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# INTERDISCIPLINARY FUTURE SCENARIO WITH 100PROSIM: FEWER ANIMAL FOODS PROVIDE SPACE FOR RENEWABLE ENERGY

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**Abstract:** The climate crisis combines land scarcity, high meat consumption, grubbing-up and environmental disasters. Agriculture needs land to ensure food security. In addition, much forestland is needed to store the greenhouse gas carbon dioxide. Access to cleaner energy sources and technologies also helps mitigate the climate crisis and the efficiency of wind- and solar-energy-infrastructures is recognized. These energy sources also require land. This raises the question of how land can be used efficiently to ensure food security, forestland and renewable energy in the context of the climate crisis. Scientific approaches are to save land area from animal husbandry by reducing animal products. Meat production is particularly resource intensive and requires more area than crop products. The project "Future Discourses in Environmental Communication" at Osnabrück University of Applied Sciences addresses different social groups in order to discuss the climate crisis, energy system made of 100% renewable energies and land consumption. For this purpose, targeted workshops are conducted in combination with a simulation tool for 100% renewable energy scenarios. The tool, based on Microsoft Excel, simulates for the participants the potential area for energy production from renewable energies as well as the relationship to energy consumption. The results of the workshops show that participants are increasingly taking up the approach of saving land from animal husbandry by producing and consuming less animal and more vegetable-foods. Consequently, there is enough space for a future based on 100% renewable energy. In general, meat consumption is related to political attitudes. Those who consume less meat are considered more environmentally conscious. The hypothesis could therefore put forward that the participants want to show their climate and energy awareness by criticizing meat consumption.

**Keywords**: renewable energy, climate crisis, land area, animal food, energy sources

## Introduction

The climate crisis is here and with it the extreme weather events. The resulting effects of the climate crisis are being felt by society. Especially due to extreme weather events such as heat extremes, drought, extreme precipitation and strong tropical storms. In 2020, e.B devastating forest fires in Australia, heat in the Arctic Circle in Siberia and ongoing droughts in South Africa have occurred (National Academy of Sciences Leopoldina, 2021). However, extreme weather events are also typical in Germany. In July 2021, a devastating flood disaster claimed more than 170 victims (Schleussner *et al*. 2021). Schleussner *et al*. (2021), based on this climate catastrophe, emphasize the urgency of reducing emissions. Other studies also emphasize that climate stabilization is urgently needed. Accordingly, climate protection measures must be taken so that the global emissions budget for compliance with the warming limit is not exceeded (National Academy of Sciences Leopoldina, 2021).


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In Germany too, national targets for reducing Greenhouse gas emissions (GHG) have already been set in the past and specified by sector-specific transformation paths. One sector that emerges from this is agriculture and thus land use. The land area is limited and there are interactions between land uses (Gömann and Fick 2021). For example, the expansion of agricultural and forestry land has increased agricultural and forestry productivity and thus supported the availability of food, but has led to the loss of natural ecosystems such as: forests, savannahs, natural grasslands and wetlands. Consequently, a decline in biodiversity has also been caused (ICPP 2019). Accordingly, Land use decisions in one land use sector also have an impact on other sectors (Gömann and Fick 2021). Modern, intensified and highly specialized agriculture not only causes environmental problems, but also places a considerable burden on the natural protected assets of soil, climate, air, water and biodiversity. Based on this, land use in connection with climate protection requires a variety of other aspects to be taken into account. In addition, climate change itself results in a necessary adaptation of agricultural land use (Gömann and Fick 2021).

The tasks of agriculture and the associated use of land are very diverse. The most important task is food production for the population. In addition, it is important to preserve the cultural landscapes and agricultural landscapes as a habitat for wild animals and plant species. Furthermore, many farmers have entered the energy supply sector in recent years: on the one hand, through rapeseed and maize cultivation, which are used for the production of biogas, on the other hand through the construction and operation of wind turbines and solar plants (Wagegg und Trumpp 2015). Due to the diverse use of agricultural land, there is already competition between the cultivation of plants for energy, food and feed production as well as material and industrial use. The diversity of agriculture also shows that only a small amount of agricultural land is unused. Only 18 % of the world's ice-free agricultural land remains unused. Of this, 12 % is unusable land. Consequently, about 70 % of the world's agricultural land is cultivated. Of this, 80 % is in turn used for global meat production (AEE 2019).

The consumption of food of animal origin is stagnating at a high level in industrialized countries. From a global perspective, consumption continues to increase (Umweltbundesamt 2018). In this context, data from 1961 indicate that the per capita supply of meat has more than doubled. The supply of food calories per capita has also increased by about a third (IPCC 2019). According to Hirschfelder and Wittmann (2015), even if the trend remains the same, it can be assumed that global meat consumption and thus feed consumption will double by the middle of this century. Intensive animal husbandry takes up space for feed cultivation and is a social issue due to the "plate or trough" discussions. If the trend towards the consumption of animal foods continues, the pressure on agricultural land will intensify drastically (Umweltbundesamt 2018). In order to open up areas for other uses, there is an increasing advocate of a more plant-based diet (Dirscherl 2015), as the reduction of meat consumption is seen as a potential for reducing land competition (Wehde 2001). In addition to the land consumption of meat consumption, the resulting greenhouse gases are also supplemented. The global food system already accounts for 21 to 37 % of global greenhouse gas emissions (IPCC 2019). This is accompanied by the reduction of meat consumption in addition to the phase-out of fossil fuels as the most important lever for climate change (dpa-infocom GmbH 2019). Reducing animal calories to an average of 15 % by 2050 would lead to an 80 % reduction in carbon emissions in agriculture. (AEE 2019).

The connection between a halving of meat consumption and the resulting area made available for other uses that counteract climate change is also taken up (Wehde 2001). Access to cleaner energy sources and technologies will help mitigate climate change. Here, the efficiency of wind and solar energy infrastructures is recognized. That is why the diversity of energy supply should be increased. The use of traditional biomass for energy production, on the other hand, should be reduced (IPPC 2019). Depending on the extent of the use of bioenergy, the original land use, the type of land system, the bioenergy raw material, original carbon contents, the climate region and the management regime, the production and use of biomass for bioenergy can bring context-specific added benefits or adverse side effects. Risks such as land degradation, food insecurity and other environmental and sustainability goals can arise as a result (IPCC 2019). In particular, the land-use competition between biofuels and food production is a social debate and it is known under the keyword "plate or tank". In addition to these conflicts over the food supply for a growing world population and the cultivation of energy crops as a substitute for the increasingly scarce and climate-damaging fossil fuels, there are other land competitions. This includes, among other things, the production of agricultural substitutes as a substitute for petroleum-based industrial raw materials and the use of land for settlement, economic and traffic areas as well as species protection and biodiversity of plants and animals (Dirscherl 2015). In addition, many forest areas will be necessary in the future, as they store the greenhouse gas carbon dioxide. Consequently, the protection of forests should be non-negotiable (dpa-infocom GmbH 2019). Modelled land use change pathways usually include combinations of reforestation, afforestation and reduced deforestation, as this supports the removal of $CO_2$ from the atmosphere (IPCC 2019). However, carbon sequestration in soil and vegetation will not be possible indefinitely. When the carbon stores in vegetation and soil reach their saturation, the annual $CO_2$ withdrawal from the atmosphere drops to zero. Peat bogs, on the other hand, can sequester carbon for centuries. Peat bogs bind about a third of the terrestrial carbon in their peat layers, although they cover only 3 % of the earth's terrestrial surface. This is about twice the carbon that all forests worldwide can sequester in their biomass (Parish *et al*. 2008). Accordingly, peat bogs can reduce competition for land use in the context of climate change (IPCC 2019).

In summary, land areas play an important role in the climate system and thus in the climate crisis (IPCC 2019). In addition, land areas form the main basis for the existence and well-being of people (IPCC 2019). In addition to the traditional demands placed on the area of housing and transport, economy and industry, agriculture and forestry, the space requirement for renewable raw materials, which are used as building and manufacturing material, also plays a major role in the context of climate change. However, renewable energies also receive extraordinary attention here. Land area is also used for wind, solar and bioenergy. Accordingly, the expansion of renewable energies has a strong impact on other landscape services. These include, for example landscape structures that promote biodiversity. Nevertheless, effects on the beauty of landscapes are also relevant (Kienast *et al*. 2014). However, in view of the climate crisis and the shortage of resources, a necessary conversion of our energy system from fossil fuels to renewable energy sources is unavoidable, but this will result in a realignment of the country's area (Bosch and Peyke 2010).

## Material and methods

Based on this background, the project “Future Discourses in Environmental Communication” at Osnabrück University of Applied Sciences addresses different social groups in order to discuss the climate crisis, energy system made of 100% renewable energies and land consumption.

Participants in (digital) workshops use the modelling software 100prosim and discuss the complexity and requirements of the climate crises and the energy transition with a focus on land use.

***Target group-oriented workshop methodology***

Relevant target groups of the workshops are stakeholders in the field of energy transition, which are defined, identified and grouped before planning the workshops. Within the framework of the project, the stakeholders are clustered into superordinate areas, such as politics, economics, science, associations and professional organizations, agriculture and society. This grouping of actors into profiles is relevant in order to focus the content of the workshops on a comparable level of interest and a similar level of influence of the participants. The agriculture stakeholder group, with its land management, occupies a prominent position in the provision of energy in the context of climate change, the energy transition and the associated expansion of renewables.

The target group-oriented workshops are generally based on a transdisciplinary communication approach. Consequently, a workshop methodology is used in combination with a simulation tool for 100 % renewable energy scenarios. The workshops are characterized by a cooperative and moderated way of working towards a common goal. Accordingly, participants develop a scenario for the future of energy supply under supervision and moderation. The hosts also stimulate discussion. This increases knowledge and acceptance. These are, therefore, reciprocal learning processes – "Citizen Science" – and not just learning in one direction (Richter *et al*. 2017).

***The scenario technique with the Excel Software 100prosim***

The workshops with 100prosim are based on the scenario technique. The latter is used to involve experts and stakeholders by constructing scenarios that reveal mental models and, thus, make heterogeneous visions of the future transparent. In contrast to forecasts, the scenario technique is useful for looking at long-term future developments. Accordingly, no statements are made about one future, but several possible alternative futures are considered (Wassermann and Niederberger 2015).

In the course of the workshops, the points of view, opinions and perspectives of the actors from the agricultural and food sectors will be combined in an individual scenario for the future energy supply from 100 % renewables. The software 100prosim is used for the visualization and comparison of the energy scenarios developed. Erneuerbare-Energie-Szenarien e.V. has developed and manages the software 100prosim, which is based on Microsoft Excel. 100prosim is free of charge and open to use. The database of the software is a report for the state government of Lower Saxony "Scenarios for Energy Supply in Lower Saxony in the Year 2050" (Niedersächsisches Ministerium für Umwelt, Energie und Klimaschutz 2016).

The report assumes that agricultural land will decrease in the future due to more settlement areas, which will be entirely at the expense of arable land. In addition, photovoltaic systems will take up more agricultural land in the future, as they are more efficient than the cultivation of energy crops. With the same amount of electricity, less space is needed for photovoltaic systems than for energy crops. At the same time, the expert opinion no longer provides for the cultivation of energy crops for the production of ethanol. In addition, the approach chosen assumes a halving of the vegetable oil area and a constant cultivation area for short rotation. Only the area under energy crops for biogas is

increasing, states the expert report. The use of the limited areas under energy crops for biogas seems more appropriate due to the significantly higher productivity of the area.

The target year for the workshops is assumed 2040, which illustrates the urgency of transforming the energy system and the associated framework conditions. The software 100prosim simulates energy scenarios for Germany, i.e. it depicts specific realities for future energy consumption and production in Germany according to the ideas of the workshop participants and presents them graphically in comparison to the status quo.

In a primary user interface, the Cockpit 1 visualizes the energy consumption, on the one hand, and the energy production for the defined target year 2040, on the other (Figure 1). In addition, energy losses, energy surplus and deficit are graphically displayed in the Cockpit. The following sectors are covered regarding energy consumption: Mobile applications, building heat, process heat and electricity applications. Carbon - based raw materials of industry are also included, which are synthesized in the model from green electricity. In the sectors mentioned above, participants can design efficiency and sufficiency according to their own ideas.

Regarding energy production, covering the energy needs of all sectors without fossil energy sources will be ensured. Accordingly, the participants create a future scenario based on wind and solar power, biofuels from energy crop cultivation, hydropower and geothermal energy. 100prosim takes into account influencing factors such as population size, development of the economy and import shares to calculate energy consumption and production. Long-term storage – using hydrogen – is dynamically simulated by the program in order to compensate for fluctuating energy production through wind turbines and solar plant.

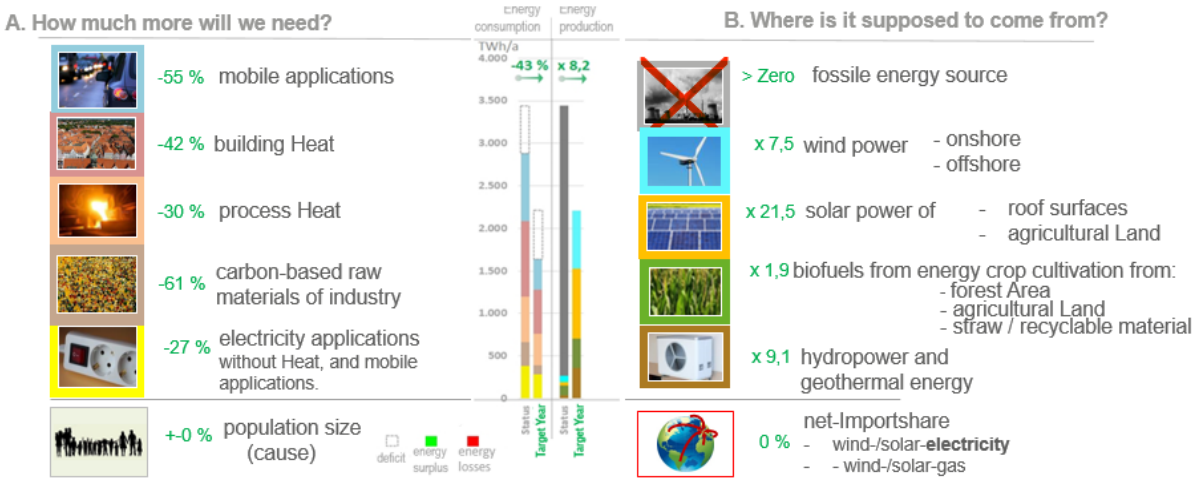


*Figure 1: Cockpit 1 – the primary user interface. Erneuerbare-Energie-Szenarien e.V. has developed and manages the software 100prosim, which is based on Microsoft Excel.*

The expansion of renewables is discussed in the context of ecological and area-dependent limits, and questions of acceptance are addressed. The potentials of the agricultural area used energetically for solar open space and energy crop cultivation are visualized in the secondary user interface, Cockpit 2. In order to achieve a stable coverage of demand, these energy gaps must be filled mainly by wind and solar energy if, in contrast to today, massive imports are to be avoided.

***Uniform structure of the digital workshops***

Only digital workshops, using Zoom videoconferencing software, were conducted as part of the Covid 19 pandemic. The digitally conducted workshops follow a uniform structure, with the content of the presentation tailored to the group of participants. The topics to be discussed are chosen according to the workshop. Each workshop starts with an introductory presentation. The presentation covers the topics: climate change, $CO_2$ and energy transition.

This is followed by an interactive part in which the participants vote on different values of energy consumption. For this purpose, the online platform MENTIMETER is used in the workshops. MENTIMETER[1] is a computer program or app for real-time feedback during a presentation. Accordingly, participants connect to the presentation via a smartphone or computer and answer questions. In the workshops, specific questions are asked about energy use (sufficiency): "How much will we travel by car/plane in the future?" But also assessments of technical innovations (efficiency): "To what percentage will traffic be electrified?" are questioned. MENTIMETER visualizes the answers of the participants in real time, shows the average resulting from the votes and creates an interactive exchange. The participants discuss their answers and, along with them, their view of the future. The mean values resulting from the votes and perceptions on the energy consumption side are then transferred to the modeling software 100prosim, and the software then shows whether there are supply gaps with the assumptions made. To close these supply gaps, the energy supply is considered. Here, the participants decide which renewable energies will be expanded and to what extent. Again, this is scrutinized with MENTIMETER and then the votes are discussed. For example, for renewables, the question asks, "What percentage of arable land should be used to grow energy crops for biogas in 2040?"

If there are still supply gaps after that, the simulation tool concludes by reconciling consumption and generation, either via wind onshore or photovoltaic open space. At the end of the workshops, general challenges and wishes for the implementation of a future based on 100% renewable energies are again questioned with MENTIMTER and subsequently discussed.

***Quantitative and qualitative evaluation of the workshops***

The quantitative evaluation of the workshops is done by exporting the results into Microsoft Excel for further analysis. In this way, the data, facts and information of the individual workshops can be statistically evaluated. In addition, corresponding diagrams can be created, which present the results more clearly and in an easy-to-understand form.

For the qualitative evaluation, the digital workshops are not only conducted but also recorded using the Zoom video conferencing software. The recorded workshops will then be transcribed anonymously. The transcription of the workshops will be done with the software MAXQDA (VERBI Software – Consult -Sozialforschung GmbH 2021). MAXQDA can be used to analyze the content of

[1] Mentimeter AB (2021). Mentimeter. Stockholm. https://www.mentimeter.com/

the audio and video files, providing insights into the data material. The evaluation of the data material is based on the theory of qualitative content analysis. In this content analysis, the transcribed text documents are first read through. This creates an overall understanding of the content of the workshops. Then key concepts or passages are highlighted and initial thoughts or theses are attached to the text in the form of memos. Thematic main categories are then developed. The main categories are used to structure the content of the data and are in turn generated from sub-questions. The formation of the main categories is done here by the inductive method. In the inductive method, these are generally derived based on the transcribed data, from which in turn various thematic categories are formed (Kuckartz 2016).

**Results**

Twelve workshops were held. Various stakeholders took part in the workshops. Among them were high school students of a grammar school (PUPILS), students of various disciplines (WING, MB1, AUL, MB2), climate protection managers from Lower Saxony municipalities (CLIMA), interested citizens (CITIZENS), business associations (V1 and V2), an interest group for women (WOMEN), a city administration (CITY) and a county administration government (COUNTY).

The topic of biogas and the associated cultivation of energy crops was only dealt with in more detail in four workshops with students from different disciplines (WING, MB1, AUL, MB2). Due to technical problems, the recording and the accompanying transcription could only be carried out at three workshops (WING, AUL, MB2). A transcribed workshop yielded few qualitative results as participants discussed little (MB2).

The demand for well-known energy producers was asked in all workshops. Here, biogas plants were named as energy producers in almost all workshops [AUL 13, V2 49, WOMEN 61-62, V1 33, WING 24, COUNTY 72].

The relevance of biogas plants was also made clear in the workshops, where they were not dealt with in detail [CITY 120]: "Yes, this is definitely a topic. We are particularly looking at biogas here in the area, because biogas is also very strongly represented in xxx or production is very strong."

Quantitative data on biogas were collected using MENTIMETER by allowing the participants to give a percentage assessment of the use of arable land for the cultivation of energy crops for biogas. "What percentage of arable land should be used to grow energy crops for biogas in 2040?" In three workshops (WING, AUL, MB2), the percentage of arable land was above the base scenario of Erneuerbare-Energie-Szenarien (ErnES) e.V. of the tool 100prosim. Only in one workshop (MB2), a smaller proportion of arable land could be determined. Overall, this resulted in a percentage of arable land of 19 % to be used for the cultivation of energy crops for biogas. So all the data also resulted in a 5 % higher assessment. The estimates are shown in Figure 2.

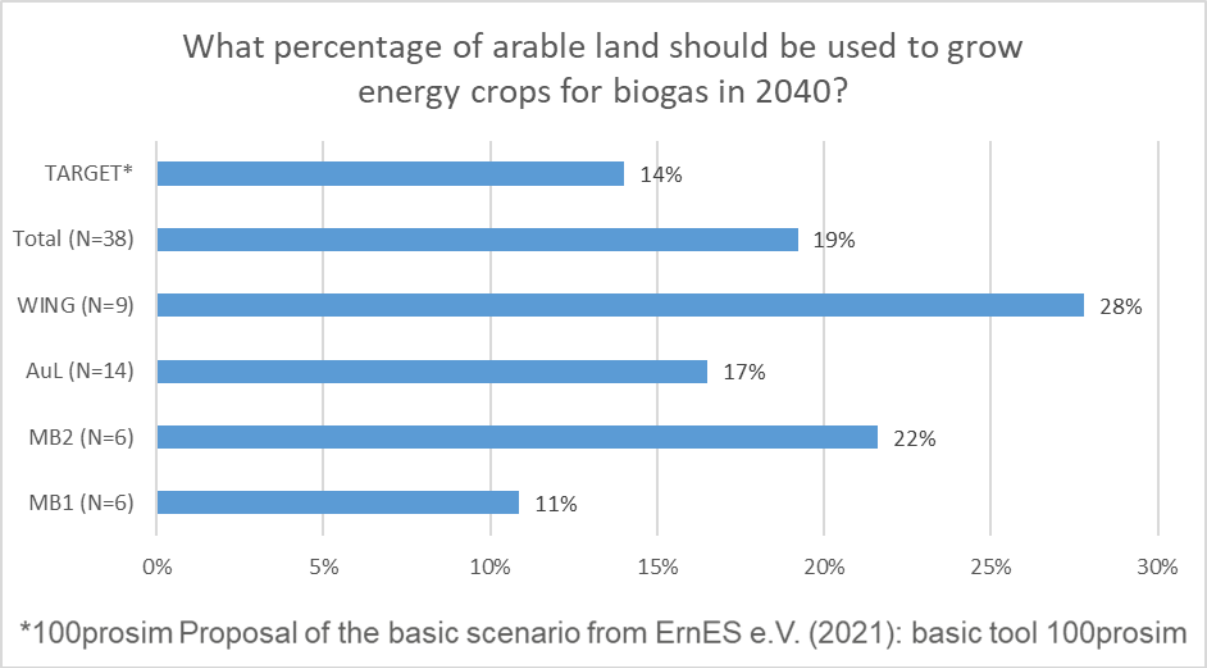


*Figure 2: Quantitative MENTIMETER Results: Estimates in the workshops "What percentage of arable land should be used for growing energy crops for biogas in 2040?"*

The qualitative results also show that in principle no directly pejorative attitude to biogas production emerges from the workshops. It is clearly stated that decommissioning and suspending subsidies for existing plants are not sensible approaches [AUL 74, AUL 155, AUL 162, AUL 173].

Acceptance problem with biogas plants due to the change in the landscape did not occur in any workshop. The cultivation of energy crops as a monoculture was also not mentioned in the workshops.

However, there were discussions and different assessments of land use for energy- and food production, [WING 64]: "(...) to feed themselves only and not to export food that is quasi plant-based, to the outside and then to use the rest energetically. That would make sense from my point of view. That's why I set the value so high." and [WING 66]: "Yes, I stayed with this 12-13 %, because I should also use that with the food industry to grow more local products, but then also save $CO_2$ in this way."

Similar perspectives were also identified in the workshops with students from the fields of agricultural sciences and landscape architecture [AUL 76]. This was specifically justified by the soil quality [AUL 78]: "Yes, exactly, I actually agree with the opinion of the predecessor that you just have to use these areas for food cultivation, because these are actually good soils as a rule, more (...)." Whether energy crops should be grown in poor soil quality remains open.

On the topic of food cultivation, direct reference was made to the topic of meat production. [AUL 164]: "(...), so you need seven times as much area to produce meat instead of plant-based food. That's going to hit a notch in the future with an increasing population in the world before necessary, I think." This critical comment also received agreement from other participants [AUL 164, AuL 166, AuL 168]. It was added to this that throwing away food is also unnecessary land consumption, but also that

land consumption has a great importance depending on the food [AuL 166]. Likewise it is referred to the fact that it stands in connection with social acting [AuL 166]: "(...) and that one there just gust that one there also however that is a thing, where one must touch in the society, (...)".

Furthermore, biogas is connected in connection with the utilization of animal excrement. Likewise, the utilization of food leftovers for the biogas production is mentioned. It is noted that biogas plants could be used efficiently for this purpose, thus saving land for recycling [AuL 70].

Finally, animal husbandry in stables [WOMEN 33] and meat consumption [WOMEN 39] are also mentioned as energy consumers in a workshop.

**Conclusion**

The workshops of the energy project “Future discourses in environmental communication” generally address current questions on the energy transition in the context of the agricultural and food sector in an original way.

The qualitative results of the workshops show that participants are increasingly taking up the approach of saving land for animal husbandry by producing and consuming less animal food and more plant food. In general, food must be used and utilized more efficiently, and less food should be thrown away unnecessarily. This leaves enough room for a future based on 100% renewable energy. In general, meat consumption is related to political attitudes. Those who consume less meat are considered more environmentally conscious. In general, meat products are considered to be among the foods to which great emotional significance is attributed. Accordingly, they are symbolically charged, have a high cultural value and arouse strong reactions. Industrial meat production represents a considerable part of the unsustainable development trend of contemporary societies due to ecological and health impacts (Astleithner 2007). Furthermore, individuals can position themselves as belonging to groups or distinguish themselves from them by deviating from them through food culture (Fingerling and Godemann 2019). So the hypothesis could be that participants want to show their climate and energy awareness by criticizing meat consumption.

A consensus on land use by developing renewables in the context of ecological and land-dependent boundaries can, thus, be seen as a qualified contribution to the social debate – not only in the sense of a stimulus but also as a contribution to its objectification.

Further digital workshops and, if possible, offline events in the agricultural and food sector should be conducted.

In addition, the tool will be further developed in a follow-up project if necessary, and at the same time, the workshops will continue to be held, as it is assumed that this type of knowledge transfer can contribute to an increase in acceptance and optimized participation. It can also stimulate a rethinking of one's own behavior, e.g. reduction of meat consumption.

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