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D4.4 Demand side actions of residents to reduce districts

September 2024

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Dissemination Level

PU	Public	X
CO	Confidential	

History

Version	Description	Lead author	Date
V1	First template	SON	December 2023
V2	First chapters	SON	July 2024
V3	Chapters 3, 4, 5, 6 and 7	SON	4th September 2024
V4	First review	SON	16th September 2024
V5	Final version	SON	30th September 2024

Disclaimer

This project has received funding in the framework of the PED Program, which is implemented by the Joint Programming Initiative Urban Europe and SET Plan Action 3.2. The Austrian part is supported by the Austrian Ministry of Climate Action, Environment, Energy, Mobility, Innovation, and Technology (BMK); the Romanian part is supported by a grant of the Ministry of Research, Innovation and Digitization CNCS/CCCDI – UEFISCDI, project number PED-JPI-SIMPLY POSITIVE, contracts number 325/2022 and 326/2022, within PNCDI III; the Dutch part is supported by the *RVO (the Netherlands Enterprise Agency), reference number ERANETPED-02767306;* and the Italian part is supported by a grant of the Ministry of Education and Merit - Department for Higher Education and Research, project number PED_00042, from the Fund for Investment in Scientific and Technological Research (FIRST/FAR) and/or Special Accounting Account no. 5944.

Executive Summary

This report evaluates the energy and GHG saving potentials of various measures in example households in the field of:

- heating,
- cooling,
- electricity,
- mobility, and
- public area.

According to interviews with example households or local representatives and literature research best practice examples are analysed. The calculated energy and GHG savings are expanded to the whole Focus District in order to be able to estimate the saving potential on a larger scale. Finally, all the examples developed are compared with each other and ranked based on two main criteria:

- the energy saving potential for the whole Focus District Großschönau, where measures like thermal renovation and the conversion to e-mobility tend to show the highest savings
- the replication potential according to costs and easiness of implementation. Simpler upgrades like adapting the room temperature or switching to LED lighting are typically easier to replicate than major renovations or renewable energy installations.

This final ranking provides a strategic roadmap for implementing the most impactful measures, balancing both environmental benefits and practicality for broader adoption.

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List of Abbreviations and Acronyms

cm	centimetre
CO_2	carbon dioxide
DHW	domestic hot water
FD	Focus District
GFA	gross floor area
GHG	greenhouse gas emissions
kg	kilogram
km/h	kilometres per hour
kWh	kilowatt hours
lcm	loose cubic meter
m^2	square meter
NFA	net floor area
PED	Positive Energy District
PEN	Positive Energy Neighbourhood
SECAP	Sustainable Energy and Climate Action Plan
W	watt
WP	work package

Table of Contents

1 Introduction

1.1 Purpose of the document

Already small changes in the usage pattern of the population can have significant impacts on the final energy balance of a district, especially when they are optimized in accordance with available local energy resources. The aim of this document is to showcase best practice examples of behavioural changes to save energy or greenhouse gas emissions based on the experience in Großschönau and provide them to the Focus Districts of SIMPLY POSITIVE for replication. According to data gathered in interviews with example households, electricity consumption measurements or in some cases through internet research, the energy savings and savings of CO_2-equivalents of different measures were calculated and applied to the whole Focus District Großschönau. As a result, the most effective examples could be identified.

1.2 Relation to other project activities

This document is one of four parts of WP 4, a key work package of SIMPLY POSITIVE, where innovative strategies are developed to support them on their pathway towards the development of PEDs and PENs.

Most of the calculations in this document that apply single best practice examples to the whole Focus District Großschönau are based on the surveys for “D1.1 Report on operation scenarios, technical characterization and identified stakeholders of Focus District”, where a detailed description of the Focus District can be found. Some tables of this deliverable were adopted for chapter 2.2. Examples in the public area are also related to “D6.1 Report on available good practice and success stories from Focus Districts”.

The document creates a foundation for “D6.3 SIMPLY POSITIVE best practice Booklet” in form of recommendations how to gain the biggest effects by behavioural changes to save energy, emissions and the climate and can be used as basis for awareness raising and designing subsidies.

1.3 Structure of the document

The document is divided into five thematic blocks, describing best practice examples of behavioural changes in the field of:

- heating,
- cooling,
- electricity,
- mobility, and
- public area.

These thematic blocks were further divided into the following 3 categories:

- save energy and greenhouse gas emissions
- switch to clean energy and thus, save greenhouse gas emissions

- produce clean energy and thus, save greenhouse gas emissions.

Based on the Integrated SECAP Report for Reșița Municipality (D4.5) measures for each of these categories and thematic blocks were identified according to the availability of data. Subchapters each describe the energy and emission savings of a specific measure in a sample household and show the savings potential if this measure were to be applied to the whole Focus District Großschönau. For better comparability, the savings are also calculated down to m² net floor area.

Chapter 8 compares the savings of all the measures described to identify the most effective ones for the foundation of the “SIMPLY POSITIVE best practice Booklet”.

2 Scientific background and calculation methodology

2.1 How to trigger behavioural changes?

The growing awareness of climate change and its impacts has sparked an urgent need for individuals, businesses, and governments to take action to reduce energy consumption and greenhouse gas emissions. While technological innovations and policy changes are critical, behavioural change is an equally essential, yet often overlooked, component of the solution. By altering everyday habits, individuals can make significant contributions to reducing their carbon footprint and preserving the environment for future generations.

2.1.1 Agency and Capacity

There are many barriers for energy-related behaviour that often stem from a combination of psychological, social, and structural factors. A framework, developed by Parag et al., analyses barriers for behavioural change with two variables:

- Agency: expresses in our context the willingness of consumers to save energy and GHG-emissions, use clean energy and produce energy in a sustainable way.
- Capacity: expresses the ability of users to implement the decisions they make [1] [2].

The likelihood of an energy user or energy prosumers to act is associated with his/her level of agency and capacity. As illustrated in Figure 1 changes in behaviour are likely, if both, the ability to act and the capacity are high and wise versa changes in behaviour are unlikely, if both are low. In case only one of the variables is high and the other one is low, behavioural change is uncertain.

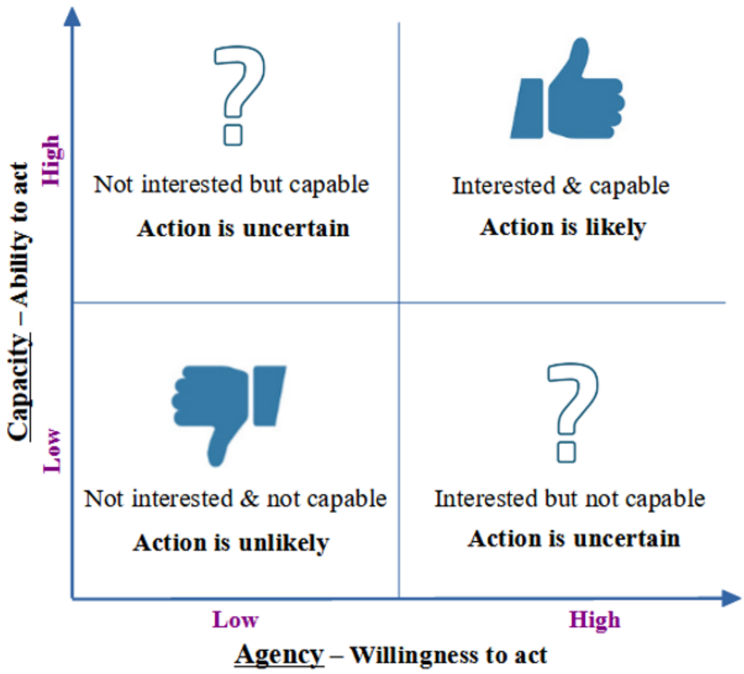

Figure 1: Relationship between agency and capacity [1][2]

Consumer's agency and capacity can be influenced by various sociological, personal, psychological and other parameters. In the project InBetween [3] the following reasons for a low level of agency are described:

- Lack of interest in information about energy consumption
- Lack of economic motivation: Some people are only willing to change their behaviour if this helps saving money.
- Lack of environmental motivation because most of the negative environmental externalities due to consumption, such as air pollution, water consumption, land use, energy use, etc., cannot be felt directly or immediately by the consumers themselves.
- People believing that their energy saving potential is already exhausted.
- Fear of loss of comfort
- Fear of unfamiliar technologies and lack of trust
- Fear of time consumption and nuisance due to proactive behaviour.

For low level of capacity, the following reasons are proposed [3]:

- Daily routines and practices, that should be changed
- Technical barriers due to energy appliances or infrastructure
- Lack of information
- Economic barriers like high costs for new, but efficient appliances
- Ownership of homes
- Potential fulfilled
- Passive people need someone or somewhat to make the actual actions.

2.1.2 Intended Fields of interest

Increasing agency and capacity is a main aspect on the way towards becoming a PED/PEN. Many aspects can influence agency and capacity and thus, contribute to the implementation of energy-saving measures. Those aspects can be split in internal and external fields of interest:

- Internal fields of interest are related to the individual behaviour.
- External fields of interest are related to the region.

Figure 2 shows various aspects promoting behavioural change that are assigned to different categories:

Figure 2: Intended fields of interest for the increase of agency and capacity

Summed up, the following aspects should be considered to increase agency and capacity:

- For applying sustainable technologies, local conditions must be in place and competences must be available. Of course, the impact of the new technology plays a significant role, as well.
- In some cases, it's a question of organisation: How can stakeholders be involved, and which structures are available?
- Financial benefits, for example fundings, as well as non-financial aspects, like comfort, can influence the motivation.
- Energy-saving measures with a great potential for replicability on a local, regional and general level are most effective from a global perspective.
- Involving stakeholders, organize a useful structure and spreading meaningful information about available technologies, benefits and the environmental added value of energy-saving actions are a prerequisite for measures to be implemented.
- On an external scale authorities, society, industry and the regulatory framework influence the behaviour and decision-making processes of the population.

2.2 Profile of the Focus District Großschönau

The described best-practice examples of behavioural change in chapters 3 to 7 were mostly gathered in Großschönau. Großschönau is a rather small but very well-known rural municipality in Waldviertel, Lower Austria, that has been pushing for decades toward sustainable and environmentally friendly ways of living. Großschönau is rated an e5-municipality, was winning the European Energy Award in Gold for its achievements in energy efficiency and has with the fair BIOEM and the permanent exhibition SONNENWELT two nationwide known showcase projects of sustainable thinking and acting.

Table 1 presents the description of the Focus District Großschönau.

Table 1: Summative characteristics of the Focus District Großschönau

Name of parameter	Value	Unit
District Area	7,047,800 705	m² ha
Gross Floor Area (GFA)	46,155	m²
District Plot Area	391,000	m²
Built area in building land	12,687	m²
Share of plot area built	3,245	%
Net to Gross Floor Area Ratio	~70	%
Building Storeys (average)	1.5	floors
Useable floor area of buildings	60,757	m²

The usage of the district area by the type of buildings is shown in Table 2.

Table 2: Building characteristics in the Focus District Großschönau

Usage	Area in m²	% of the area	Type of owner
Residential*	21,620	35.58 %	15 rented flats, rest private
Commercial **	7,283	11.99 %	private
Agricultural***	7,919	13.03 %	private
Primary School (incl. Kindergarten)	2,658	4.37 %	municipality
Secondary School (incl. Uni)	-	-	-
Retail Food	289	0.48 %	private
Retail Other	200	0.33 %	private

Source: Calculation based on useable area of all buildings (60.757 m²)
* complete area, which is approved for residential usage (data from building register)
** complete built area of buildings which have registered companies paying municipal tax (as of 2022)
*** complete built area of buildings which have an active announced farmstead (INVEKOS data, as of 2022)

Further information about the Focus District can be found in D1.1. Report on operation scenarios, technical characterization and identified stakeholders of Focus Districts.

A crucial role in the success and implementation of energy efficiency initiatives play the different stakeholders, each with their own interests, responsibilities, and impacts. Understanding their roles and perspectives is key to fostering effective energy-saving strategies. Table 3 shows the identified stakeholder groups in the Focus District Großschönau.

Table 3: Identified stakeholder groups in the Focus District Großschönau

Stakeholder	Description
Municipality	Mayor, Vice Mayor
Municipality organisations	Representatives of municipal council and public administrator
Opinion Leader organisations	Regional organizations with focus on climate strategies for municipalities, strategic alliances and information campaigns
Private Businesses	Local businesses: tourism, guest house, farming, information centre, retail, craftsmen, etc.
Infrastructure	Energy and grid provider (heat, electricity)
Local Associations	Representatives from associations: Tourism & local economic development, rural youth club, volunteer firefighter, …
Citizens	Representatives from the community, consumers and prosumers

Effective collaboration among these stakeholders is essential for the successful implementation of energy-saving measures. Each stakeholder's contribution helps build a comprehensive approach to energy efficiency, combining regulation, innovation, financial support, and public engagement to achieve meaningful and sustainable energy savings.

2.3 Information on the calculation methodology

The calculations in this report are mainly based on interviews with example households, where the residents or other local representatives provided information in form of bills or assumptions. In some cases, the electricity consumption of different devices was measured with electricity meters, whereby the date, the used meter and the brand and type of the electrical device was noted. If no example household could be found, a literature search and a theoretical calculation were carried out.

For all best practice examples, the annual energy savings in kWh, the savings in greenhouse gas emissions in kg CO_2 equivalents and the financial savings in € were calculated where possible.

Concerning electricity three different possibilities were considered, when calculating the savings of greenhouse gas emissions, namely:

- the usage of electricity certified with the Austrian ecolabel (only renewable energy)
- the usage of an electricity-mix from Austria only and
- the usage of an electricity-mix from Austria and abroad.

The financial savings of the example buildings/households due to the specific action were calculated based on the following prices:

- Electricity: 0,22 €/kWh (indication of local representatives, average in the year 2024)

- District heating system: 0,1224 €/kWh (indication of the district heating manager, year 2024)
- Water: 1,85 €/m³ (indication of local representatives, year 2023)
- Heating oil extra light: 1,1 €/l [25] (average price January 2024 – September 2024)
- Pellets: 0,299 €/kg [22] (average price January 2024 – September 2024)
- Soft firewood Lower Austria: 75 € per cubic meter, delivered with bark, volume including bark [23] (July 2024) and 0,211 €/kg (conversion factor of 1/355 = 0,002816901 [29])
- Coke: 1,152 €/kg [24] (average price in September 2024 of crush 2)
- Wood chips: 115 €/atro-ton, delivered with bark, volume including bark [23] and €/kg (conversion factor according to local representatives: 1,25)
- Petrol: 1,6 €/l [26] (average January 2024 – August 2024)
- Diesel: 1,638 €/l [27] (average January 2024 – August 2024)
- Annual pass for the public transport in the region Lower Austria and Burgenland 2024: 495 € [28].

The extrapolation to the entire Focus District Großschönau was carried out on the basis of the data collected in Work Package 3 of the project SIMPLY POSITIVE in consultation with local representatives, like the major of the municipality Großschönau, and its elaboration in "Deliverable 3.3 Assessment Report on Focus Districts".

3 Replication in the field of "Heating"

Within the category "Heating", we identified 13 different actions, which are summarized below, and in detail described within this chapter.

- Thermal renovation
- Build a passive house
- Exchange the old domestic hot water pump and use a high efficiency pump
- Take a shower instead of bathing
- Use an economy shower head
- Vent the radiators regularly
- Use a separate thermostat for each room and adapt the room temperature
- Conversion from oil to wood pellets
- Conversion from a multi-fuel stove to wood pellets
- Conversion from a multi-fuel stove to woodchips
- Conversion from oil to heat pump
- Use solar collectors for water heating instead of oil
- Choosing the right heating system for new buildings

3.1 Save energy

3.1.1 Thermal renovation

A house with ~300 m² GFA, heated with the district heating system in Großschönau and – occasionally – with a tiled stove and a wood kitchen stove, was renovated in summer 2014 as follows:

- Insulation of the exterior façade with 14 cm mineral foam panels,
- Replacement of the windows with 3-pane glazing (including cellar windows), and
- New garage door.

The costs amounted to 60,000 – 65,000 €.

Due to this **thermal renovation** the energy index of the building could be reduced from 119 kWh/m²a to 56 kWh/m²a. Table 4 shows, that the yearly energy consumption from the district heating system could be nearly halved, as well as the yearly CO_2-equivalents in kg. This results in energy savings of around 6,850 kWh per year and savings of CO_2-equivalents of around 1,230 kg per year in total and yearly energy savings of around 29 kWh/m² NFA and yearly savings of CO_2-equivalents of around 5 kg/m² NFA, as shown in Table 4 [5]. The financial savings amount to 840 € per year (for calculation basis see chapter 2.3).

Table 4: Savings concerning the thermal renovation of an example house in Großschönau

	Average yearly energy consumption in kWh	Average yearly CO_2-equivalents in kg [5]
Before thermal renovation	14,223	2,560
After thermal renovation	7,375	1,327
Yearly savings in total	**6,848**	**1,233**
Yearly savings per m²	**29**	**5**

Additionally, the inhabitants stated, that the amount of wood for the tile and the kitchen stove could be halved, too, but this amount is not included in the shown calculation. The renovation also resulted in **other benefits**, namely:

- positive effect on the interior climate
- pleasant floor temperature
- no more mould in window reveals and room corners, and
- much better noise protection.

In "D3.3 Assessment-Report on Focus Districts" [1]of the project SIMPLY POSITIVE all buildings in Großschönau were divided into 8 categories based on typologies provided in [4] and it was suggested, that **building types 1-6 could improve by the modernization of their windows and the insulation of their walls** with a thickness of 16 cm similar to the above mentioned example. This applies to about 111 residential buildings in the Focus District Großschönau with a summed up NFA of about 18,897 m² [1]. Recently renovated buildings (renovation after the year 2000 and buildings with an energy index better than 56 kWh/m²a) were excluded. At the moment, these 111 buildings have an **average energy index of 236 kWh/m² a**, whereby the energy index is not known for all buildings. The energy index of 87 out of the whole 146 buildings in the Focus District is known, especially due to a project in the year 2009, where voluntarily participating households were individually assessed.

If the whole NFA of 18,897 m² would be renovated like described above from an average energy index of 236 kWh/m²a to 56 kWh/m²a, about 3,401,460 kWh could be saved yearly.

3.1.2 Build a passive house

An **example passive house** with 145 m² living space, built in the year 2007 (Figure 3), needs about 1,890 kWh per year for heating and hot water preparation with a heat pump.

Figure 3: Example passive house in Großschönau

In comparison, a low-energy-house with 177 m² living space, built in the year 2012 with an energy index of about 24 kWh/m² needs yearly about 4,230 kWh for heating and hot water preparation with a heat pump of the brand Hoval, Thermalia^{R} 7P (Figure 4).

Figure 4: Heat pump of the brand Hoval, Thermalia^{R} 7P

This results in energy savings of around 2,350 kWh per year and savings of CO_2-equivalents of around 11 kg per year in total [5] and yearly energy savings of around 400 kWh/m² NFA and yearly savings of CO_2-equivalents of around 2 kg/m² NFA, as shown in Table 5. The financial savings amount to 520 € per year (for calculation basis see chapter 2.3).

Table 5: Savings when building a passive house in Großschönau

	Example for passive house	Example for low-energy - house
Construction year	2007	2012
Net floor area in m²	145	177
Yearly energy consumption for heating in kWh	1,885	4,232
Yearly energy consumption for heating in kWh/m² NFA	13.00	23.91
Yearly energy savings in kWh in total		**2,347**
Yearly energy savings in kWh per m² NFA		**11**
Yearly savings of CO_2-equivalents in kg [5]		**399**
Yearly savings of CO_2-equivalents in kg per m² NFA [5]		**2**

The above calculated CO_2-equivalents refer to a **mix of imported electricity and electricity produced in Austria**. Considering **only electricity produced in Austria** or **electricity certified with the Austrian ecolabel,** defined in the directive "UZ 46 – Grüner Strom", where environmental criteria hast to be considered and only renewable energies are allowed, the CO_2-equivalents would change as following [5]:

Table 6: CO_2-equivalents when considering different types of electricity generation

	Corresponding to the above-described example	
	Yearly savings in CO_2-equivalents in kg [5]	**Yearly savings in CO_2-equivalents in kg per m² NFA [5]**
Mix of imported electricity and electricity produced in Austria	540	3
Electricity following the criteria of the Austrian ecolabel	23	0.11

138 buildings in the Focus District Großschönau are not built as passive houses, 124 of them are residential buildings with a summed up NFA of about 23,654 m² and an **average energy index of 228 kWh/m² a**, whereby the energy index is not known for all buildings [1]. As already described in chapter 3.1.1, the energy index of 87 out of the whole 146 buildings in the Focus District is known, especially due to a project in the year 2009, where voluntarily participating households were individually assessed.

If the whole NFA of about 23,654 m² would have been built in passive house standard with a maximum energy index of 15 kWh/m²a instead of the average energy index of 228 kWh/m²a, about 4,060,720 kWh could be saved yearly.

3.1.3 Exchange the old domestic hot water pump and use a high efficiency pump

This best-practice example will be based on a theoretical calculation, because there are no data concerning the energy usage of different DHW pumps in example households available.

According to the Energy and Environmental Agency of Lower Austria a DHW pump is running on average about 4,000 hours per year [16]. New DHW pumps (Figure 5) adjust their output to the actual consumption. Old DHW pumps (Figure 6) have 3 stages, that must be set manually, whereby most people forget to adapt them for example during summer. Therefore, the old DHW pumps are mostly running on stage 3 the whole year.

Figure 5: An example of a high-efficiency DHW pump in Großschönau

Figure 6: An example for an old DHW pump in Großschönau

Depending on the set stage of old DHW pumps, the **conversion to a high-efficiency DHW pump can** save between 136 kWh and 300 kWh per year and between 1 and 70 kg CO_2-equivalents per year (depending on the source of electricity) (shown in Table 7). The financial savings amount to 30 – 70 € per year (for calculation basis see chapter 2.3).

Table 7: Savings due to the exchange of old DHW pumps

	High-efficiency DHW pump	About 15-year-old DHW pump, stage 1	About 15-year-old DHW pump, stage 3
Power in W [16]	15	49	90
Daily electricity consumption in kWh [16]	0.015	0.049	0.09
Yearly electricity consumption in kWh [16]	60	196	360
CO_2-equivalents in kg/year when using electricity certified with the Austrian ecolabel (only renewable energy) [5]	0.60	1.96	3.60
CO_2-equivalents in kg/year when using an electricity mix from Austria only [5]	10.20	33.32	61.20
CO_2-equivalents in kg/year when using an electricity mix from Austria and abroad [5]	13.80	45.08	82.80
Yearly energy savings in kWh		**136**	**300**
Yearly savings of CO_2-equivalents in kg, when using an electricity mix from Austria and abroad [5]		**31.28**	**69.00**
Yearly savings of CO_2-equivalents in kg, when using an electricity mix from Austria only [5]		**23.12**	**51.00**
Yearly savings of CO_2-equivalents in kg, when using electricity certified with the Austrian ecolabel [5]		**1**	**3**

135 buildings in the Focus District Großschönau with a net floor area of 24,869 m² were built before the year 2010. Assuming all these buildings still have old DHW pumps like in the description above and convert them to high-efficiency DHW pumps, there would be a yearly saving potential of:

- 18,360 kWh - 40,500 kWh (depending on the set stage)
- 4,220 – 9,320 kg CO_2-equivalents when using an electricity-mix from Austria and abroad
- 3,120 – 6,890 kg CO_2-equivalents when using an electricity-mix from Austria,
- 180 - 410 kg CO_2-equivalents when using certified electricity from renewable sources and
- thus, between 0.74 and 1.63 kWh per m² NFA and between 0.01-0.37 kg CO_2-equivalents per m² NFA [1] [5].

3.1.4 Take a shower instead of bathing

In an example household with 2 persons one of them is showering twice a week for about 5 minutes with an economy shower head and the second one is showering once a week for about 5 minutes with an economy shower head and additionally bathing once a week. For this, they need about 184 litres water and about 6.5 kWh per week [6]. In case, both would go **exclusively showering** they would only need 144 litres water and 5.2 kWh per week, which results in yearly savings of about 2,080 litres water and 70 kWh energy, as shown in Table 8. In the case the warm water is prepared with a heat pump, the financial savings amount to about 20 € per year (for calculation basis see chapter 2.3).

Table 8: Savings of an example household due to the substitution of one bath per week with showering

	In general, for one shower/bath		Current situation (3 showers and 1 bath per week)		Assumption (4 showers per week and no bath)	
	Water consumption in l [6]	Energy consumption in kWh [6]	Water consumption in l per week	Energy consumption in kWh per week	Water consumption in l per week	Energy consumption in kWh per week
Showering 5 minutes with an economy shower head	36	1.30	108	3.90	144	5.2
Bathing	76	2.64	76	2.64	0	0
Sum			184	6.54	144	5.2
Yearly savings					2,080	70

In case **every residential household of the 133 in the Focus District Großschönau** would substitute one bath per week with showering about

- 276,640 l water and
- 9,260 kWh energy

could be saved.

Showering longer than 10 minutes with an economy shower head needs approximately the same water amount and energy as an average bath described above. Thus, also by **reducing the showering durance** lots of water and energy can be saved.

3.1.5 Use an economy shower head

According to the example household in chapter 3.1.4 the usage of different types of shower heads should be considered as well. Assuming the 2 persons are taking 4 showers per week with a durance of 5 minutes each time, **using an economy shower head** instead of a normal shower head saves about 6,030 l and 200 kWh per year [6]. The savings are even bigger when comparing an economy shower head with a rain shower head, namely 11,230 l and 380 kWh per year, as shown in Table 9. In case the warm water is prepared with a heat pump, the financial savings of the conversion to an economy shower head from a normal shower head amount to about 60 € per year and from a rain shower head to about 100 € per year (for calculation basis see chapter 2.3).

Table 9: Savings concerning the usage of different types of shower heads in an example household

					Comparison with an economy shower head	
Showering 5 minutes with	**Water consumption in l [6]**	**Energy consumption in kWh [6]**	**Water consumption in l per week**	**Energy consumption in kWh per week**	**More water consumption in l/year**	**More energy consumption in kWh/year**
an economy shower head	36	1.30	144	5.20		
a normal shower head	65	2.26	260	9.03	6,032	199
a rain shower head	90	3.13	360	12.50	11,232	380

Under the described assumptions of 4 showers per week with a durance of 5 minutes **all 133 residential households in the Focus District Großschönau** could save yearly about:

- 26,470 kWh or 1.15 kWh/m² NFA when substituting their normal shower head or
- 50,490 kWh or 2.18 kWh/m² NFA when substituting a rain shower head.

3.1.6 Vent the radiators regularly

As there is no practical example household for this measure available in Großschönau, it is described and calculated based on researched data. Radiators should be ventilated regularly at the beginning of the heating period because the heating system cannot work efficiently, in case there is air in the water circuit of the heating system. This can save up to 15 % of the energy needed for heating [15].

For the calculation we used the example household of chapter 3.1.1, needing on average 7,375 kWh/year for heating the building with 240 m² net floor area with the district heating system. As shown in Table 10 the **saving potential of ventilating the radiators regularly** is up to 1,110 kWh/year and 200 kg CO_2-equivalents per year [5].

Table 10: Saving potential of ventilating the radiators regularly

Saving potential	10 % of the energy consumption for heating	15 % of the energy consumption for heating
Yearly savings in kWh in total	738	1,106
Yearly savings in kWh per m² NFA	3.07	4.61
Yearly savings in CO_2-equivalents in kg [5]	133	199
Yearly savings in CO_2-equivalents in kg per m² NFA [5]	0.83	0.02

Assuming 80 % of the buildings in the Focus District Großschönau have radiators, thus about 117 buildings, the regular ventilation of radiators could save about 86,290 – 129,430 kWh per year.

3.1.7 Use a separate thermostat for each room and adapt the room temperature

There is no example household available in Großschönau, that started adapting the room temperature to the usage and that knows the heating demand before and after this behavioural change. Thus, this example is described based on researched data.

The following room temperatures are recommended for a cosy living and can be adapted with separate thermostats for each room (Figure 7):

- Check room: 14 – 17 °C
- Bedroom: 16 – 18 °C
- Children's room: 18 – 21 °C
- Living room: 20 – 22 °C
- Bathroom: 20 – 24 °C [18].

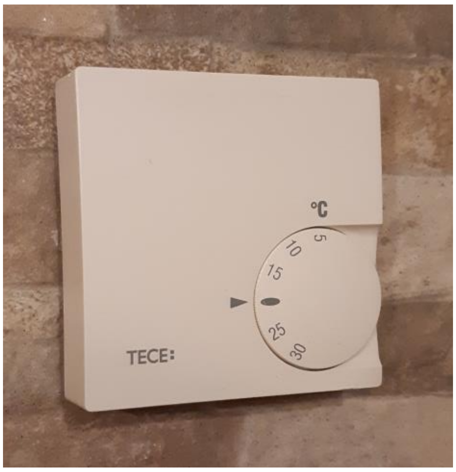

Figure 7: Room thermostat for adapting the temperature to the usage of the room

Additionally, some rooms can be lower tempered at nights. This helps to save up to 10 % of the heating demand [18].

An example household of Großschönau with a net floor area of 205 m² and a pellet heating system uses 2,000 kg pellets or 9,000 kWh [7] for heating and hot water preparation, additionally to a solar system. **Lowering the temperature by 1°C** can save up to 6 % of the heating demand [18], thus 540 kWh and 16 kg CO_2-equivalents per year in total or about 3 kWh and 0.08 kg CO_2-equivalents per m² NFA [5].

In case, they would **adapt their room temperatures to the usages with separate thermostats for each room and lower the temperatures at nights,** they could save about 900 kWh and 26 kg CO_2-equivalents per year , thus 4 kWh/m²a and 0.13 kg CO_2-equivalents per m² and year [18] [5] (Table 11).

Table 11: Savings in case of adapting the room temperature to the usage and daytime

	Energy in kWh	CO_2-equivalents in kg [5]
Status quo	9,000	260
Reduce the room temperature by 1 °C [18]	8,460	244
Adapting the room temperatures to the usage and daytime [18]	8,100	234
Yearly savings in total when reducing the room temperature by 1 °C	**540**	**16**
Yearly savings per m² NFA when reducing the room temperature by 1 °C	**2.63**	**0.08**

Yearly savings in total when adapting the room temperatures to the usage and daytime	**900**	**26**
Yearly savings per m² NFA when adapting the room temperatures to the usage and daytime	**4.39**	**0.13**

In case of the usage of a heat pump, the financial savings of adapting the room temperature to the usage amount to about 200 € per year and the reduction of the room temperature by 1 °C saves about 120 € per year. If the building is connected to the district heating system, about 110 € can be saved by adapting the room temperature to the usage and about 70 € by reducing the room temperature by 1 °C (for calculation basis see chapter 2.3).

In case all 146 buildings would adapt their room temperatures to the usage of the rooms and reduce the temperature at night:

- 123,422 kWh and
- 3,566 kg CO_2-equivalents

could be saved per year.

In case all 146 buildings would reduce their room temperatures by 1 °C:

- 74,053 kWh and
- 2,139 kg CO_2-equivalents

could be saved per year.

3.2 Use clean energy

3.2.1 Conversion from oil to wood pellets heater

A building with a NFA of about 200 m² has been heating with an oil heating system since 1980. The capacity of the oil boiler with an amount of 4,000 litres oil lasted for about 1.5 years. In 2023, the family **switched to a pellet heating system** (Figure 8). In addition, a solar system with 12 m² and two buffer storage tanks with a total capacity of 2,000 l were installed (Figure 9), so that not only the hot water can be prepared with renewable energy, but the heating can also be supported with it.

Figure 8: The new pellet boiler of the example household

Figure 9: The two buffer storage tanks of the example household

The annual consumption of around 2,800 litres of oil is now offset by around 2,000 kg of pellets. This results in yearly savings of about 17,840 kWh and 9,230 kg CO_2-equivalents in total and about 90 kWh and 50 kg CO_2-equivalents per m² NFA [7][5], as shown in Table 12. The financial savings of the example household amount to 2,480 € per year [25][22].

Table 12: Savings of an example household due to the conversion of the heating system from oil to wood pellets

	Yearly consumption in l or kg	Average calorific value in kWh/l or kWh/kg 89[7]	Yearly energy consumption in kWh	Yearly CO_2-equivalents in kg [5]
Oil heating	2,800	10	28,000	9,492
Pellet heating	2,000	4.5	9,000	260
Yearly savings in total			**19,000**	**9,232**
Yearly savings per m² NFA			**95**	**46**

In the Focus District Großschönau there are still about **11 oil heating systems.** If all of these would be replaced with pellet heating and solar systems (like in the example above) about

- 178,020 kWh energy and
- 86,500 kg CO_2-equivalents

could be saved yearly.

3.2.2 Conversion from a multi-fuel stove to a wood pellets heater

An example building with a net floor area of about 132 m² was heated with a multi-fuel stove using about 3,000 kg coke and 12.5 cubic meter/4,250 kg wood per year. In 2021, the household **switched to a pellet heating system** that needs about 6,800 kg pellets per year. This results in yearly savings of about 9,210 kWh and 1,650 kg CO_2-equivalents in total and 50 kWh and 10 kg CO_2-equivalents per m² NFA [9][5], as shown in Table 13. The financial savings of the example household amount to about 2,320 € per year [23][24][22].

Table 13: Savings of an example household due to the conversion of the heating system from a multi-fuel stove to wood pellets

	Yearly consumption kg	Average calorific value in kWh/l or kWh/kg [9]	Yearly energy consumption in kWh	Yearly CO_2-equivalents in kg [5]
Wood for multi-fuel stove	4,250	4.45	18,913	359
Coke for multi-fuel stove	3,000	8.10	24,300	2,070
Pellet heating	6,800	5.00	34,000	782
Yearly savings in total			**9,213**	**1,647**
Yearly savings per m² NFA			**49**	**9**

Due to lack of data – the number of multi-fuel stoves is not known - it's not possible to roll this example out to the whole Focus District Großschönau.

3.2.3 Conversion from a multi-fuel stove to a woodchips heater

An example building with a net floor area of about 265 m² was heated with a multi-fuel stove since 1998. The 35 kW-boiler produced yearly about 69,960 kWh (including warm water heating) using about 44 cubic meter/14,960 kg spruce wood. In 2021 the family **switched to a wood chip heating system** using about 50 lcm/10,250 kg wood chips/year and therefore reduced the energy consumption for heating to about 51,400 kWh/year [9]. This results in yearly savings of about 31,520 kWh and 480 kg CO_2-equivalents in total and 80 kWh and 1 kg CO_2-equivalents per m² NFA [9][5], as shown in Table 14. The financial savings of the example household amount to about 1,690 € per year [23].

Table 14: Savings of an example household due to the conversion of the heating system from a multi-fuel stove to a wood chips heating system

	Yearly consumption in kg	Average calorific value in kWh/kg [9]	Yearly energy consumption in kWh	Yearly CO_2-equivalents in kg [5]
Spruce wood	14,960	4.45	69,960	1,329
Wood chips	10,250	3.75	38,438	846
Yearly savings in total			**31,523**	**484**
Yearly savings per m² NFA			**83**	**1**

Due to lack of data – the number of multi-fuel stoves is not known - it's not possible to roll this example out to the whole Focus District Großschönau.

3.2.4 Conversion from oil heater to heat pump

An example building with a net floor area of about 225 m² was heated with an oil heating system and a multi-fuel stove since 1981 in combination with a thermal solar system of 20 m². Yearly about 400 l oil and about 5,690 kg wood (mainly spruce wood) were used for heating including water heating. In 2020, the family **switched to a heat pump** of the brand IDM, Type: Terra SW13, that needs about 2,400 – 3,300 kWh per year. This results in yearly savings of about:

- 26,450 kWh
- 1,212 kg CO_2-equivalents, when using an electricity mix from Austria and abroad
- 1,380 kg CO_2-equivalents, when using an electricity mix from Austria and

- 1,840 kg CO_2-equivalents, when using certified electricity and (shown in Table 15).

Downscaled on m² NFA they can save yearly about 130 kWh and 6-9 kg CO_2-equivalents per m², depending on the source of electricity. The financial savings of the example household amount to about 1,010 € per year[25][23](chapter 2.3).

Table 15: Savings of an example household due to the conversion of the heating system from a combination of an oil boiler and a multi-fuel stove to a heat pump

	Oil heating	Multi-fuel stove (spruce-wood)	Heat pump	Yearly Savings
Yearly consumption in l or kg	400	5,685		
Average calorific value in kWh/l or kWh/kg [9]	10	4.5		
Energy consumption in kWh/year	4,000	25,300	2,850	26,450
CO_2-equivalents in kg/year by using certified electricity [5]			29	1,839
CO_2-equivalents in kg/year by using an electricity mix from Austria [5]	1,356	512	485	1,383
CO_2-equivalents in kg/year by using an electricity mix from Austria and abroad [10]			656	1,212

In the Focus District Großschönau there are still **about 11 oil heating systems**. If all of these would be replaced with heat pumps (like in the example above) about

- 247,820 kWh and
- 11,357 - 17,232 kg CO_2-equivalents

could be saved yearly.

3.2.5 Use solar collectors for water heating instead of oil

There's no example household available which could be used to quantify the savings resulting from this changeover, but they could be included in chapter 3.2.1, where we calculated the savings of the conversion from an oil to a pellet heating system. During the conversion of the heating system, a solar system was installed as well.

3.2.6 Choosing the right heating system for new buildings

Assuming the construction of a new one-family building in Großschönau with an energy index of around 20-25 kWh/m² we want to compare the installation of a pellet heating system, a heat pump and the connection to the heating system. For the calculation we use the heat demand of the example household with a net floor area of 177 m² in chapter 3.1.2: 4,232 kWh/year.

As shown in Table 16, the **operation of a heat pump using certified electricity** would cause the least CO_2-equivalents, namely only 42 kg/year. Depending on the heating system in question, this results in yearly savings of 80 – 900 kg CO_2-equivalents in total and 0.45 – 5 kg/m² NFA. The production of the different heating systems (grey energy) was not taken in consideration in the shown calculations.

Table 16: Comparison of CO_2-equivalents of different heating systems [5]

	Heat pump with electricity certified with the Austrian ecolabel (only renewable energy)	Heat pump with an electricity mix from Austria only	Heat pump with an electricity mix from Austria and abroad	District heating system	Pellet heating system
CO_2-equivalents in kg/kWh	0.01	0.17	0.23	0.18	0.03
CO_2-equivalents in kg/year	42	719	973	762	122
Yearly savings of CO_2-equivalents in comparison to the heat pump using certified electricity in kg		677	931	720	80
Yearly savings of CO_2-equivalents in comparison to the heat pump using certified electricity in kg/m² NFA		3.83	5.26	4.06	0.45

4 Replication in the field of "Cooling"

In the chapter "cooling", we are talking about one measure, namely:

- Correct ventilation of windows and shadowing instead of an air conditioner

4.1 Save energy

4.1.1 Correct ventilation of windows and shadowing instead of an air conditioner

As there is no local example household known, which uses an air conditioner, the example households of this chapter are from other villages in Lower Austria.

The first example household of the village "Großpertenschlag" uses an air conditioner of the brand DAIKIN, Model RXF35A5V1B (Figure 10 and Figure 11) for cooling the living room with a space of 20 m², where they are spending most of their time. They are using the air conditioning about 6 times a year for roughly 4 hours.

Figure 10: Example air conditioner – indoor unit

Figure 11: Example air conditioner – outdoor unit

The second example household of the village "Niederrußbach" with a net floor area of 140 m² uses the heat pump of the brand Vaillant, Type VWL 77/5 IS, for cooling. Reverse operation of the heat pump allows the room temperature to be lowered via the underfloor heating system. This example household uses the cooling option on all hot days and switches the heat pump off at 5.30 p.m. We assume that they use it on 30 days per year.

Using the air conditioner 6 times a year for 4 hours causes an energy consumption of 170 kWh and 40 kg CO_2-equivalents using an electricity mix from Austria and abroad as our example household or downscaled about 9 kWh and 2 kg CO_2-equivalents per m² NFA [5] (Table 17). Due to correct ventilation of windows and shadowing the example household could save about 40 € per year (for calculation basis see chapter 2.3).

Cooling 30 days per year for 17.5 hours with the heat pump causes a consumption of 220 kWh and 40 kg CO_2-eqvuialents using an electricity mix from Austria only as our example household or downscaled about 1.56 kWh/m² and 0.27 kg CO_2-equivalents [5] (Table 17). Due to correct ventilation of windows and shadowing the example household could save about 50 € per year (for calculation basis see chapter 2.3).

Table 17: Energy consumption and caused emissions due to cooling via air conditioner or heat pump instead of correct ventilation of windows and shadowing

	Air conditioner	Cooling with the heat pump
Yearly electricity consumption in kWh	170	219
CO_2-equivalents when using an electricity mix from Austria and abroad in kg/year [5]	39.19	50.37
CO_2-equivalents when using an electricity mix from Austria only in kg/year [5]	28.97	37.23
CO_2-equivalents when using electricity certified with the Austrian ecolabel (only renewable energy) in kg/year [5]	1.70	2.19
Yearly electricity consumption in kWh/m²	8.52	1.56
CO_2-equivalents when using an electricity mix from Austria and abroad in kg/m²/year [5]	1.96	0.36
CO_2-equivalents when using an electricity mix from Austria only in kg/m²/year [5]	1.45	0.27
CO_2-equivalents when using electricity certified with the Austrian ecolabel (only renewable energy) in kg/m²/year [5]	0.09	0.02

In the Focus District Großschönau, there are **133 residential buildings**. Using an **air conditioner** on 6 days per year in all these buildings instead of the correct ventilation and shadowing of windows would cause:

- an electricity consumption of 196,890 kWh
- 45,280 kg CO_2-equivalents, when using an electricity mix from Austria and abroad
- 33,470 kg CO_2-equivalents, when using an electricity mix from Austria only and
- 1,970 kg CO_2-equivalents, when using certified electricity.

Using the heat pump for cooling on 30 days per year in all these buildings would cause

- an electricity consumption of 36,150 kWh
- 8,310 kg CO_2-equivalents, when using an electricity mix from Austria and abroad,
- 6,150 kg CO_2-equivalents, when using an electricity mix from Austria only and

- 360 kg CO_2-equivalents, when using certified electricity.

In this calculation it was not considered, how many buildings in Großschönau have a heat pump. In case all **10 buildings with heat pumps** would use this option for cooling and all other residential buildings in the Focus District Großschönau would use an air conditioner for cooling like described in the example above, cooling would cause:

- an electricity consumption of 48,670 kWh per year
- 11,190 kg CO_2-equivalents, when using an electricity mix from Austria and abroad,
- 8,270 kg CO_2-equivalents, when using an electricity mix from Austria only and
- 490 kg CO_2-equivalents, when using certified electricity.

5 Replication in the field of "Electricity"

Within the category "electricity", we listed 14 different measures:

- Conversion to LED-technology
- Identify energy saving potentials in the household through energy consulting
- Conversion of old appliances
- Wash dishes and clothes with low temperatures
- Air drying or heat pump dryer instead of tumble dryer
- Avoid Stand-by
- Defrost the refrigerator regularly
- Induction stove instead of ceramic hob
- Usage of water boiler instead of a pot
- Usage of lids
- Usage of an egg boiler instead of a pot
- Electric lawn mower instead of gasoline lawn mower
- Usage of energy from an energy community
- Energy production via own photovoltaic system.

5.1 Save energy

5.1.1 Conversion to LED-technology

An example household with a net floor area of about 145 m² and 5 inhabitants has already converted the whole lighting in the household to LED-technology (Figure 12).

Figure 12: LED-technology

Table 18 shows the exact list of the whole lighting equipment. In sum the following lamps are used:

- 12 LED lamps with a power of 2 W, which corresponds to 18 W for halogen lamps
- 19 LED lamps with a power of 4 W, which corresponds to 28 W for halogen lamps
- 8 LED lamps with a power of 4,3 W, which corresponds to 35 W for halogen lamps and
- 9 LED lamps with a power of 7 W, which corresponds to 42 W for halogen lamps.

Table 18: The whole lighting equipment of the example household

Room/Location	Number of bulbs	Estimated average lighting duration in hours per year
Living room	9	940
Dining room	3	728
Kitchen	3	728
Bathroom	4	304
Toilet 1	1	136.5
Toilet 2	2	250.75
Bedroom/Ceiling lamp	4	53
Bedroom/Bedside lamp	1	91.25
Staircase	2	91.25
Office	4	499.5
Checkroom	1	68.25
Hallway 1	2	304
Hallway 2	2	54.75
Children's room 1/Ceiling lamp	3	1215
Children's room 1/Bedside lamp	1	91.25
Children's room 2/Ceiling lamp	1	577
Children's room 2/Desk lamp	1	36.5
Children's room 2/Bedside lamp	1	182.5
Children's room 3/Ceiling lamp	1	607
Children's room 3/Bedside lamp	1	182.5
Utility room	1	36.5

Due to the **conversion from halogen lamps to LED lamps** the described example household could save about 510 kWh electricity and about 5 kg CO_2-equivalents, as they are only using energy from renewable sources [5] (as shown in Table 19). The financial savings amount to about 110 € per year (for calculation basis see chapter 2.3).

Table 19: Savings considering the conversion to LED technology

	Using halogen lamps only	Using LED lamps only	Savings
Energy consumption in kWh/year	601	87	**514**
CO_2-equivalents in kg/year by using an electricity mix from Austria and abroad [5]	138	20	**118**
CO_2-equivalents in kg/year by using an electricity mix from Austria [5]	102	15	**87**
CO_2-equivalents in kg/year by using certified electricity [5]	6	1	**5**

If all the **133 residential buildings in the Focus District Großschönau** would replace their halogen lamps with LED lamps like the example described above, about

- 68,300 kWh
- 15,710 kg CO_2-equivalents, when using an electricity mix from Austria and abroad
- 11,612 kg CO_2-equivalents, when using an electricity mix from Austria
- 680 kg CO_2-equivalents, when using certified electricity and
- thus, 2.96 kWh and between 0.03 and 0.68 kg CO_2-equivalents per m² NFA

could be saved yearly.

5.1.2 Identify energy saving potentials through professional energy consulting

A professional energy consulter informs a household or a company individually, personally and in detail about the causes of its energy consumption and saving potentials that can be achieved in form of investments in energy-efficient equipment and in form of changes in usage behaviour.

Figure 13: Professional energy consulting

The saving potential of a **comprehensive energy consulting for electricity and heat in a private household** can be calculated as follows: 19,000 kWh/a * 3 % = 570 kWh [8]. The duration of an energy consulting is stated as 2 years. Therefore, the calculated factor can be multiplied by 2. Thus, the saving potential of a professional energy consulting in a private household is 1,140 kWh.

The saving potential of a comprehensive energy consulting in small and medium companies is calculated with 2 % of the real end energy use of the company and lasts for 2 years, as well [8]. For example, the kindergarten in Großschönau needed about 60,000 kWh for heat and electricity in the year 2023. The saving potential of **a professional energy consulting in the kindergarten** is calculated as follows: 60,000 kWh/a * 2 % * 2 a = 2,400 kWh.

In the Focus District Großschönau, there are **119 buildings that are only used for living and 27 buildings that are used as company/communal facility** (as well). The office building and the exhibition will be excluded in the further calculations, as they are already built as plus energy buildings and therefore, no further energy saving potential can be expected. According to [1] 82,2 % of the gross floor area are used residential and 17,8 % are used commercial, for schools, kindergarten and retail. In total an energy saving potential of 135,660 kWh and 27.11 kWh/m² NFA can be expected from energy consultations in private households and 55,200 kWh in total and 2.57 kWh/m² NFA from energy consultations in companies/commercial buildings, as shown in Table 20.

Table 20: Energy saving potential of the Focus District Großschönau by energy consultations

	Residential usage only	Commercial usage, school, kindergarten, retail[1]
Number of buildings	119	25
Net floor area in m² [1]	5,004	21,504
Energy saving potential for 1 (example) building in kWh [8]	1,140	2,400
Energy saving potential for all buildings in kWh	135,660	55,200
Energy saving potential in kWh/m² NFA	27.11	2.57

5.1.3 Replacement of old appliances

An example household uses an old fridge for cooling drinks in the pantry (Figure 14) additionally to the fridge-freezer-combination in the kitchen (Figure 15). This fridge of the brand “Whirlpool”, Model ART 405-2/H, has an included freezer compartment and is at least 27 years old.

Figure 14: Old fridge of the example household

Figure 15: New fridge-freezer-combination of the example household

Table 21 shows the measured energy consumption of the old fridge and the fridge-freezer-combination in the kitchen, which is much bigger than the old model and about 11 years old, measured with the “Energy Check 3000” on 8th and 18th August 2024. Further, these energy consumptions are compared with the theoretical energy consumption according to the datasheet of a new model of the brand Liebherr, Rc 1401_994791451, with the energy

[1] The buildings of the Sonnenplatz Großschönau GmbH were excluded, as they are already built as plus energy buildings and have no further energy saving potential.

simply positive

efficiency class C and a comparable seize to the old model including a freezer compartment, too (Figure 16).

Figure 16: New fridge with freezer compartment of the brand Liebherr

Although the fridge-freezer-combination is much bigger, it consumes about 210 kWh less per year than the old fridge and produces 2.08 kg CO_2-equivalents less using electricity from renewable sources. The financial savings amount to about 60 € per year (for calculation basis see chapter 2.3). **Substituting the old fridge** with the new one of Liebherr described above would save about 400 kWh, 4 kg CO_2-equivalents and 90 € per year [5] (chapter 2.3).

Table 21: Comparison of the energy consumption and the CO_2-equivalents caused by different fridges (old and new ones)

	At least 25 years old fridge with freezer compartment (Whirlpool – ART 405-2/H)	New fridge with freezer compartment (Liebherr, Rc 1401_994791451)	Fridge-freezer-combination (Siemens, KG KGEE34A)
Energy consumption in kWh/year	488	91	208
CO_2-equivalents in kg/year when using an electricity mix from Austria and abroad [5]	112.24	0.91	47.77
CO_2-equivalents in kg/year when using an electricity mix from Austria only [5]	82.96	15.47	35.31
CO_2-equivalents in kg/year when using electricity certified with the Austrian ecolabel (only renewable energy) [5]	4.88	20.93	2.08

Yearly energy savings in kWh	**397**	**280**
Yearly savings of CO_2-equivalents in kg, when using an electricity mix from Austria and abroad [5]	**91.31**	**64.47**
Yearly savings of CO_2-equivalents in kg, when using an electricity mix from Austria only [5]	**67.49**	**47.65**
Yearly savings of CO_2-equivalents in kg, when using electricity certified with the Austrian ecolabel [5]	**3.97**	**2.80**

In case **all 133 residential buildings** would substitute one old appliance as described above, there's a saving potential of

- 52,800/37,280 kWh/year
- 12,140/8,580 kg CO_2-equivalents, when using an electricity mix from Austria and abroad
- 8,980/6,340 kg CO_2-equivalents, when using an electricity mix from Austria
- 530/370 kg CO_2-equivalents, when using certified electricity and
- thus, 1.61/1.28 kWh and between 0.02 and 0.53 kg CO_2-equivalents per m² NFA [1][5].

5.1.4 Wash dishes and clothes with low temperatures

An example household in Großschönau with a net floor area of 200 m² and 4 inhabitants (2 adults and 2 young children) uses the dish washer on average 6 times a week and the washing machine on average 4 times a week. Over the course of a year, about 300 washing cycles with the dishwasher (2 weeks excluded due to holidays) and 208 washing cycles with the washing machine are carried out.

The dishwasher of the brand "Siemens", Type SL6P1S, offers different programs, whereby the following two will be compared:

- Intensive program with 70 °C
- Sensor-optimized program with 45-60 °C, that optimizes according to the soiling of the dishes with the help of the sensor technology.

Table 22 shows the saving potentials, when using the program with the lower temperature. The energy consumption was measured with the "Energy Monitor 3000" of the brand "Voltcraft" on 29th and 30th July 2024. Over the course of a year, **washing dishes with low**

temperatures can save about 150 kWh and in case of our example household about 1.47 kg CO_2-equivalents, as they are using certified electricity [5] (shown in Table 22). The financial savings amount to about 30 € per year (for calculation basis see chapter 2.3).

Table 22: Saving potentials when washing dishes with low temperatures

	Intensive program with 70 °C	Sensor-optimized program with 45-60 °C	Savings
Energy consumption in kWh/washing cycle	1.15	0.66	**0.49**
Energy consumption in kWh/year (300 washing cycles)	345	198	**147**
CO_2-equivalents in kg/year by using an electricity mix from Austria and abroad [5]	79.35	45.54	**33.81**
CO_2-equivalents in kg/year by using an electricity mix from Austria [5]	58.65	33.66	**24.99**
CO_2-equivalents in kg/year by using certified electricity [5]	3.45	1.98	**1.47**

Concerning washing clothes, the described example household uses 3 times a week a program with 30 °C and once a week a program with 60 °C of a washing machine of the brand Siemens, Type WU14Q440 (Figure 17).

Figure 17: Washing machine of the brand Siemens, Type WU14Q440

Measurements with the “Energy Monitor 3000” of the brand “Voltcraft” on 30th and 31st August 2024 showed the following electricity consumption per washing cycle:

- 0,227 kWh at 30 °C
- 0,937 kWh at 60 °C.

Over the course of a year, our example household consumes 84 kWh for 156 washing cycles at 30 °C and 52 washing cycles at 60 °C and saves about 110 kWh and 1 kg CO_2-equivalents, as they are using certified electricity, **in comparison to washing all the clothes at 60°C** (shown in Table 23). The financial savings amount to about 20 € per year (for calculation basis see chapter 2.3).

Table 23: Saving potentials when washing clothes with low temperatures

	Example Household	Using only the program with 60 °C	Savings
Energy consumption in kWh/year	84	195	**111**
CO_2-equivalents in kg/year by using an electricity mix from Austria and abroad [5]	19.35	44.83	**25.47**
CO_2-equivalents in kg/year by using an electricity mix from Austria [5]	14.30	33.13	**18.83**
CO_2-equivalents in kg/year by using certified electricity [5]	0.84	1.95	**1.11**

In the Focus District Großschönau, there are **133 residential buildings**. In case, all of them would wash their dishes and clothes with low temperatures as described above, about

- 34,280 kWh
- 7,880 kg CO_2-equivalents, when using an electricity mix from Austria and abroad
- 5,830 kg CO_2-equivalents, when using an electricity mix from Austria
- 340 kg CO_2-equivalents, when using certified electricity and
- thus, 1.48 kWh and between 0.01 and 0.34 kg CO_2-equivalents per m² NFA [3] [1]

could be saved yearly.

5.1.5 Air drying or heat pump dryer instead of tumble dryer

The example household described in chapter 5.1.4 uses a tumble dryer of the brand AEG, Model T65280AC (Figure 18) on average 4 times a week. The program “extra dry” needs about

2.126 kWh (measured with the “Energy Monitor 3000” of the brand “Voltcraft” on 21st August 2024). Air drying of clothes could save about 440 kWh/year, 4 kg CO_2-equivalents and 100 € per year, as they are using certified electricity [5] (chapter 2.3).

Heat pump dryers form an air cycle - the dry air is not blown out, but reheated and fed back into the drum. This allows them to use the energy more efficiently than a tumble dryer and therefore save energy. As there is no example household known, that uses a heat pump dryer, data from the product’s data sheet of a machine of the brand Bosch, Model WQG233D40 (Figure 19) are used.

Figure 18: Old tumble dryer of the example household

Figure 19: Potential new heat pump dryer

Internet research showed that drying with a heat pump dryer takes about 2 hours. Thus, the standard cotton program needs about 1.68 kWh. Per year **cloth drying with the heat pump dryer instead of the tumble dryer** would cause savings of about 93 kWh, 1 kg CO_2-equivalents and 20 € [5] (chapter 2.3) (shown in Table 24).

Table 24: Comparison of a tumble and a heat pump dryer

	Tumble dryer	Heat pump dryer	Savings
Energy consumption in kWh/year	442	349	**93**
CO_2-equivalents in kg/year by using an electricity mix from Austria and abroad [1][5]	101.7	80.4	**21.3**
CO_2-equivalents in kg/year by using an electricity mix from Austria [5]	75.2	59.4	**15.8**
CO_2-equivalents in kg/year by using certified electricity [5]	4.4	3.5	**0.9**

In case all **133 residential buildings in the Focus District Großschönau** would use a heat pump dryer instead of a tumble dryer about

- 12,340 kWh electricity
- 2,840 kg CO_2-equivalents, when using an electricity mix from Austria and abroad
- 2,100 kg CO_2-equivalents, when using an electricity mix from Austria and
- 120 kg CO_2-equivalents, when using certified electricity and
- thus, 0,53 kWh and between 0,01 and 0,12 kg CO_2-equivalents per m² NFA [5][1]

could be saved per year.

Drying the whole laundry of the 133 buildings in the air instead of using a tumble dryer would save yearly about

- 58,810 kWh electricity
- 13,530 kg CO_2-equivalents, when using an electricity mix from Austria and abroad
- 10,000 kg CO_2-equivalents, when using an electricity mix from Austria and
- 590 kg CO_2-equivalents, when using certified electricity,
- thus, about 2.55 kWh and between 0,03 and 0,59 kg CO_2-equivalents per m² NFA [5][1].

5.1.6 Avoid Stand-by

The standby consumption of the following electrical appliances within 24 hours was measured with the "Energy Monitor 3000" and the "Energy Check 3000" of the brand "Voltcraft" during August 2024 (ranked from lowest to highest energy consumption):

- TV of the brand LG, Type 43LH590 V - ZD (Figure 20): 0 kWh
- Laptop Lenovo ThinkBook 14 G2 ITL (Figure 21): 0,018 kWh
- Vacuum cleaner of the brand Philips, Model SSA-5AP-12 EU 120030 (Figure 25): 0,024 kWh
- Monitor HP Z24 nG2 (Figure 22): 0,025 kWh
- Smart Speaker with Alexa, Eco Dot (4th Generation, 2020), Model B7W64E (Figure 23): 0,026 kWh
- Apple Watch Magnetic Charging Cable, Type EMC 3975 (Figure 24): 0,026 kWh
- Set Top Box Ocilion P420 IP (Figure 26): 0,051 kWh
- Router TP-link, Model: Archer MR 600 (Figure 27): 0,09 kWh
- Stereo system Philips FW 12 (Figure 28): 0,116 kWh
- Desktop computer HP ProDesk 400 G7 Small Form Factor PC (Figure 29): 0,13 kWh.

Figure 20: TV of LG, Type 43LH590 V - ZD

Figure 21: Laptop Lenovo ThinkBook 14 G2 ITL

Figure 22: Monitor HP Z24 nG2

Figure 23: Smart Speaker with Alexa, Eco Dot (4th Generation, 2020), Model B7W64E

Figure 24: Apple Watch Magnetic Charging Cable, Type EMC 3975

Figure 25: Vacuum cleaner of the brand Philips, Model SSA-5AP-12 EU

Figure 26: Set Top Box Ocilion P420 IP

Figure 27: Router TP-link, Model: Archer MR 600

Figure 28: Stereo system Philips FW 12

Figure 29: Desktop computer HP ProDesk 400 G7 Small Form Factor PC

According to interviews with several people from different households about their consumer behaviour, we assume an example household with 2 school kids and one person making home-office 2-3 days a week that uses all the above-mentioned electrical devices as described in Table 25. All electrical devices are switched off, when not used to **avoid stand-by**. Due to this behaviour, about

- 159 kWh
- 37 kg CO_2-equivalents, when using an electricity mix from Austria and abroad
- 27 kg CO_2-equivalents, when using an electricity mix from Austria and
- 2 kg CO_2-equivalents, when using certified electricity [5]
- 40 € (for calculation basis see chapter 2.3)

could be saved per year.

Table 25: Savings in an assumed household due to avoiding stand-by of diverse electrical devices

	Average duration of use in hours/day	Energy savings in kWh/year when avoiding stand-by
Laptop	3	5.70
Vacuum cleaner	0.25	8.67
Monitor	3	7.98
Alexa	2	8.57
Charging Cable Smart Watch	0.75	9.19
Set-top Box	3	16.14
Router	12	16.43
Stereo system	1	40.58
PC	3	42.02
Yearly energy savings in kWh		**159.47**
Yearly savings of CO_2-equivalents in kg, when using an electricity mix from Austria and abroad [5]		**36.68**
Yearly savings of CO_2-equivalents in kg, when using an electricity mix from Austria only [5]		**27.11**
Yearly savings of CO_2-equivalents in kg, when using electricity certified with the Austrian ecolabel [5]		**1.59**

In case all **133 residential buildings in the Focus District Großschönau** would avoid stand-by as in our example household about

- 21,210 kWh electricity
- 4,880 kg CO_2-equivalents, when using an electricity mix from Austria and abroad
- 3,610 kg CO_2-equivalents, when using an electricity mix from Austria and
- 210 kg CO_2-equivalents, when using certified electricity

- thus 0.92 kWh and between 0.01 and 0.21 kg CO_2-equivalents per m² NFA [5][1]

could be saved yearly.

5.1.7 Defrost the refrigerator regularly

An example household uses a deep freezer of the brand Liebherr Comfort GT 1432 (Figure 30).

Figure 30: Deep freezer used in the example household

Once a year this freezer is defrosted to save energy. Measurements with the "Energy Check 3000" of the brand "Voltcraft" on 29th July and 5th August showed an energy consumption of 0.528 kWh/day before the defrosting and 0.552 kWh/day after the defrosting with the same filling. Over the course of a year, the **defrosting** brings savings of about 9 kWh, 0.09 kg CO_2-equivalents as the example household uses certified electricity and 2 € [5] (see chapter 2.3). (Table 26).

Table 26: Savings due to defrosting the freezer

	Commercial usage, school, kindergarten, retail[2]
Daily energy consumption before the defrosting in kWh	0.528
Daily energy consumption after the defrosting in kWh	0.552
Energy savings in kWh/year	**9**
Savings of CO_2-equivalents in kg/year by using an electricity mix from Austria and abroad [5]	**2.01**
Savings of CO_2-equivalents in kg/year by using an electricity mix from Austria [5]	**1.49**
Savings of CO_2-equivalents in kg/year by using certified electricity [5]	**0.09**

In case all **133 residential buildings in the Focus District Großschönau** would defrost their freezers regularly they could save in sum about:

- 1,170 kWh/year
- 270 kg CO_2-equivalents in kg/year by using an electricity mix from Austria and abroad
- 200 kg CO_2-equivalents in kg/year by using an electricity mix from Austria
- 10 kg Savings of CO_2-equivalents in kg/year by using certified electricity
- and less than 0.1 kWh and kg per m² NFA [5][1].

5.1.8 Induction stove instead of ceramic hob

The energy savings of **using an induction stove** instead of a ceramic hob are calculated theoretical as there is no example household available where the energy consumption of the induction stove could be measured.

According to "Stiftung Warentest" – a German non-profit consumer organization that provides information on "proper housekeeping" and a "healthy lifestyle" through comparative tests – an intensively cooking household needs on average 315 kWh/year for cooking with an induction stove [17]. In comparison to the usage of a ceramic hob, this household can save yearly about 80 kWh, between 1 and 20 kg CO_2-equivalents (depending on the source of electricity) and about 20 € [5] (chapter 2.3). (Table 27).

[2] The buildings of the Sonnenplatz Großschönau GmbH were excluded, as they are already built as plus energy buildings and have no further energy saving potential.

Table 27: Comparison of ceramic hob and induction stove

	Ceramic hob	Induction stove	Savings
Energy consumption in kWh/year [17]	395	315	**80**
CO_2-equivalents in kg/year by using an electricity mix from Austria and abroad [5]	91	72	**19**
CO_2-equivalents in kg/year by using an electricity mix from Austria [5]	67	54	**13**
CO_2-equivalents in kg/year by using certified electricity [5]	4	3	**1**

In case all **133 residential buildings in the Focus District Großschönau** would use an induction stove instead of a ceramic hob they could save in sum about:

- 10,640 kWh/year
- 2,450 kg CO_2-equivalents in kg/year by using an electricity mix from Austria and abroad
- 1,810 kg CO_2-equivalents in kg/year by using an electricity mix from Austria
- 110 kg CO_2-equivalents in kg/year by using certified electricity and
- 0.46 kWh and less than 0.2 kg CO_2-equivalents per m^2 NFA and year [3][1].

5.1.9 Usage of water boiler instead of a pot

An example household boils 0,5 l water for tea every day with a water boiler of the brand Ambiano, Model GT-WKeds-06, thus – except 2 weeks holidays – on average 38 times a year (Figure 31).

Figure 31: Water boiler used in the example household

In **comparison to boiling the water with a pot** they can save about 3 kWh/year and about 0.5 kg CO_2-equivalents per year using an electricity mix from Austria in comparison to the usage of a pot (shown in Table 28), but this measure has hardly any financial impact. The energy consumption of the water boiler and in comparison, of a ceramic hob of the brand BEKO, Type: HDCC 32200 X was measured with the Energy Control 3000 USB and the Socket Sensor “ES-1” of the brand “Voltcraft®Plus” on 2nd of August 2024.

Table 28: Comparison of boiling 0.5-liter water with a water boiler or a pot

	Water boiler	Pot	Savings
Energy consumption in kWh per boiling process	0.03	0.114	**0.084**
Energy consumption in kWh/year	1	4	**3**
CO_2-equivalents in kg/year by using an electricity mix from Austria and abroad [1][5]	0.26	1	**0.73**
CO_2-equivalents in kg/year by using an electricity mix from Austria [5]	0.19	0.74	**0.54**
CO_2-equivalents in kg/year by using certified electricity [5]	0.01	0.04	**0.03**

In case **all 133 residential buildings in the Focus District Großschönau** would defrost their freezers regularly they could save in sum about:

- 420 kWh/year

- 100 kg CO_2-equivalents in kg/year by using an electricity mix from Austria and abroad
- 70 kg CO_2-equivalents in kg/year by using an electricity mix from Austria
- 4 kg Savings of CO_2-equivalents in kg/year by using certified electricity and
- less than 0.1 kWh and kg CO_2-equivalents per m² NFA [1][3].

5.1.10 Usage of lids

An example household of 5 persons (2 adults and 3 kids between 6 and 13 years) cooks every day for about 45 minutes on average on two hobs. About once a week the family uses the oven instead of the stove. Calculated for 1 year – excluded holidays, grilling, invitations and lunch in restaurants or at friends or relations - they use the stove about 275 times. One cooking process on one hob of a ceramic hob of the brand BEKO, HDCC 32200 X, Class 1 was measured with the "Energy Check 3000" of the brand "Voltcraft" on 14. August 2024 with lids, consuming about 0.67 kWh. The same cooking process was measured without lids on 16. August 2024, consuming about 1.02 kWh.

Figure 32: Ceramic hob of the brand BEKO, HDCC 32200 X, Class 1 used for the measurements of cooking processes as the power source was accessible

Yearly **the example household** can save about 200 kWh, 2 kg CO_2-equivalents using certified electricity and 40 € [5] (chapter 2.3) (shown in Table 29).

Table 29: Comparison of cooking with a lid and cooking without lid

	Cooking with a lid	Cooking without lid	Savings
Energy consumption in kWh/cooking process	0.67	1.02	**0.36**
Energy consumption in kWh/year (275 cooking processes, each on 2 hobs)	368	563	**195**
CO_2-equivalents in kg/year by using an electricity mix from Austria and abroad	85	130	**45**
CO_2-equivalents in kg/year by using an electricity mix from Austria	63	96	**33**
CO_2-equivalents in kg/year by using certified electricity	4	6	**2**

In case **all 133 residential buildings in the Focus District Großschönau** would change their cooking habit from cooking without lids to cooking with lids, they could save about:

- 25,970 kWh/year
- 5,970 kg CO_2-equivalents in kg/year by using an electricity mix from Austria and abroad,
- 4,420 kg CO_2-equivalents in kg/year by using an electricity mix from Austria,
- 260 kg Savings of CO_2-equivalents in kg/year by using certified electricity and
- about 1.10 kWh and less than 0.3 kg CO_2-equivalents per m^2 NFA [1][3].

5.1.11 Usage of an egg boiler instead of a pot

An example household cooks 4 hard-boiled breakfast eggs every Sunday and on feast days, thus about 64 times a year, using an egg boiler of the brand SIMPEX Basic 28668 (Figure 33).

Figure 33: Egg boiler of the brand SIMPEX Basic 28668

In comparison to the usage of a pot they can save about 3 kWh/year and about 0.5 kg CO_2-equivalents per year (using an electricity mix from Austria) (shown in Table 30), but this measure has hardly any financial impact. The energy consumption of the egg boiler and in comparison, of a ceramic hob of the brand BEKO, HDCC 32200 X, Class 1 (Figure 32) was measured with the Energy Control 3000 USB and the Socket Sensor "ES-1" of the brand "Voltcraft® Plus" on 2nd of August 2024.

Table 30: Comparison of boiling eggs with an egg boiler and a pot

	Energy consumption in kWh per cooking process	Energy consumption in kWh/year	CO_2-equivalents in kg/year when using an electricity mix from Austria and abroad [5]	CO_2-equivalents in kg/year when using an electricity mix from Austria [5]	CO_2-equivalents in kg/year when using certified electricity [5]
Egg boiler	0.082	5	1.21	0.89	0.05
Pot	0.124	8	1.83	1.35	0.08
Yearly savings		**3**	**0,62**	**0.46**	**0.03**

If **all 133 residential buildings in the Focus District Großschönau** would cook eggs like in the example described above, about

- 360 kWh
- 80 kg CO_2-equivalents, when using an electricity mix from Austria and abroad,
- 60 kg CO_2-equivalents, when using an electricity mix from Austria,
- 4 kg CO_2-equivalents, when using certified electricity and

- thus 0.02 kWh and less than 0.01 kg CO_2-equivalents per m² NFA [1]

could be saved yearly [5].

5.2 Use clean energy

5.2.1 Electric lawn mower instead of gasoline lawn mower

An example household mows its lawn with the size of 646 m² about 28 times a year. In former times the family used a gasoline lawn mower and needed about 16,8 l premium petrol per year. Now they switched to an electric lawn mower (Figure 34), which uses about 1.5 charges of a battery of the brand "BOSCH" with a charging capacity of 144 Wh per mowing process (Figure 35).

Figure 34: Electric lawn mower of the brand Bosch

Figure 35: Battery for the lawn mower of the brand Bosch

Due to this conversion, they can save about 140 kWh/year and about 45.5 kg CO_2-equivalents (using an electricity mix from Austria) (as shown in Table 31). The financial savings amount to 270 € per year [26] (for calculation basis see chapter 2.3).

Table 31: Comparison of gasoline and electric lawn mower

	Petrol in l/year	Energy in kWh/year	CO_2-equivalents in kg/year when using an electricity mix from Austria and abroad [5]	CO_2-equivalents in kg/year when using an electricity mix from Austria [5]	CO_2-equivalents in kg/year when using certified electricity [5]
Gasoline lawn mower	167	151 [9]	47	47	47
Electric lawn mower	0	9	2	1.5	0.09
Yearly savings		**143**	**45**	**45.5**	**46.91**

If **all 133 residential buildings in the Focus District** have a similar size of lawn, that is mown 28 times a year

- 18,960 kWh and about
- 6,000 kg CO_2-equivalents

could be saved per year.

5.2.2 Usage of energy from an energy community

In 2023 a small energy community existing of one producer and three consumer was founded in the Focus District Großschönau. The generation system with an output of 25 kWp is located on the roof of an agricultural building (Figure 36). The regional local supplier and 2 private households (a family and a senior couple) were won as customers. In one year around 15,500 kWh of electricity were generated for communal use. The virtual allocation of the energy generated by the community is based on the actual physical consumption (measurement at the metering point) of the consumption systems, limited to quarter hours. Around 9,500 kWh were consumed within the energy community and about 6,000 kWh of electricity generated within the community were fed into the grid. The energy community's degree of self-sufficiency is 16 %. The remaining electricity demand is purchased individually by each consumer. In the first year the consumers could save between 70 € and 920 € (depending on the amount of electricity used from the community).

Figure 36: The chairman and owner of the production plant (seen in the back) of the local energy community in Großschönau

The energy community causes no energy savings, but **in comparison to using an electricity mix from Austria** it saves about 1,520 kg CO_2-equivalents/year and **in comparison, to using an electricity mix from Austria and abroad** it even saves about 2,090 kg CO_2-equivalents/year.

Further, it enables the whole population to become part of the energy transition and use cheap and renewable electricity from a local electricity market. The described energy community was a first possibility in the Focus District Großschönau to produce and consume electricity locally. This reduces the load on the grid and increases local added value. In addition, the energy community contributes to the municipality's goal of becoming energy self-sufficient by 2030 and fits in perfectly with the region's slogan "Self-sufficient into the future".

There are also **economic benefits**, namely:

- Locally generated energy contributes to local value creation.
- Supra-regional electricity transportation is reduced. Above all, this is a key cornerstone of the future energy system and grid expansion plans.
- Regions and municipalities become more autonomous.
- Grid fees for members are lower.

The local energy community has already found **potential for imitation**. Building on the experience gained from the establishment of the local energy community, the “Climate and Energy Model Region Lainsitztal” founded a **regional energy community** in close cooperation with Sonnenplatz Großschönau GmbH. In a first step, this is limited to all production and consumption facilities in the municipality of Großschönau with a total of 32 metering points. Initially, the photovoltaic systems of the elementary school, the building yard, the daycare facility, the municipal office, fire brigades and the sewage treatment plants were included. In the other member municipalities of the “Climate and Energy Model Region Lainsitztal”, which are connected to a different substation, another regional energy community was established. Here too, the municipal buildings will be integrated as a first step. As experience is gained, private individuals and businesses will also be invited to participate in these two regional energy communities.

5.3 Produce energy in a sustainable way

5.3.1 Energy production via own photovoltaic system

Table 32 shows the **monthly electricity production via PV-systems in 3 example households** in the Focus District Großschönau in the year 2023. On average, the 3 example households produced 20,020 kWh in total and 1,010 kWh per kWp. **In comparison to the usage of an electricity mix from Austria and abroad**, the 3 example households can save about 3,540 kg CO_2-equivalents/year and **in comparison to the usage of an electricity mix from Austria** about 2,340 kg CO_2-equivalents/year [10][5]. The financial savings of the example households amount to 230 € – 1,060 € per year (for calculation basis see chapter 2.3).

Table 32: Electricity production via PV-systems of 3 example households in the Focus District Großschönau

	Example household 1	Example household 2	Example household 3
Capacity of PV-system in kWp	6	25	28
Alignment	south	south-east	south
Inclination	15 °	40 °	18 °
Electricity produced in kWh in the year 2023			
January	115	762	539
February	185	1,133	1,270
March	488	2,114	2,280
April	537	2,170	2,534
May	811	3,175	3,691
June	917	3,524	4,096
July	934	3,659	4,058
August	700	2,811	3,118
September	704	2,910	3,245
October	428	1,870	2,041
November	189	937	1,005
December	91	516	489

Year	6,098	25,582	28,366
CO_2-equivalents in kg/year for electricity produced by a PV-system [10]	323	1,356	1,503
CO_2-equivalents in kg/year by using an electricity mix from Austria and abroad [5]	1,403	5,884	6,524
CO_2-equivalents in kg/year by using an electricity mix from Austria [5]	1,037	4,349	4,822
Savings of CO_2-equivalents in kg/year in comparison to an electricity mix from Austria and abroad	1,079	4,528	5,021
Savings of CO_2-equivalents in kg/year in comparison to an electricity mix from Austria	713	2,993	3,319

Up to now, 32 out of 146 buildings in the Focus District Großschönau have already installed a PV system with a summed-up capacity of 551 kWp, thus on average, about 17 kWp per building.

Figure 37: Aerial view of Großschönau with several PV-systems

In case **all the remaining 114 buildings** would install an average PV system with a capacity of 17 kWp, they could produce 1,951,180 kWh/year and save yearly about

- 345,360 kg CO_2-equivalents in comparison to the usage of an electricity mix from Austria and abroad
- 28,290 kg CO_2-equivalents in comparison to the usage of an electricity mix from Austria and
- 13 - 20 kg CO_2-equivalents per m² net floor area, depending on the compared electricity mix as described above [10][5].

Further ecological and economic benefits of PV-systems are:

- Generating their own electricity raises the awareness of the population in concern of energy efficiency and saving.
- Electricity is produced and consumed locally, and supra-regional electricity transportation is reduced.
- Locally produced electricity contributes to the municipality's goal of becoming energy self-sufficient by 2030 and fits in perfectly with the region's slogan "Self-sufficient into the future".
- In Austria, PV-systems have a guarantee that they can still generate 80 % of their output after 25 years. Under favourable conditions, PV-systems pay for themselves after 8 years.

6 Replication in the field of "Mobility"

Within the category "mobility", we describe 6 different measures:

- Reduction of speed
- Carpooling
- Conversion from combustion to electric car
- Usage of e-car-sharing
- Conversion from combustion to public transport
- Conversion to e-bike.

6.1 Save energy

6.1.1 Reduction of speed

This best-practice example will be calculated theoretical. We assume, that a person, living in Großschönau, drives to Vienna and back to Großschönau once a week. This could be the case, because the person is studying at the university and therefore lives in an apartment or in a student residence in Vienna during the week. In this case, we further assume, that the person is staying in Großschönau due to holidays for 6 weeks per year.

The route from Großschönau to Vienna leads over 48 km highway from St. Pölten to Vienna (shown in Figure 38). In Austria it is allowed to drive a maximum of 130 km/h on the highway. In case the person would drive 100 km/h instead of 130 km/h, he or she could save 0,73 l fuel and 2 kg CO_2-equivalents per trip. This was determined with a calculation system based on the open-source-databank "OpenStreetMap" that considers the current speed limit on the road section and refers to the average consumption of the Austrian passenger car fleet [19].

Figure 38: Highway on the route from Großschönau to Vienna [19]

As shown in Table 33 the **person can save** between 620 and 670 kWh/year (depending on the fuel of the car) and 180 kg CO_2-emissions per year [17]. The financial savings amount to about 110 € per year [26][27].

Table 33: Savings when driving on average 100 km/h instead of 130 km/h on the highway from St. Pölten to Vienna [19]

	1 trip (St. Pölten – Vienna)	Per week (St. Pölten – Vienna and back)	Per year (considering 6 weeks holidays)
Kilometres	48	96	4,416
Saving of fuel in l	0.73	1.46	67.16
Additional driving time in minutes	6	12	552
Savings of kWh in case of a petrol car (Average calorific value: 9,2 kWh/l)	**6.72**	**13.43**	**617.87**
Savings of kWh in case of a diesel car (Average calorific value: 10 kWh/l)	**7.30**	**14.60**	**671.60**
Savings of CO_2-emissions in kg	**2**	**4**	**184**

In the **Focus District Großschönau**, there are **26 people commuting to Vienna once a week or at least once per month**, some of them in a carpool. In sum, we assume 1,640 drives from Großschönau to Vienna and back per year. In case, all these people would drive on average 100 km/h instead of 130 km/h on the highway from St. Pölten to Vienna, like in the example described above, they could save yearly

- between 11,010 and 11,970 kWh (depending on the used fuel) and
- 3,280 kg CO_2-emissions per year [19].

6.1.2 Carpooling

Two persons from separate households, who live in Großschönau and work 5 days a week in Zwettl, a city about 19 km away, drive to work together and take turns driving. One of them drives with a Škoda Superb Combi with an engine power of 110 kW/150 PS (year of manufacture: 2015) and the other one with a VW Sharan with an engine power of 103 kW/140 PS (year of manufacture: 2012).

In the year 2023 with 247 working days each of them droves 4,693 km. In the case the two of them had driven separately, each of them would have covered 8,056 km (holidays and sickness leave excluded).

As shown in Table 34 **this example of carpooling** saves about 5,600 kWh/year and 1,820 kg CO_2-equivalents per year and yearly 2,800 kWh/person and 910 kg CO_2-equivalents/person [3]. The financial savings amount to about 920 € per year [27].

Table 34: Savings due to carpooling

		Škoda (diesel)	VW Sharan (diesel)	Sum
	Average fuel consumption in l/100 km (according to calculations of the vehicle owners)	8,1	8,54	
	Average calorific value in kWh/l [9]	10	10	
Carpooling (4,446 km/car/year)	Average fuel consumption in l/year	380	401	
	Average energy consumption in kWh/year	3,801	4,008	7,809
	Average CO_2-equivalents in kg/year [5]	1,235	1,303	2,538
Without carpooling (7,632 km/car/year)	Average fuel consumption in l/year	653	688	
	Average energy consumption in kWh/year	6,525	6,880	13,405
	Average CO_2-equivalents in kg/year [5]	2,121	2,236	4,357
Yearly energy savings in kWh				**5,596**
Yearly energy savings in kWh/person				**2,798**
Yearly savings in CO_2-equivalents in kg [5]				**1,819**
Yearly savings in CO_2-equivalents in kg/person [5]				**909**

In the **Focus District Großschönau 123 persons commute from their hometown**. In case all of them would at least drive with another person like in the example described above, about

- 341,360 kWh and
- 110,940 kg CO_2-equivalents

could be saved per year.

Further ecological and economic benefits of carpooling are:

- Cost savings
- Reduction of traffic
- Reduced risk of accidents
- Social contacts and maintenance on the way to work
- Share of responsibility
- And above all cost savings: In the described example above each person could save about 440 € in the year 2023 with an average diesel price of 1,58 €

6.2 Use clean energy

6.2.1 Conversion from combustion engine to electrical car

An example household of 5 people needs 2 cars to make the daily journeys to the workplace of the two adults. Switching to public transport is not possible due to the location of the workplaces. In 2022, around 5,500 km were driven with a Honda Civic (using petrol) and 17,000 km with a Ford Galaxy (using diesel). With a total mileage of 22,500 km/year, this results in a yearly energy consumption of around 16,200 kWh. In 2023, the **Honda Civic was replaced by a Renault Zoe electric vehicle**, which is now used by the family (Figure 39).

Figure 39: Electrical vehicle of the brand Renault Zoe

As a result, only around 10,000 km were covered with the diesel vehicle in 2023 and around 12,500 km with the electric vehicle. With a total consumption of around 9,250 kWh, this results in annual savings of around 6,950 kWh and 2,870 kg CO_2-equivalents using certified electricity, thus in annual savings of around 1,390 kWh per person and 570 kg CO_2-equivalents per person (shown in Table 35). The financial savings amount to about 1,060 € per year [26][27] (for calculation basis see chapter 2.3).

The so called "grey energy", the energy needed throughout the life cycle of the cars from its production to its disposal, is not considered in the calculations.

Table 35: Savings due to the conversion from a burner to an e-car

	Honda Civic (petrol)	Ford Galaxy (diesel)	Renault Zoe (electric	Sum
Mileage 2022 in km	5,500	17,000		22,500
Mileage 2023 in km		10,000	12,500	22,500
Average fuel consumption in l/100 km	9	7		
Average fuel consumption in the year 2022 in l	468	1,190		
Average fuel consumption in the year 2023 in l		700		
Average calorific value in kWh/l [9]	9,2	10		
Average energy consumption in kWh/100 km	78	70	18	
Total energy consumption in kWh in 2022	4,301	11,900		16,201
Total energy consumption in kWh in 2023		7,000	2,250	9,250
Average CO_2-equivalents in the year 2022 in kg [5]	1,300	3,868		5,167

Average CO_2-equivalents in the year 2023 in kg using certified electricity [5]		2,275	23	2,298
Average CO_2-equivalents in the year 2023 in kg using an electricity mix from Austria [5]			383	2,658
Average CO_2-equivalents in the year 2023 in kg using an electricity mix from Austria and abroad [5]			518	2,793
Yearly energy savings in kWh				**6,951**
Yearly energy savings in kWh/person				**1,390**
Yearly savings in CO_2-equivalents in kg using certified electricity [5]				**2,870**
Yearly savings in CO_2-equivalents in kg/person using certified electricity [5]				**574**
Yearly savings in CO_2-equivalents in kg using an electricity mix from Austria [5]				**2,375**
Yearly savings in CO_2-equivalents in kg using an electricity mix from Austria and abroad[5]				**2,510**

Now, only about 12 vehicles out of about 227 vehicles in the Focus District Großschönau are electrically driven. If the calculated savings in the described example are transferred **to all inhabitants in the Focus District Großschönau**, approximately

- 421,230 kWh and
- 173,900 kg CO_2-equivalents using certified electricity
- 152,090 kg CO_2-equivalent using an electricity mix from Austria and
- 143,900 kg CO_2-equivalents using an electricity mix from Austria and abroad [5]

could be saved per year.

6.2.2 Usage of e-car-sharing

Private cars usually only drive a few hours per day and spend most of the time parked. "Car-sharing" means, that a car is provided and can be borrowed for a fee. Thus, people don't have to buy their own car but can use the provided car when they really need it and the rest of the time, other people can use it. All costs incurred for maintenance and care, insurance and tax, repairs, tire changes and all organizational matters are borne by the car-sharing provider and people don't need their own garage or parking space. This is why the concept of sharing one car with other people makes lots of sense, especially considering sustainability, but also concerning costs.

The most sustainable way is to **share an e-car** because the life cycle assessment of cars with different drive systems shows, that e-cars cause less emissions than burner. Considering the **whole lifecycle of cars** – including not only the operation, but also the production, maintenance, disposal and recycling of the vehicle and battery and the consumption and the provision of electricity and fuels – an e-car can save about 0.05 kg CO_2-equivalents per km in comparison to a diesel car and 0.071 kg CO_2-equivalents per km in comparison to a standard car. Basis for these calculations are an average lifetime mileage of 150,000 kilometres and the production of the cars in Europe, while battery production is considered according to the current mix of manufacturing countries. [12] Considering the whole lifetime mileage, 7,500 kg CO_2-equivalents can be saved in comparison to a diesel car and 10,650 kg CO_2-equivalents in comparison to a standard combustion based car (shown in Table 36).

Table 36: Comparison of the life cycle assessment of cars with different drive systems [12]

	E-car	Diesel car	Petrol car
CO_2-equivalents in g/km	162	212	233
CO_2-equivalents in kg according to the whole lifetime mileage of 150,000 km -	24,300	31,800	34,950
Savings of CO_2-equivalents in kg according to the whole lifetime mileage of 150,000 km in comparison to an e-car		**7,500**	**10,650**

Austrians invest on average about 5,700 € per year in their car[30]. E-car-sharing systems use different conditions. In the case of the e-car-sharing system in Zwettl each user must pay an annual fee of 240 €, 18 cents per kilometre driven and from the 4th hour of usage 1 €/hour or par thereof [31]. Without considering the hourly costs this would result in financial savings of about 3,140 € per year.

In Großschönau there is no car-sharing-system available. This is why the following example is just theoretical. **One car-sharing system can replace up to 20 private cars** [13]. This means, that an e-car-sharing system could save up to 150,000 – 213,000 kg CO_2-equivalents during the whole lifetime of the e-car. As Austrians drive on average 12,900 km/year [21] these 150,000 km will be driven in about 11.5 years. Thus, the savings per year are on average 15,780 kg CO_2-equivalents.

6.2.3 Conversion from combustion to public transport

An example person living in Großschönau and working in the bank in Zwettl from Monday to Friday from 8 a.m. to 4 p.m. switched to public transport in the year 2024. In the year 2023 the person drove about 8,140 km to work (holidays and sickness leave excluded), using a VW Passat Kombi with an engine power of 110 kW (year of manufacture: 2015) and an average diesel consumption of 6 l/100 km (details of the vehicle owner). In the year 2024 the person started driving per bus, whereby the timetable differs between vacations and school days. During vacations the bus drives directly to Zwettl (Figure 40), but on school days the route goes via other villages/towns, which extends the route from 19,2 to 31,5 km (Figure 41) or the person has to switch the bus in Weitra, which extends the route to 27,6 km (Figure 42).

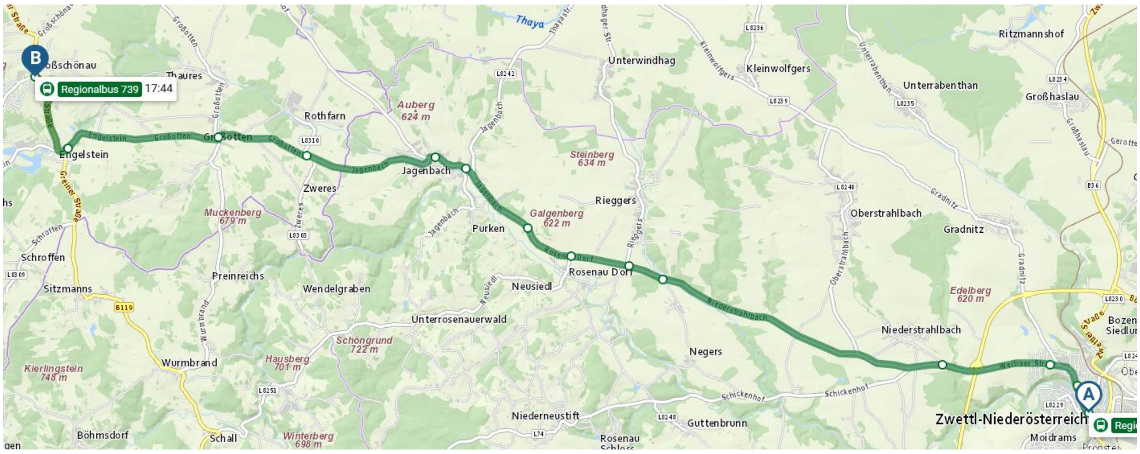

Figure 40: Direct bus route from Großschönau to Zwettl and back during vacations (19,2 km)

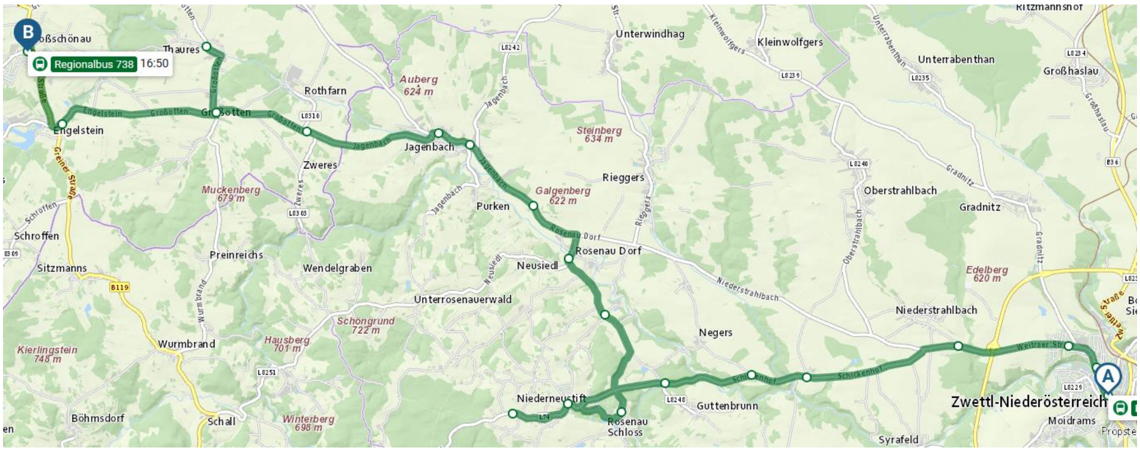

Figure 41: Bus route from Zwettl to Großschönau via several villages on school days (27,6 km)

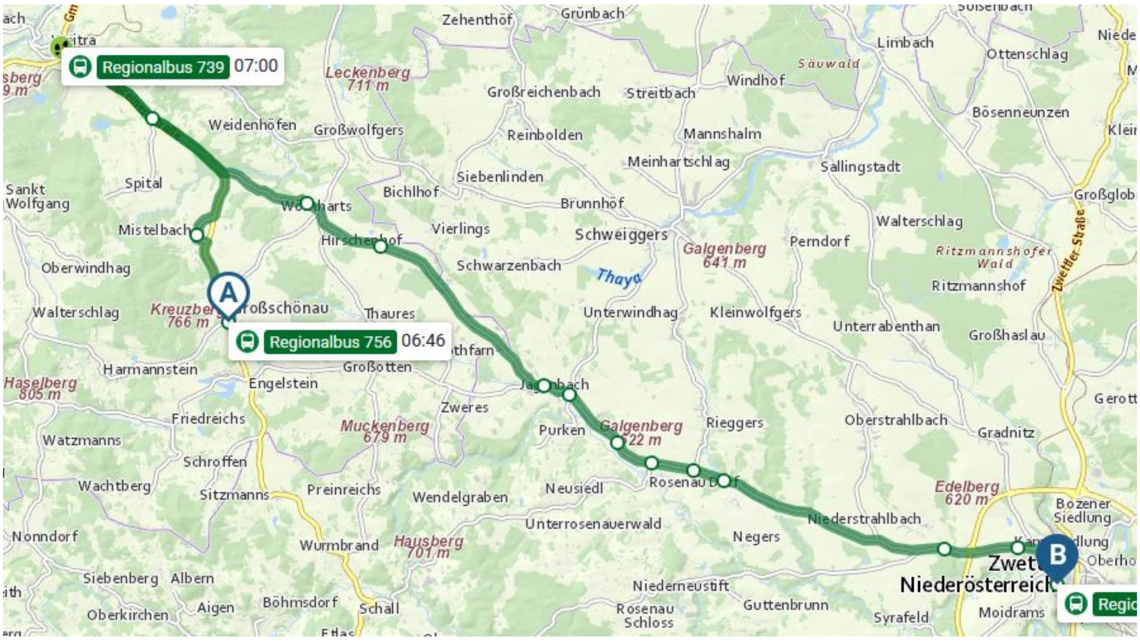

Figure 42: Bus route from Großschönau to Zwettl via Weitra on school days (31,5 km)

Of course, one single person driving with the bus, causes no savings. But as you can see in Table 37 the **8th person driving from Großschönau to Zwettl by bus every working day** according to the example described above already causes savings of about 4,730 kWh/year and 720 kg CO_2-equivalents/year [5][9][14].

Table 37: Savings when using the bus instead of driving by car to work

	Bus	VW Passat Kombi (diesel)	7 VW Passat Kombis (diesel)	8 VW Passat Kombis (diesel)
Driven distance in km/year	11,525	8,141	56,986	65,126
Average energy consumption in kWh/year	34,345 [14]	4,884 [9]	34,191	39,076
Average CO_2-equivalents in kg year	11,976 [14]	1,587 [5]	11,112	12,700
Yearly energy savings when using the bus in kWh		**-29,461**	**-154**	**4,731**
Yearly savings of CO_2-equivalents when using the bus in kg		**-10,388**	**-864**	**724**

During school days the bus in the morning is normally fully loaded with about 45 passengers. In the afternoon the utilization of the bus differs from day to day, assuming 10-20 passengers. During vacations the bus is not used very much, assumed by 3 passengers on average. Thus, the average utilization of the bus is 23 passengers. In case **23 drives from Großschönau to Zwettl during the working days could be substituted** as described above

- 78,000 kWh and about
- 24,540 kg CO_2-equivalents

could be saved per year [3][7][13].

The financial savings of the person using the bus instead of his car amount to about 300 € per year [27][28].

6.2.4 Conversion to e-bike

An example person, working in Großschönau, must cover a working distance of 8.3 km. A test ride showed that completing this route to work and back home on an e-bike "EVO eco lite" consumes about 0.067 kWh.

Figure 43: E-bike used for the example travel

Per year the example person would drive about 4,100 km on 227 working days (taking holidays, sick leaves and bad weather days into account). In sum, driving by e-bike would require about 15 kWh per year. **In comparison to the cars**, already described in chapter 6.2.1 **driving by e-bike** could yearly save between 660 and 2,930 kWh and between 7 and 1,100 kg CO_2-equivalents (Table 38). The financial savings amount to about 150 €, substituting the e-car, and about 600 €, substituting a burner [26][27] (for calculation basis see chapter 2.3).

Table 38: Comparison of driving an example route by e-bike or petrol, diesel or electric car

	E-Bike	Honda Civic (petrol)	Ford Galaxy (diesel)	Renault Zoe (electric)
Average energy consumption in kWh/year driving 4,100 km	15	2,947 [9]	2,638 [9]	678
Average CO_2-equivalents in kg/year when using electricity from Austria and abroad [5]	3	1,199	733	156
Average CO_2-equivalents in kg/year when using	3			115

electricity from Austria [5]				
Average CO_2-equivalents in kg/year when using certified electricity [5]	0.15			7
Yearly energy savings in kWh when using the e-bike		**2,932**	**2,623**	**663**
Yearly savings of CO_2-equivalents in kg when using the e-bike and an electricity mix from Austria and abroad		**1,099**	**730**	**153**
Yearly savings of CO_2-equivalents in kg when using the e-bike and an electricity mix from Austria		**1,100**	**731**	**113**
Yearly savings of CO_2-equivalents in kg when using the e-bike and certified electricity		**1,102**	**733**	**7**

In the Focus District Großschönau **11 households have e-cars**. All the other **122 households still have burner.** In case all 133 residential buildings would at least **substitute a route of 16.6 km on 227 days per year** (as described above) with an e-bike, about

- 338,800 kWh and between 111,540 and 111,950 kg CO_2-equivalents can be saved in comparison to the 122 burners
- 7,290 kWh and between 70 and 113,220 kg CO_2-equivalents can be saved in comparison to the 11 e-cars and
- 346,090 kWh and between 112,020 and 113,220 kg CO_2-equivalents can be saved in sum.

simply positive

7 Replication in the Public Area

For the public sector, a combination of the other categories can be applied, only with respect to specifics of public administration. In this area we identified and described below in detail 7 different measures:

- Thermal renovation of public buildings
- Conversion of all street lighting to LED
- Build new public buildings as passive houses
- Conversion of public lighting to LED
- Usage of electric cars
- Usage of photovoltaic systems
- Installation of wind turbines.

7.1 Save energy

7.1.1 Thermal renovation of public buildings

The childcare facility with a gross floor area of about 472 m², heated with the district heating system in Großschönau was renovated and expanded 2017 as follows:

- Expansion to 674 m² gross floor area
- Insulation of the exterior façade with 14 cm polystyrene (EPS+) and
- Insulation of the storey ceiling in the attic with 30 cm polystyrene concrete.

Due to this **thermal renovation** the energy index of the building could be reduced from 143,5 kWh/m²a to 46,7 kWh/m²a. **Despite the expansion**, the average energy consumption could be reduced by about 1,870 kWh/year, which causes savings of CO_2-equivalents of about 340 kg/year (Table 39) and financial savings of about 230 €/year. Per m² NFA the yearly savings are ~ 80 kWh and 10 kg CO_2-equivalents [5].

Table 39: Savings concerning the thermal renovation of the childcare facility in Großschönau

	Before thermal renovation	After thermal renovation
Average yearly energy consumption in kWh	63,605	61,732
Average yearly CO_2-equivalents in kg [5]	11,449	11,112
Average yearly energy consumption in kWh/m²	168	115

Average yearly CO_2-equivalents in kg/m² [5]	30	21
Yearly energy savings in kWh in total		**1,873**
Yearly savings of CO_2-equivalents in kg in total		**337**
Yearly energy savings in kWh/m² NFA		**54**
Yearly savings of CO_2-equivalents in kg/m² NFA		**10**

As described in chapter 3.1.1. **building types 1-6 could improve by the modernization of their windows and the insulation of their walls** with a thickness of 16 cm similar to the above mentioned example [1][4]. This applies to 11 public buildings in the Focus District Großschönau with a summed up NFA of about 4,274 m² [1]. Recently renovated buildings (renovation after the year 2000 and buildings with an energy index better than 47 kWh/m²a) and a museum that cannot be renovated due to monument protection were excluded. Now, these 10 buildings have an **average energy index of 87 kWh/m² a**, whereby the energy index is not known for all buildings. All in all, the energy indexes of 87 out of the whole 146 buildings in the Focus District are known, especially due to a project in the year 2009, where voluntarily participating households were individually assessed.

If the whole NFA of 4,274 m² would be renovated like described above from an average energy index of 87 kWh/m²a to 46,7 kWh/m²a, about 173,326 kWh could be saved yearly.

7.1.2 Conversion of all street lighting to LED

Since 2016 the **municipality of Großschönau switched the street lightings to LEDs** gradually. Of 423 luminaires on the municipal territory, almost 95% (about 400 pieces) have already been converted to LEDs up to now. In comparison to the year 2016 about 21,830 kWh, thus 54 % of the electricity used for street lighting, can be saved per year (Figure 44). The financial savings amount to about 4,800 € in the year 2024 in comparison to the year 2016 (for calculation basis see chapter 2.3).

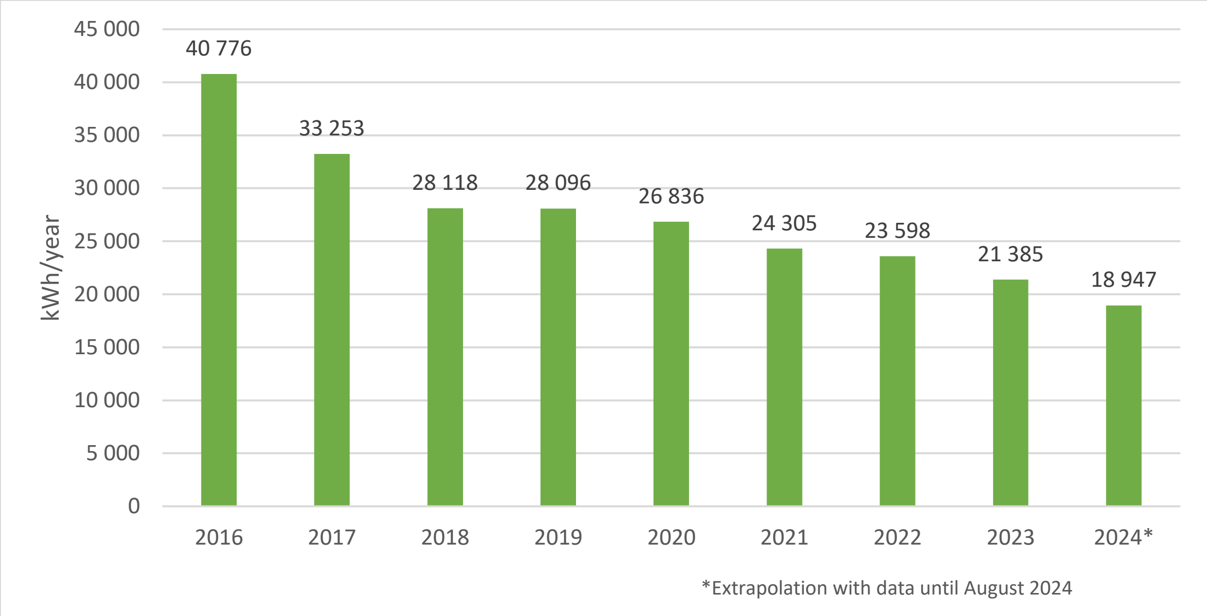

Figure 44: Yearly electricity consumption of the street lighting in the Focus District Großschönau

This results in yearly savings of CO_2-equivalents of about:

- 5,020 kg using an electricity mix from Austria and abroad
- 3,710 kg using an electricity mix from and
- 220 kg using certified electricity [5]

7.1.3 Build new public buildings as passive houses

The multi-purpose building Sonnenplatz in Großschönau, which consists of a bureau including seminar rooms (the smaller part of the building on the right in Figure 45) and an exhibition hall (the larger part of the building on the left in Figure 45), was built as a passive house in 2012. The bureau has an energy index of 11 kWh/m²/a, and the exhibition hall of 7 kWh/m²/a.

Figure 45: Exterior view of Sonnenplatz Großschönau

As already described in chapter 7.1.1 the childcare facility was renovated to **low-energy house standard**, which means that it has an energy index below 50 kWh/m²/a now. The municipality office has an energy index of 96,1 kWh/m²/a. All three buildings are connected to the district heating system.

Table 40 shows the yearly energy consumption for heating of these three buildings. The described **passive house** needs about 60 kWh/m² less than the low-energy house and about 116 kWh/m² less than the normal house and thus saves 12-18 kg CO_2-equivalents per m² and year [5]. The financial savings amount to about 10 € per m² and year.

Table 40: Comparison of the energy consumption of 3 communal buildings with different energy standards in Großschönau

	Example for passive house	Example for low-energy house	Example for normal house
Construction year	2011	1800/1998	1978/1970/182
Energy index in kwh/m²/a	7 and 11	46,7	96,1
Net floor area in m²	4,063.4	539	546.4
Yearly energy consumption for heating in kWh	56,734	42,093	63,183
Yearly energy consumption for heating in kWh/m² NFA	13.96	78.09	115.63
Yearly energy savings in kWh per m² NFA		**64**	**102**
Yearly savings in CO_2-equivalents in kg per m² NFA [5]		**12**	**18**

In the **Focus District Großschönau** there are 16 public buildings, only the **2 building parts** described above are built **as passive houses**. The other 13 public buildings (one was excluded in this calculation due to monument protection) have a NFA of about 5,984 m² and an **average energy index of 101 kWh/m²a**, whereby the energy index is not known for all buildings [1]. As already described in chapter 3.1.1, the energy index of 87 out of the whole 146 buildings in the Focus District is known, especially due to a project in the year 2009, where voluntarily participating households were individually assessed.

If the whole NFA of about 5,984 m² would have been built in passive house standard with a maximum energy index of 15 kWh/m²a instead of the average energy index of 110 kWh/m²a, about 268,755 kWh could be saved yearly.

7.1.4 Conversion of public lighting to LED

The soccer field in Großschönau is illuminated with 24 lights (6 columns with 4 luminaires each). In former times, mercury vapor lamps were used, which were not very bright. Now those lamps were substituted by LED lamps with 400 Watt. LED lamps can reach 210 lm/W, whereby mercury vapor lamps can only reach 105 lm/W [20]. If mercury vapor lamps with the same brightness as the new LED lamps had been used, they would require 800 Watt.

As the **lighting of the soccer field** is used about 10 times a year for 4 hours, **the conversion to LED lamps** saves yearly about 770 kWh and 8 kg CO_2-equivalents, using certified electricity [5]. The financial savings amount to about 80 € per year (for calculation basis see chapter 2.3).

Table 41: Savings due to the conversion of the lighting of the soccer field in Großschönau to LED lamps

	Mercury vapor lamps	LED lamps
Energy consumption of 24 lights in kWh/year [20]	384	768
CO_2-equivalents in kg/year when using an electricity mix from Austria and abroad [5]	88.32	176.64
CO_2-equivalents in kg/year when using an electricity mix from Austria only [5]	65.28	130.56
CO_2-equivalents in kg/year when using electricity certified with the Austrian ecolabel [5]	3.84	7.68
Yearly energy savings in kWh		**384**
Yearly savings of CO_2-equivalents in kg, when using an electricity mix from Austria and abroad [5]		**88.32**
Yearly savings of CO_2-equivalents in kg, when using an electricity mix from Austria only [5]		**65.28**
Yearly savings of CO_2-equivalents in kg, when using electricity certified with the Austrian ecolabel [5]		**3.84**

7.2 Use clean energy

7.2.1 Usage of electric cars

The construction yard employees of the municipality of Großschönau used their private cars, a VW Caddy (petrol) and a Dacia Duster (diesel), for working and invoiced mileage in the past. In the year 2022 the municipality purchased two electric cars: a Renault Kangoo (Figure 46) and an Opel Vitara, which are now used for a mileage of about 20,000 km/year in sum.

Figure 46: An electric car of the municipality of Großschönau

Calculating with an average fuel consumption of former burners of 6.5 l/100 km, the **conversion to e-cars** saves about 7,740 kWh and 2,360 kg CO_2-equivalents per year, using electricity from renewable sources [5][9] (Table 42). The financial savings amount to about 1,090 € per year, using electricity from the grid. As the municipality has installed a PV-system the financial savings will be even bigger as they can use their own electricity.

Table 42: Savings due to conversion of e-cars in the municipality Großschönau

	VW Caddy (petrol) and Dacia Duster (diesel)	Opel Vitara (electric)	Renault Kangoo (electric)
Average km per year	19,754	6,924	12,830
Average fuel consumption in l/100 km	6.5		
Average fuel consumption in l/year	796		
Average calorific value in kWh/l [9]	9.6		

Average energy consumption in kWh/year	12,247	1,939	2,566
CO_2-equivalents in kg/year by using an electricity mix from Austria and abroad [3]	2,400	1,036	
CO_2-equivalents in kg/year by using an electricity mix from Austria [3]		766	
CO_2-equivalents in kg/year by using certified electricity [3]		45	
Yearly energy savings in kWh			**7,743**
Yearly energy savings in kWh/km			**0.39**
Yearly savings of CO_2-equivalents in kg by using an electricity mix from Austria and abroad [5]			**1,364**
Yearly savings of CO_2-equivalents in kg by using an electricity mix from Austria [5]			**1,634**
Yearly savings of CO2-equivalents in kg by using certified electricity [5]			**2,355**

7.3 Produce energy in a sustainable way

7.3.1 Usage of photovoltaic systems

There are **12 PV-systems with a summed-up capacity of 174 kWp installed on the 16 public buildings** in the Focus District Großschönau. One of them is a wall installation, the others are installed on the roofs. These PV-systems could produce about 180,734 kWh in the year 2023, which saved about 21,150 kg CO_2-equivalents in comparison to the usage of an electricity mix from Austria and abroad and about 31,990 kg CO_2-equivalents in comparison to the usage of an electricity mix from Austria [10][5]. In comparison to the usage of electricity from the grid, all public buildings can save about 39,770 € per year in sum (production costs of the PVs are not taken into account here).

Table 43: Electricity production via PV-systems of the public buildings in the Focus District Großschönau

		12 PV-systems on the 16 public buildings in the Focus District Großschönau
Electricity produced in kWh in the year 2023	January	3,285
	February	6,682
	March	13,204
	April	14,369
	May	24,282
	June	27,791
	July	28,591
	August	21,091
	September	21,195
	October	11,948
	November	5,523
	December	2,771
	Year	**180,734**
CO_2-equivalents in kg/year for electricity produced by a PV-system [10]		**9,579**
CO_2-equivalents in kg/year by using an electricity mix from Austria [5]		**30,725**
CO_2-equivalents in kg/year by using an electricity mix from Austria and abroad [5]		**41,569**
Savings of CO_2-equivalents in kg/year in comparison to an electricity mix from Austria		**21,146**
Savings of CO_2-equivalents in kg/year in comparison to an electricity mix from Austria and abroad		**31,990**

Now, the PV-potential on public buildings in the Focus District Großschönau is nearly exhausted. The remaining roofs are not usable due to shadowing or the material. There would be only a small, but not perfect suited potential of about 15 kWp on the municipal office (Figure 47), that could produce about 15,400 kWh per year and therefore save about 2,720 kg CO_2-equivalents in comparison to the usage of an electricity mix from Austria and abroad and about 1,800 kg CO_2-equivalents in comparison to the usage of an electricity mix from Austria [10][5].

Figure 47: Current PV-system on the municipal office and potential roof area for a further installation

7.3.2 Installation of wind turbines

In the year 2023 a small wind turbine of the brand Schachner, SW1.5 with a rated power of 1,500 W and a diameter of 1.9 m was installed in Großschönau. Up to now (for the course of one year), the turbine produced 51.76 kWh. From January to August 2024 the turbine produced 21.8 kWh. Using the produced electricity instead of electricity from the grid could save about 10 € up to now (production costs of the wind turbine not taken into account).

As there is no life cycle balance available for small wind turbines, the CO_2-equivalents cannot be calculated and compared to other types of power generation.

Figure 48: The small wind turbine of the brand Schachner, SW1.5, installed in Großschönau

8 Conclusions

This report provides calculations of energy, GHG and financial savings of different best practice examples in the field of:

- heating,
- cooling,
- electricity,
- mobility, and
- public area

and the expansion of these examples to the whole Focus District Großschönau.

The greatest energy saving potentials for the whole Focus District Großschönau lie, for example, in:

- Building passive houses
- Thermal renovation
- Conversion to e-cars or e-bikes
- Carpooling or
- Conversion to sustainable heating systems.

Table 44 shows a ranking of all the measures described and calculated in this report according to their energy saving potential, starting with the greatest one, and the saving potentials of greenhouse gas emissions, where it was possible to calculate them. The colour of the rows shows the respective assignment to the subject areas, as described below the table. Further information can be found in the chapters listed. Not all examples described in chapters 3 - 7 are listed in Table 44. For example, the conversion from a multi-fuel stove to a pellets or a woodchips heater couldn't be calculated for the whole Focus District due to lack of data. The usage of energy from an energy community or a photovoltaic system has other advantages than energy savings, described in chapter 5.2.2 and 5.3.1. Chapter 3.2.6 describes the savings of different heating systems for a new building, that is not listed in Table 44 either and some examples concerning the public area only describe single examples that cannot be expanded, like the conversion of public lighting of the soccer field to LED or the installation of a small wind turbine.

Table 44: Ranking of the measures according to their energy saving potential

Chapter	Actions	Energy saving potential for the whole FD Großschönau in kWh	Saving potential for the whole FD Großschönau in kg CO_2-equivalents
3.1.2	Build a passive house	4 060 720	
3.1.1	Thermal renovation	3 401 460	
7.1.3	Build public buildings as passive houses	529 132	95 240
6.2.1	Conversion from burner to e-car	421 231	143 900 - 173 900
6.2.4	Conversion to e-bike	346 090	112 020 - 113 220
6.1.2	Carpooling	341 360	110 940
7.1.2	Conversion of street lightings to LED	268 755	
3.2.4	Conversion from oil heater to heat pump	247 823	11 357 - 17 232
4.1.1	Correct ventilation of windows and shadowing instead of an air conditioner	196 890	1 970 - 45 280
3.2.1	Conversion from oil to wood pellets heater	178 021	86 499
7.1.1	Thermal renovation of public buildings	173 326	
5.1.2	Energy consultations in residential buildings	135 660	
3.1.6	Regular ventilation of radiators	129 430	
3.1.7	Adapting the room temperature to the usage and daytime	123 422	3 566
6.2.3	Conversion from burner to public transport	78 000	24 540
3.1.7	Reduction of the room temperature by 1 °C	74 053	2139
5.1.1	Conversion to LED technology	68 304	683 - 15710
5.1.5	Drying the laundry in the air instead of a tumble dryer	58 814	588 - 13 527
5.1.2	Energy consultations in companies/commercial buildings	55 200	
5.1.3	Substitution of an old small fridge with a new small fridge	52 800	580 - 12 140
3.1.5	Use an economy shower head instead of a rain shower head	50 487	
4.1.1	Correct ventilation of windows and shadowing instead of air conditioner and cooling with a heat pump	48 667	487 - 11 193
3.1.3	Exchange the old domestic hot water pump (stage 3) and use a high efficiency pump	40 500	410 - 9 320
5.1.3	Substitution of an old small fridge with a new fridge-freezer combination	37 280	370 - 8 580
4.1.1	Correct ventilation of windows and shadowing instead of cooling with a heat pump	36 149	361 - 8 314

5.1.4	Washing dishes and clothes at cold temperatures	34 280	340 - 5 830
3.1.5	Use an economy shower head instead of a normal shower head	26 473	
5.1.10	Using lids	25 968	260 - 5 973
5.1.6	Avoiding stand-by	21 210	212 - 4 878
5.2.1	Electric lawn mower instead of gasoline lawn mower	18 955	6 000
3.1.3	Exchange the old domestic hot water pump (stage 1) and use a high efficiency pump	18 360	180 - 4 220
5.1.5	Using a heat pump dryer instead of a tumble dryer	12 338	123 - 2 838
6.1.1	Reduction of speed	11 490	3 280
5.1.8	Using an induction stove instead of a ceramic hob	10 640	106 - 2 447
3.1.4	Showering instead of bathing	9 260	
7.2.1	Usage of electric cars	7 743	1 364 - 2 355
5.1.7	Defrosting the refrigerator	1 165	12 - 268
5.1.9	Using a water boiler instead of a pot	425	4 - 100
5.1.11	Using an egg boiler instead of a pot	357	4 - 80

Heat   Cooling   Electricity   Mobility   Public Area

The described and calculated measurements in this report have a different potential for replication, which can be divided into the following three stages:

1. simple to replicate for everyone and (if at all) associated with low costs
2. only possible under certain circumstances or low investment required
3. costly and/or complex technical adaptation required.

As shown in Table 45 there are lots of measures that can be easily implemented and still have a high energy-saving potential for the entire Focus District, for example by a professional energy consultation, the regular ventilation of radiators or the adaption of the room temperature. But of course, the most efficient measures are also related to technical adaption.

Table 45: Ranking of the measures according to their replication potential

Chapter	Actions	Energy saving potential for the whole FD Großschönau in kWh	Saving potential for the whole FD Großschönau in kg CO_2-equivalents	Replication potential
5.1.2	Energy consultations in residential buildings	135 660		1
3.1.6	Regular ventilation of radiators	129 430		1
3.1.7	Adapting the room temperature to the usage and daytime	123 422	3 566	1
3.1.7	Reduction of the room temperature by 1 °C	74 053	2 139	1
5.1.1	Conversion to LED technology	68 304	683 – 15 710	1
5.1.2	Energy consultations in companies/commercial buildings	55 200		1
3.1.5	Use an economy shower head instead of a rain shower head	50 487		1
3.1.3	Exchange the old domestic hot water pump (stage 3) and use a high efficiency pump	40 500	410 - 9 320	1
5.1.4	Washing dishes and clothes at cold temperatures	34 280	340 - 5 830	1
3.1.5	Use an economy shower head instead of a normal shower head	26 473		1
5.1.10	Using lids	25 968	260 - 5 973	1
5.1.6	Avoiding stand-by	21 210	212 - 4 878	1
3.1.3	Exchange the old domestic hot water pump (stage 1) and use a high efficiency pump	18 360	180 - 4 220	1
6.1.1	Reduction of speed	11 490	3 280	1
5.1.8	Using an induction stove instead of a ceramic hob	10 640	106 - 2 447	1
3.1.4	Showering instead of bathing	9 260		1
5.1.7	Defrosting the refrigerator	1 165	12 - 268	1
5.1.9	Using a water boiler instead of a pot	425	4 - 100	1
5.1.11	Using an egg boiler instead of a pot	357	4 - 80	1
6.2.4	Conversion to e-bike	346 090	112 020 - 113 220	2
6.1.2	Carpooling	341 360	110 940	2
7.1.2	Conversion of street lightings to LED	268 755		2
4.1.1	Correct ventilation of windows and shadowing instead of an air conditioner	196 890	1 970 - 45 280	2
6.2.3	Conversion from burner to public transport	78 000	24 540	2
5.1.5	Drying the laundry in the air instead of a tumble dryer	58 814	588 - 13 527	2

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5.1.3	Substitution of an old small fridge with a new small fridge	52 800	580 - 12 140	2
4.1.1	Correct ventilation of windows and shadowing instead of air conditioner and cooling with a heat pump	48 667	487 - 11 193	2
5.1.3	Substitution of an old small fridge with a new fridge-freezer combination	37 280	370 - 8 580	2
4.1.1	Correct ventilation of windows and shadowing instead of cooling with a heat pump	36 149	361 - 8 314	2
5.2.1	Electric lawn mower instead of gasoline lawn mower	18 955	6 000	2
5.1.5	Using a heat pump dryer instead of a tumble dryer	12 338	123 - 2 838	2
5.2.2	Usage of energy from an energy community			2
6.2.2	E-car-sharing		15 780	2
3.1.2	Build a passive house	4 060 720		3
3.1.1	Thermal renovation	3 401 460		3
7.1.3	Build public buildings as passive houses	529 132	95 240	3
6.2.1	Conversion from burner to e-car	421 231	143 900 - 173 900	3
3.2.4	Conversion from oil heater to heat pump	247 823	11 357 - 17 232	3
3.2.1	Conversion from oil to wood pellets heater	178 021	86 499	3
7.1.1	Thermal renovation of public buildings	173 326		3
7.2.1	Usage of electric cars	7 743	1 364 - 2 355	3
3.2.2	Conversion from multi-fuel stove to wood pellets heater			3
3.2.3	Conversion from a multi-fuel stove to a woodchips heater			3
3.2.6	Choosing a heat pump using certified electricity instead of a pellet heating system for a new building			3
3.2.6	Chosing a heat pump using certified electricity instead of the connection to the DHC for a new building			3
5.3.1	Energy production via own photovoltaic system		28 290 - 345 360	3
7.1.4	Conversion of public lighting of soccer field to LED			3
7.3.1	Using photovoltaic systems		21 146 - 31 990	3
7.3.2	Using small wind turbines			3

These listings will be taken up for “D6.3 SIMPLY POSITIVE best practice Booklet”, which will summarize recommendations how to gain the biggest effects by behavioural changes to save energy, emissions and the climate.

Sources

[1] More than Filler: Middle Actors and Socio-Technical Change in the Energy Sytsem from the "Middle-Out. Energy Research & Social Science 3. https://www.sciencedirect.com/science/article/abs/pii/S2214629614000899 (Accessed on 4 September 2024)

[2] Levels of consumers' agency and capacity as predictors for electricity demand reduction in the residential sector. Energy Efficiency. https://link.springer.com/article/10.1007/s12053-016-9471-6 (Accessed on 4 September 2024)

[3] D3.3 Assessment-Report on Focus Districts. http://simplypositive.eu/wp-content/uploads/2024/07/D3.3-Assessment-Report-on-Focus-Districts-vFinal.pdf (Accessed on 11 July 2024)

[4] TABULA WebTool. https://webtool.building-typology.eu/#bm (Accessed on 11 July 2024)

[5] Berechnung von Treibhausgas (THG)-Emissionen verschiedener Energieträger. https://secure.umweltbundesamt.at/co2mon/co2mon.html (Accessed on 15 July 2024)

[6] Ein behutsamer Umgang mit Warmwasser lohnt sich. https://www.klimaaktiv.at/haushalte/wohnen/energiesparen/warmwassersparen.html (Accessed on 15 July 2024)

[7] Compare Biomass Pellets With Conventional Fuels. http://www.gemcopelletmills.com/biomass-pellets-vs-conventional-fuel.html (Accessed on 16 July 2024)

[8] Verordnung des Vorstands der E-Control über die Voraussetzungen an die fachliche Qualifizierung und Requalifizierung von Energiedienstleisterinnen und Energiedienstleistern (Energieeffizienz-Qualifikationsbewertungs-Verordnung – EEff-QBV) – BGBI.II Nr. 264/2023. https://www.ris.bka.gv.at/eli/bgbl/II/2023/264/20230908 (Accessed on 19 July 2024)

[9] Brennwert. https://www.geothermie.de/bibliothek/lexikon-der-geothermie/b/brennwert (Accessed on 01. August 2024)

[10] Photovoltaik. https://www.umweltbundesamt.de/themen/klima-energie/erneuerbare-energien/photovoltaik#%C3%96kobilanz (Accessed on 01. August 2024)

[11] Informationsblatt CO_2-Faktoren. https://www.bafa.de/SharedDocs/Downloads/DE/Energie/eew_infoblatt_co2_faktoren_2024.html (Accessed on 08. August 2024)

[12] Wie umweltfreundlich sind Elektroautos? Eine ganzheitliche Bilanz. https://e-mo-ne.de/wp-content/uploads/2022/12/BMU-Elektroautos.pdf (Accessed on 16. August 2024)

[13] VCÖ-Magazin 2024-02 Carsharing spart Platz, Geld und Ressourcen. VCÖ-Magazin 2024-02 Carsharing spart Platz, Geld und Ressourcen - Mobilität mit Zukunft (vcoe.at) (Accessed on 16. August 2024)

[14] Emissionsfaktoren bezogen auf Fahrzeugkilometer. https://www.umweltbundesamt.at/umweltthemen/mobilitaet/mobilitaetsdaten/emissionsfaktoren-verkehrsmittel (Accessed on 19. August 2024)

[15] Heizung entlüften und Energie sparen. https://www.vis.bayern.de/produkte_energie/energiesparen/verbrauchertipp_heizung_entlueften.htm (Accessed on 20. August 2024)

[16] Leitfaden Stromsparen. https://www.energie-noe.at/leitfaden-stromsparen (Accessed on 22. August 2024)

[17] So viel Strom verbraucht Induktion. https://www.gasag.de/magazin/energiesparen/stromverbrauch-induktion#:~:text=Der%20Stromverbrauch%20von%20Induktion%20liegt,die%20gelten%20nur%20f%C3%BCr%20Back%C3%B6fen) (Accessed on 30. August 2024)

[18] Raumtemperatur anpassen. https://www.umweltberatung.at/raumtemperatur (Accessed on 30. August 2024)

[19] Tempo-100-Rechner: Wie viel Sprit und CO2 man spart, wie viel Zeit man verliert. https://www.derstandard.at/story/2000138215817/der-tempo-100-rechner-wie-viel-sprit-und-co2-man (Accessed on 09. August 2024)

[20] Lichtausbaue. https://de.wikipedia.org/wiki/Lichtausbeute (Accessed on 04.09.2024)

[21] VCÖ: Haushalte in Wien und Westösterreich fahren weniger mit dem Auto als der Österreich-Schnitt. https://vcoe.at/presse/presseaussendungen/detail/vcoe-haushalte-in-wien-und-westoesterreich-fahren-weniger-mit-dem-auto-als-der-oesterreich-schnitt (Accessed on 04.09.2024)

[22] Monatsdurchschnittspreise Pellets. www.heizpellets24.at/pelletpreise (Accessed on 25.09.2024)

[23] Holzmarktbericht der LK Österreich Juli 2024. www.holz-fair-kaufen.at/wp-content/uploads/2024/07/Preistabelle-Juli-2024.pdf (Accessed on 25.09.2024)

[24] Hüttenkoks / Steinkohlekoks online kaufen mit Lieferung www.brennstoffe.kaufen/huettenkoks (Accessed on 25.09.2024)

[25] Durchschnittlicher Preis für einen Liter Heizöl in Österreich von Januar 2023 bis September 2024 (in Euro). https://de.statista.com/statistik/daten/studie/1113029/umfrage/durchschnittlicher-preis-fuer-einen-liter-heizoel-in-oesterreich/ (Accessed on 25.09.2024)

[26] Preisentwicklung beim Benzinpreis in Österreich. www.wissenswertes.at/benzinpreis-oesterreich-preisentwicklung (Accessed on 25.09.2024)

[27] Preisentwicklung beim Dieselpreis in Österreich. www.wissenswertes.at/dieselpreis-oesterreich-preisentwicklung (Accessed on 25.09.2024)

[28] VOR annual pass https://www.vor.at/en/tickets/ticket-overview/annual-pass/klimaticket (Accessed on 25.09.2024).

[29] 2.4 Der Kauf von Brennholz – Beispiel RM: Weicholz https://www.energieberatung-hessefort.de/brennholz.html (Accessed on 25.09.2024)

[30] Ratgeber Car-Sharing/E-Car-Sharing https://www.net-eb.at/download/Ratgeber/Car-Sharing_E-Car-Sharing_Ratgeber.pdf (Accessed on 25.09.2024)

[31] E-Car Sharing Zwettl https://www.zwettl.info/Ecar_Sharing_Zwettl (Accessed on 25.09.2024)

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