NUDGE

Nudging consumers towards energy efficiency through behavioural science

ELECTRICITY AT HOME

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INTRODUCTION

There are many forms or sources of energy such as electricity, coal, wood, gas, heat, hydrogen, nuclear, wind, solar, hydropower, food, energy from human activities, battery energy, earth and solar energy.

It is often useful to convert energy from one form to another, as for example

- converting electricity into the movement of a pump's motor
- converting electricity into heat with a hair dryer
- converting wind energy into electrical energy in a windmill
- converting solar energy into electrical energy in panels with solar cells on the roof.

Energy is converted from one form to another, but energy can never be created. So such a conversion can never create more energy than goes in, because that would be magic. In practice, any conversion involves a certain loss of energy, usually in the form of heat that is given off to the environment and cannot be put to any further useful use. A conversion with few losses is called an efficient conversion. The efficiency of the conversion is the ratio between the amount of energy usefully converted and the amount of energy from the source.

For example, a wood stove is usually fired for heat, but there is also a conversion from the energy source (wood) to light. That light is usually (in the home) not useful energy..

Different classifications are possible in various types of energy.

A first classification is into high-value energy such as electricity and low-value energy such as heat. Electricity is a high-grade type of energy because you can convert it to many other forms of energy without much loss. For example, you can convert electrical energy almost entirely into heat in a hair dryer. You can also use that same electricity to charge your laptop.

We can use coal or gas as a source of energy: for example, this can be converted into heat (when burned). However, if we want to use gas to charge our laptop, we must first convert that gas into electricity. This can be done, but is very inefficient. Only 30-40% of the energy can be converted into electrical energy. So there are a lot of losses in this conversion, just think of the heat losses that come out of the cooling towers of power plants in the form of steam.

A second way of classifying energy types is into renewable and non-renewable energy sources. 'Sustainable energy, green energy or renewable energy is energy available to mankind for an indefinite period of time and where, through its use, the environment and opportunities for future generations are not harmed.' [1]

So this means that this energy is not depleted (it is sustainable) and is not harmful to the environment (it is 'green'). In addition, you have non-renewable energy sources such as fossil fuels (e.g. coal, petroleum, natural gas): these energy sources are getting depleted in more and more places on earth (they are not sustainable) and they harm the environment through e.g. CO_2 emissions (they are 'not green').

Energy is a broad concept that is not so easy to grasp. However, it is very important for our life as humans on Earth. You cannot see or move energy like matter or objects. We all buy energy and so you need to be able to measure it.

To measure how much electrical energy you consume in your home and thus have to pay for, you have the meter installed in your home by the electricity distribution company. That measures how much electrical energy you used from the grid.

You have to pay for the amount of imported electrical energy used in your home, which is expressed in kilowatt-hours (kWh). Be sure to look for your electricity meter in the house (often in the entrance hall or garage).

If you still have an 'old' (analogue) meter, you can actually see it spinning and counting (as in the example in Figure 1).

Figure 1: Analogue electricity meter

Many have a day counter and a night counter as you can see in Figure 1 (indicated by a moon and a sun). The arrow (indicated on the figure by the green frame between the sun and the moon) indicates which counter is active. The day counter measures consumption during the day (until 9pm-2pm depending on the region) and the night counter measures consumption at night (until 6am-7am) and at weekends.

There are now also digital meters that continuously measure both the energy you draw from the grid in your home and the energy you put on the grid with your home (if you have solar panels, for example).

What is electricity?

Electricity is also called 'power'. Why?

Electricity is a form of energy. Energy is measured in joules (J), just as you measure distance in metres. We call 'joule' the unit of energy.

Watch the following film about the discovery of electricity throughout history:

History of electricity - https://www.youtube.com/watch?v=arvwTlemoh8

In this booklet, we will study our electricity consumption at home. We will look at which appliances use a lot of electricity, how much electricity we use throughout a year, what the price of electricity is, how we can generate and store our own electricity at home and, of course, how to save electricity.

ELECTRICITY CONSUMPTION OF AN APPLIANCE

Which appliances in your home consume electricity? Make a list and put the appliance you think consumes the most at number 1.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________
7. ______________________________
8. ______________________________
9. ______________________________
10. ______________________________

We will now take a quick look at how we can find out for ourselves which appliances in the house consume the most energy.

1. Power

When you purchase an appliance, its power is given. Power is the amount of energy consumed by a device per unit of time, e.g. a lamp, an electric fire, an iron, an energy-saving bulb, etc. This is expressed in watts (= W = joules/s).

So when you buy an appliance, it is important to look carefully at that power rating. It is indicated on the appliance. Look at the examples in Figure 2 and indicate the wattage on each one.

Figure 2: Example information kettle, coffee machine and tumble dryer

Example: An electrical shop sells 3 different hair dryers with the following power ratings:

Hairdryer 1: 1400 W (16,95 €)

Hairdryer 2: 2000 W (24,95 €)

Hairdryer 3: 2400 W (59,95 €)

Which hairdryer will give more heat?

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Does this affect electricity consumption and therefore electricity bills? Why or why not?

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The power listed on a device is the maximum power. Most appliances do not operate continuously at the maximum power. To know the actual power, you can measure the power yourself with a mobile wattmeter. You place this between the wall socket and the appliance (see test set-up in figure 3).

Figure 3: Sample test setup measuring power of laptop with a wattmeter

Table 1 shows measurements of the power of a fridge, a freezer and a washing machine every 20 seconds.

Table 1: 10 power measurements of domestic appliances

Measure	Refrigerator	Freezer	Washing machine
1	43,1 W	58,6 W	180,5 W
2	43,4 W	58,3 W	197,8 W
3	43,7 W	58,9 W	217,9 W
4	44,1 W	58,2 W	248,7 W
5	44,5 W	58,5 W	289,5 W
6	44,7 W	57,8 W	192,2 W

7	45,0 W	57,7 W	147,9 W
8	44,8 W	2,0 W	71,1 W
9	44,0 W	2,0 W	266,1 W
10	1,3 W	2,0 W	94,6 W
Mean			

Calculate the mean of the 10 measurements and record it in the last row of Table 1.

Look at the values of these measurements. What stands out? What can you conclude? Did you expect this?

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Now get started yourself! Choose six appliances. Look at the power mentioned on the appliance's rating plate and make a note of it:

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________

Measure the effective power of these devices with a mobile wattmeter. This value may fluctuate. Therefore, take 10 measurements every 20 seconds. Compare your measurements with those of another student and interpret the differences. Calculate the average. Record the data in table 2.

Table 2: Own power measurements of household appliances

Measure	....	....	....	....	....	....
1						
2						
3						
4						
5						
6						
7						
8						
9						

10						
Mean						

2. Kilowatt-hour

Electricity consumption is expressed in **kilowatt-hours** (kWh), like gas consumption. This unit kWh is used for the amount of electrical energy we consume, which e.g. solar panels produce, or which is stored in a battery. 1 kWh = 1000 Wh = 3 600 000 joules

Calculate how many kilowatt hours you consume to run a 5-watt LED bulb for 10 hours.

If you buy 1 kWh of energy, what can you do with it? Is that a lot or a little?

Read in figure 4 what you can do with 1 kilowatt hour.

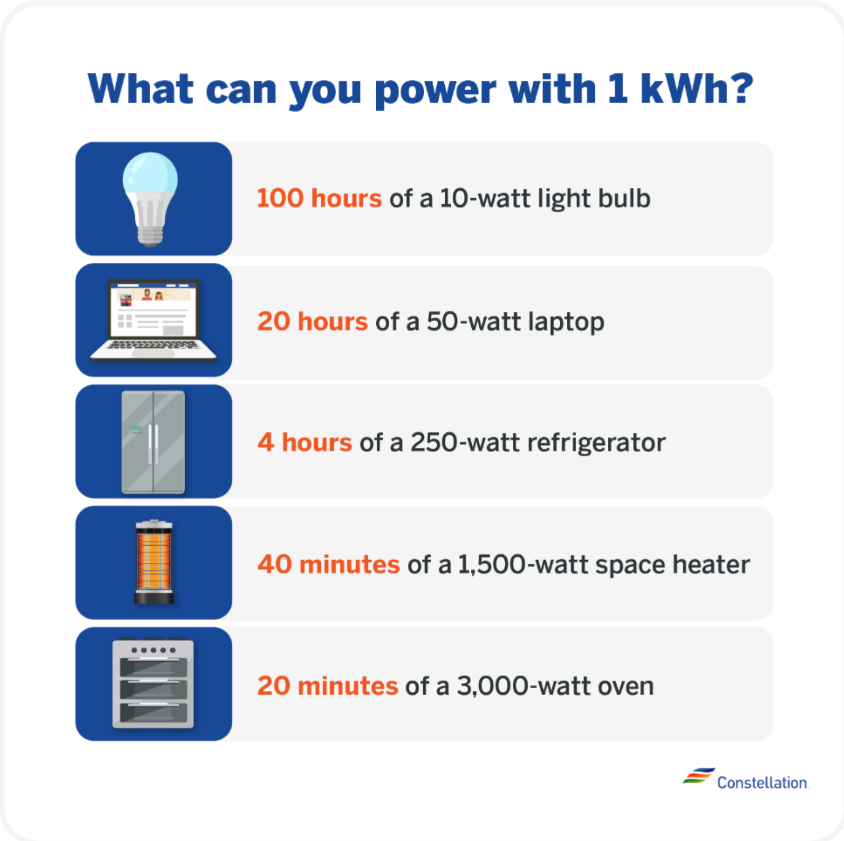

Figure 4: What can you do with 1 kWh? [2]

3. Calculating the consumption of a device

The consumption of an appliance in kilowatt-hours (kWh) is calculated on the basis of:

the power (expressed in kilowatts)

X

duration of use: the number of hours per day and days per year (duration + frequency) [3].

Calculate the consumption of appliances you often use at home and complete Table 3 further.

- First find out the **power of the appliance** by reading it on the appliance, by measuring it with a mobile wattmeter or by looking up the power of the same type of appliance online. Express this power in kilowatts. Enter this in Table 3 in the **second column**.

  E.g. The power of your hoover is 900 Watts = 0.900 kW
- In the **third column**, write down how many hours per year you use this appliance. Make an estimate!
  E.g. You use your hoover for 2 hours per week, so 2 X 52 hours = 104 hours = 104 h per year.
- Based on the power and duration of use per year, calculate the consumption of each appliance per year in kilowatt-hours (kWh) and note this in the fourth column.
  E.g. The 900 W hoover that you use 104 h per year consumes 0.900 kW X 104 h = 93.6 kWh per year.
- In the last column, write the cost price per year. The cost price depends on the type of contract and the supplier. In these calculations, you can calculate 0.57 euros per kilowatt hour (the December 2022 high energy price for households with average consumption). [4]
  E.g. Using the hoover per year costs 93.6 kWh X 0.57 €/kWh = 53.4 €.

In the house, go look for three additional appliances that consume electricity. List these in the empty columns in Table 3. For these appliances too, find out what the power and calculate the price you pay for them per year.

Table 3: Power, consumption and cost of household appliances per year

Appliance	Power (kW)	Use per day (u) x number of days per year	Consumption per year (kWh)	Cost / year (€)
hoover	0,900 kW	2 h x 52 days	93,6 kWh	53,4 €
hob				
oven				
microwave				

fridge				
freezer				
washing machine				
dryer				
dishwasher				
kettle				
coffee				
laptop				
GSM				
TV				
halogen floor lamp				
energy-saving lamp				
LED desk lamp				
Total				

In the last row of Table 3, calculate the total consumption and total cost of electricity per year in your home. Here, we assume that all electrical appliances in your home are listed in this table (you can investigate this further yourself at home).

Then calculate the percentage consumption per year of the five appliances that use the most electricity: put these in a table and make a bar chart of this on a separate page.

Hang this bar chart in a visible place at home so that you also make your housemates aware which appliances use a lot of electricity.

Now look at figure 5 to compare your data on the electricity consumption of various appliances in your home during one year with the averages from the Sibelga brochure.

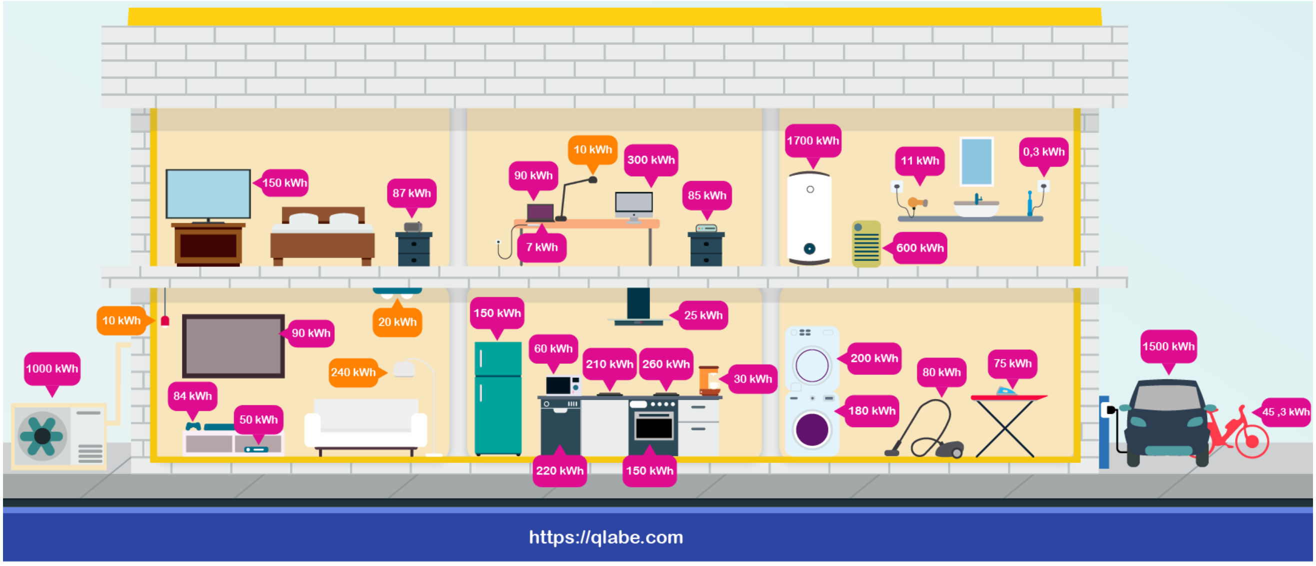

Figure 5: Electricity consumption per year of appliances in the home [3]

4. Energy labels

Energy efficiency varies greatly from one appliance to another. Each appliance is therefore given an energy label. These energy labels help in choosing a suitable household appliance: they provide information on energy consumption. They classify household appliances according to energy consumption on a scale from A to G, with A (or a green label) representing the most energy-efficient and G (or a red label) being the most energy-consuming. This helps buyers save money by choosing products that use less energy. It also encourages companies to design products that use less energy. [5,6]

Technological developments are making appliances more and more energy efficient. As a result, more and more appliances fall into energy classes above A (from A+ to A+++). To distinguish again more clearly between the most and least efficient appliances, the scales were adjusted to a simpler system from A to G. An appliance with an old label A+++ can thus have a new label B or C. The new class A does not yet include appliances.

The new labels are mandatory for a number of appliances (washing machines, TVs and computers, refrigerators, dishwashers). Step into an electrical shop that sells these appliances, you will immediately recognise the labels. For some appliances, they still use the old energy labels (from A+++ to G). Check out the differences between the old and new energy labels in Figure 6.[7]

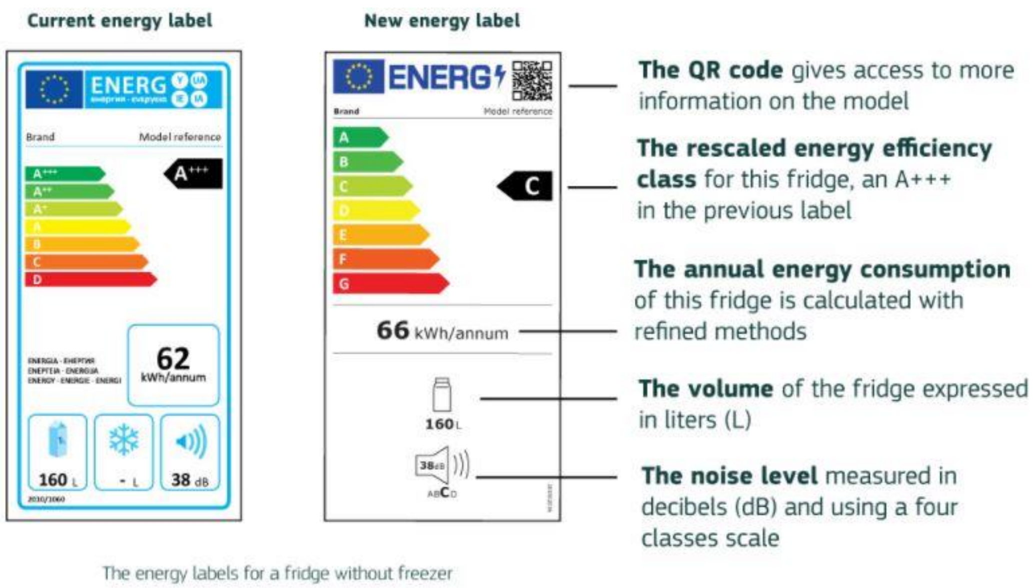

Figure 6: New energy label with explanation [7]

The dishwasher with an old energy label A+++ from figure 6 is now given a new label B. Does this mean that this dishwasher has become less energy-efficient?

Testaankoop mentioned in an article on 22 September 2017 that Europe imposed a new directive limiting the energy consumption of hoovers. Since September 2017, the maximum power is limited to 900 watts. [8]

Why are they banning high-power hoovers?

At home, look for appliances with an energy label yourself and see which class this appliance belongs to.

TOTAL ELECTRICITY CONSUMPTION AT HOME

1. Electricity consumption per day and per month

You can view graphs of your electricity consumption in your EnergieID file. If you have a day and night meter, this consumption is shown in two separate graphs. If you also have solar panels, you will also see graphs of the production of your solar panels (day and night) and the injection of electricity into the grid (with possibly also separate measurements for day and night).

You can view your electricity consumption per day and per month.

Figures 7 and 8 show a family's electricity consumption for one day measured by the day and night meter, respectively.

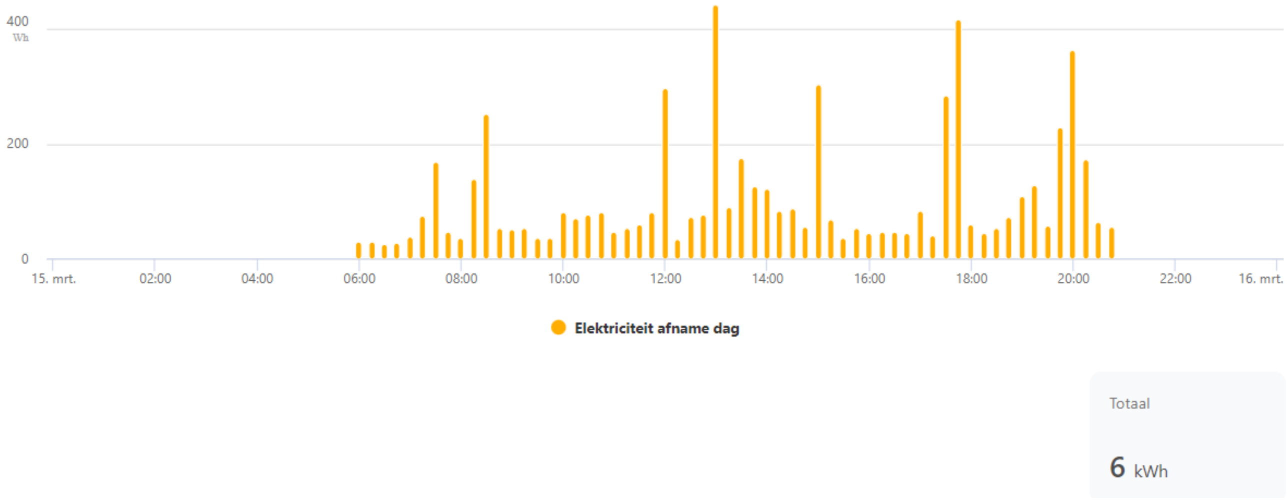

Figure 7: Electricity consumption of a household per 15 minutes measured by the daily counter on 15 March 2023 [9]

Look at figures 7 and 8. At which hours does this family consume the most electricity? What would cause this?

Figure 8: Electricity consumption of a household per 15 minutes measured by the night meter on 15 March 2023 [9]

Figures 9, 10 and 11 show the electricity consumption of the day counter, night counter and the two counters together of a family **per month**, respectively.

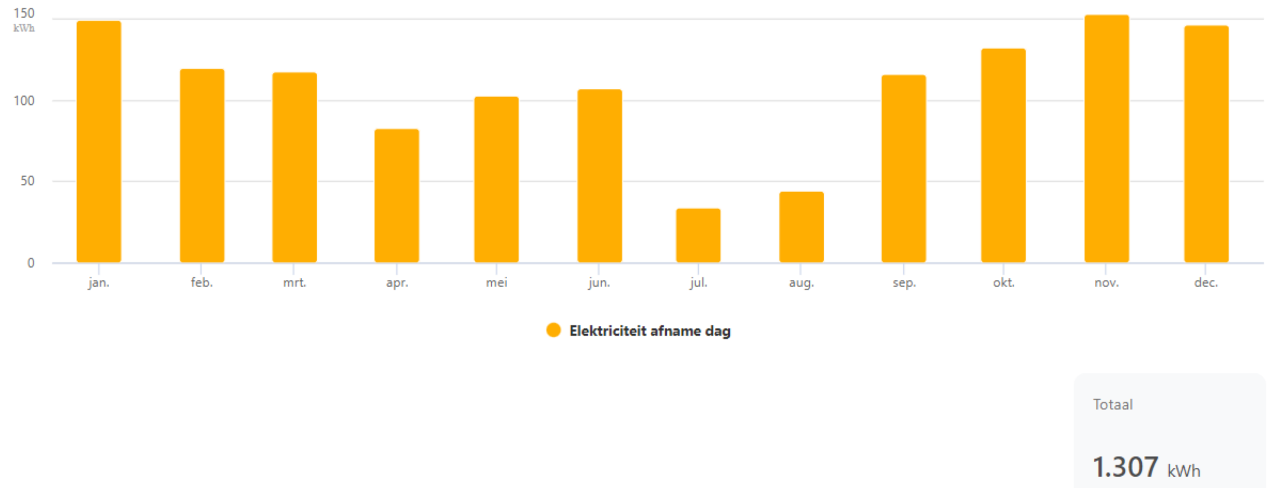

Figure 9: Electricity consumption of a household per month in 2022, measured by the daily counter [9]

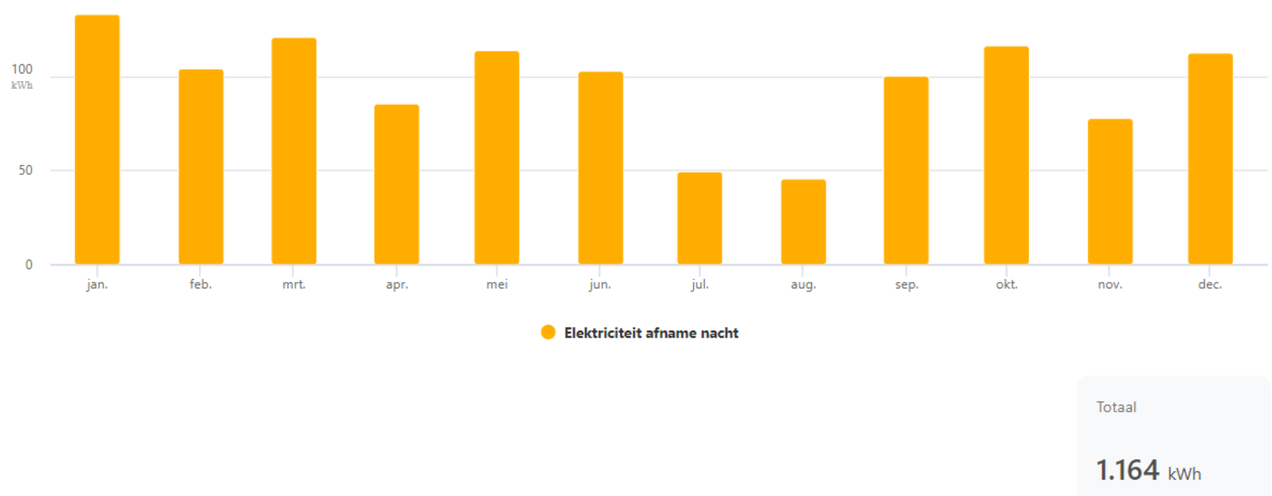

Figure 10: Electricity consumption of a household per month in 2022, measured by night meter [9]

Figure 11: Total household electricity consumption per month in 2022 (day + night) and expected consumption [9]

Approximately how much electricity did this family consume per month? Compare the consumption over the different months. How could you explain these differences?

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Check your electricity consumption at home on average per day and per month (see overview in EnergieID). Do you see peaks and troughs? Can you explain them?

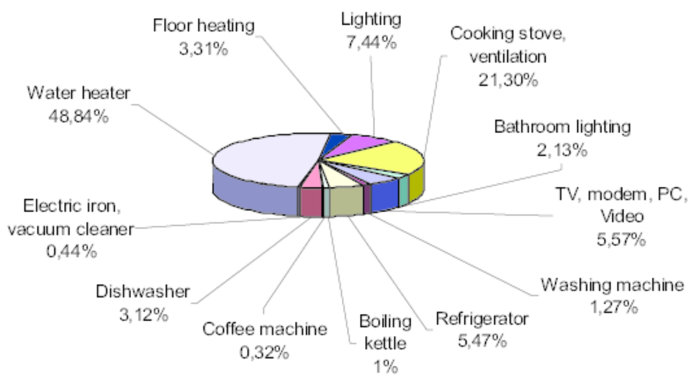
We compare electricity consumption per day and per month within the group. Do we see differences and how can we explain them?

2. Average household consumption and cost

In 2020, the average electricity consumption of a Flemish family was **2944 kWh per year**. [4] Table 4 shows the average consumption by appliance in Europe.

Table 4: Electricity consumption per consumption category (European reference values) [10]

Load name(s)	ON-time per day	ON-time/day, %
Refrigerator	15 h 36 min	65
TV, modem, PC, Video	12 h 42 min	53
Lighting	7 h 58 min	33
Water heater	5 h 46 min	24
Floor heating	4 h 5 min	17
Bathroom lighting	2 h 57 min	12
Cooking stove, ventilation	2 h 12 min	9
Iron, vacuum cleaner	2 h 2 min	8
Dishwasher	1 h 7 min	5
Washing machine	32 min	2
Coffee machine	10 min	0,7
Boiling kettle	7 min	0,55



Compare your own average annual consumption at home with the European average and with the consumption category that best suits your situation. How much is the difference? How can you explain it?

COST OF ELECTRICITY

We have to pay for energy, but we don't just pay for the electricity we consume each year. This is only part of the annual electricity bill. We also pay an annual subscription cost of sorts. We also pay to deliver the electricity to our house (these are the net tariffs). On top of this, the federal and Flemish governments levy a number of taxes on energy. You can compare this to the cost of a car: you buy or rent a car, but you also pay maintenance costs, fuel, taxes, etc.

The components of the energy price are summarised here:

- Energy cost: varies from one supplier to another
    - Annual fee
    - Energy component: electricity consumption
        - Fixed: fixed amount for each kWh consumed
        - Variable: amount depends on the evolution of the indexation parameter in contract

- dynamic (only possible with digital electricity meter): electricity consumption is charged per hour; amount depends on the evolution of prices in the energy market + offtake profil

- Network tariffs: distribution and transmission tariffs
- The levies [11,12]

The Flemish Regulator of the Electricity and Gas Market (VREG) created a non-commercial online test (the V-test) to help people find the energy contract that suits them best. This test compares different energy contracts and suppliers and estimates the annual price you would pay for each of the contracts on offer. You can complete this V-test via the following website: https://vtest.vreg.be/ [13]

Electricity prices have risen sharply over the last year. The evolution of the price per kilowatt-hour and per year are shown in figures 12 and 13 respectively.

In Figure 12, look at the structure of the price of electricity per kilowatt-hour. Which part or parts of the energy price have changed significantly in the last year?

Estimate what percentage of the March 2023 cost is electricity consumption itself.

How much did you pay per kilowatt-hour in September 2022 and in March 2023?

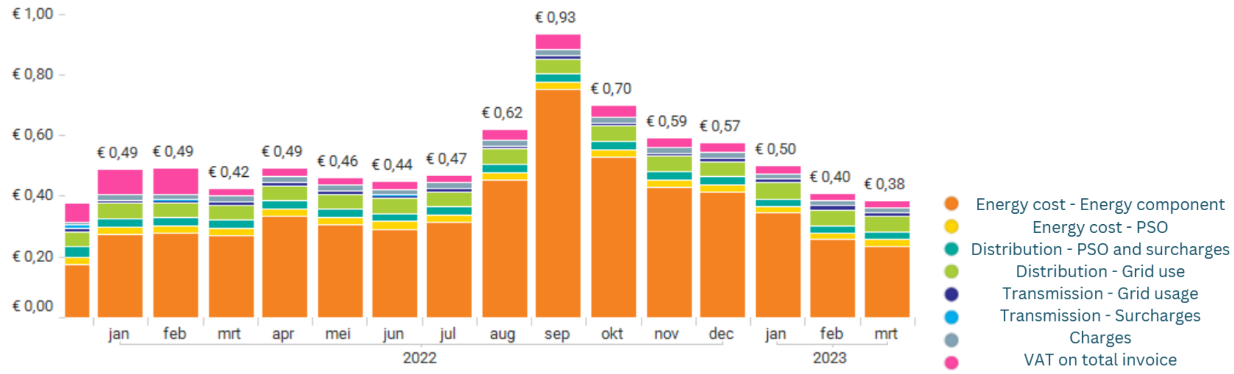


Figure 12: Cost of 1 kWh of electricity (evolution per month, for homes with average consumption) [4]

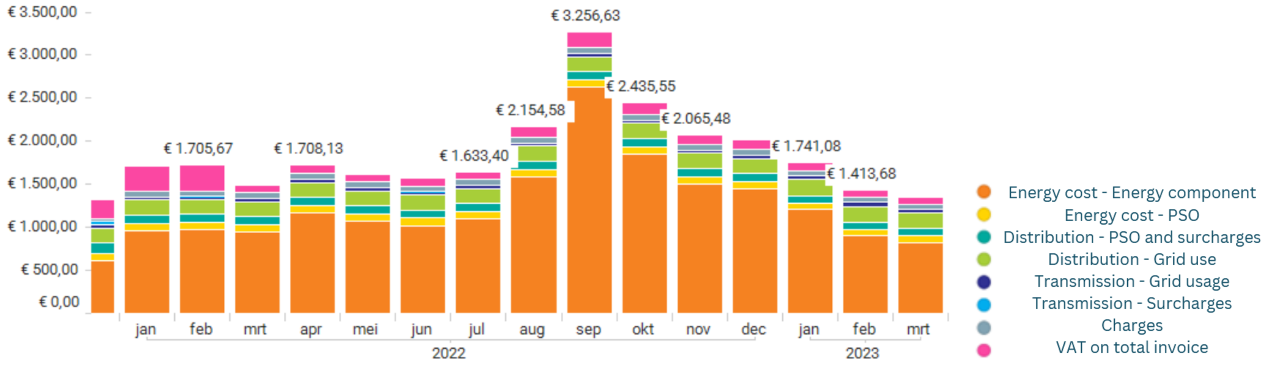


Figure 13: Cost of electricity per year (evolution per month, for homes with average consumption) [4]

Describe the evolution of the price of electricity from January 2022 to January 2023?

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GENERATING YOUR OWN ELECTRICITY AT HOME

1. Solar panels

Photovoltaic solar panels are increasingly being installed on the roofs of houses to generate their own electricity (to convert energy from the sun into electrical energy).

How much electricity do solar panels generate?

Over the course of the day and depending on clouds, a changing amount of sunlight reaches the solar panels. Each solar panel, when purchased, has a maximum power that the panel can deliver according to the manufacturer's specifications. Typically, this is 300 W per panel. If there are then 20 panels on the roof, you can produce a maximum of 6000 W = 6 kW of electrical power. 6 kW is peak power, achieved only in ideal conditions. For a typical sunny winter day, then 6 hours of around 4000 W of power can produce a yield of 6 X 4000 W = 24000 Wh = 24 kWh.

Estimate how much electricity solar panels can generate on one sunny day in summer.

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What happens to the electrical energy produced?

There are two ways to put the electrical energy from solar panels to good use.

1. First, you can use this energy for the **electrical appliances** in your home, such as an electric cooker, a music system, a computer, a refrigerator, lights, etc. This is also the most interesting use..

2. The remaining energy that cannot be used or stored yourself is put on the **electricity distribution network outside your home** (exported). That energy can then be used by another customer of your electricity supplier. Your digital meter from the distribution company records how much energy you put on the grid in this way, which you are then refunded when you are billed for your electricity consumption. However, you will always be reimbursed less for one kWh you put on the grid or export, than you have to pay for one kWh you take off or import and consume from the grid, because you have to pay transmission costs for every transfer of energy to or from the grid. Clearly, then, it is best to put as much generated energy as possible to good use yourself in electrical appliances.

To minimise energy costs, you can try to match your habits with solar energy production as much as possible.

How can you do this?

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Those who have their own solar panels can check the output of the solar panels on the dashboard of EnergieID. In figure 14, you can see the electricity production of a family's solar panels per month.

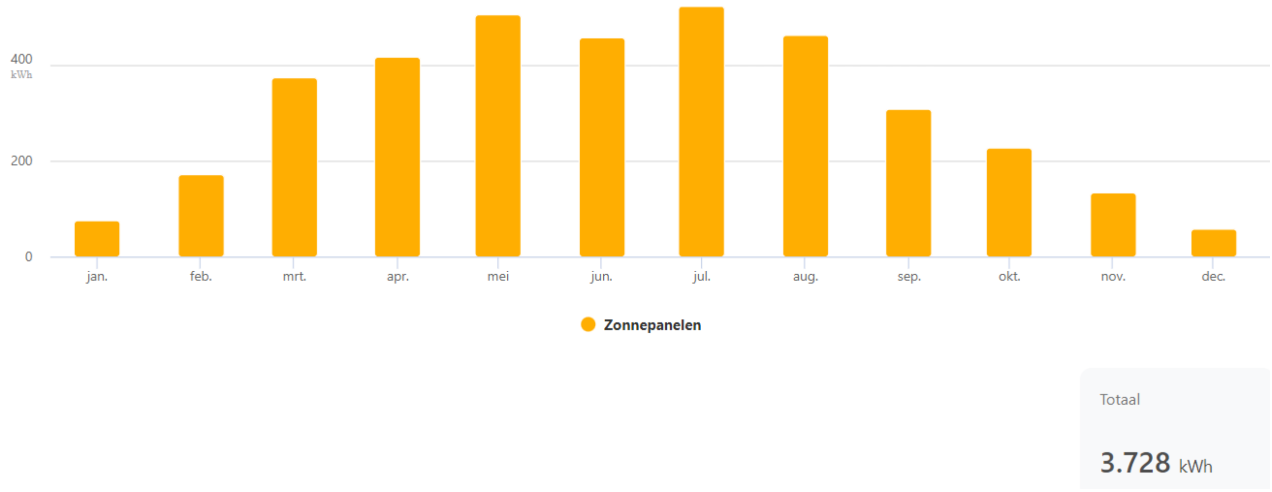

Figure 14: Electricity yield from a family's solar panels per month (2022) [10]

The amount of electricity generated by the solar panels that cannot be consumed by itself is returned to the grid. This is the electricity injection. Figures 15 and 16 show the electricity injection from this same family.

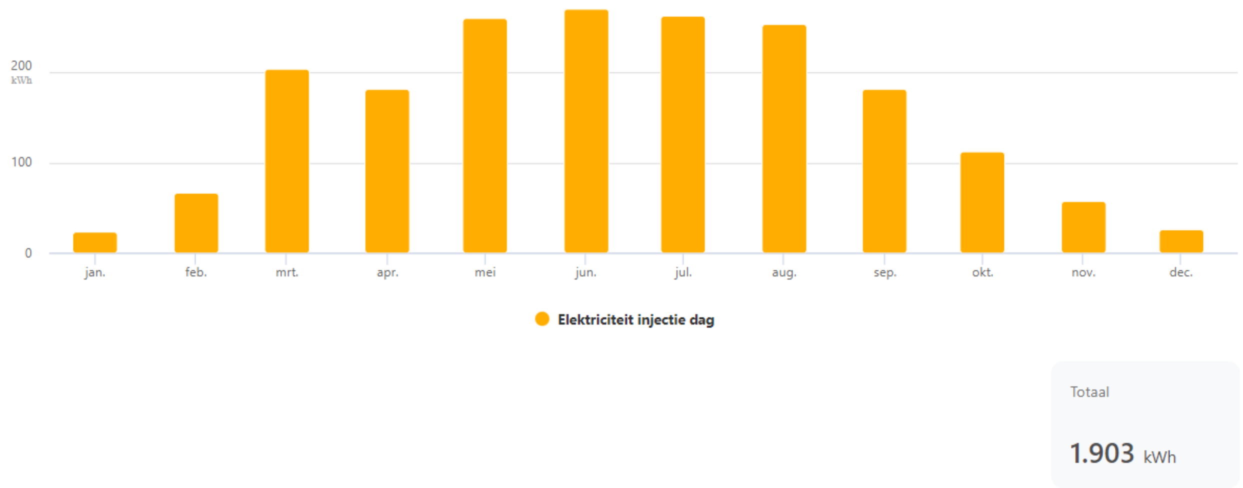

Figure 15: Electricity injection of a household measured by the daily counter (2022) [10]

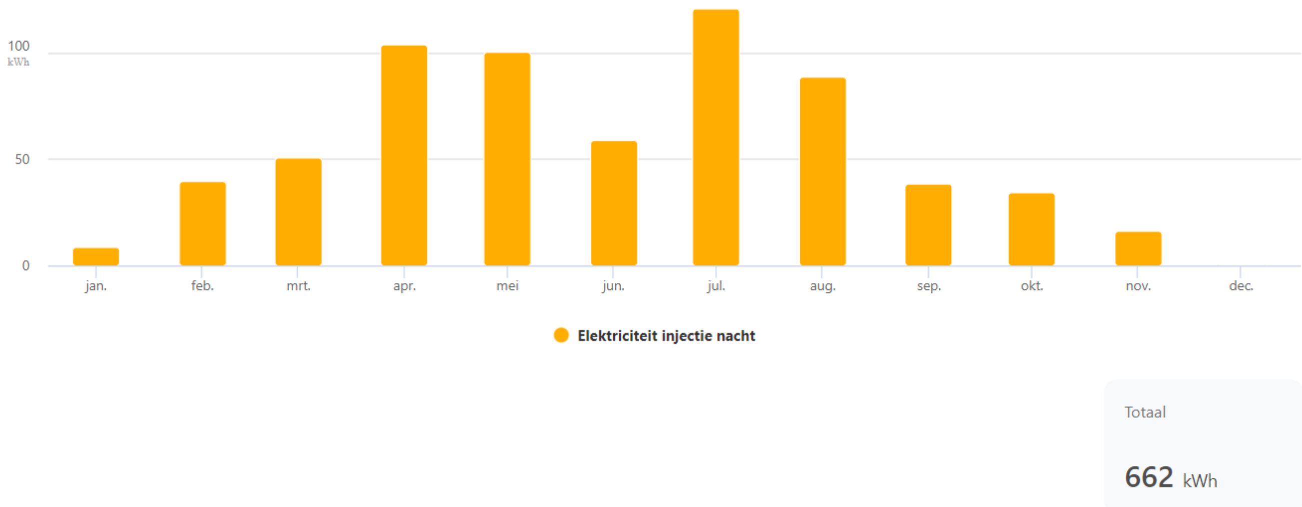

Figure 16: Electricity injection of a household measured by the night meter (incl. weekends) [10]

Note that the scale of the Y-axis in the different figures is not the same!

Calculate how many kilowatt-hours and what percentage of self-generated electricity is consumed by the family itself each month. Enter the rounded values in Table 5.

Table 5: Calculation of the amount (in kWh) and percentage of self-generated energy per month

	Jan	Feb	Ma	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
kWh												
%												

In which periods can the most electricity be used from your own zone panels?

Did you expect this?

Figures 17 and 18 show how much electricity is still taken from the grid by this household.

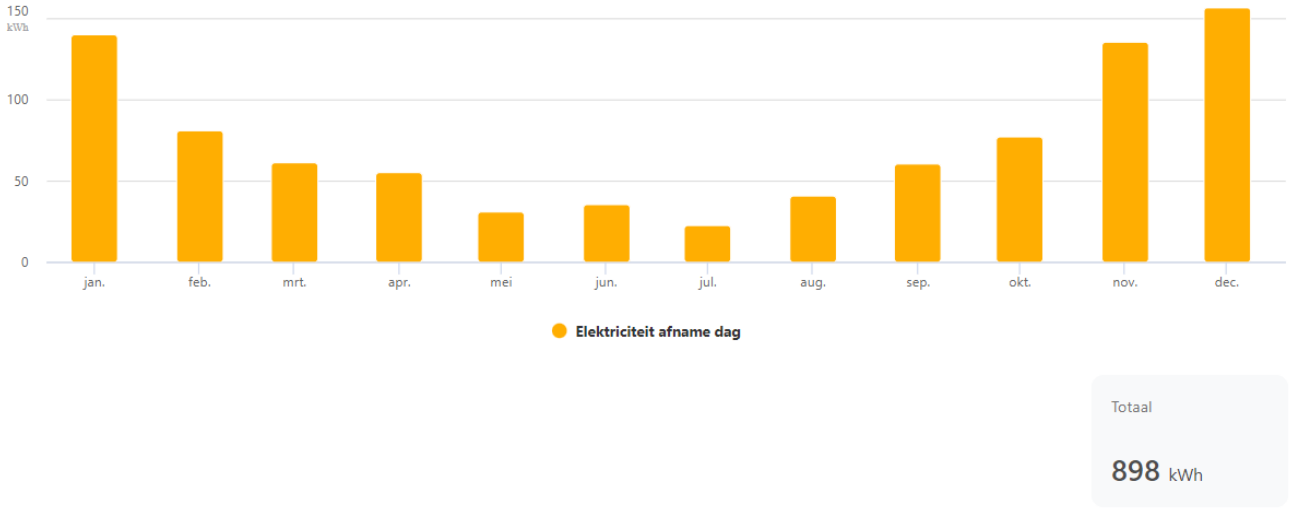

Figure 17: Electricity consumption of a household measured by the daily meter [10]

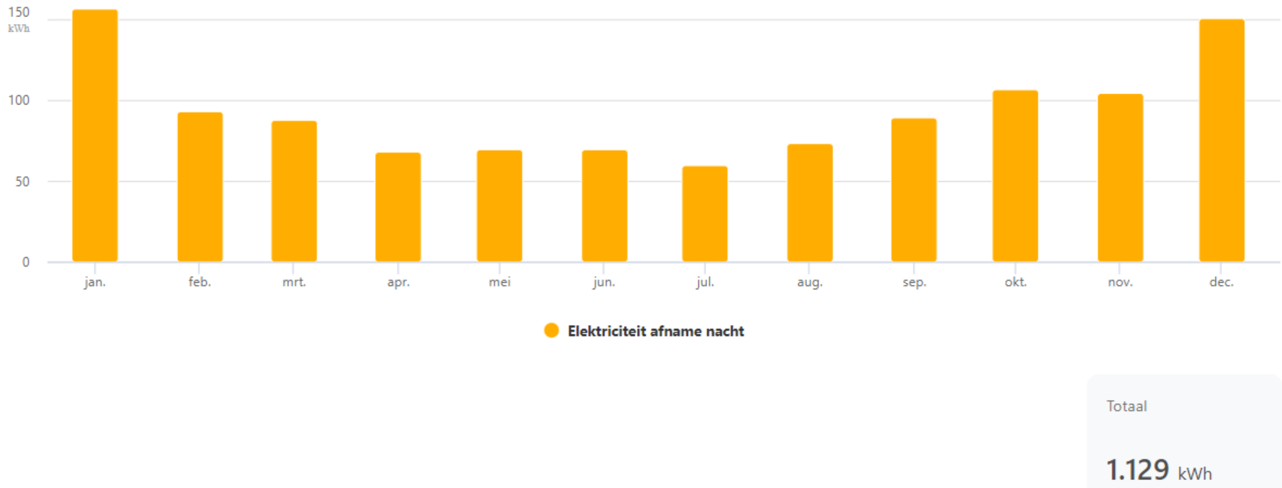

Figure 18: Electricity consumption of a household measured by the night meter [10]

Why is it that even in the summer months, electricity is still taken from the grid while electricity is also released to the grid?

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2. Combination of solar panels and a home battery

Owners of solar panels on average use 30% of their generated energy themselves. To make even more use of self-generated solar energy, more and more households are installing a home battery. On average, a home battery has a storage capacity of 2 to 10 kWh. If you have a home battery, the energy generated by the solar panels that cannot be used immediately can be stored in this home battery. The energy stored in the home battery can then be used yourself at a later time (when the sun is not shining e.g. in the evening or at night).

When the home battery is fully charged, nothing more can be added (like a vessel that is fully filled). Then the remaining energy from the solar panels will be put on the grid to still earn something from it.

If you have a smart control for your solar and home battery, it will work according to that preference: own consumption from your own appliances first, then on the home battery and the surplus on the grid (export).

To understand the cooperation of solar panels and a home battery, let's look at two examples.

Figure 19 shows an example of 20 solar panels that produced a total of 9.71 kWh of electrical energy on a winter day (on 22 December 2021). They never produced more than 4 kW of power. As this is one of the shortest days, they only produced energy from 9 a.m. to 4.15 p.m. So you can see that the peak power of 6 kW is not delivered every day or for the whole duration of the day.

Figure 19: Power produced by the solar panels on 22 December 2021 for 1 day [14,15]

Figure 20 shows the power consumed by the solar panels themselves (in blue). In green, the power produced by the solar panels is shown: this line is difficult to see because it matches the green line almost all day. Only around midday is the green line very briefly slightly higher than the blue one, as you can see on the enlargement. The amount of electrical energy produced by the solar panels is almost entirely consumed at home or or stored in the battery. Almost nothing is supplied to the grid. You can see in Figure 20 that the total export of 0.02 kWh that day is very small indeed.

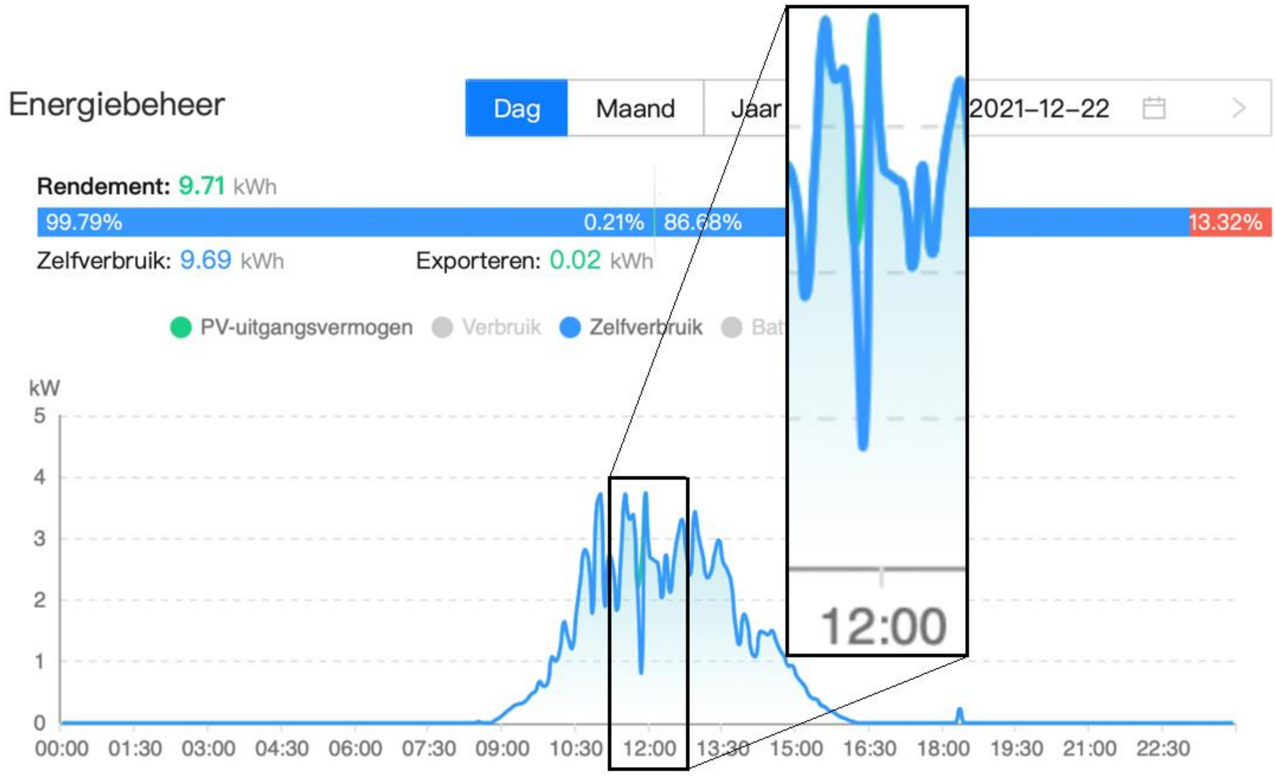

Figure 20: Power self-consumed in the dwelling on 22 December 2021 for 1 day with a total amount of energy of 9.69 kWh [14,15]

What stands out in this family's electricity consumption? How does this differ from your family's electricity consumption?

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The solar panels do not provide enough electricity: the additional electrical energy needed is taken from the grid. Of course, we also consume electrical energy outside the hours when there is sunshine. Which appliances in your home consume electricity outside sunshine hours?

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In a second example, we now look at a full graph showing the course of five measured energy powers (5 curves) on a different day, i.e. 21 December 2021 (see Figure 21). From this, we learn even more about the whole home energy event.

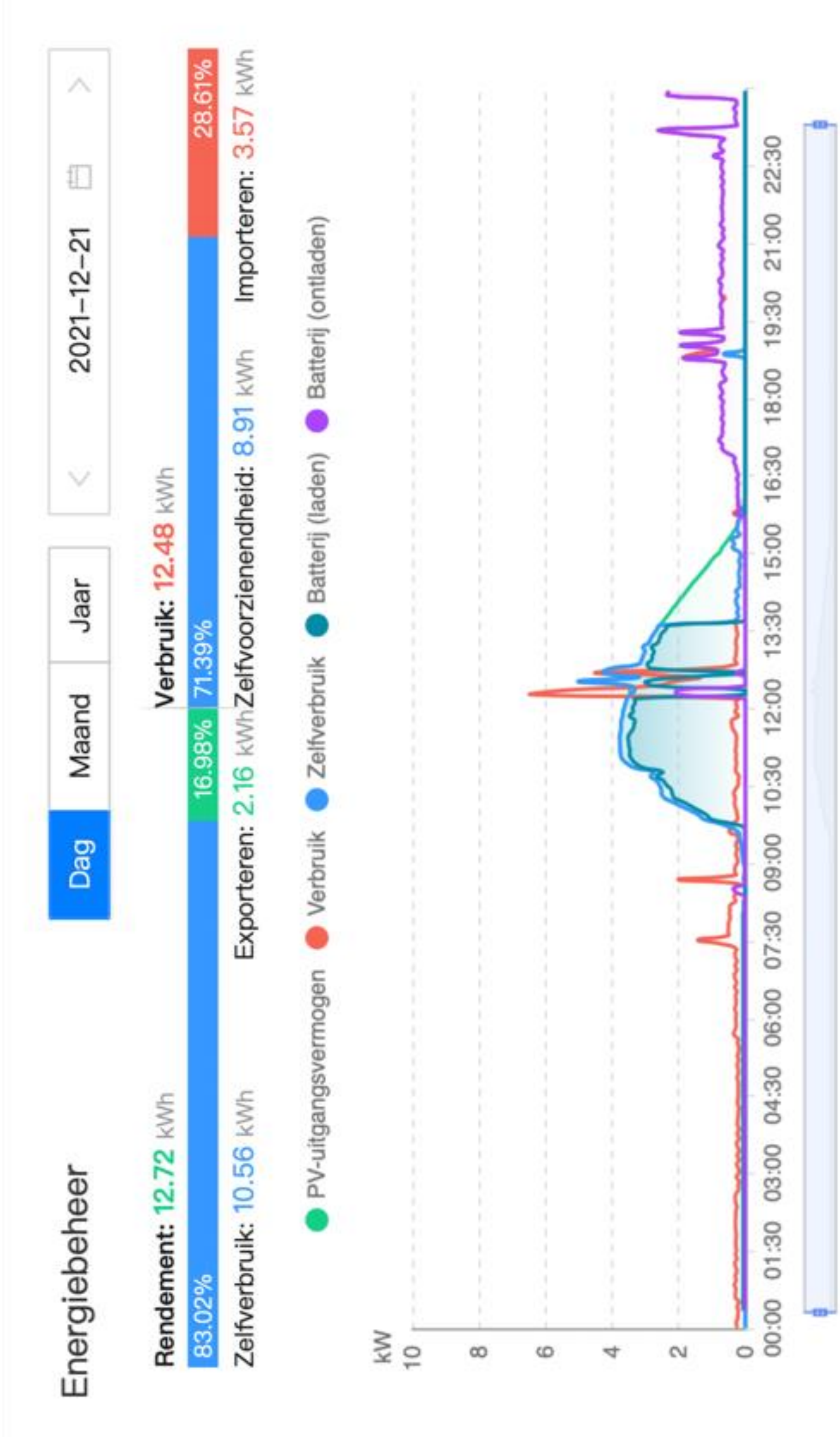

Figure 21: Circulation of 5 powers of energy in the house in 1 day (21 December 2021) [14,15]

In Figure 21, we note the following:

- The total amount of energy output from the solar panels (efficiency) on 21 December was 12.72 kWh.
- The course of the power, which was delivered by the solar panels, is shown in the green curve (PV output power).
- The red line shows the 'consumption' by appliances in the house. You can see that electrical power is consumed throughout the day, but especially at noon for the cooker in the kitchen.
- The dark blue line shows the power charged on the battery. This fits pretty well with the green curve of the output, until the power becomes completely zero at 1.45pm and remains zero from then on because the battery is then fully charged.
- The purple curve shows the course of discharge of the home battery. You can see that it usually fits pretty well with the red course of consumption from 3.45pm, when the sun was no longer shining on the panels (the purple curve is on top of the red one).
- Of the total output of the solar panels 12.72 kWh, 10.56 kWh is either consumed in appliances or charged in the battery and the surplus 2.16 kWh is delivered to the off-grid for other users (export).
- Looking at the total consumption of electrical energy that day (12.48 kWh), we see that part was imported (3.57 kWh) from the grid and another part was self-supplied (self-consumption), i.e. 8.91 kWh. Since the battery was empty at the start of the day, from midnight until the solar panels started supplying energy, the home consumption had to be supplied by the off-grid electric grid. You can see that the red curve from midnight to around 9am is thus higher: this means a total of 3.57 kWh imported from the grid. The remaining amount of energy (self-sufficiency) 8.91 kWh consumed at home comes directly from the solar power generated or from the battery.

Calculate how much energy is left in the battery for the next day.

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If we now look at the energy flows in Figure 21, we can distinguish four different time intervals with different ways of functioning of the whole system.

Period 1 from midnight to around 9.30am: this is where the red curve is higher and the other curves are almost completely zero. So this is a period where energy has been consumed and where the solar panels and the home battery have provided almost nothing for this consumption. This is where we use energy from the grid (import). This is a period of import from the grid. There is 3.57 kWh of energy imported from the grid that day.

Period 2 from around 9.30am to 1.45pm: there, the green curve of energy production from the solar panels almost completely coincides with the dark blue curve of storage (battery charging), except around midday when electric cooking is taking place, where this gives red peaks. This is the period of the system's own operation at home away from the grid. Most of the energy is stored on the home battery and also well used in the kitchen around noon.

Period 3 from around 1.45pm to around 3.45pm: then the green curve of energy production from the solar panels continues while the dark blue curve of storage has fallen to zero because the battery is fully charged. Own consumption in the house is very limited (blue curve) and so energy is then put on the grid (export). This is the period of output from the solar panels where 2.16 kWh is 'exported' to the grid.

Period 4 from around 3.45pm to midnight: here the green curve is zero because there is no output from the solar panels and there the purple curve of discharge from the home battery almost completely coincides with the red curve of consumption in the house. In other words, the appliances in the house only use energy from the home battery. This is again a period of its own operation separate from the grid. Here you can see the usefulness of a home battery.

Together, those two periods of self operation of the electrical energy system provide a useful use in the home of 10.56 kWh of solar energy from that day. By estimating how much the red curve of consumption is below the green curve during the sunny period of that day, you can see that you would have much less self-consumption if there were no home battery.

So it is not so easy to work with that, but we can learn a lot from it. Despite the fact that that day the 12.72 kWh of energy generated by the solar panels roughly equalled the 12.48 kWh of energy consumed in the house, 3.57 kWh of energy still had to be taken from the grid in the morning because the battery was empty at the start of the day. During the day when the battery was fully charged, 2.16 kWh of energy was still fed into the grid. So the home's energy production and consumption did not work all the time on its own.

If you look at this over several days, you can see that there are days when no energy is exchanged with the grid. Other days with lots of sunshine, nothing is taken from the grid, but only non-consumed or stored energy is put on the grid. There are also days with little sun where only energy is consumed from the grid and nothing is put on the grid.

Now look at some other days as shown in the daily diagrams in Figure 22. Link the following daily activities to the appropriate diagram A, B, C and D.

1. Large output from the solar panels and rapid full charging of the house battery and after it is fully charged, another large amount of energy is exported to the grid.

= diagram _________

2. Alternating sun and clouds with rather moderate output from the solar panels, intensive use in the house and charging of the house battery, little surplus and thus also low export to the grid. The house grid works well independently of the public grid.

= diagram _________

3. Very little output from solar panels and home battery charging and discharging, quite a lot of consumption of electricity along the public grid. Still some utility from solar panels and house battery

= diagram _________

4. Almost no output from the solar panels and almost exclusively consumption of electricity from the public grid. The solar panels and house battery are not useful.

= diagram ________

Diagram A

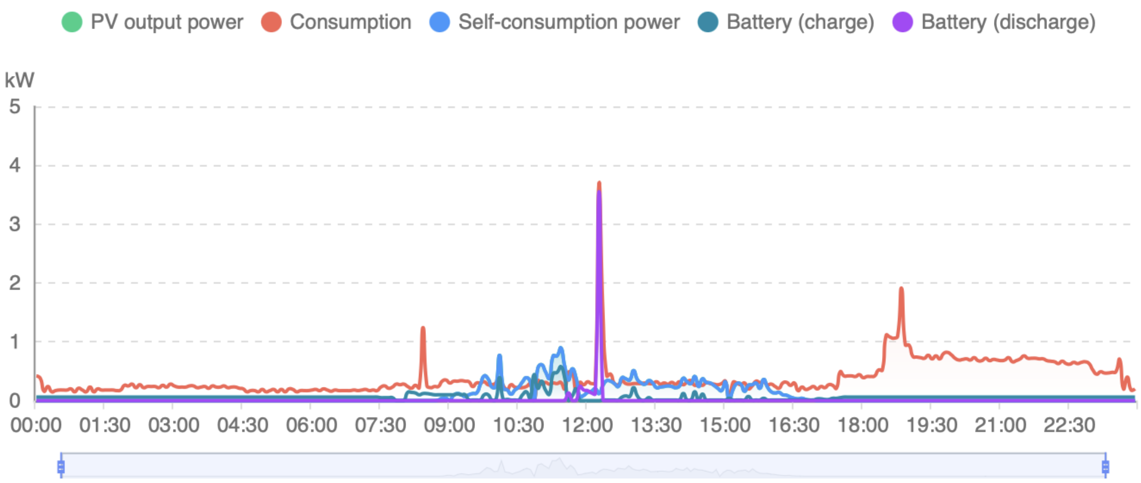

Diagram B:

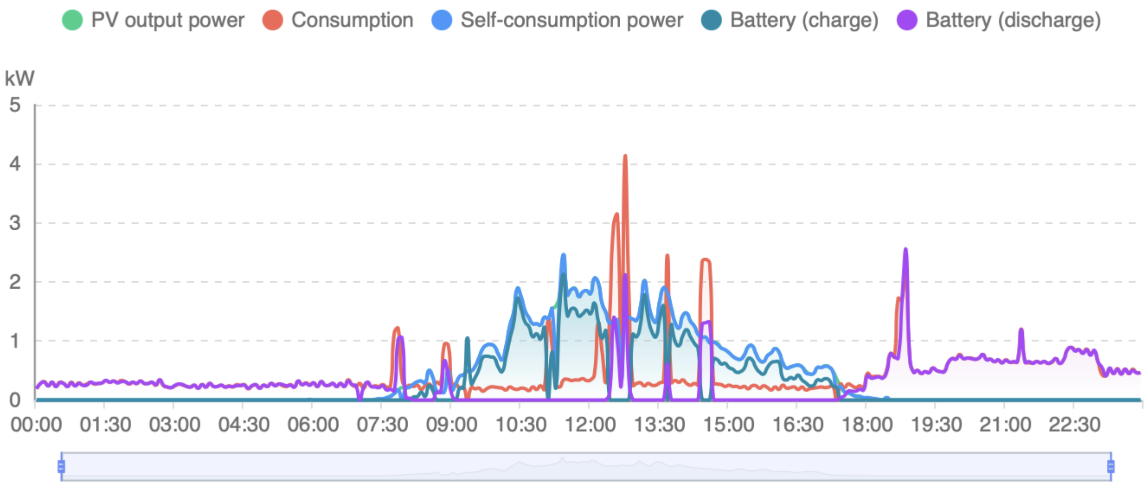

Diagram C:

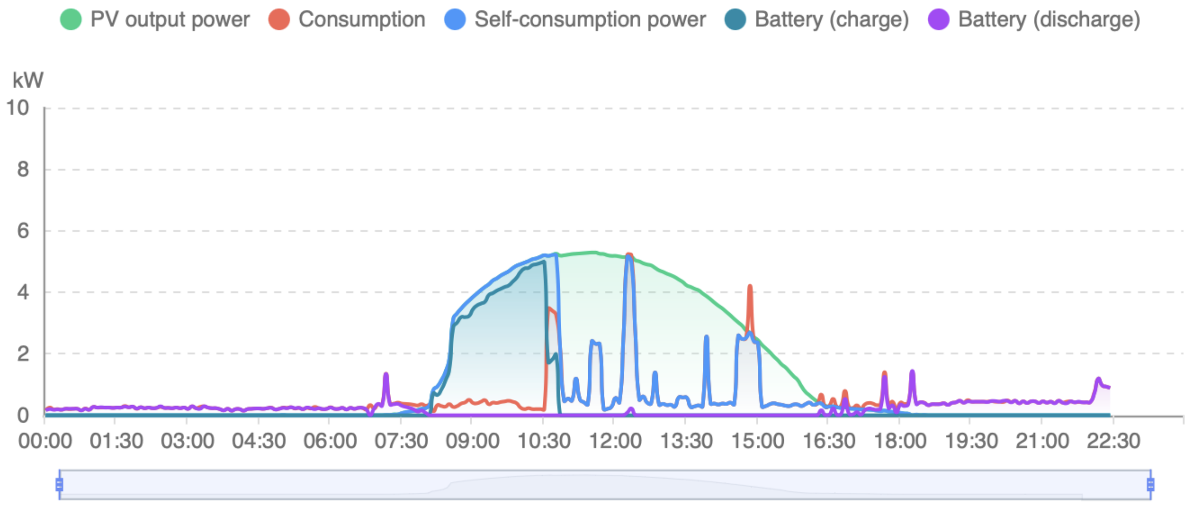

Diagram D:

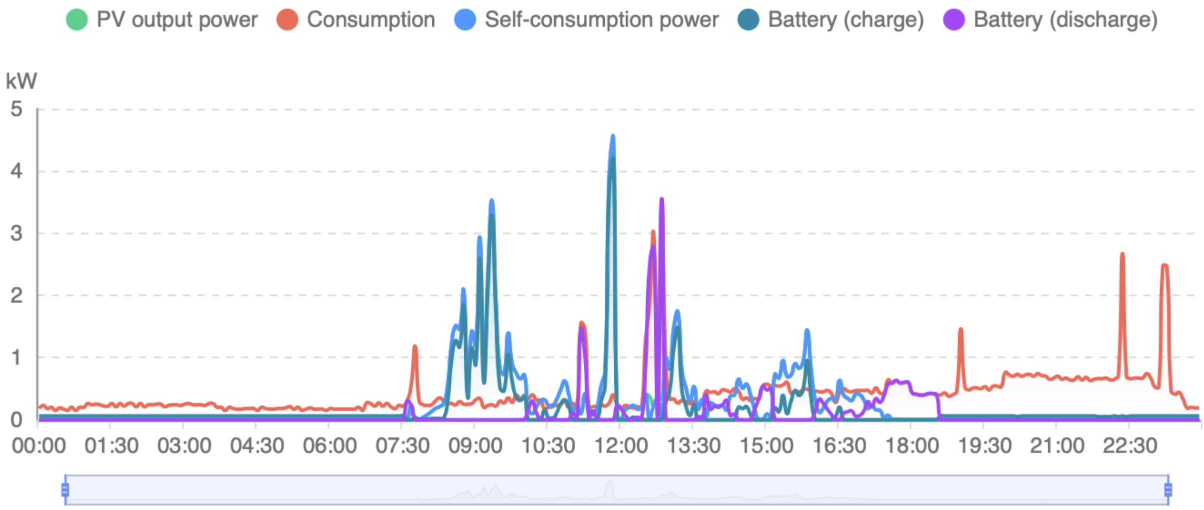

Figure 22: Diagrams of different days with 5 measured energy powers

What would be the effect if you put more solar panels?

If the home battery is fully charged and you only use that energy, how long can you use it to power your home?

What would be the effect of installing a larger home battery?

It's not just the amount of solar panels and the size of the home battery that affect overall energy costs, our behaviour also has a big impact.

What actions can you take to import less energy from the grid?

Read the following newspaper articles:

- https://theconversation.com/thinking-of-buying-a-battery-to-help-power-your-home-heres-what-you-need-to-know-192610
- https://www.theguardian.com/money/2023/mar/04/solar-panels-home-batteries-save-cut-bill-costs [16]

List all savings tips.

On average, what percentage of energy generated by solar panels can a family consume itself?

Up to what percentage of the energy generated by solar panels can you consume with a home battery?

What tips do they give in this article to increase your self-consumption? Can you think of any tips of your own?

Why should you avoid peak consumption?

SAVING ELECTRICITY

1. Calculate electricity savings

You replace 6 35-watt halogen spotlights with 3-watt LED spots (this gives about the same amount of light, 300 to 500 lumens, because LED spots convert energy into light more efficiently). Based on estimates, calculate how much electricity and how much money you will save in one year.

Which way do you use more energy to heat one litre of water: on an electric hob (of e.g. 2000 W), with a kettle (of e.g. 2200 W) or with the microwave (of e.g. 1000 W)? Make an estimate.

You replace your old 54-watt freezer with a new 19-watt freezer. How much money will you save on an annual basis by doing this? What is the payback period for this investment?

You decide not to use your tumble dryer during the warm months from June to September, but to hang the washing out to dry outside. How much electricity and money will you save by doing this? Make the necessary estimates.

2. Saving tips

Read the tips to save electricity on the following website: https://www.energuide.be/en/energy-tips/

Give 10 tips that you think are most effective for saving electricity.

Mark above with a cross the 3 tips that you think are most effective in your home. Estimate how much savings they could generate.

ASSIGNMENT

We set one common goal to reduce your electricity consumption in your home:

Which tips will you try at home in the next month?

How are you going to convince your family members to try this out with you?

HOME OPERATION

At least once a week, look at your electricity consumption on the EnergyID dashboard.

Note which hours of the day or days of the week you consume the most. Are these the same hours every day/week? If you have solar panels and possibly a home battery check which hours of the day you use electricity from the grid.

Week 1: ____

Week 2: ____

Week 3: ____

Week 4: ____

Which appliances use electricity at peak times? Discuss with your family members whether you can further fine-tune your consumption to meet your needs.

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Write down a quiz question on electricity consumption with four answer options and hand it in the next lesson.

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