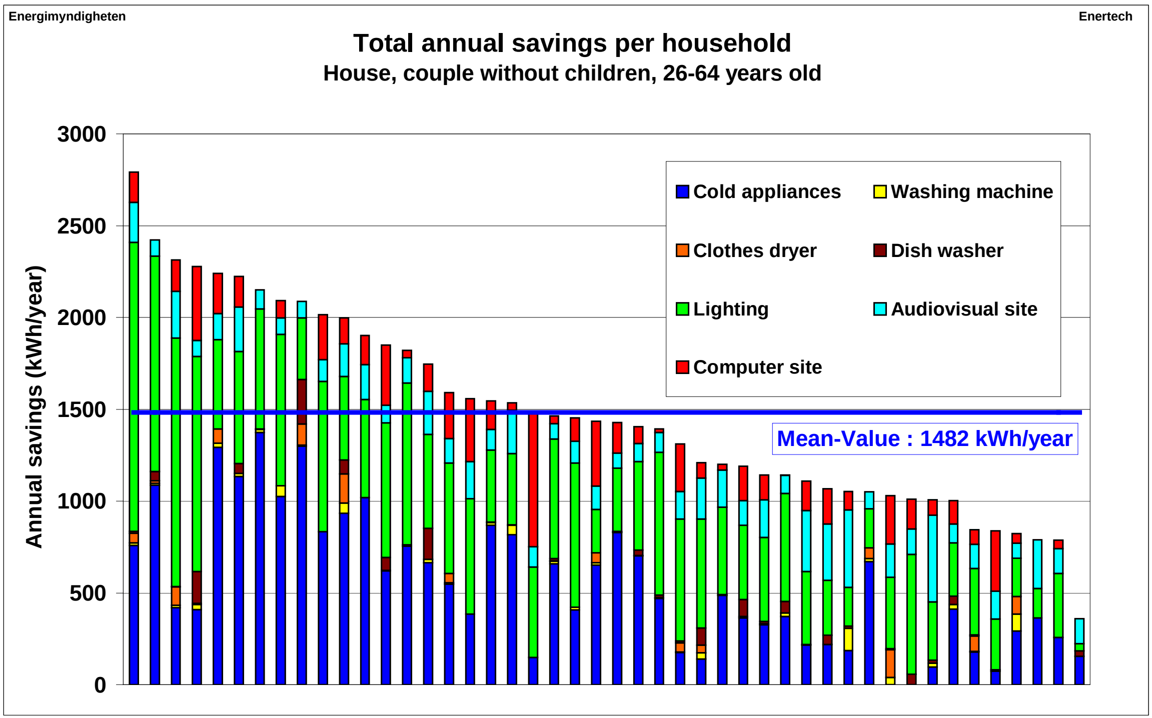


Figure 3.28: Total annual savings per household – House, couples without children, 26-64 years old

Distribution of the savings between the different families of appliances

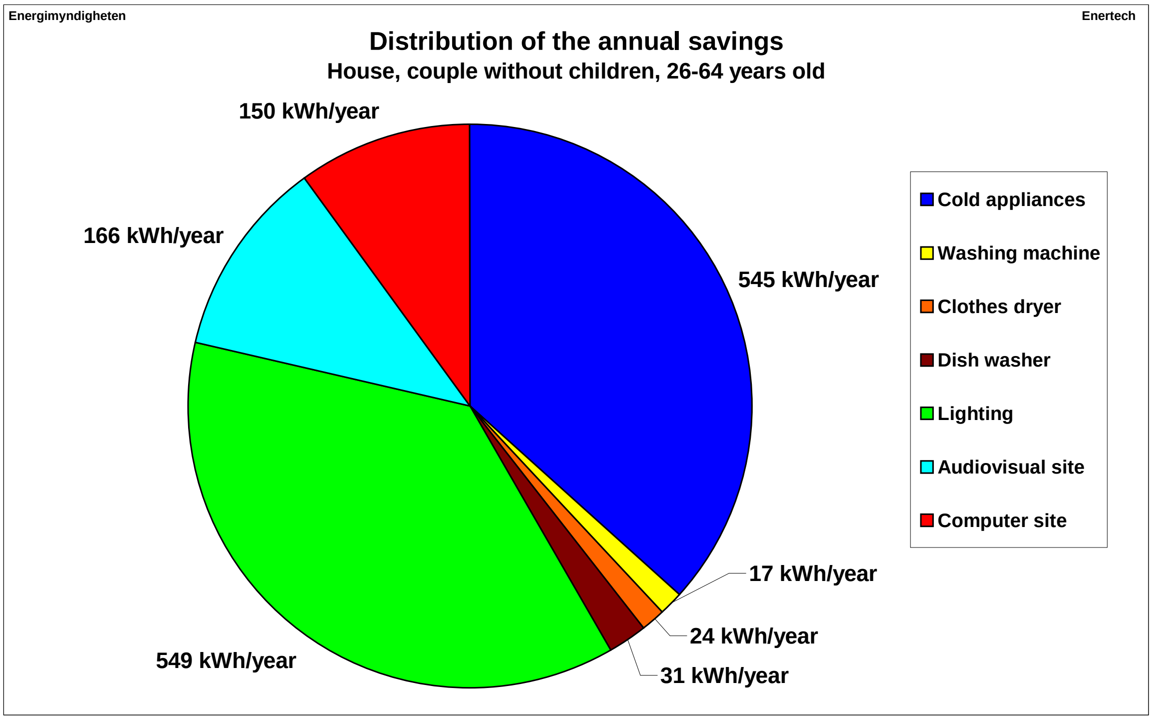


Figure 3.29: Distribution of the annual savings – House, couples without children, 26-64 years old

House, couples without children, 64 years old and above

Annual savings

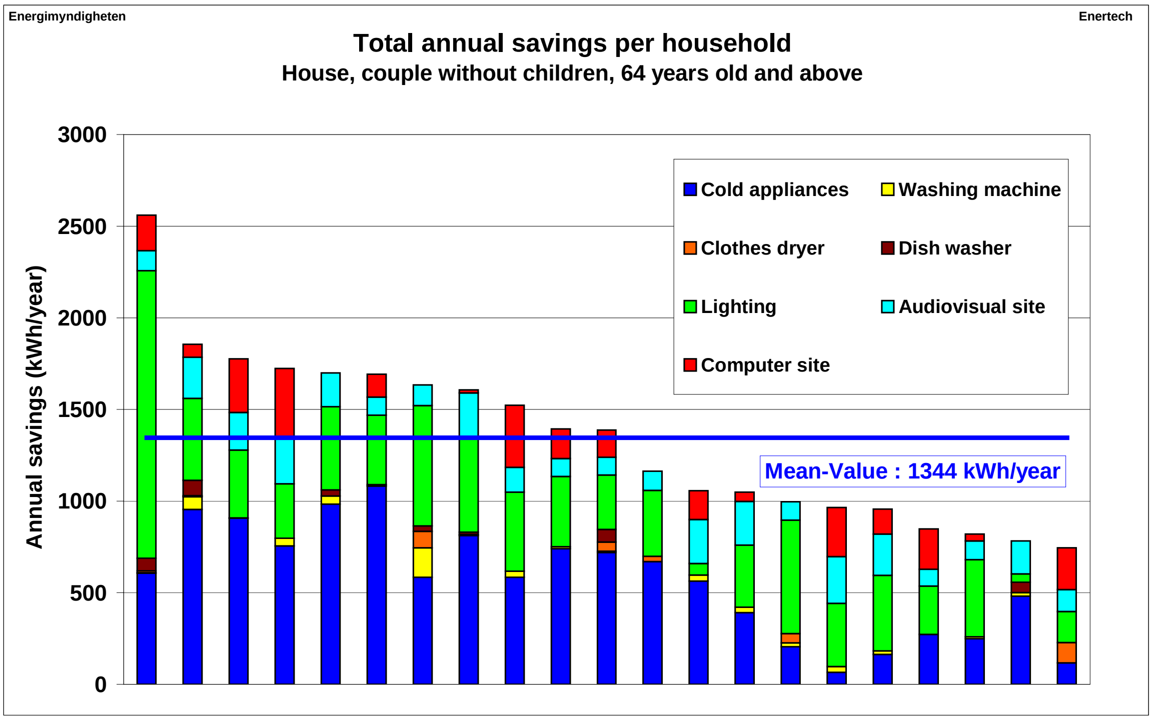


Figure 3.30: Total annual savings per household – House, couples without children, 64 years old and above

Distribution of the savings between the different families of appliances

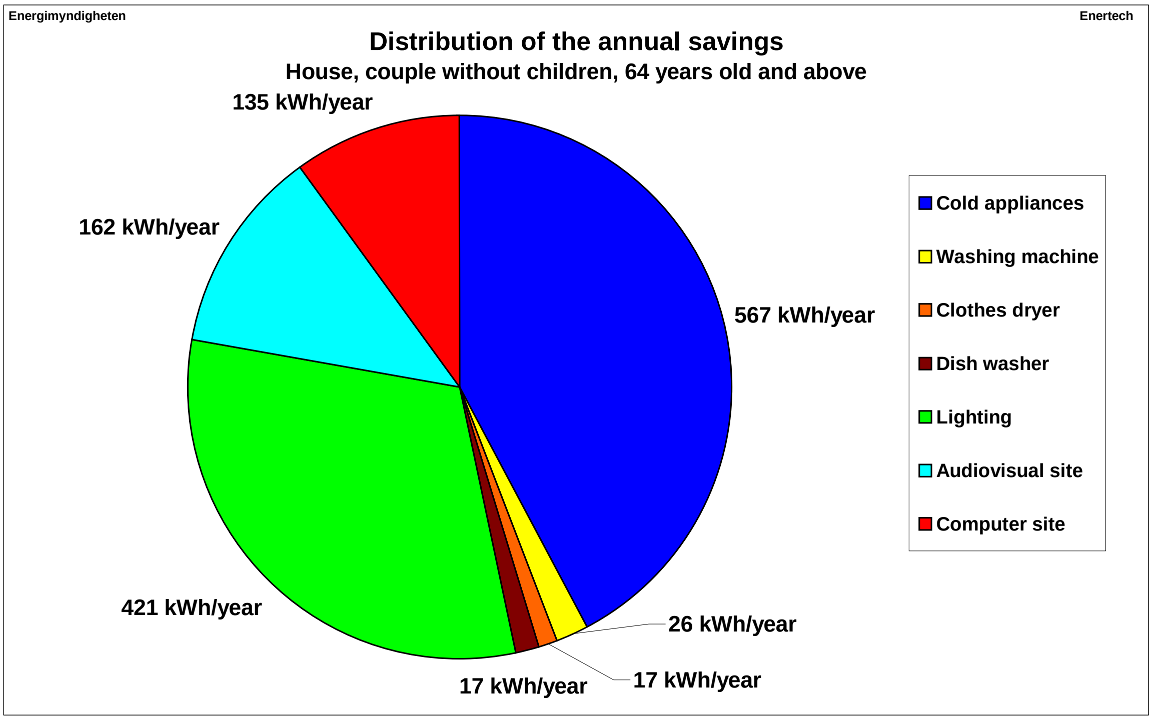


Figure 3.31: Distribution of the annual savings – House, couples without children, 64 years old and above

CONCLUSION

This project represents the biggest measurement campaign ever made in Europe (and certainly in the world). The high number of households monitored and analysed lets us have a precise overview of the electrical consumption and more important, lets us calculate the potential savings:

- Today in Sweden, the total potential electricity saving per household ranges from 600 to 1800 kWh/year depending on the type of household.
- The priority actions that should be carried out for Demand Side Management (DSM) concern cold appliances, lighting, audiovisual and computer sites:
  - Replacing the inefficient cold appliances by the best ones can save up to 560 kWh/year per household
  - Replacing the incandescent and halogen light bulbs by compact fluorescent lamps would reduce the annual consumption by 650 kWh for certain households
  - Choosing a laptop instead of a desktop and reducing the Standby consumption can save up to 550 kWh/year for the computer site,
  - Using only audiovisual appliances with Standby powers less than 0.5 Watt can reduce this site consumption by 160 kWh/year.

Therefore it is important:

- to implement the regulation that bans the putting on the market of appliances with Standby power above 1 W, or even 0·5 W,
- to implement Standby power management procedures for computer appliances using power managers like ***Energy star***,
- to implement a national program to address existing Standby powers. The objective is to remove them, by simply cutting the electrical supply of the appliances by using manual switches or Standby power managers, which are generally very cheap devices,
- to intensify and accelerate the fixation of stricter consumption norms, and class A appliances should in a very short term become the standard.

Reference

The ecodrome project, Experimental Study of highly efficient Electrical Appliances in Household Use, Enertech, 1998 (Save n° 1031/S/94-093)

The eureco project, End-use metering campaign in 400 households of the European Community, Assessment of the Potential Electricity Savings, Save project (N° 4.1031/Z/98-267)

The remodece project, Residential Monitoring to Decrease Energy Use and Carbon Emissions in Europe, 2009, ISR-University of Coimbra, Dep. of Electrical Engineering, an EU, EACI project.