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The Energy System of an Ecovillage: Barriers and Enablers

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Abstract: Nowadays, in the context of climate change, efficient energy management and increasing the share of renewable energy sources in the energy mix are helping to reduce greenhouse gases. In this research, we present the energy system and its management and the possibilities of its development through the example of an ecovillage. The basic goal of such a community is to be economically, socially, and ecologically sustainable, so the study of energy system of an ecovillage is especially justified. As the goal of this community is sustainability, potential technological and efficiency barriers to the use of renewable energy sources will also become visible. Our sample area is Visnyeszéplak ecovillage, where we examined the energy production and consumption habits and possibilities of the community with the help of interviews, literature, and map databases. By examining the spatial structure of the settlement, we examined the spatial structure of energy management. We formulated development proposals that can make the community's energy management system more efficient.

Keywords: energy transition; organic farming; ecological agriculture; renewable energy; rural development; energy planning

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1. Introduction

One of the central environmental issues today is reducing greenhouse gas emissions, which cause climate change and its associated negative environmental impacts [1]. An essential part of this effort is energy management, increasing the share of renewable or zero-emission energy sources in energy production. Despite society's growing energy needs [2,3] and the limit of technological opportunities, the share of renewable energy sources in the European Union is increasing. As a result, greenhouse gas emissions are declining [4], it is important to take the cultural system into account in long-term planning [5–8] and in the changing economic environment [9]. The energy sector is responsible for more than 80% of greenhouse gas emissions (Figure 1). Therefore, it is crucial to reduce emissions and increase energy efficiency. Ten percent of the output can be attributed to agricultural activity, which this research focuses on. Additionally, the transport and processing of agricultural products also cause GHG emissions.

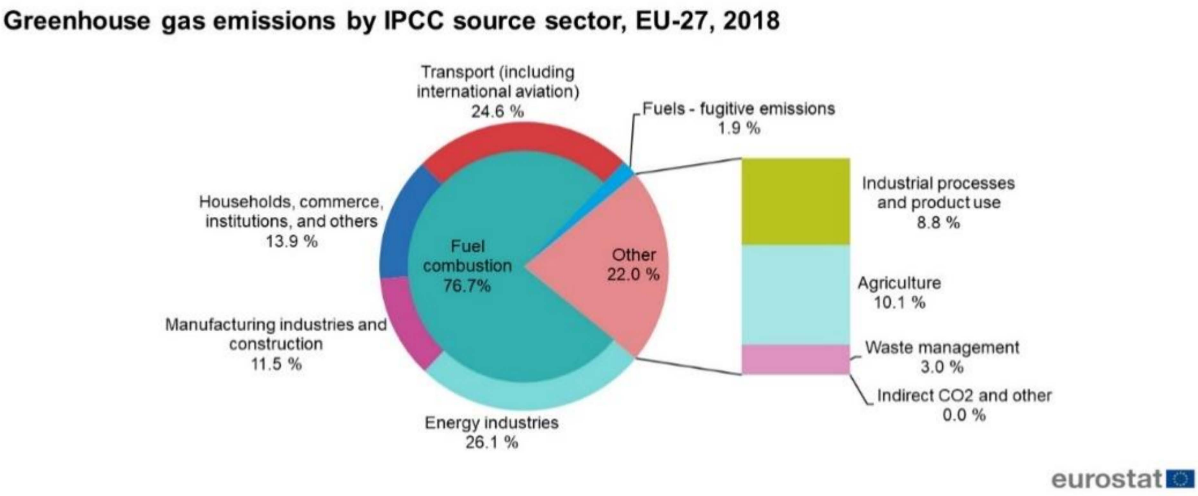


Figure 1. Greenhouse gas emissions by IPCC source sector, EU-27, 2018 [10].

The share of renewable energy sources in the energy mix is increasing, which means that the spatial structure of energy production is changing. Therefore, it is necessary to examine the landscape planning tools and their application in spatial planning practice. Currently, research on the environmental impact of renewable energy sources is mainly related to the location of energy production, examining the effects of each energy source [11–13]. Thus, analyzing the effects of the energy system in a given sample area is not widespread. However, understanding the mechanism of household energy is useful because environmental systems in the landscape are open or closed systems, and therefore, energy flow affects both the system and related subsystems [14]. Furthermore, the method can be used to examine a demarcated area's production and consumption system from an environmental, socioeconomic, and cultural point of view. In landscape design, there are some examples of examining the possibility of carbon neutrality for a specific territorial unit [15] or integration into a settlement-level plan [16]. This area of research is still in its infancy and has many aspects that need to be explored [17] to be integrated into landscape planning.

In our research, we synthesize the knowledge of natural sciences, economics, and society, which is a characteristic of landscape architecture [18–21]. The research is expressly limited to the landscape in connection with the study of the energy system. However, we also describe the issues that are the limitations of the present research. In selecting the sample area, we considered the trends of changes in the economic system [22], the aspects of sustainable agriculture, and the possibilities of rural development [23]. Recent studies also emphasize the necessity to protect the knowledge of people who work closely with nature [24,25]. In 2015, the European Commission adopted the Circular Economy Package [9], which lays the foundations for future economic processes in the EU. According to the European Union definition, the value of raw materials and resources in this system must be preserved as much as possible during the various processes, thus minimizing the amount of waste. The process is illustrated in Figure 2, which also shows the role of energy: energy is the basis of the processes of the circular economy. While a significant part of greenhouse gas emissions can be linked to the system of energy production and consumption, natural [14], economic [26], and cultural processes [27–29] do not take place without it, and all these areas affect the efficiency of energy management. The theoretical foundations of the circular economy already appear in studies related to industrial ecology in the 1990s [30–33].

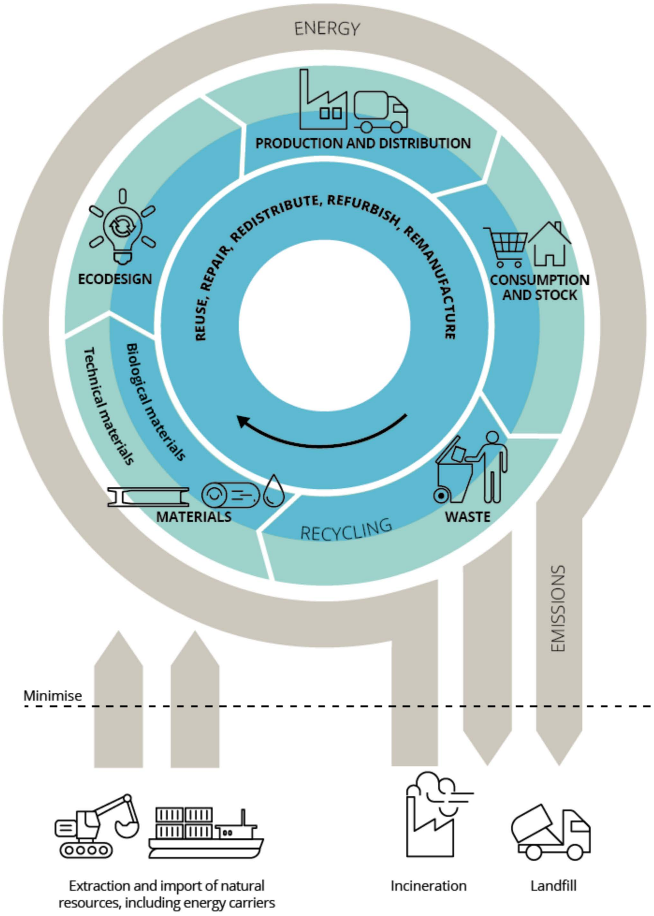


Figure 2. The process of circular economy [9].

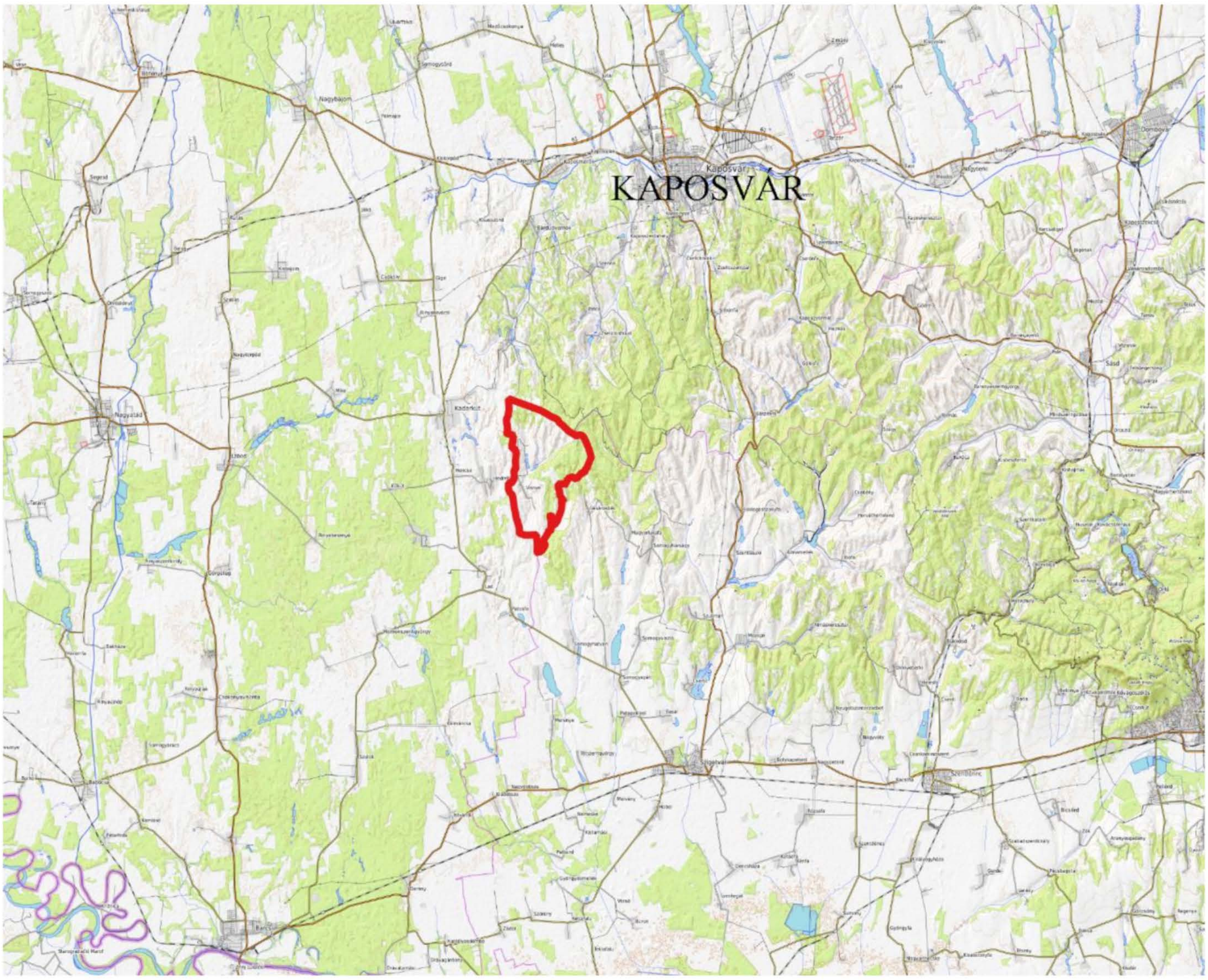
As organic farming methods use a holistic approach to circular farming in agriculture [34], the sample area was selected in the area of an organic farm. In our research, we examined the energy system, and it is essential to highlight that even ecovillages have limits to self-sufficiency and sustainability, which is partly influenced by the way the community lives, the organization of the community, or the extent to which we examine self-sufficiency [35,36]. Research on ecovillages examines many different aspects [37], but our knowledge is still limited in many segments. Hungarian ecovillages often differ in their self-determination to such an extent that the issue of self-sufficiency becomes challenging to determine [38]. Our choice fell on the Visnyeszéplak ecovillage in Somogy county, Hungary, because in this case, the farming and the energy system of households can be examined. Even in the case of the studied community, the self-determination related to self-sufficiency is not uniform based on the on-site inspections. It is clear that all families in the community strive for self-sufficiency, but external factors limit them. Families raising children face choices they have to make on account of their children's education with regard to travel to the educational institution or the unavoidable use of electronic devices during the pandemic. In this respect, the legal framework also limits the possibilities for parents [39]. Access to health services is also a limiting factor, in which case you also have to travel. Therefore, there are legal and social factors that limit the possibilities for self-sufficiency in many cases in the study area. There are limitations related explicitly to energy users, which are described in the research.

Visnyeszéplak, as an ecovillage, was established in the early 1990s, when the first families moved in. There are currently 150–180 people living in the village, roughly 25–30 families. Although the original village was not wholly extinct at that time (to this day, the indigenous people of Visnyeszéplak live here), its infrastructure has almost completely deteriorated. The area itself is located in Somogy county, on the border of

Baranya county, in the southwestern part of Zselic (Figure 3). Administratively, it belongs to Visnye, but, interestingly, the mayor of Visnye is also a resident of Visnyeszéplak. Based on the preliminary fieldwork, we can say that the area has a mosaic and looser structure. The ecovillage's typicall land use forms are: gardens, orchards, lawns (pasture, meadow), or forest. Its area totals 189.61 hectares, of which more than half is forest, more than 30 percent is grassland, more than 10 percent is an orchard, and only 1 percent is a garden. Visnyeszéplak (like ecovillages in general) is characterized by close-to-nature and chemical-free farming, and this area is outstanding for food self-sufficiency. An essential factor is that Visnyeszéplak can be classified as one of the ecovillages that exclude (modern) technology the most. However, it is also one of the most successful ecovillages in Hungary at the same time [40]. Thus, the study of energy use in a village where they build on sustainability and consciously restrained consumption can be fundamentally emphasized.

(a)

Figure 3. *Cont.*



(b)

Figure 3. Overview map of Visnye in Hungary (**a**) and in regional scale (**b**).

2. Materials and Methods

In our research, we used several methods to examine the energy management system of the sample area. We conducted a detailed, semistructured interview with two members of the community, during which, in addition to having a prewritten interview thread (Appendix A), subjects were free to express their empiricism about the topic [41,42]. The interviews were conducted in September 2020 with two members of the ecovillage community). The interviews lasted 1.5 and 2.5 h, respectively, and in addition to taking notes, an audio recording was made with the interviewees' consent. Interviewees were asked about energy production and consumption habits and opportunities through their own experience related to their own household and the ecovillage generally. In compiling the questions, we took into account the statistical data available on energy in Hungary [43], the European Union [44], and the world [45]. With the help of the data, we determined the possible energy sources, their use (household, public lighting, agriculture, industry, etc.) and their availability due to infrastructure (local, grid, not locally) that is not physically in the study area but is transportable. This includes natural gas, which is available as a gas cylinder, and gasoline and diesel used for internal combustion engines. During the site visit before the interview questions, we determined the locations of the activities: household, agriculture and forestry, and small industry. Based on the interviews, we determined the activities, resources used for them, and the energy sources' origin. We then determined the current energy sources (primary and secondary energy sources) and the system of energy consumption (household, transport, and industry) in the area. For primary resources, wood and charcoal, human and animal muscle power, and agricultural production were considered, as these resources are equally part of the energy system. However, today's technical and technological advances have overshadowed their importance. Cooking, heating, lighting, and various electrical appliances play a role in household energy consumption. For the interviews, an aggregate summary of notes and audio recordings was used.

The QGIS program was used to study the spatial structure of household energy. Because the ecovillage economy is based on agricultural production and processing, we used the 2018 Corine database to determine the primary land uses [46]. As the accuracy of the Corine database is 1:50,000, the description of each land use was clarified during the basic map of Hungary's Ecosystem [47], using Google Satellite [48] and by site visits. Data from Open Street Map [30] and Open Topo Map [31] were also used in the map analysis. The maps used were available in georeferenced form to compare their information on different overlays, and it was also possible to clarify them. To analyze the data related to the geographical location available for the Corine database and the Hungarian ecosystem map, we selected the layers in the study area to determine the typical land use. Google Satellite, Open Street Map, and Open Topo Map were used to identify the built-up areas and the surface water network.

Energy balance was examined in the analysis based on the cultural system. Previous studies [49,50] have identified this system as identifying the tools used by the community and the activities, practices, and constraints that determine their use, as well as the cognitive norms that characterize the community's energy use and are integrated into the community's daily lives and passed on to the younger generation [51].

3. Results

We examined the cultural system from three perspectives (Figure 4) based on previous research: tools, characteristics associated with their use, and cognitive norms [52]. We first identified the community's main activities, the tools used in the activities, and finally the energy sources used for them.

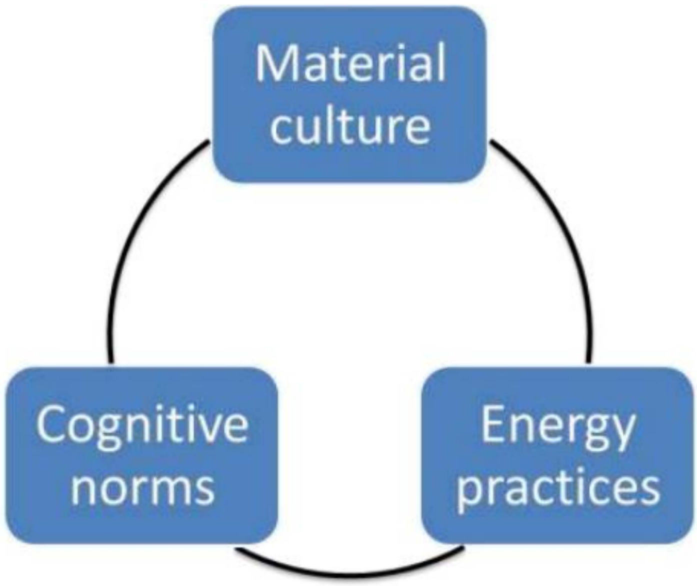


Figure 4. Energy and cultural system [52].

Based on the interviews, the activities related to energy use were grouped according to household, agriculture, and small-scale industry, and the energy sources and the origin of the energy sources were determined (Tables 1–3). Small-scale industry's energy consumption, which is mainly related to food processing, and household components are the same. The result differs in part from expectations, as we identified the small-scale industry as an activity differently from our initial expectations. In both cases, electricity is transformed energy because the community is connected to the electricity grid, so in this case, the primary energy source is determined by the country's electricity mix [45].

Table 1. Activities, energy resources, and place of production of households.

Activity	Energy Resource	Place of the Production
Living labor	Muscle power	Local
Lighting	Electricity	Local Network
Electric devices	Electricity	Local Network
Cooking	Biomass Natural gas Electricity	Local Non-local Network
Heating	Biomass	Local
Transport	Petrol Diesel	Non-local

Table 2. Activities, energy resources, and place of the production of agriculture.

Activity	Energy Resource	Place of the Production
Machine work	Electricity Petrol Diesel	Network Non-local Non-local
Living labor	Muscle power	Local

Table 3. Activities, energy resources, and place of production of small-scale industry.

Activity	Energy Resource	Place of the Production
Living labor	Muscle power	Local
Lighting	Electricity	Local Network
Electric devices	Electricity	Network
Cooking	Biomass Natural gas Electricity	Local Non-local Network
Heating	Biomass	Local
Transport	Petrol Diesel	Non-local

There is a significant overlap between households and small-scale activities. The processing of goods produced in agricultural and forestry areas also partly supplies the household, depending on how close the family is to systems outside the community. Energy-intensive activities of households include living, lighting, electrical appliances, cooking, heating, and transport. Electrical appliances include a washing machine telephones, computer, and dryer. We highlighted earlier that the use of electrical devices was affected by the pandemic, as the education of school-age children could only be ensured by using these devices. They try to keep their use to a minimum; some families use solar energy, e.g., for phone charging. However, some families do not use electrical appliances; lighting is also solved with a candle. Larger electric machines are used for cleaning: this is also essential to ensure a healthy environment, so it can control the frequency of the need to seek medical help. Small-scale industry's energy use does not differ in activities. However, its energy consumption is higher due to power tools and petrol machines. Households and nonindustrial energy use show the same patterns in space, but here they cannot currently provide pre-electric electricity from local resources to use machines. Activities can also coincide because these machines are used similarly in small-scale industry and in individual households for processing food, wood products, cosmetics, and other products. Live labor and machinery are used for agricultural and forestry work. External energy sources are used for the machines: e.g., diesel, petrol. These energy carriers are also used by and available in nearby places. In summary, locally produced energy provides minimal labor, heating, a significant portion of cooking, and electricity.

The spaces of energy production and consumption are intertwined and overlapping. Among the renewable energy sources, biomass is significant: both wood (felled or fallen trees) and agricultural waste are used; it is used primarily for heating and secondarily for cooking. Biomass is a conditionally renewable energy source [53], and regeneration must be ensured for sustainability. Among the renewable energy sources, the sun is emerging as a popular choice: with a less powerful solar collector, they produce hot water, and solar cells generate electricity in some households. Households are typically connected to the electricity grid due to the limited amount of electricity produced locally and the security of supply. The expansion of the capacity of solar panels may be partly hindered if a connected grid system is to be developed by the fact that the medium-voltage network was built only up to the village of Visnye (Figure 5).

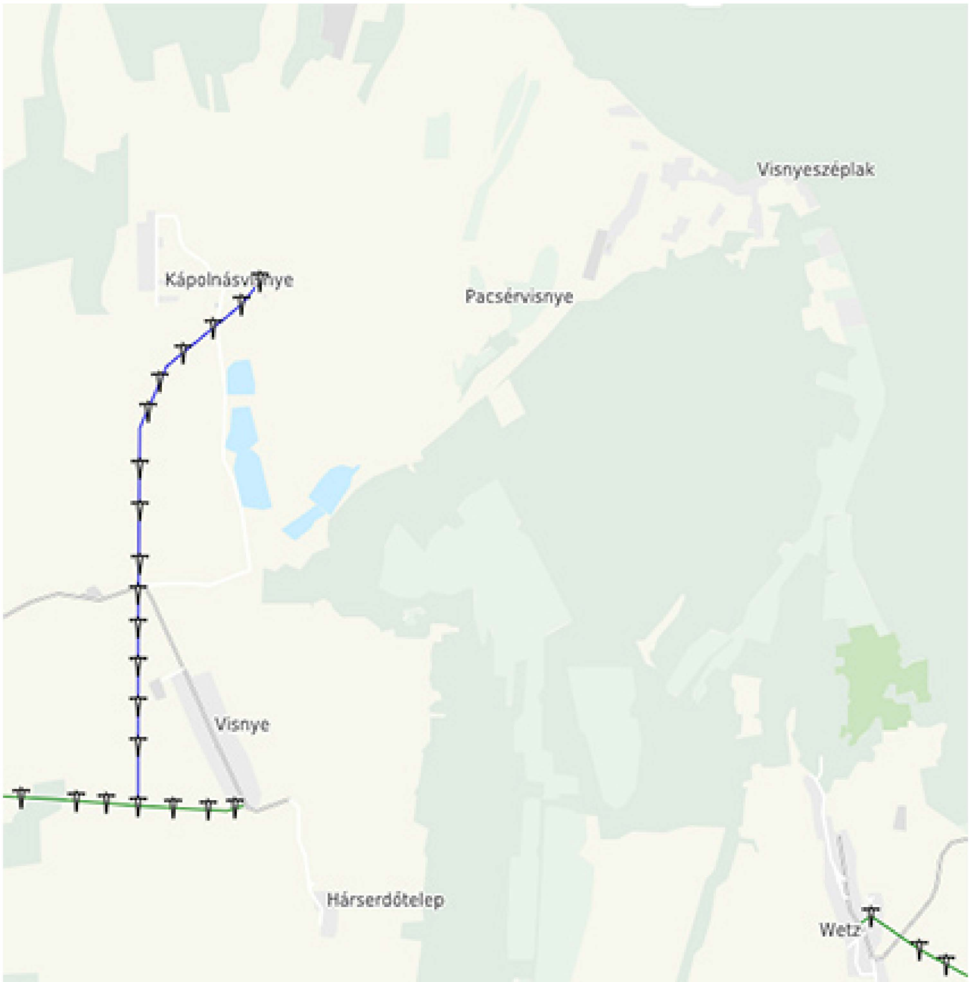


Figure 5. Medium-voltage network around Visnyeszéplak [54].

The consumption of the ecovillage contains the energy use of households, agricultural, and small-scale production, especially food processing. In the case under study, industrial use is limited, but consumption is decisive, as the community partially processes crops and raw materials. Activities can be broken down into subunits to identify energy sources. However high their energy consumption, the activities are not necessarily optional [55,56]. Household supply is intertwined with production for sale: agricultural production and related food processing can appear as energy consumption in both households and small-scale industry. The process of energy production and consumption is cyclical (Figure 6) since the law of energy conservation and thermodynamics prevails in environmental systems [57]. Humans are also part of this system, we burn energy during both physical and mental activity as examined in research planning decades ago [58], the results of which are utilized in various activities and again become resources of both physical and mental activity. Therefore, these processes are circular and recursive, repeating in infinite numbers [59,60].

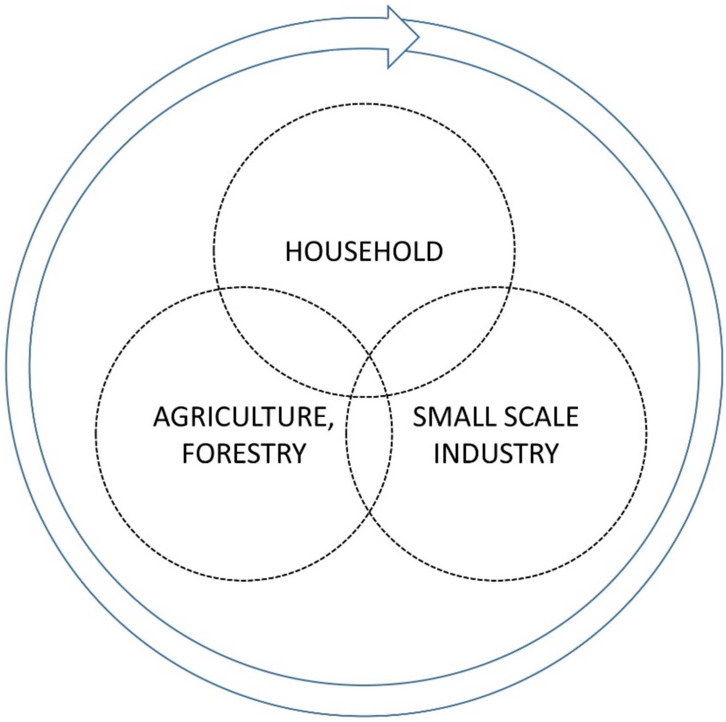


Figure 6. Main activities related to the cyclical energy use of organic farms.

Solar power use is negligible, but several aspects of its application support it in the sample area. Due to Hungary's geographical location, the technology can be used efficiently according to the radiation values in the whole country [61]. Small-scale solar systems can be used well and pay off in a relatively short time [62–64]. It also has short-term goals in national plans [65]. The mosaic nature of the area and the forest patches are an obstacle (Figure 7). However, based on the energy studies made earlier, it can be minimized by proper planning without cutting down the efficiency, taking into account the shadow effects [66]. According to the interviews, one household has an outstanding energy consumption, approximately 3000 kWh a year, including household, food processing and other small-scale production. We calculated the performance and location of a 5 kW three-phase solar system for the area. The actual gross price is approximately HUF 2.2 million [67]. A 1 kW solar cell has an annual production approach of 1200 kWh in the sample area [68]. For a 5 kW system, this means 6000 kWh of power per year. This is twice as much as the current consumption. The area requirement of the solar system [69] is calculated to be almost 26 m^2.

As additional production can be achieved by building the system, it is worth considering whether petrol and diesel used for transport can be replaced by solar energy. The interviews show that traveling to Kaposvár, 30 km from the settlement, is important for the community. There are different models on the market, based on a median consumption of 17 kWh/100 km [70]. Calculated with 20 working days per month and a distance of 60 km back and forth for the whole year, the annual consumption is 2448 kWh. Therefore, with a 5 kW system, this consumption can be ensured. The members of the community do not go to Kaposvár every day. We calculated the maximum number of working days to cover the provision of energy consumption for possible longer distances (the number and distance of which cannot be determined precisely). For the community, using solar system and electric cars, the obstacle is the cost of the investment. In terms of the amount of energy that can be produced, vehicles powered by an internal combustion engine can be replaced. When using electric cars, diesel cars also enjoy better torque. The use of natural gas for cooking can be replaced by electricity generation.

The existing electricity network (Figure 5) is a barrier, as we highlighted that capacity can be a constraint on electricity generation. However, it is also an opportunity: there is no need to invest in energy storage equipment [71], which would mainly mean batteries [72], the production of which causes environmental damage [73]. The possibility to connect to the grid is also important for energy security [74,75].

Biomass is an even more significant source of energy in the life of the community. The mosaic pattern of the ecovillage area (Figure 7.) represents a holistic approach to agriculture. Agricultural production for cooking and heating provides biomass, and crops provide energy for human and animal muscle power. According to the interviews, 5–10 m^3 of firewood is required per household in a year. The community can use several types of wood as firewood. In our study, we highlight acacia (*Robinia pseudoacacia*) its effective wood productivity is 12 m^3/ha/year. The community employs fiber cutting; therefore, up to half an acre of land is sure to supply a household with biomass in a year. Biomass leftover from agricultural production is also used for heating (e.g., collecting waste trees from pruning fruit trees, sediment bundling). The biomass, which is typical for heating and cooking, is designed in furnaces and stoves according to the traditional folk architecture. For the community, traditional village traditions serve as a source of self-sustaining living.

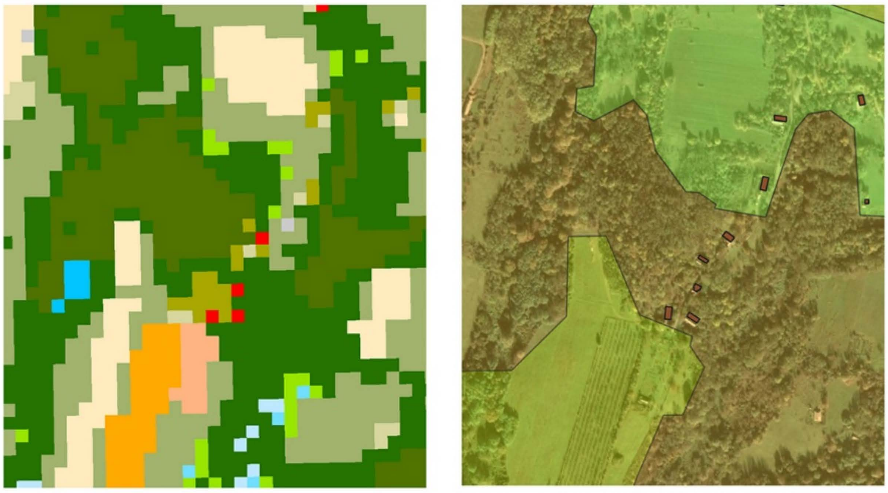
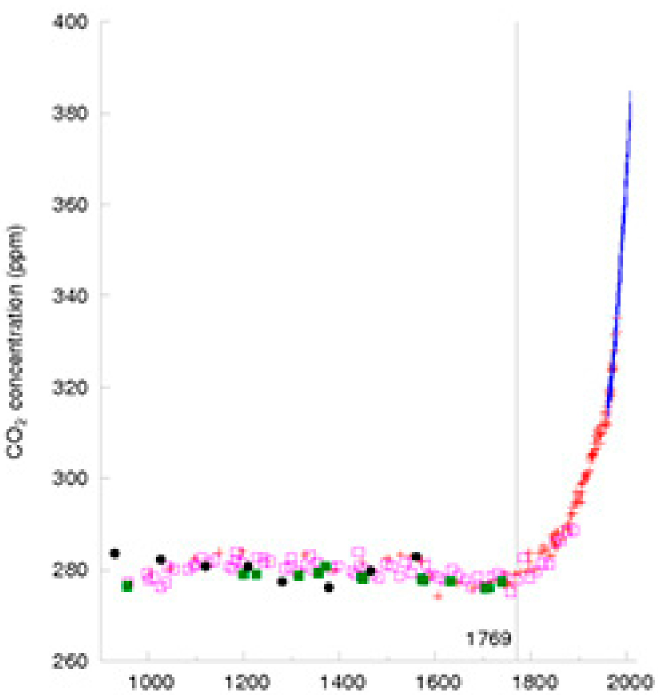


Figure 7. Example of Land use system of Visnyeszéplak with legend (Table 4). Based on Corine, Ecosystem Map of Hungary and Google Satellite [46–48].

The use of biomass as an energy source is worth considering due to the degree of air pollution, as biomass combustion involves greenhouse gas emissions [76]. The energy use of human history has been determined by using muscle power and wood and charcoal until the discovery of the steam engine [77]. Figure 8 shows the relationships between greenhouse gas emissions and biomass combustion. Carbon dioxide emissions began to increase exponentially after the spread of the steam engine compared to the previously effective biomass combustion. Biomass combustion contributes extremely little to air pollution in the life of an ecovillage. This rate can be reduced by using filters [78], and for higher value investment, geothermal energy can be switched [79].

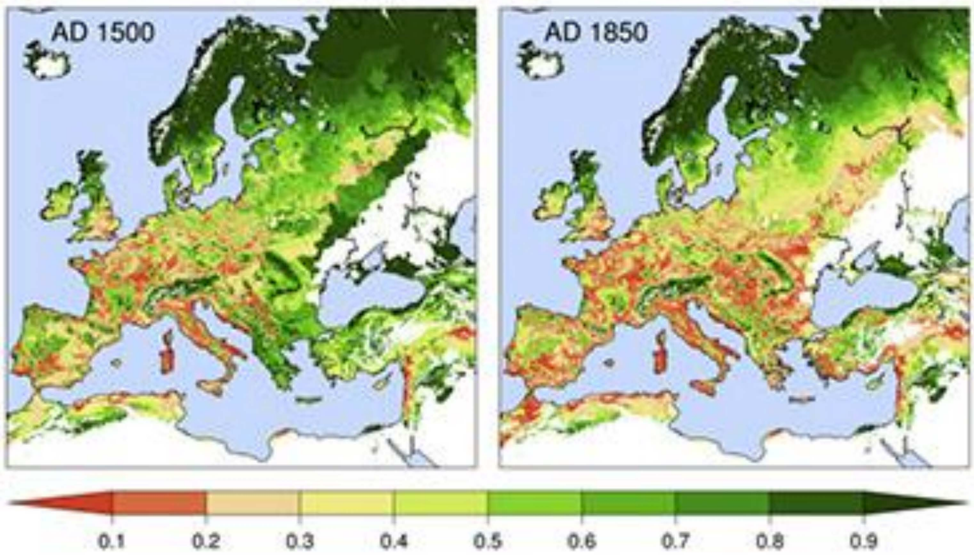
Table 4. Figure 7 Legend.

Corine Land Cover 2018	Ecosystem Map of Hungary
Non-irrigated arable land ☐	Fruit and berry, and other plantations ☐
	Complex cultivation patterns with scattered buildings ☐
	Green urban areas without trees ☐
Land principally occupied by agriculture ☐	Black-locust-dominated mixed plantations ☐
	Other ligneous vegetation, woodlands ☐
	Closed grasslands in hills and mountains or on cohesive soil ☐
	Green urban areas with trees ☐
	Tall-herb vegetation of marshes and fens standing in water ☐
	Fens and mesotrophic wet meadows, grasslands with periodic water effect ☐
Complex cultivation patterns ☐	Other herbaceous vegetation ☐
	Arable land ☐
	Other ligneous vegetation, woodlands ☐
	Low building ☐



(a)

Figure 8. *Cont.*



(b)

Figure 8. Relationships between air pollution and wood burning (**a**) carbon dioxide (CO_2) concentrations (in parts per million) from 1000 AD till 2000 AD [80]. (**b**) Historical forest clearance map from 1500 AD till 1850 AD [81].

Agricultural areas serve as a source of energy for human and animal muscle power. Both animals and humans are supplied with energy in the mosaic areas seen in Figure 7. The need for space, in this case, is difficult to determine—it depends on the individual's diet, climate, and fertility indicators of the area [82]. In terms of farming aspects, the ecological approach prevails, the energy loss during the processes is minimal.

Both the ecosystem map of Hungary and Google Satellite represent the mosaic of landscape use in the ecovillage. There are three major units in the exemplary area, and within this, we can distinguish subunits: arable land, orchards, pastures, and forests provide an opportunity to ensure food supply, at least for the most part. Due to land use, this can mean a varied meal for both community members and animals. By examining the land use, it can be seen that vegetables and fruits are grown in the area by examining the land use. Animal husbandry provides food of animal origin: dairy products, eggs, meat. They can also provide adequate care for the animals on pastures and meadows. Adequate care contributes to animal welfare and health [83,84]. Buildings are scattered in agricultural and forestry spaces. Work and household spaces are cohesive so that movement can be minimized depending on the areas (Figure 9).

We examined the spatial structure of energy consumption, the current supply, and the introduced renewable energy sources. Figure 10 shows the system of households where solar energy can replace most external energy sources: natural gas, gas oil, and gasoline. In heating and cooling, the energy source is currently provided by biomass in the internal system of the ecovillage, which the use of geothermal energy could replace. The cost of the investment, however, currently exceeds the potential of the community. Figure 11 shows a similar picture of small-scale energy use. Greater use of energy, in this case, can also trigger external, mainly nonrenewable energy sources. However, agriculture and forestry (Figure 12) represent constraints. According to the interviewees, a significant part of the machines can only be triggered by muscle power. There are currently no machines with renewable energy sources.

In our research, we determined the elements of the energy management of the Visnyeszéplak ecovillage, the process of energy use and the possibilities of replacing non-renewable energy sources. Our results are summarized in a SWOT analysis (Figure 13), which illustrate both the positives and negatives within the system of the sample area and to determine the role of the external system [85]. The area already uses renewable energy sources: biomass uses an ecological vision, i.e., the circularity of natural processes. The potential of the energy source is maximized. Solar energy can still represent significant potential; the lack of financial resources causes the lack of development. Using solar energy, community energy production can even be based on fully renewable energy sources. The use of geothermal energy may also arise in the future: for both heating and electricity generation.

Figure 9. Example of biomass use. (**a**,**b**) Cooking stove, (**c**) furnace of the community, (**d**) beehive oven, (**e**) mass stove and its other side, and (**f**) cooking stove (photographs by the authors).

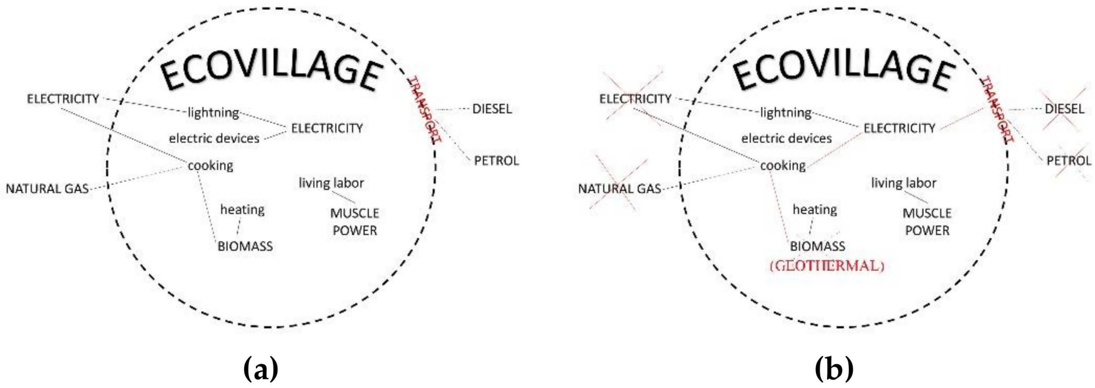


Figure 10. Space structure of energy system of households in Visnyeszéplak (**a**) present (**b**) prospective.

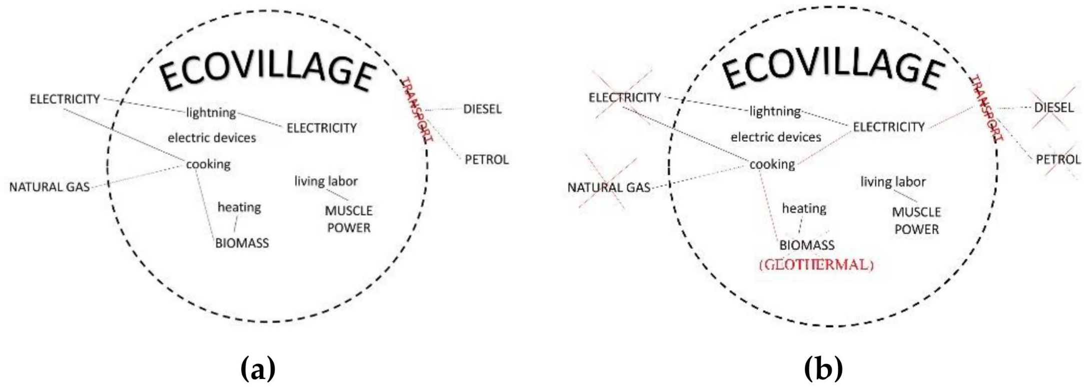


Figure 11. Space structure of energy system of small-scale industry in Visnyeszéplak (**a**) present (**b**) prospective.

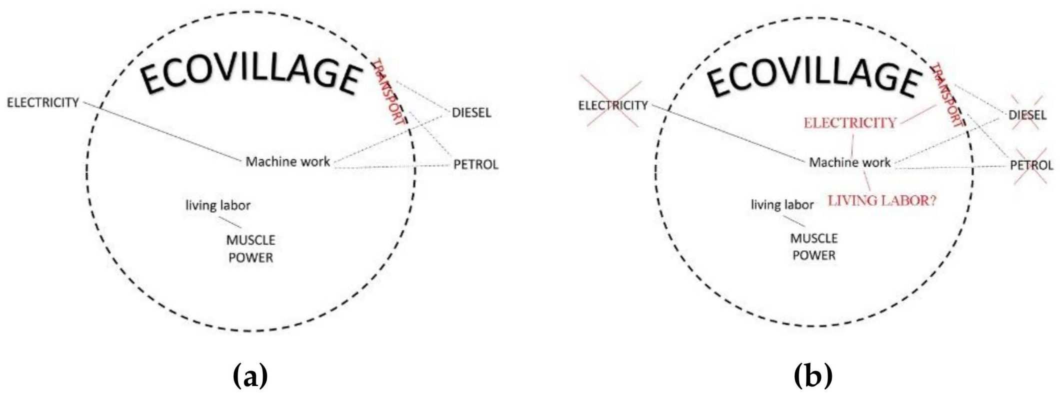


Figure 12. Space structure of energy system of agriculture and forestry in Visnyeszéplak (**a**) present (**b**) prospective.

Carbon neutrality has both internal and external limitations. Internal boundaries are determined by the community's financial means, and the financial possibilities also limit technological developments. The external barrier is more complex than this. The community's economy is built on food production and processing, so agricultural machinery limits the opportunity. Electric propulsion has already appeared in this industry [86], but these are only long-term options and may be limited by locally generated electricity. In agriculture, an alternative to power machines is human or animal muscle power, according to the interviewees. However, the changed cultural habits are not conducive to these: the micro-community and the population of the settlement should be involved in the agricultural work to be able to compete effectively with the machines. Initially, everything within the micro-community was solved with human and animal muscle power, but this changed over time. According to the interviews, this can be traced back to several reasons: on the one hand, as the children flew out, the available muscle strength decreased, and the size of the land increased. At the settlement level, the influencing factor is the changed lifestyle—a negligible part of the population is engaged in agriculture, as having a permanent job means this is no longer possible. It is also challenging to find a reliable person to do the machinery works with their own tractor, easier to solve within a community. Mechanical work is usually carried out efficiently, with equipment being made available to the community for use or for planned purchase. Animal muscle strength is also limited by efficiency; however, here it is not the changed cultural system that is the limitation, but time. The transport system can be replaced by electric cars powered by own solar power. However, it is important to emphasize that transport is generated because some services are not available locally.

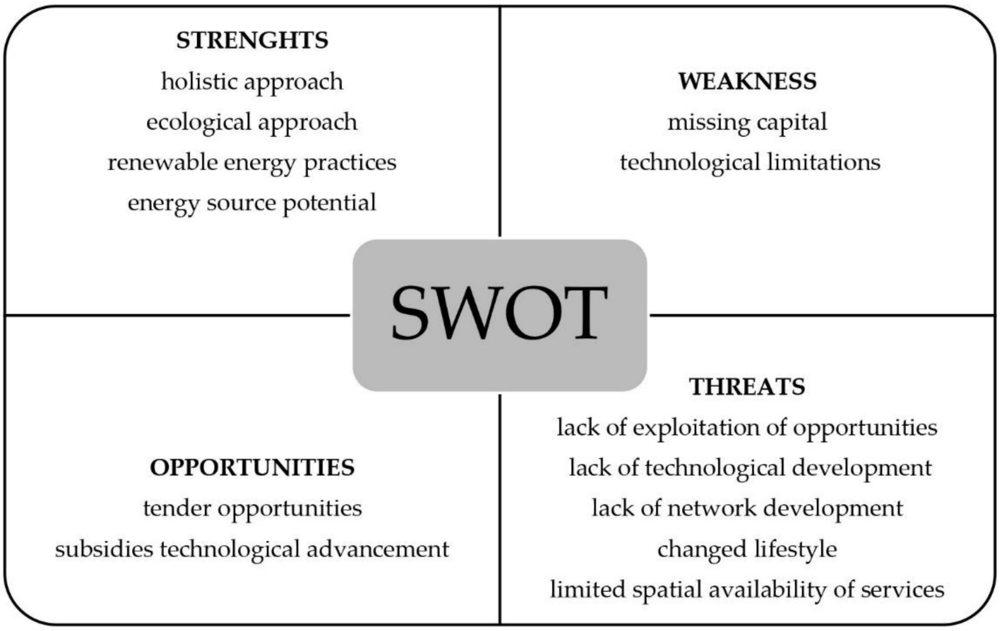


Figure 13. SWOT-analysis of energy improvement of Visnyeszéplak.

Based on the interviews, it can be established that there is a desire for self-sufficiency in energy use. In the organization of work, the energy consumption component of both time and space is taken into account, and the most efficient solutions are preferred. In the context of energy, self-reinforcement to use renewable-based energy solutions is very strong. This perspective is built into everyday life, so the behavior is given over to the next generation. However, there are many difficulties in adapting this perspective outside the examined community [87].

We have made some suggestions to help ensure that the ecovillage community can provide energy sources from local sources. The production of electricity can now be solved technologically easily. This can be ensured in two ways: on the one hand through targeted energy subsidies from external financial sources or through a slower process within the community, where they switch to solar energy step by step. The biggest issue is to reduce the use of agricultural and forestry-related machinery. Here, the involvement of muscle strength is the solution for the near future. The organization of sustainable living [88] and ecovillage tourism [89] can be the basis: visitors can be involved in these works to get acquainted with sustainable living forms and approaches.

4. Discussion

Ecovillage communities typically organize their lives in harmony with nature, according to the ecosystem. However, even in these communities, there are obstacles to carbon neutrality: lack of capital, a changed cultural system, a level of technological development. Because the social system is not a closed system, these communities are part of society; they can very rarely exclude interaction with other communities from their lives completely. It is also clear that the current level of technological development limits opportunities in a changed cultural–social environment. Achieving carbon neutrality can now be helped in the short term by helping to use solar panels on a small scale with a targeted financial support system. In the case of the transport system, the question arises as to whether to use carbon-neutral transport or reduce the number of journeys by organizing services.

In addition to renewable energy sources, research has raised many related issues. The first issue is the energy and landscape: current research on energy facilities and networks is part of the energy landscape [90,91]. Examining the energy system of the ecovillage, on a human scale, agriculture is a significant source of energy for muscle strength, which also networks our daily activities. In landscape planning and design, energy is not only a system of industrial facilities but a broader interpretation covering all land use categories.

What kind of lifestyle and standard of living can reduce greenhouse gas emissions, even within an ecovillage system [92]? How do we define the services we need, and within what legal framework do we interpret our living space? Our research is limited to landscape opportunities. However, these frameworks define opportunities.

The third issue is the issue of energy justice [93]. Who should pay the price of carbon neutrality? What price should we pay for it? An audited community consciously relinquishes many things to provide the foundation for living from internal resources. Do individuals have to give up objects and activities to embark on a carbon-neutral path? Alternatively, companies and states have to pay for investments that reduce emissions. The communities of ecovillages set an example in this, as it is their own decision to live in harmony with the environment and nature. At the same time, they cannot be completely isolated from the outside world, and environmental effects persist even in complete community isolation.

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Appendix A

Questions from the Interview

Household

In general, what energy source do you use and in what proportion in the household (for heating, cooking, lighting, transport, electrical or electrotechnical devices)?

Can you tell me the exact details? (Example: how many cars are in the family when using it and what distances you have gone with it; how often do you refuel and, on average, how many liters and in which car (petrol/diesel); how much wood do you use in a year, or if there is another similar energy source, how much of it you use)

Do you use renewable energy sources? If so, what and for what, how much?

Agriculture

What proportion of animal or human muscle power and machinery do you use on the farm? What kind of animals and how much do you use in which segment of farming? Or what type of machines and in which habitat?

How do you manage your own or rented forest within the village, what energy sources do you use for forestry and harvesting wood? How much wood comes out of the forest in a year and what do you use that for?

How do you manage your own or rented lawn within the village, what energy sources do you use to maintain it? How much hay comes off the lawn in a year?

How do you manage your own or rented orchard within the village, what energy sources do you use to maintain it? In addition to the fruit, what does the orchard produce (hay, wood, etc.)?

How do you manage your own or rented garden within the village, what energy sources do you use to maintain it? To what extent does mechanization increase efficiency? Can grazing replace mowing?

Development

Are there renewable energy sources you would like to use? What are these?

Do you see a real chance of using an electric car?

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