Report from the Transnational Workshops

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Abstract

This report collates the submission reports from 3 regional hubs that each organised and conducted a transnational innovation workshop (TIW). The submitted thematic TIW reports comprised the outcomes of workshops about energy use, FEFTS utilisation and research and policy needs. The themes were divided into greenhouse production, open-field crop production, and livestock production. This report contains a summary and conclusions of the post-it notes canvases and discussion from the separate working groups for each workshop about the current situation of energy use in agricultural production systems, and their opinion, interests and ideas about the future policies and research to assist on defossilization of EU agri- and horticulture. For each thematic area, this report provides a structured walkthrough of the transnational opinions about relevant categories of FEFTS, the identified problems regarding energy in existing production systems, the assessment of relevant FEFTS for solving the problems identified, extraction of ideas on how to solve such problems, the suggestions to research needs, and the recommendation to policies to be incorporated nationally as well as in EU and the new CAP and other policy instruments to assist on FEFTS integration in local agri- and horticulture.

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1. Introduction

The AgroFossilFree project has conducted a series of 24 Regional Innovation Workshops (RIW) covering the 3 production systems of agriculture, namely open-field, greenhouses and livestock. Therefore, 3 workshops were held in each of the 8 participating countries (Greece, Italy, Spain, Ireland, the Netherlands, Germany, Denmark and Poland) in the local language to extract the interests and ideas of local agricultural stakeholders in terms of energy use in these agricultural production systems. The results were summed in D3.3 and based on these results, 3 Transnational Innovation Workshops (TIW) were organized on June 14th, 2022, for greenhouses in Athens, Greece, on September 23rd, 2022 for open-field systems in Warsaw, Poland and on December 1st, 2022 for livestock facilities in Herning, Denmark. The aims of these workshops were to bring together relevant agricultural stakeholders (greenhouse, open-field and livestock respectively) together to: provide an overview of and discuss energy consumption in EU agricultural production as well as the factors affecting the adoption of innovative strategies and technologies; to present and discuss the main and current European agricultural industry solutions and associated policies as well as discussing future developments regarding energy efficiency improvements and renewable energy sources for agricultural production; and to present and evaluate past and current research results of specific agriculture related FEFTS and to identify needed research direction, collaboration schemes, cross-border and educational efforts. Overall, the workshops achieved the active participation of 140 stakeholders (greenhouse: 55, open-field: 44, livestock: 41) relevant stakeholders. In each workshop, participants were split in two working groups which had stakeholders with variety of expertise, from across the EU, allowing to receive important relevant insights and outputs for policy. This report provides an overview of the structure of the workshops; its methodology, aims and outputs; results of the working groups; and an analysis covering the main themes of the discussion.

2. Details of the organisation of the Transnational Workshops

The locations of the workshops are given below:

- **Greenhouses:** The workshop was held at the Agricultural University of Athens (AUA). AUA was selected to host this event for a number of reasons. Expect being one of the partners of AgroFossilFree, AUA has a long history in researching and promoting relevant greenhouse production strategies in Greece and internationally making it both a relevant location and

also providing stakeholders with an opportunity for a greenhouse site visit showcasing new and relevant research. In addition, AUA is centrally located in Greece with accessible and frequent local, regional and international transport routes facilitating the participation of both local Greek and European stakeholders.

- **Open-field:** The workshop was held at the Institute of Agricultural and Food Economics - National Research Institute (IRiGŻ-PIB) in Warsaw. The capital city of Poland was selected to provide high accessibility to interested stakeholders both from the country and from abroad, and thus ensure high number of participants to the workshop. The date was chosen to coincide with the biggest exhibition of agricultural machinery in Poland, the AGRO SHOW held in Poznań, on September 23rd to 25th 2022. The exhibition is the most important event in the field of agricultural technology in Poland and one of the largest international agricultural exhibitions in Europe.
- **Livestock:** The workshop was held at the Messecenter Herning (MCH) in Herning, Denmark on December 1st, 2022. The location and timing were selected to coincide with the indoor fair AGROMEK (www.agromek.com). This fair is one of the most important events in the field of agricultural technology in Europe and brings seven sectors together in one big fair: field equipment, tractors and harvesting machinery, grain handling, livestock mechanisation, energy, knowledge, and services as well as contractors, parks, roads and construction both from national and international companies, and thus encourage a high number of participants to the AFF workshop.

The agendas of all workshops were based on the same format, and are presented in the Appendix of this document.

The first part of the TIW consisted of a round of presentations with the aim of introducing the workshops' aims as well as providing an overview of the current energy use situation, available technologies and innovative solutions in the three production systems. Specifically, these presentations included an overview of the AgroFossilFree (AFF) project given by the Project Coordinator (Thanos Balafoutis), an interactive showcasing of AFF's AgEnergy platform by Michalis Kaminiaris, a presentation by Vasiliki Kanaki (AUA) focusing on the needs, barriers and incentives of EU farmers regarding FEFTS adoption identified in the context of Task 1.3, a presentation by Michael Nørremark (AU) providing a synopsis of AFF's thematic Regional Innovation Workshops results and other interesting presentations from industry

representatives and/or other ongoing EU projects. More information about the speakers and their presentations are presented in chapters 7.1-7.3 of the Appendix.

Prior to the second part and during the coffee break time, stakeholders had also the opportunity to talk to each other, exchange views and be informed about the specific outcomes produced by each thematic Regional Innovation Workshop. This information was depicted in several posters printed in A0 size, which were mounted in specific places of the main room inviting the participants to get information about the outcome from each country and raise their interest to further discuss about the synopsis of results presented before.

The second part of the workshop was focused on facilitating discussion and collaboration on several related topics through a unique working group format. The goal was to stimulate discussion and develop constructive solutions around key questions and developments facing all three agricultural production systems in the EU. In each workshop, the stakeholders were split in 2 working groups, trying to achieve a mix of expertise, but also gender and geographical diversity of stakeholders in each one of them. At the same time, creating 2 separate groups ensured that everyone would be able to express his/her opinion, and actively contribute to the discussion. Finally, a total of 140 stakeholders (greenhouse: 55, open-field: 44, livestock: 42) participated in the project's workshops. A wide variety of stakeholders characterized each working group, including farmers/producers, agronomists, scientists, industry representatives, academics/researchers, agricultural advisors, NGOs etc.

The discussion in each working group was split in three parts according to the corresponding theme; each part began with an introductory pitch and a question set via the Mentimeter app with the goal of introducing the topic and stimulating participation on the topic. This was then followed by a more 'open' format whereby a series of related questions and sub questions were asked to stakeholders. Stakeholders were first asked to start a round of discussion and then write down their responses to each question on post-it notes which were collected and added to a board/canvas. After the discussion had concluded the working group moved on to the next theme. More specifically, the three themes for each part were:

- Current status of the energy consumption of the 3 EU agricultural production systems (greenhouses, open-field, livestock)

- Main and current European industry solutions, and policies accompanied by possible anticipated developments for the next 10 years regarding reduction of energy consumption and fossil free energy use for these agricultural production systems.
- Past and current research results of specific FEFTS of interest identified in each AgroFossilFree country, always related to European agricultural energy situation and identify needed research direction, collaboration schemes, cross-border and educational efforts.

An optional third part of the workshop followed after the completion of the working group discussions. In the 1st TIW in Athens, this part included a site visit to AUA's greenhouse facilities led by Professor Georgia Ntatsi (AUA) where participants were able to see specific technologies used in greenhouses and discuss AUA's latest research on greenhouse crop production (see figures in the Appendix about greenhouse production). In the 2nd TIW, several AFF partners took advantage of the opportunity to travel to Poznan in order to visit the annual AGRO SHOW fair, the International Agricultural Exhibition with Farming Equipment in Poland. It is the most important event in the field of agricultural technology in Poland and one of the largest international agricultural exhibitions in Europe (see figures in the Appendix section about open-field production). In the 3rd TIW in Herning, AFF partners had the opportunity to visit AGROMEK fair, Northern Europe's largest trade fair for the agricultural sector focusing mainly on agricultural machinery for livestock production e.g., cattle, pigs and poultry (see figures in the Appendix section about livestock production).

3. Transnational Innovation Workshop on greenhouse production

The discussion part of the workshop was managed by appointed moderators/facilitators. Michael Nørremark (AU), Konstantinos Vaiopoulos (CERTH), and Bas Paris (AUA) in Working Group A and Thanos Balafoutis (CERTH), Matina Voulgaraki (CERTH) and Camino Fabregas (INI), in Working Group B.

3.1. Greenhouse Working Groups: 1st category of questions.

The workshop sessions were initiated by a question shared with the audience by Mentimeter. This initial question was concerning how many times more energy do high energy consumption

greenhouses (GH) use per hectare per year as compared to low energy GH systems. The figure 1 and 2 represent the answers to the above question for consideration by the participants in group A and B, respectively.

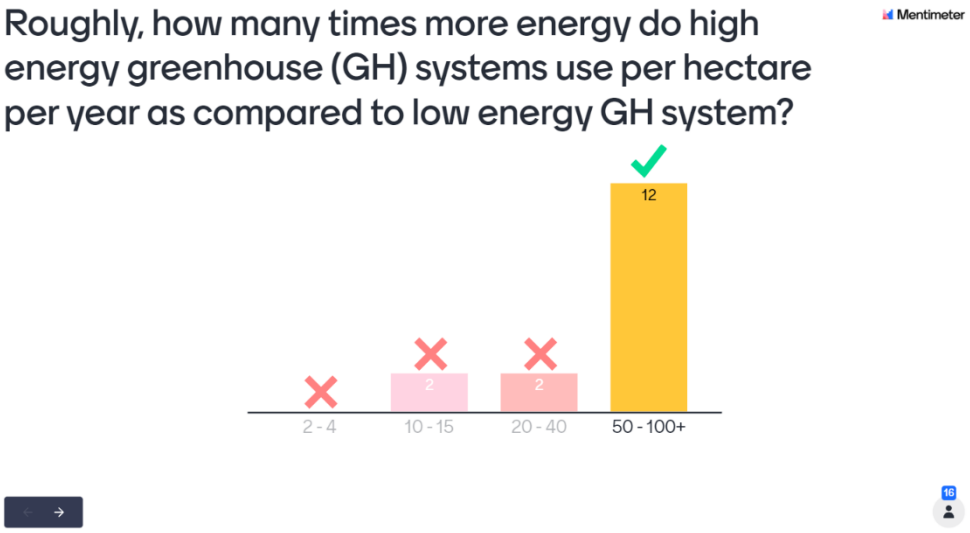

Figure 1.*Working Group A Pitch 1 Mentimeter voting results*

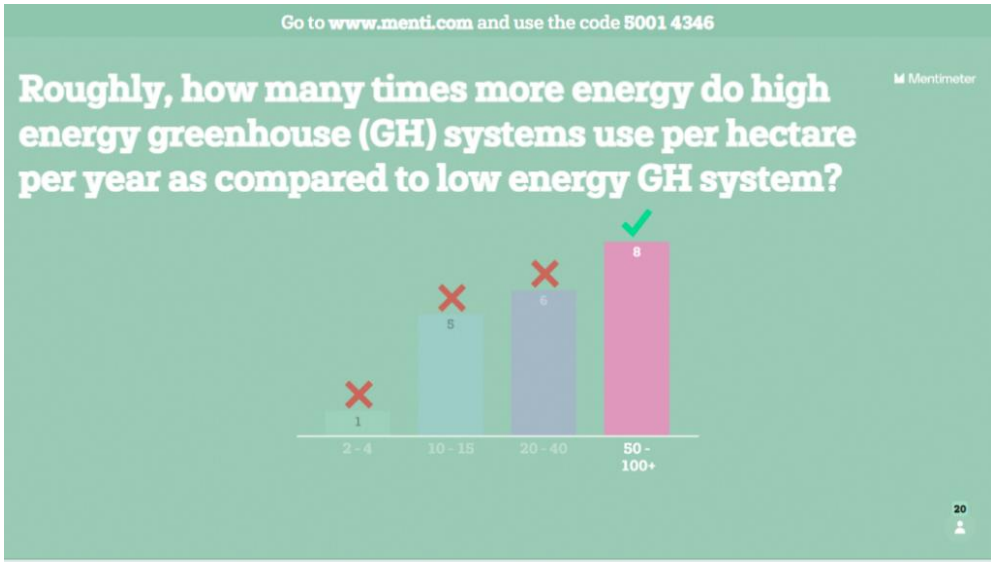

Figure 2. *Working Group B Pitch 1 Mentimeter voting results*

During the introductory pitch and the opening question shown in the Mentimeter (Fig. 1 and 2) and from comments from the participants, it was clear that most stakeholders were aware that

a very large variation in energy use between greenhouses exist and that this illustrates the importance of the specific context and type of greenhouse design, control and energy efficiency when discussing potential energy related solutions.

Then, the first category of questions focusing on energy use in greenhouses, was given to the participants and the respective answers are shown below:

1.1. If fuel and electricity costs continue to rise, how will it affect the production processes, farm logistics, export, etc?

Regarding question 1.1 and based on the discussion and on the posit-its canvas, most of the participants in both working groups agreed that increased fuel and electricity costs are likely to lead to decrease in overall greenhouse production and yields as well as contribute to decrease in the quality of greenhouse crop production, at least in the short term. Interestingly and indeed relevantly, a number of stakeholders pointed out that in the long run these increases are likely to stimulate improvements in energy efficiency and the adoption of alternative fuel sources followed, at the same time, by a comment on increasing food prices as a consequence.

1.2.A. Will this number (of greenhouses) increase or decrease and why?

Regarding question 1.2 A, most respondents in working group A indicated that the area under greenhouse production is likely to increase due to a range of factors, including: need and increased demand for locally produced products, increased focus on environmental sustainability and optimised production systems. By contrast, the canvas, which was not evident during the discussion, also indicated that some stakeholders believed that greenhouse production could decrease due to the increasing costs associated with increasing energy prices. The participants who argued that the greenhouse crop production will increase, did foresee an increased demand for local/EU produced crops from greenhouses because of high costs of logistics and focus on sustainability as underlined by EU policies. For the same reasons, but also due to failures meeting EU sustainability guidelines for imported crops and other EU policies, imports from countries far away from EU may also decrease, which will result in more focus on sustainable and more specialised “protected under covered structures” crop production in the EU. In working group B both the discussion and canvas indicated that some stakeholders

believed that the area under greenhouse production is likely to increase while others believed that it would decrease. The reasons given were the same as in working group A.

1.2.B. How will the energy use efficiency (EUE) develop, increase, decrease or status quo and explain why?

Regarding question 1.2 B, in both working groups, during the discussion, the consensus was that energy efficiency (EE) for the greenhouse sector in the EU will increase for several reasons. The dominant reason, supported by most stakeholders, indicated that a combination of conventional energy price increases combined with improvements in EE technologies and associated policies will drive EE improvements across the board. Interestingly, a considerable number of stakeholders indicated that they see this process as almost inevitable and seeing no other viable option. In group B it was noted that high investment costs may decelerate the overall EE interventions, due to the considerable number of low-tech greenhouses. In addition, a standardisation of the framework for protected crop production on an EU level including EE improvement goals are key factors for increased sustainable production. It was notable that very few participants expressed the opinion that EE adoption would remain stable or decrease.

1.3.A. Do you know what is the current direct energy use (e.g., KJ or MJ) per unit (e.g., Kg or ha) of a greenhouse product?

Regarding question 1.3A, most stakeholders claimed that they didn't know the current direct energy use (e.g., KJ or MJ) per unit (e.g., Kg or ha) of a greenhouse product in both working groups. However, the succeeding discussion brought up a number of interesting trends: in working group A the discussion mainly focused on the need for the development of effective energy measurement methods such as energy audits and that these are largely missing or not adequately developed currently. In working group B, the discussion mainly focused on the difficulty in effectively measuring energy use though there was some consensus on the fact that if policy makes this a priority, it is likely to stimulate effective energy measurement practices, similar to what has occurred for the energy labelling on products in the EU over the past two decades. Greenhouse crop producers care mostly about the total cost per product unit, which they can measure currently, and it will be wrong to make the sector responsible for something they cannot control and for what it is complicated to measure/audit. Participants in group B

also agreed that energy intensity per se is not so important for the consumer as is carbon neutrality per unit of greenhouse cultivated crops, which is becoming increasingly important to retailers and consumers.

1.3 B. Identify possible wasteful energy parameters showcasing problematic management approaches.

Regarding question 1.3 B, there were a variety of answers both in the discussions and the canvas. In working group A, the answers varied between, building envelope design, obsolete production techniques (heating, lightning and irrigation were often mentioned in group B), annual variability, variability in market demands, marketing approached, fertilizers. While in working group B most stakeholders indicated bad heating, cooling and irrigation strategies as the most wasteful energy parameters, a couple of stakeholders also indicated electricity consumed for lighting.

A few noteworthy outcomes from the feedback that was taken from the stakeholders for this category are:

1. Most stakeholders believed that increased energy prices would lead to decreased greenhouse production, and to rising food prices as well.
2. In the long run these cost increases together with common efficiency improvement goals on EU partnership level will drive the adoption of EE technologies and practices.
3. In many ways the long-term transition to the adoption of FEFTS is very much underway and that the speed of adoption is dependent on the prices of fossil fuels, technological developments, and policy.

In this manner, it was clear that there were considerable similarities between both working groups regarding price rises leading to decreased production in the short term and that this combined with other factors will likely drive the adoption of FEFTS. However, unexpectedly, there were some notable differences regarding question 1.3 B in opinions related to ‘wasteful energy parameters’ and ‘management approaches’ suggesting that stakeholders have different opinions on where energy is ‘wasted’ and that in effect this likely means different opinions in type of interventions and FEFTS that should be prioritised to support a green transition in the EU greenhouse sector.

3.2. Greenhouse Working Groups: 2nd category of questions.

As in the previous set of question, an introductory question started the process, and it was answered from both groups through Mentimeter and the respective results are shown in the figures below.

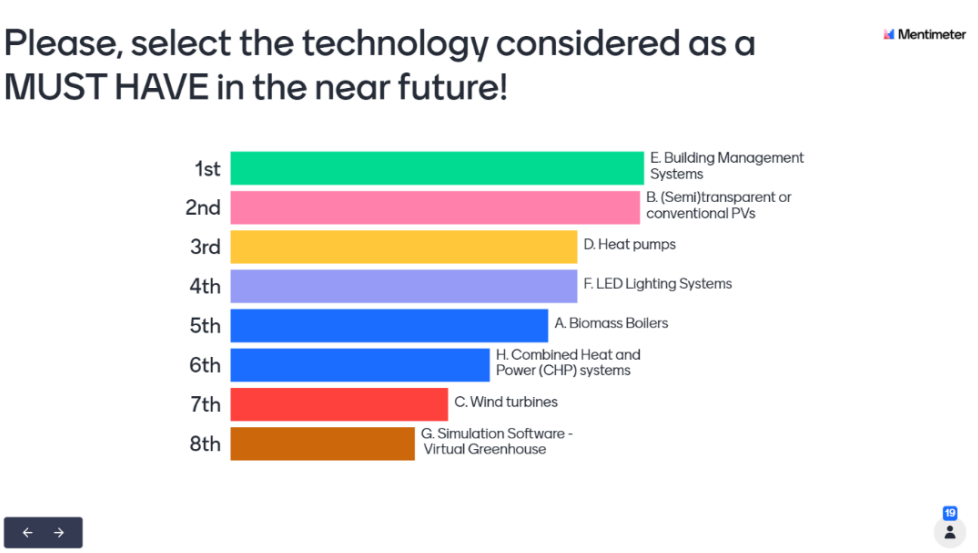

Figure 3. *Working Group A Pitch 2 Mentimeter question and voting results*

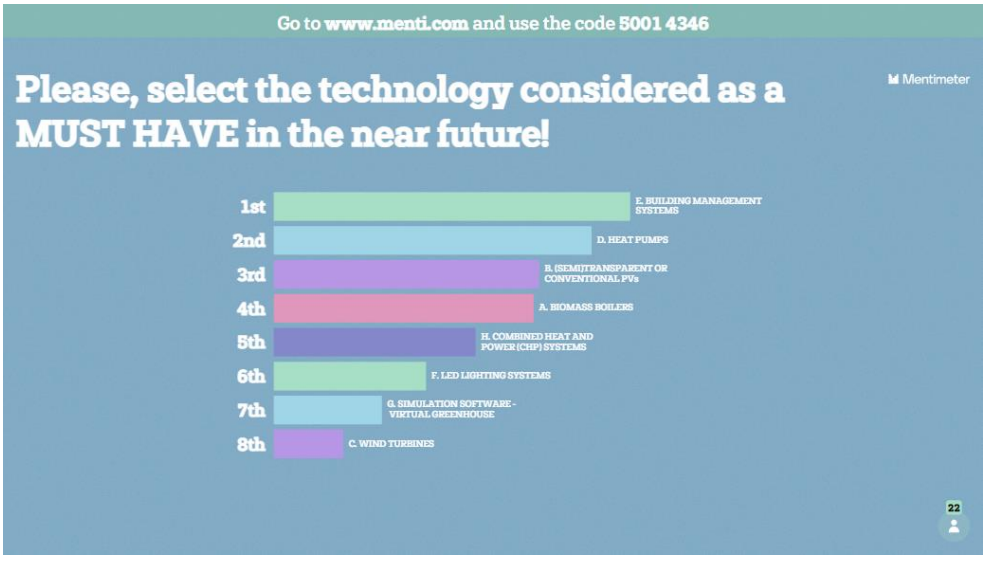

Figure 4. *Working Group B Pitch 2 Mentimeter question and voting results*

During the opening pitch and results from the second Mentimeter question it was clear that stakeholders had similar opinions on 'must have' future technologies. In both working groups

Building Management Systems were most popular followed by (Semi-) transparent or conventional PVs and heat pumps.

The second category of questions on the FEFTS solutions consisted of the following questions and the respective answers were given by the attendants:

2.1.A. How to increase awareness of FEFTS solution in order to promote Energy Use Efficiency?

Regarding question 2.1 A, a range of potential methods were proposed by stakeholders to increase awareness of FEFTS solutions in both working groups, including through:

- National and European policy methods,
- the development of a new vocational specialisation on FEFTS,
- funds for farmer education,
- advisors stimulating awareness of relevant technologies,
- more effective dissemination strategies,
- economic subsidies for adoption,
- the development and adoption of a FEFTS label,
- paid farmer trainings.

For group B, the economic earnings weighed the most. Despite this diversity, a common theme amongst many of these responses were centred around promoting a form of education and/or training of farmers and especially advisors. This is important as it highlights the preference around traditional training and extension programs among most stakeholders.

2.1.B. What would you like to learn and how? (i.e., what kind of training you prefer?)

Regarding question 2.1 B. a range of specific training and educational practices were proposed. Overall, it appeared that the desire for a specific training was largely unique to each stakeholder across the two working groups. Knowledge transfer under the headline “how to!” was a widely held view, especially in group B. The proposed framework for knowledge sharing were summer schools, workshops, case study presentations, practical trainings, webinars, virtual tools, presentations of experimental demos and site visits. Some of the training content that was proposed included: latest EU developments, energy savings strategies, specific technology trainings, and how to access subsidies.

2.2.A. Are there any novel national or EU policies (or changes to current national/EU policies) that could benefit sustainable investments in certain FEFTS for greenhouse production?

Regarding question 2.2 A. the existing novel policies that were discussed in both working groups included: the new CAP, CO2 tax, targeted modernisation schemes (for instance, in Ireland a grant exist for the purchase of RES equipment, similarly, in the Netherlands there is a national scheme subsidising the adoption of heat pumps) and tax deduction of investment in RES. Here the consensus, across both working groups, seemed to be that some relevant and novel policies exist but the general impression was that stakeholders wanted to see more policy support and more outreach on relevant policies in general. Clear and long-term national strategies are key factors for sustainable and implementable policies that will encourage investments in new technologies. For working group B, in particular, the discussion focused on the fact that, rather than just providing subsidies for adoption, policies that support returns on investment are generally more effective. It was noticed that only the participants from Poland in both groups concordantly expressed that there have never been subsidy policies targeting the greenhouse crop production sector in Poland, indicating that the framework for subsidies are widespread within the EU.

2.2.B. Propose new policies!

Regarding question 2.2 B, the following new policies were suggested: a minimal price for agricultural produce, support for smaller farms, CO2 reduction rewards, subsidies for heating and cooling, phasing out of fossil fuel boilers, capital for demonstration plants, investments subsidies under CAP, subsidies for farmer energy training, programs on energy efficiency for advisors. Overall, the discussion for this question indicated a variety of responses by stakeholders.

As main outcomes from the feedback that was taken from the stakeholders for this category are:

1. A range of incentives can stimulate FEFTS adoption including, policy, subsidies, effective communication strategies, knowledge sharing, training and education.
2. Some relevant and novel policies exist but the general impression was that stakeholders wanted to see more and more effective policy support and more outreach on policies.

3. A range of policies were suggested to help focus on supporting FEFTS adoption and improvements in energy efficiency.

In this way, it was clear that there are similarities between the diversity of methods for FEFTS adoption with both working groups highlighting the same methods, as is clearly illustrated in the canvas (see appendix). At the same time, big differentiations were recorded between stakeholders in working group A and working group B, where the focus of the discussion in working group B was mainly on extension services and their potential in driving adoption, while in Working group A most of the focus of the discussion was on the role of policy. Similarly, in Working group B the discussion was very much focused on the need for policies that are investment related while in Working group A were focused on a broader range of policies.

3.3. Greenhouse Working Groups: 3rd category of questions.

Closing the session, once more, an introductory question started the process, and it was answered from both groups through Mentimeter and the respective results are shown in the figures below.

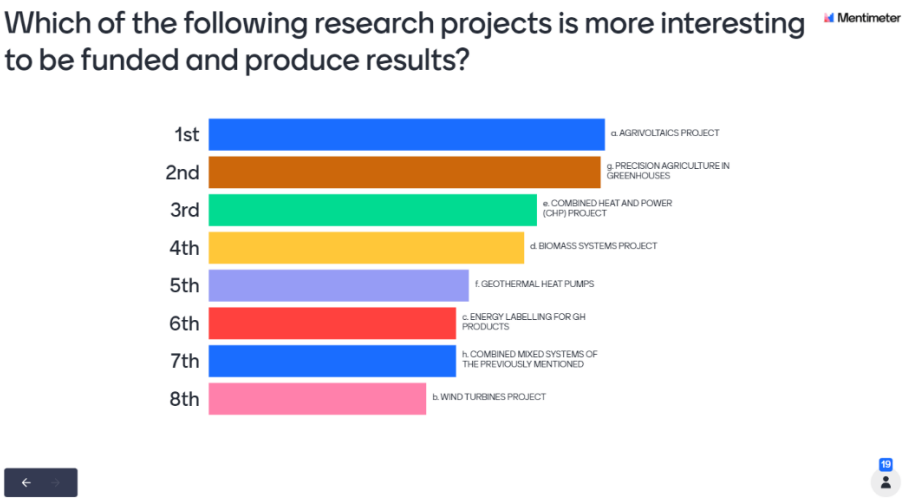

Figure 5. *Working Group A Pitch 3 Mentimeter question and voting results*

Figure 6. *Working Group B Pitch 3 Mentimeter question and voting results*

During the opening pitch and voting results from the third Mentimeter question showed some notable similarities and variations between the two working groups. Regarding differences, in working group A, projects related to agrivoltaics was the most popular choice while in working group B, projects about biomass systems around the concept of circular economy was the most popular one. In both groups, new projects on precision agriculture applied in greenhouses, and CHP (Combined Heat and Power) systems were also a popular choice. The least popular topic between both groups was wind turbines. The geothermal heat pumps were placed by both groups on the fifth place.

The third category of questions on the FEFTS solutions consisted of the following questions and the respective answers were given by the attendants:

3.1 According to your point of view, which of the following research projects is more interesting to be funded and produce results?

Regarding question 3.1, in working group B the discussion around most suitable research projects focused mainly on Agrivoltaics and PV systems and decisions support systems, while in working group A the discussion was more diversified and highlighted research preferences amongst stakeholders in: drones for precision agriculture, nutrient and energy use inefficiency, nuclear power, re-use of materials, how various renewable energy types can be combined to provide results for producers, research in both agronomy and energy combined, robotics and a decision support system for irrigation. It is interesting that in two instances stakeholders

suggested research projects that focus on a multidisciplinary approach (combining agronomy and energy and combining different renewable energy types).

3.2 What type of research collaborations and cross-border schemes would you consider to realise your research concerns?

Regarding question 3.2 on research collaborations, the following collaborations were suggested: joining already established pan EU networks to get support on technical issues, alternative agricultural strategies (conservation, permaculture), collaborate with different agricultural production systems other than greenhouses (livestock, industrial processes), create associations (private organisations), EU-China, EU - USA, EU - Africa, PhDs, joint events, pilot cases around the globe, enterprise information portal (EIP), cost projects, energy consumer associations, community energy projects, sustainable energy communities.

3.3 How to merge all the growers and how to push the industry to get involved in research and development of FEFTS?

Regarding question 3.3 answers generally focused on effective dissemination strategies. The discussion in group A was focused on the need for knowledge transfer groups, where these groups should be focused on topics that at the end of the day will benefit and be profitable for all collaborators. Some stakeholders argued that incentives were needed for industry to be involved while others argued that industry was already driving innovative research. The answers in the canvas included: workshops, trainings, exhibitions, open days, knowledge transfer groups, and funding of living labs.

The main outcomes from the feedback that was taken from the stakeholders for this category are:

- A varying range of research projects and goals are preferred by different stakeholders.
- That focused networks and multidisciplinary knowledge transfer groups can provide clear information and orientation on research and involve different stakeholders.
- Effective disseminations strategies are key to creating and driving research and development of FEFTS.

In this way, it was clear that some stakeholders were more focused on RES production technologies and associated research while other stakeholders were more focused on energy use efficiency technologies and associated research.

4. Transnational Workshop about Open-field production

The discussion part of the workshop was managed by appointed moderators/facilitators: Magdalena Borzęcka (IUNG), Thanos Balafoutis (CERTH), and Małgorzata Wydra (IUNG), in Working Group A, and Michael Nørremark (AU), Konstantinos Vaiopoulos (CERTH), and Bas Paris (AUA) in Working Group B.

4.1. Open-field Working Groups: 1st category of questions

The workshop sessions were initiated by an introductory question shared with the audience by Mentimeter. This question was concerning what percentage of total energy used in open field agricultural systems can be related to the production and application of specifically inorganic fertilizer. Figures 8 and 9 represent the answers to the above question for consideration by the participants in groups A and B, respectively:

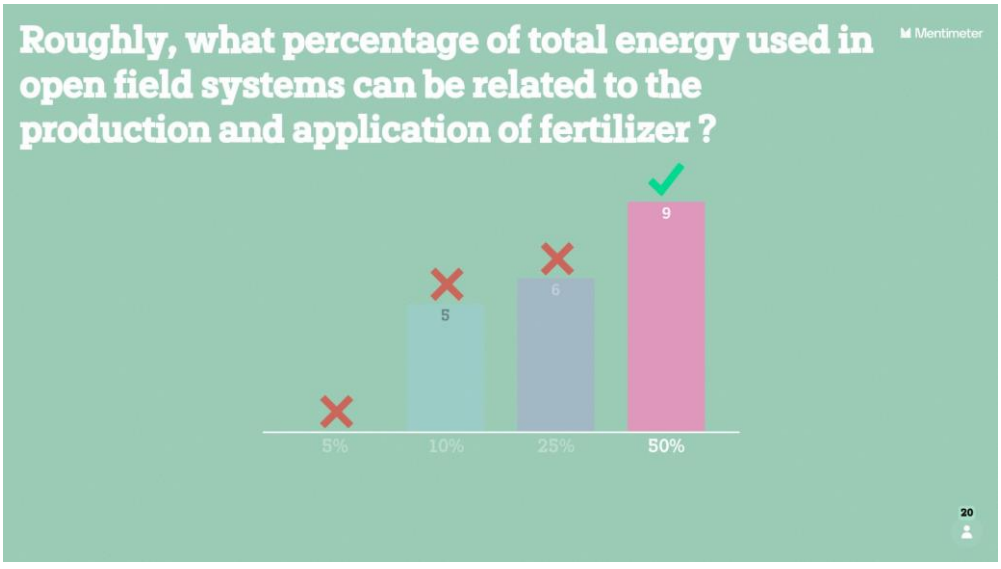

Figure 7.*Working Group A Pitch 1 Mentimeter questions and voting results*

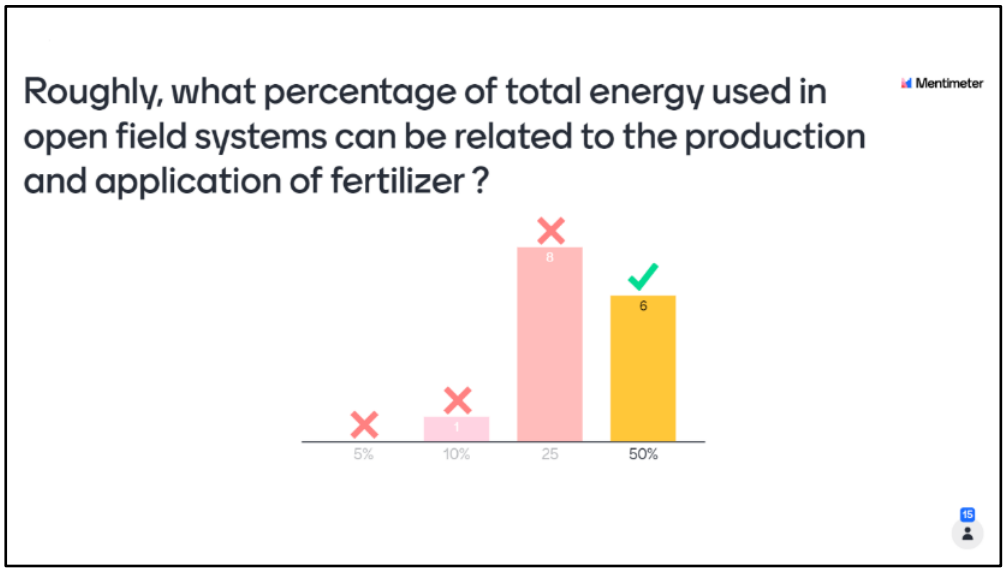

Figure 8. *Working Group B Pitch 1 Mentimeter questions and voting results*

In both groups, the participants showed that they were aware that fertilisation is related to energy in some extend, yet most of them did not realise its important share in overall energy consumption. The majority of the respondents did not find the correct answer, believing that the contribution of fertilisers in energy consumption was large, but not the largest of all categories. In the discussion followed, it was seen that some attendants did not correlate fertilisers (and generally agricultural inputs) with their embedded energy and have in mind that energy in farming is related mainly to direct energy consumption in farms.

About half of the participants in group A answered correctly that 50% of the total energy used in open field agriculture is related to the production and application of inorganic fertilizers. Cumulatively across both groups, participants were equally divided on whether the energy for inorganic fertilizers production and application accounted for 25% or 50% of the total energy used in open field agriculture systems. A discussion that followed this poll question proved that participants were aware that it is mainly the indirect (i.e., production) energy consumption that constitutes almost all energy assigned to inorganic fertilisers used in arable farming, which further supports the fact that indirect energy consumption is often neglected when considering the total energy consumption in agricultural practices. In general, participants were aware of a high energy consumption associated with fertilisation, but referring to the discussion after the poll results, the participants were in general surprised by the 50% level. In addition, and cumulatively, 6 out of 35 participants answered 10% share of fertilizer in the overall energy consumption for open field agriculture.

Then, the first category of questions focused on energy use in open-field agriculture was given to the participants and the respective answers are shown below:

1.1 What are the implications of the rising fuel and electricity costs? How will it affect open field agricultural production?

Regarding question 1.1, all participants in groups A and B agreed the rising costs of fuel and electricity will negatively affect open field agricultural production, subsequently increase food prices. A comment from group B concerned the increase in energy prices that will lead to increased fertiliser prices. The implications they foresee are a considerable reduction in fertilizing and other operations requiring the use of agricultural vehicles. A farmer in group B explained that his colleagues want him to cultivate their land by no-till methods, after they have 'looked over his shoulders' and realised the benefits of no-till agriculture. They also expect investments to be postponed, and instead, farmers may try to optimise the use of machinery they have and optimise the agricultural practices in the field. Farmers will shift towards more circular use of their resources to reduce external inputs and become more independent. Some farmers have overused fertilisers in the past, now if they reduce, they find that sometimes they achieve the same yield. It happens that people reduce lime/nitrogen and it makes no real difference. Some see this situation as a window of opportunity for renewable energy to become more popular. There is also an inclination towards using precision agriculture and conservation agriculture, to reduce cultivation and to optimise production without increasing inputs, e.g. thanks to precise irrigation. Farmers will focus on the right choice and scheduling of crops and choose those with low demand on water. It was mentioned that no-till farming is slowly gaining supporters, as they start seeing the benefits in reducing diesel consumption with no or very low yield loss. Some may even decide to take risk of lower production with the aim of lowering the inputs and saving money. In group B there was the concern that increase in higher prices on fuel and energy will hid smaller farms harder than for big farms, as big farms have better opportunities to investigate and invest in novel technologies, optimization and rationalisation of their farm business.

The results of growing fuel and electricity costs will be high prices of crops, due to high costs of production and reduced amount of crops in the market as production may be lower – however, higher prices for consumers do not translate into higher revenues for farmers. Transition to e.g. no-till crop cultivation and optimization of granular fertilizer application should be supported. In addition, a question was raised about the limited use of solar PV power for irrigation in

Greece/Southern Europe, which would seem to make a lot of sense. The reason for that lies on the fact that this transition is starting to happen now, but it is happening slowly. The main hurdle is bureaucracy and getting the right regulations in place.

1.2 Now that the fuel and electricity costs are so high, did you take any measures to overcome the implications? What are the possible pathways that a farmer/producer could follow? (e.g., change of machinery, agricultural practices, renewable energy, energy use efficiency)

Regarding question 1.2, participants in group A gave examples of already introduced measures as well as suggested possible solutions to be applied. In the Netherlands and Spain, for instance, there has been observed a growing interest in renewable energy, especially for irrigation purposes (mostly PV). If economical viable and legislative actions allow for selling electricity to the power grid and storage will be possible, then solar PV and/or heat pumps could be a business game changer for arable landowners. However, some participants do not see this trend continuing, claiming the investment in renewable energy may slow down and the interest may/should shift to digitalisation and trainings for farmers, teaching them optimisation practices and energy saving using the machinery they already have. It is worth mentioning that this shift towards renewable energy does not include small agricultural holdings, which instead of investing in new technology to produce renewable energy, small holding farmers will probably shift to manual machinery rather than fuel dependent. The need for locally produced 'green' fertilizers and biofuel from cover/green crops and grain/seeds, respectively, was expressed. In addition, while in some EU countries it is legal for farmers to produce and sell biofuel and meal from cold pressed rapeseed, this is not the case for some other EU countries (German example was given in group B).

An interesting suggestion for increasing energy use efficiency was encouraging contractors to invest in energy efficient machinery – that way, they could offer energy efficient services to small farmers, unable to invest in the said machinery themselves. This idea could work in a form of a cooperative or alternatively base the field operations on contractors' assistance and postpone/skip own investments.

Another important suggestion made by a farmer in group A and an advisor in group B was overcoming the rising costs of fertilisation by introducing cover crops and legumes instead, and practice conservation agriculture for saving both fossil fuel and inorganic fertilizers. In Denmark,

farmers have been good at using cover crops and in the present context there is an increasing trend of conventional farmers using this approach in response to higher fertiliser prices and regulations for reduction of nitrogen leaching. In parallel, conservation and organic agriculture that have been around for at least 10 years is being more applied and farmers are becoming very good at it. In addition, farmers are becoming better at handling and spreading of manure and ensuring a high nitrogen use efficiency in crop production. Use of plant protection products and need for irrigation may be overcome by choosing more resilient varieties of plants.

An interesting idea especially for small holders was given from a German stakeholder that referred to a Bavarian company that offer a solution where rapeseed oil, produced on farm, is used as a biofuel for tractors. It was suggested as an example to make farms independent and be an important alternative to imports. However, Greek stakeholders raised the question of legality, as in Greece non-fossil fuels that are derived from refineries cannot pay taxes and therefore, they are considered illegal. The German stakeholder ensured the participants that after a long discussion, it is indeed legal in Germany to use this system and Irish stakeholders suggested a tax relief system to avoid long legislation changes.

1.3 Which are the TOP 3 most energy wasteful parameters in open-field agricultural activities?

Regarding question 1.3, the 3 most energy wasteful parameters in open field agriculture identified by both group A and B was: fertilisation, tillage, and irrigation, mentioned by the majority of participants, where it is important to include both direct and indirect sources of energy waste as part of the findings/calculations. When it comes to fertilisation, not only the cost and application but also the losses of nutrients were mentioned as a factor affecting this parameter. Regarding tillage, lack of knowledge on the appropriate cultivation methods was indicated by one of the farmers, suggesting the need for education/training in this regard. Transportation of produce (from field to the farm, and then to sell) was also mentioned as a most energy wasteful parameter. Among the other parameters mentioned in the group, irrigation was the most frequent. Significant attention was also given to the storage of harvested products and cooling, drying e.g. cereals and lack of cooling/heating energy efficiency overall.

Within this question's discussion, a few other issues were raised. It was mentioned that the inclusion of both direct and indirect parameters should be considered, something that was not so clear to all participants before this workshop. It was also highlighted that this is a tricky

question, as it is really about energy and resource efficiency (in other words the balance between the natural resource of crop yield in relation to the amount of natural resources and other efforts utilised to obtain the yield). A Greek stakeholder declared that the mindset of the average farmer is to produce more, but there are cases (e.g. conservation agriculture schemes) where a farmer can make more money with less inputs. Based on this statement, a German stakeholder pointed out that organic farming is usually more energy demanding, so it is kind of a trade-off. There are some cases where, from a holistic environmental perspective, even high energy use farms are more acceptable from this perspective. During the discussion the measure of energy waste was discussed. The balance between the natural resource of crop yield in relation to the amount of natural resources and other efforts utilised to obtain the yield. For instance, the ratio of 80% of yield to 20% of natural resources and effort utilised is better than a 100% to 100% ratio. A Danish advisor suggested that is better to make a sufficient yield, don't go for max if you can do the 80% to 20% ratio. A Polish researcher agreed, and argued for introducing policy measures on how the entire economy works, i.e., we should look at the whole circular bioeconomic measures. Organic farming is usually more energy demanding, making circular bioeconomy measures very difficult.

4.2. Open field Working Groups: 2nd category of questions.

The 2nd category of questions was introduced with a short pitch presentation on the 10 most interesting FEFTS identified according to the feedback gained from the participants of the respective 9 Regional Workshops on open-field agriculture. The theme of the 2nd category of questions was about current European industry solutions and the respective policies promoting them. Figures 9 and 10 indicate both the introductory questions answered through Mentimeter and the respective voting results.

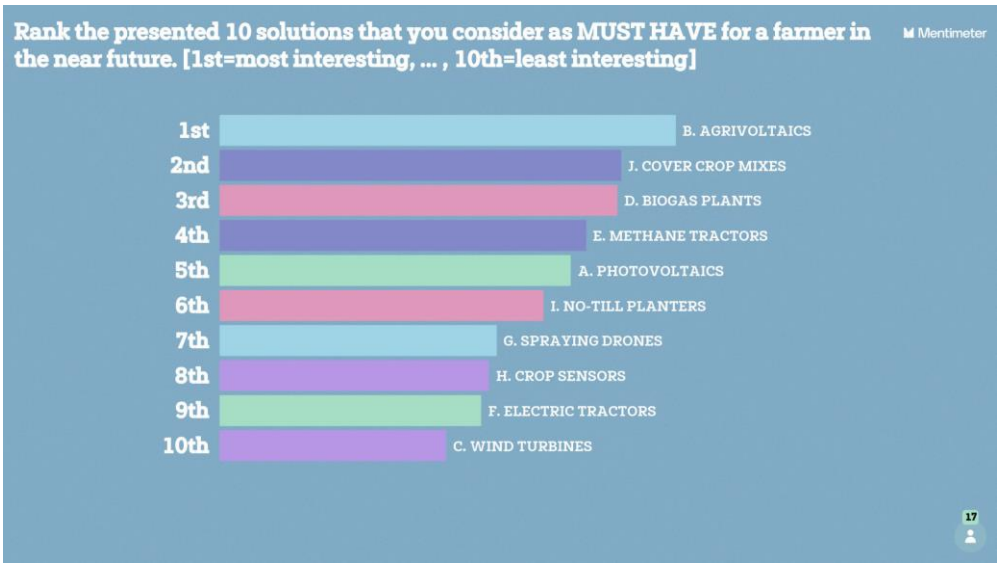

Figure 9. *Working Group A Pitch 2 Mentimeter question and voting results*

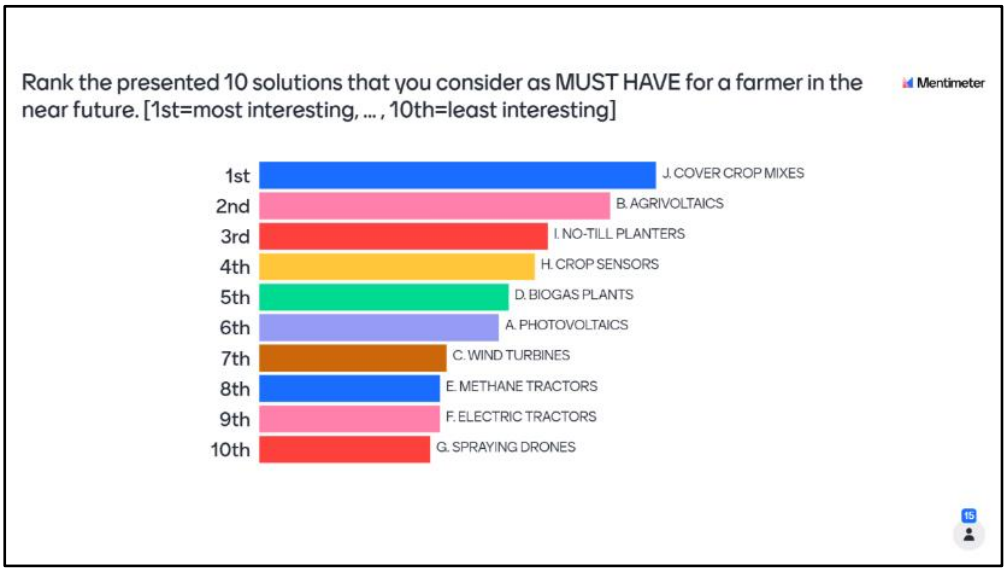

Figure 10. *Working Group B Pitch 2 Mentimeter question and voting results*

From Figures 9 and 10 it appears that the group A and B agreed that cover crop mixes and agrivoltaics are both FEFTS which are considered as must haves for farmers in the near future in the context of transnational level among EU countries. More specifically, in Group A, agrivoltaics received the most votes, with cover crop mixes and biogas plants on the 2nd and 3rd place. Their answers were justified by the fact that agrivoltaics allows for renewable energy production, without taking the land devoted for agricultural production, therefore it may be a good option for incorporating renewable energy. Cover crop mixes were chosen as a means (strategy) to manage nutrients circulation and allow reductions in the use of fertilisers.

However, starting from the 3rd most interesting FEFTS there were some differences in the answers. Where for group A there was a lot of focus on biogas and bio-methane-fuelled agricultural machinery, the participants in group B had more focus on field operations in terms of reduced energy consumption, either with no-till planters and enhancing soil carbon sequestration or through optimised application of fertilizers and pesticides (i.e. precision farming technologies and methodologies). These FEFTS constitute solutions for reduced energy consumption (during field operations), either by enhancing soil carbon sequestration (use of no-till planters) or through optimised application of fertilizers and pesticides (achieved through precision farming technologies and methodologies in general). It is noteworthy that the participants in both groups did not consider investments in wind turbines as a must have for the near future open field agriculture, due to the required large size to be cost effective and ensure a fast return of investment, a reality that does not fit well with small European agricultural holdings. It was also mentioned that it may be easier for big companies to set up a renewable energy plant than it is for a single farmer, since the prices offered to energy producers tend to differ. Both groups were also reluctant to electrical tractors adoption as well, which depicts a perspective that refers to a transnational pan-European level and the case may be different in certain countries.

The replacing of fossil fuel with renewable energy sources was discussed in Group B, where vegetable oils for conventional engines were considered as a sustainable circular bioeconomy solution for replacing fossil fuel at farm level. Replacing diesel with vegetable oils is however not an easy task, as EU regulations for allowing circular bioeconomy solutions at farm level to produce and consume first-generation biofuels in the form of vegetable oils for agricultural machinery is non-existing. There are also some technical challenges to solve, particularly the combination of vegetable oils with modern agricultural machines with engines with exhaust gas post-treatment systems.

It is noteworthy that, biogas plants and bio-methane-fuelled agricultural machinery were considered in group A as closely related, and both FEFTS may be especially interesting when combined. It was also mentioned that it may be easier for big companies to set up a renewable energy plants than it is for a single farmer, since the prices offered to energy producers tend to differ.

The second category of questions on the FEFTS solutions consisted of the following questions and the respective answers were given by the attendants:

2.1 Can you propose 3 ways (national or EU) that would help you familiarise with FEFTS?

Regarding question 2.1, participants in both groups A and B expressed a high interest in practical trainings and demonstrations on pilot platforms and farms, showing how particular FEFTS can be used in practice and how they are successfully used by pioneering farmers. Need for innovation brokers and more support to pioneering farmers was pointed out. Some participants claimed that a lot of useful information about FEFTS in agriculture have been produced and are available, but they should be disseminated more effectively in order to reach the end users. Direct interaction with farmers and possibility of consulting their doubts with actual FEFTS users would be appreciated. Another suitable method of educating on FEFTS would be spreading information through extension services and agricultural advisors, who should receive an appropriate prior training in the specific subject, as they often know the needs of local farms quite well. There were participants in group B who requested that more advisors should be specifically educated to support relevant transition to FEFTS.

When it comes to the national dissemination measures, promotion of FEFTS should be accompanied by incentives or subsidies for investments, whilst on the EU level a regulation or promotion of EU-funded projects in the area was mentioned. A comment from a farmer participating in group B reviewed pilot platforms and farms as well as transition subsidies as *"beautiful things, but money talks"*. Transition intensions needs to be implemented in the CAP and related subsidy eco-schemes as well. Subsidy schemes should prompt farmers to realize that one farmer can find ways to increase his/her revenues per hectare (for instance thanks to fuel saving from no-tilling and other conservation agriculture practices that increase soil organic matter through carbon sequestration) and start thinking if they should revise the current strategy they follow. Implementation of subsidy schemes was also a really important issue to deal with. For instance, in Greece referring to nitrogen pollution, the government subsidized farmers to diversify their crop rotations, but the implementation was completely wrong and it did not reduce nitrification of water environment as much as expected. It was suggested that EU countries should share and adopt the most efficient ways of implementation of subsidy schemes.

A very important comment was given by an Irish advisor that pointed out the need to train advisors adequately about implementation of energy efficiency measures, as they receive a lot of questions about it and often find they don't have the answers. Of course, it is also significant to train farmers, and then other farmers like to copy. It should be built into education curriculums. However, teachers need to be up to date. A Greek farmer liked the idea, but explained that unfortunately in Greece, there is no formal integration of the advisor into the agricultural system. In contrast, a Danish advisor realised that the Danish advisory system is quite good, as one advisor assists about 40 customers/farmers, while in Ireland this proportion is about one to 300.

Overall, the most mentioned ways to familiarize with FEFTS were training programs for advisors, pilot platforms and farms where events and demonstrations can take place, and last but not least well implemented subsidy schemes.

2.2 A Are you aware of any novel national or EU policies (or changes to current national/EU policies) that could benefit sustainable investments in certain FEFTS for open-field agriculture production?

Regarding question 2.2 A, not many participants in either group A and B were able to name either national or EU policies, but most of them indicated a need for being informed about such. Among the mentioned existing policies there was a subsidy for investment in new technology in Denmark (DK), where 40% subsidy can be applied for in relation to investment in FEFTS that reduce energy consumption for livestock and greenhouse production. Furthermore, the Danish organic agriculture has introduced a crop diversity regulation, demanding 20% nitrogen-fixing crops or cover crops in the rotation and 50% carbon capture crops. In France, certain policies exist about carbon credits, and amortization in relation to investments in specific technologies. In Northern Ireland and the UK, a policy is also established about Renewable Transport Fuel Certificates (RTCF). An interesting comment by a farmer/advisor indicated that most of the existing opportunities are not suitable for medium and small agricultural holders.

2.2 B Can you write down 3 ideas for new policies?

Regarding question 2.2 B, the most popular ideas for new policies proposed by group A focused on energy efficiency and carbon storage, however the interest in alternative fuels to power agricultural machinery was also mentioned. Participants of the discussion would like to see a greater attention given to conservation agriculture and precision agriculture, since those may

be the best solutions for the time being. Currently, many farmers cannot afford investment in new technology, therefore they should focus on efficient use of the resources they have. In Group B, a Greek researcher wondered about how we really could change the farming community mindset and a Greek farmer responded that it is a pretty difficult task. Regarding the use of fossil free technology, financial incentives for those who introduce climate-friendly measures should be included as a driver for change. From group B it was mentioned to reduce taxes on energy when the energy used is provided from RES and apply policies for self-sufficiency of biofuel, biofertilizer (i.e. composting/biofertilizer production/farm scale biogas plants) and electricity. This was commented by an Irish advisor, who suggested that carbon taxes could be a policy to assist FEFTS to grow, but they are complicated and make things difficult. A Greek researcher enforced this argument saying that it is tricky to effectively measure carbon sequestration and the Irish advisor agreed specifically for below ground biomass and explained that PV or wind turbines are easier to measure and that's why they are considered as the only FEFTS solution also for agriculture. Often the energy sector gets lots of credits rather than agriculture. In addition, policies or incentives to improve education and knowledge sharing of FEFTS and ease the application for grants to invest in FEFTS, and regulations should not complicate the FEFTS after implementation, e.g. by simplification of rules and possibilities for connecting photovoltaics to grid and self-sufficiency of biofuel. There should be no barriers to the implementation of renewable energy. In Ireland, they are now changing planning permission requirements, now implementing a less bureaucratic version for larger systems. However, the electricity grid is not prepared for RES influxes and needs to be upgraded. In Ireland there is a 40% grant for placing solar PV on the farm and it is seen as essential for dairy farms at the moment. Danish stakeholders were confused with this policy, as the expected biogas plants for dairy installations to be more subsidized; in Denmark it has really helped doubling the biomethane production this year to account for all natural gas by 2035. In Ireland, they believe that a mix of technologies should be integrated. Closing, a Greek researcher pointed out that we shouldn't promote subsidies for things that are profitable on their own.

Overall, the most mentioned ideas of new policies were result/measurable based subsidy financing of FEFTS, where the subsidy extent is correlated to the national or regional level of independence on fossil fuel and dependence of production of energy from renewable energy sources (PVs, grid, biogas etc.) and e.g. carbon sequestration (of measurable). Additionally, carbon credit schemes to support any effort of carbon sequestration, cover crops, zero emission

open field agriculture, and finally incentives for self-sufficiency of feed protein from sustainable protein crop cultivation on an EU level. Also, policies for self-sufficiency of biofuel and biofertilizer (i.e. composting/biofertilizer production/farm scale biogas plants) could be applied.

4.3. Open-field Working Groups: 3rd category of questions.

The third category of questions was again introduced with a Mentimeter poll upon the most interesting research project topics (involving FEFTS) to be funded. Figures 11 and 12 indicate both introductory questions answered through Mentimeter and the respective voting results.

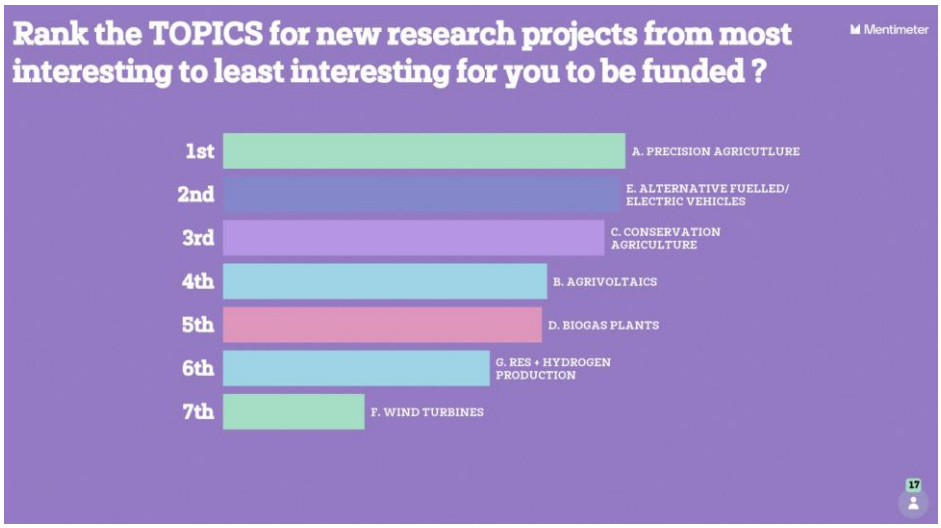

Figure 11. *Working Group A Pitch 3 Mentimeter question and voting results*

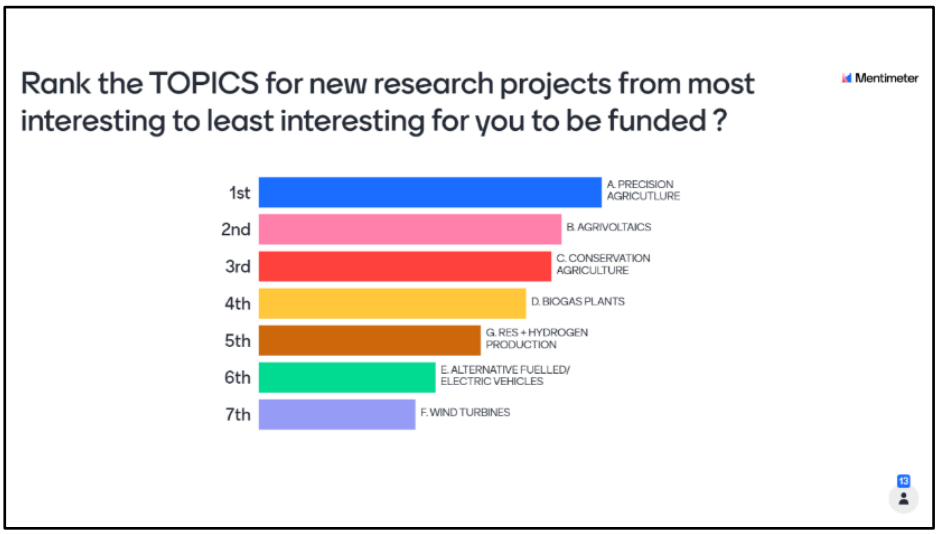

Figure 12. *Working Group B Pitch 3 Mentimeter question and voting results*

Groups A and B in common expressed their high interest and expectation for valuable research results produced by projects dealing with the further development of precision agriculture and conservation agriculture, respectively. This fact fortified the opinions that had been expressed up to that point in the workshop. Additionally, it was observed that workshop stakeholders tend to gain knowledge from research results regarding FEFTS that are closely related to field operations and the overall crop management. The most popular answers do not cover energy production per se, but rather energy efficiency and carbon sequestration. There was a disagreement between the groups for their interest in research on agrivoltaics. For example in group B, there was a participant who mentioned that one disadvantage of agrivoltaics is the claiming/trapping of land for decades after installation in the field. Specifically for group B, precision agriculture was the priority of research, followed by agrivoltaics and conservation agriculture. In contradiction to group A, the alternative fuelled/electric vehicles were not so interesting to be applied to carry out open field agricultural activities. Another disagreement between the two groups was about their interest in research on agrivoltaics. For example in group B, there was a participant who mentioned that one disadvantage of agrivoltaics is the claiming/trapping of land for decades after installation in the field.

Overall, the research topics deserving further funding to produce valuable results for EU's open field agricultural community were concerning precision agriculture and conservation agriculture applications. In immediate continuation of these topics, the interest of projects was divergent, having group B focusing on application and further development of agrivoltaics, while group A were focusing on hydrogen/biomethane/electric power trains for agricultural machinery. Research topics related to biogas plants scored medium interest by the stakeholders in both groups. The research topics concerning hydrogen production combined with RES and wind turbines appeared not to have unanimous agreement among the stakeholders as being the ones most in need for funding in order to produce research results for the farming community.

The third category of questions on the FEFTS solutions consisted of the following questions and the respective answers were given by the attendants:

3.1 Why the first 3 ranked research ideas are most interesting to you? If they are NOT, why NOT?

Regarding question 3.1, group A supported their answers by the fact that at the moment, precision agriculture and conservation agriculture can offer the most to those farmers who

cannot afford investment in RES production technologies, whilst alternatively fuelled vehicles are in demand in the context of rising fuel prices. However, research is needed to adapt both precision and conservation agriculture to national or even regional levels, and the demonstration/knowledge sharing should play a key role in the research dissemination.

The renewable energy production categories such as agrivoltaics or biogas plants have already gained some popularity and some of those solutions are currently being implemented, whilst the categories chosen for further research may offer some additional potential and hence deserved more attention. In group B, an interesting comment (about research topics related to biogas) was about how far it is possible to extent self-sufficiency of heat and electricity produced from biogas on a European level, and what will be the implications of this self-sufficiency. Group B did not find alternative fuelled or electric vehicles an interesting research topic, but their attention was devoted to agrivoltaics. However, there was a discussion that even if PV are and can be subsidised, an energy advisor suggested that the taxpayer should not subsidise PV as the banks can finance it and the investor can make a business revenue. Also, net metering is a good option especially for agricultural holdings to reduce the final electricity bill for the farm with smaller investments. Even if the full conservation agriculture concept was very interesting for the participants, it was mentioned that even a good crop rotation system is often the answer to the reduction of agricultural inputs (indirect energy) problem and that sometimes research that was conducted 20-30 years ago is relevant and a lot easier to be adopted with low investments, achieving significant results on energy consumption in agriculture. A discussion about biogas and its optimisation through research was also interesting for the working group members wondering about how far can we can go with biogas in Europe and with which implications (i.e. how far it is possible to extent self-sufficiency of heat and electricity produced from biogas on EU level). This was a subject that should be thoroughly analysed. At this point, an important aspect of how research should be executed was raised; the fact that European research schemes are mainly based on siloed projects does not help so much and we need to shift to holistic projects that look at the whole circular economy including the agricultural sector as a fully connected link of the value chain

3.2 Is it easy for growers to connect with industry and research in order to solve their problems?

Regarding question 3.2, most farmers and advisors in groups A and B stated that it is difficult for them to connect with both researchers and industry in order to find solutions for their

problems (although it is a bit easier than it used to be). However, these difficulties were obviously country specific. Now, more and more farmers get information about the newest technologies e.g. from social media, where researchers directly disseminate the results of their projects. From the advisors' perspective, however, farmers are more willing to discuss their problems with people they know, they establish a relation with a consultancy service, and they prefer to consult in person rather than go to the Internet and look for solutions by themselves. In Denmark, for instance, this collaboration between farmers, contractors, advisors and university is well established, as well as in the Netherlands. In group B, it was mentioned that too many research projects are siloed, i.e. solving some specific issues, where the connection and holistic approach to the circular bioeconomy is missing, which sometimes makes the projects irrelevant for the broader crowd of farmers and advisors. Regarding research, it was mentioned that basic research can stay within the borders of research institutions, but applied research should be conducted in a multi-actor approach, in a real sense, including farmers as a vivid part of the research work considering large farmers' unions/associations and their needs to produce healthy, competitive commodities produced with the least energy consumption.

3.3 Would you participate in a multidisciplinary team in order to conduct a research project? If YES, please explain the reasons. If NO, why NOT?

Regarding question 3.3, both groups A and B expressed a 100% common interest in participation in research projects, if they are likely to find solutions to their problems. It was, however, underlined, that the projects should rather focus on local issues (smaller scale), offering practical knowledge and demonstrations, and that multidisciplinary involvement is a key aspect for innovation. Farmers would like to exchange their opinions, consult, and solve problems, and learn about farming techniques and useful technologies. Projects aiming at solving existing problems, "not research for research, but for a good reason" are welcome and would be an interesting opportunity.

5. Transnational Workshop about Livestock production

The discussion part of the workshop was managed by appointed moderators/facilitators: Michael Nørremark (AU), Konstantinos Vaiopoulos (CERTH), and Bas Paris (AUA) in Working Group A, and Arne Grønkjær Hansen (ICOEL), Thanos Balafoutis (CERTH), and Janni Tilia Granger (ICOEL) in Working Group B.

5.1. Livestock Working Groups: 1st category of questions.

The workshop sessions were initiated by a question shared with the audience by Mentimeter. This initial question was concerning whether manure handling, animal feed, livestock housing, or other are the most energy consuming category in the production of pork is, chicken, eggs and dairy. The figure 2 and 3 below represent the answers to the above question for consideration by the participants in group A and B, respectively.

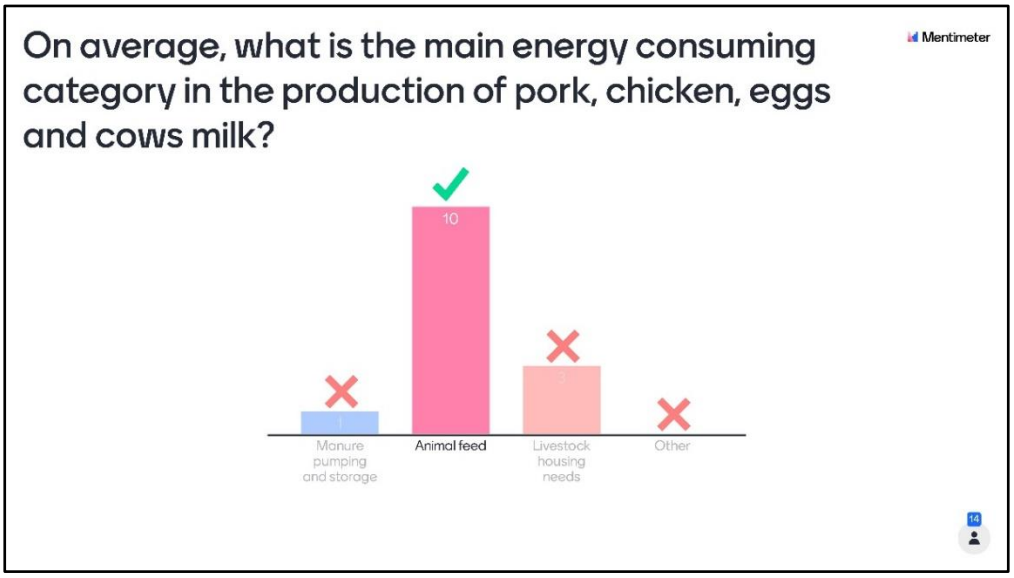

Figure 13. *Working Group A Pitch 1 Mentimeter voting results*

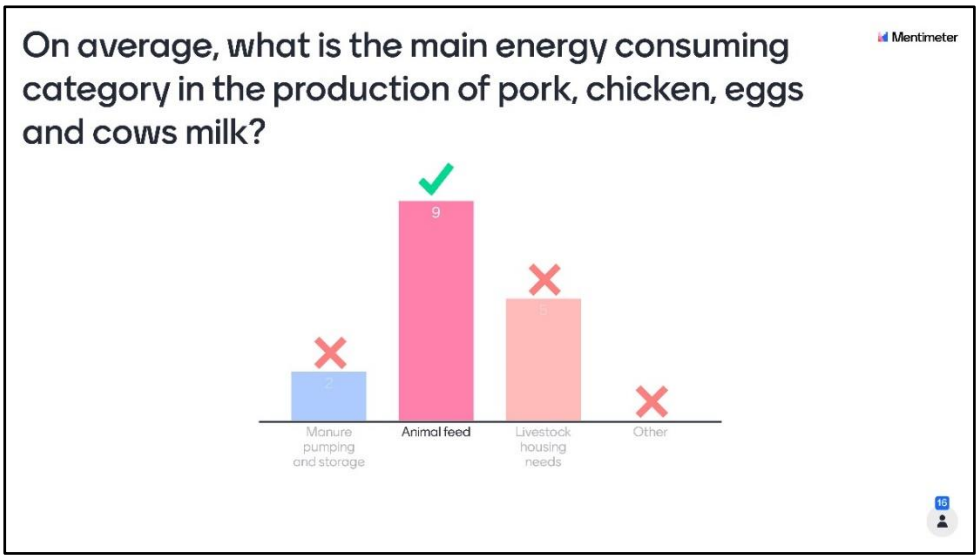

Figure 14. *Working Group B Pitch 1 Mentimeter voting results*

Across the two groups, 19 out of 30 respondents answered correctly that feed production is the main energy consuming category for livestock meat, poultry, and dairy production. However, across the groups, there were 11 out of 30 respondents who was considering energy for livestock housing and manure handling together as the highest energy consuming parts of livestock production. A discussion that followed this poll question proved they are aware it is mainly the indirect energy consumption involved in the production of feed, which is often neglected when considering the energy consumption in livestock facilities. Participants were aware of the high energy consumption connected to feed, yet some of them did not realise their share in overall energy consumption, as they were not following the whole value chain (e.g., the fact that close to 60% of agricultural land is used for animal feed production).

The first category of questions focused on energy use in livestock production, where the first was phrased as the following:

1.1 What are the implications of the rising fuel and electricity costs? How will it affect livestock production?

Regarding question 1.1 participants in group A discussed and made clear on the posit-it notes canvas, that on the short term, the implication of rising fuel and electricity costs will be low because they were estimating that fuel and electricity account for only 5-10% of the production cost of livestock production. In Spain, it was explained that there is no big awareness about energy costs, as it is only 5-6% of their total costs (always considering only direct energy). Therefore, energy in livestock farming is not seen as a big problem. Overall, there is a view that these higher prices are not a major driver for investments. In Denmark rising prices are clearly an incentive for RES, for instance rooftop solar and biogas. The big farms or at least the farms having the economic strength have already undertaken FEFTS investments in the past, and an increase is apparent during the last year. But it is also clear that some farmers in Denmark do not have the financial strength to invest in FEFTS, especially for the pig production due to perceived difficulties, while dairy provides more possibilities for the moment. It might be that big livestock producers might reduce their production a little bit but no major changes are expected to take place. The main problem in Italy is not only rising energy prices but the production of feed as well. There are also important problems regarding supply chain of feed, which is now taken at a national level in an effort to improve the supply chain. The participants in both group A and B were convinced that the extra costs will be reflected in higher food prices while at the same time livestock production will increase or at least support the transition to

bigger farms. Group A was also convinced that bigger farms will be able to invest in renewable energy production, e.g., solar panels and biogas plants, which will drive the change to improve business opportunities. Small farms will not invest without subsidies and will have harder time to overcome rising fuel and electricity costs. Across group A and B there was consensus about the smaller farms finding increasing costs difficult to deal with, and one solution proposed was to decrease or completely stop all livestock production. Small farms seem to go out of business due to high overall production costs, where simply too expensive heating and feed can be the pivotal factor. In the Netherlands it was mentioned that farmers do not make investments to reduce energy consumption, a situation mainly driven by uncertainty. Basically, farmers are not sure what the future will bring, and most farmers seem to simply adopt a hesitant attitude. The hesitant attitude of farmers is not necessarily exclusively related to rising energy costs, but also the outcome of other issues; for instance, in the Netherlands another challenging aspect for the agricultural policy is a new nitrogen legislation .

Regarding question 1.1 in group B, the view from especially advisors on rising fuel and electricity costs was concerning that the most sustainable and self-sufficient farms for feed and energy will be the least affected, and the farms of low-level self-sufficiency and small farms as well will discontinue. A decline in livestock production was mentioned. A Danish advisor was mentioning that it is not only the rising fuel and electricity costs that affects livestock farming, but indeed the cost for feed and fertilizers. In Denmark, farmers are for sure affected by higher costs, not exclusively regarding fuel and electricity, but also for feed. Biogas at farm level would be a good solution, but they are also very limited in what they can do due to regulations. Farmers in Denmark have been lucky to have a very good harvest this year which has helped them through the current difficult times. This was the case for several countries where the climatic conditions of this season were favourable. However, it is not thoughtful to count of possible good weather for the future. Many will decide to step out of business and big farms will grow bigger by taking over non-sustainable farms. Several participants stated that such situation will decrease livestock production and/or lower the quality of livestock products. The main effect of the energy and related economic crisis is that many farmers are ready to phase out production due to higher costs of operation that make farming not profitable. In Spain, participating advisors believe that many farmers will be forced to seize operations due to higher prices, with an expectance to also see an increase in price for the final products. This is especially the case in intensive production systems, less so in extensive production systems. A Greek stakeholder pointed out that there are many different points of view on answering this question. Some

people say that it will help incentivize green transitions, while others say that it will lead to less agricultural production. In agreement with group A, several participants of group B also stated that rising energy costs will put pressure on final product prices. In Italy, the farmers and advisors expect to also see an increase in price for intensive livestock products where energy consumption is a significant part of the production, but perhaps less propagated for extensive livestock production. Another problem that participants see is that the price for milk and meat are too low (e.g. in Germany), leading consumers to not understand that the real cost should be higher. However, there is a certain limit that consumers are able/willing to pay. For the farmers the benefit is close to zero as higher costs minimize profits. The challenges in Italy are not only concerned with rising direct energy prices, but the production of feed as well that is indirectly impacting livestock farming. At a national level they are trying to improve the supply chain. For some livestock production and regions, heating is not required, and thus, these farms are not affected by higher costs for heating. Biggest challenge identified is the rising cost for electricity, so substitution of fossil fuels (e.g. natural gas) with biogas derived from livestock facilities could be realized for local use in the farm and the excess provided to the grid. If we do not find solutions to decrease costs, the overall system will collapse. There was consensus about the effect that the rise of energy costs will have in relation to the financial standing of farmers. An example was given that for some farms, the biggest challenge is the rising cost of electricity. For such challenge, the incentives must focus on finding new solutions regarding energy for instance by the production of biomethane. If the incentives do not find solutions to lower costs the system will collapse, because there is a clear limit to how much the retailing sector and consumer are able/willing to pay. On the positive side, an agronomist in group B foresaw movement towards increases in industrial symbiosis for energy production and increased use of alternative energy sources. It may also entail that some farmers will look for other opportunities and ways to optimize farming, needing also access to training and advisory services. Biogas at farm level or in a collaborative scheme among farms would be a good solution, but a Danish example was mentioned stating that farmers are limited in what they can do for energy production and self-sufficiency due to regulations. As a logical consequence of a situation where the food production framework changes considerably, a researcher in group B mentioned that the CAP needs to be changed too, to make agriculture more sustainable in Europe. One approach towards this goal could be the stimulation of circular bioeconomy and the encouragement of increased collaboration. The participants agreed and saw a positive impact on the possibility of stimulating circular economy and encouraging increased collaboration to overcome the situation.

1.2 Now the fuel and electricity costs are so high, did you take any measures to overcome the implications? If YES, which are they? If NO, what are the possible pathways that a livestock farmer could follow? (e.g., change of machinery, farm practices, renewable energy, energy use efficiency)?

Regarding question 1.2, both group A and B expressed opinions that long term investments are not really there yet for renewable energy; for instance, an attitude was to ride off the wave of rising energy costs, i.e. the present recommendation is to wait regarding embarking on big investments. In both groups there was a focus on external induced incentives, by highlighting more focus on EU than before; for instance the need for support schemes directed to farmers who intend to invest in energy saving technologies, to increase use of FEFTS and to reduce fossil energy use. A FEFTS industry representative mentioned that there can be uncertainty about governments seeing agricultural policies as black and white, for some EU countries it seems that the government wants to reduce overall farm/livestock numbers. A Dutch stakeholder and journalist claimed that the EU had all kinds of rules to prevent RES in the past, but maybe the new energy supply situation in Europe will help to foster adoption of RES and FEFTS. In addition, bureaucracy problems were expressed as a big issue for RES and FEFTS implementation in the past, they still seem to be. A Greek stakeholder did not find the problem in EU headquarters, but in bureaucracy problems that have been a big issue for implementation in the past due to national legislation in many countries and unfortunately, they still seem to be. The same industry representative thought that if governments ask the industry for feasible solutions and they are able to provide such a solution, adoption rates will increase quickly. For the internal induced incentives by farmers themselves to overcome rising fuel and electricity costs, group A was mentioning that the obvious solution is that farmers should invest in energy saving technologies. For instance, energy saving technologies and management regarding pumping and transport of manure, ventilation of stables, lightning, precision farming, conservation tillage and finally more utilisation of contamination/pollution-free public by-products, like sewage and compost. It was mentioned that currently many farmers are investing in new machinery and methods for manure handling and spreading to obtain utilisation of organic fertilizers. Farms producing renewable energy by PV and biogas was also mentioned as solutions, but also that it is the larger farms who solves the advantage of the subsidy for renewable energy. The consensus was that the biomethane could be a real new business model for RES produced by farmers. Group B was in line with more investment in production of renewable energy by farmers, and wished a rapidly increase of biogas production in some EU countries where the

livestock production is concentrated on bigger farms. There were several points of views expressed. It was expressed as a common idea that farmers should measure consumption in different places at the farm to see where they stand and take measures in the most consuming practice. Modern farms have building management systems that also measure energy consumption, e.g., In Greece, poultry houses are in most cases electronically controlled. In Ireland, if you are a dairy farmer, it is recommended to evaluate annually production, consumption and costs. Interest in keeping records is increasing in an effort to reduce costs. Biogas production is appealing but there is a need to find out what biomass to use for biogas plants; for instance, there is a contradiction for straw, as farmers also need straw for bedding, and in some countries straw is utilised for district heating. Photovoltaic installations that have an operational lifetime of many years could help both small and large farms to overcome the rising costs of electricity, but a stakeholder in group B mentioned that he did not like the idea of solar panels on arable fields because we need all the solar energy we can get for growing crops. It is evident that renewable energy production locally at farms or as a cooperative effort has some contradictions. The internal induced incentives by farmers themselves to overcome rising fuel and electricity costs were in line with that of group A, for example LED lightning, efficient insolation of buildings, efficient heating systems and climate control, fuel efficient machinery (variable transmission etc.), biofuel driven tractors, as well as increase the efficiency and effectiveness of production processes with a clear focus on analysing the energy costs. The latter could be realized by adopting more advanced energy efficiency measures, tools and monitoring systems, and farmers should measure consumption different places at the farm, as well as perform an annual evaluation of consumption and costs. There was a series of views expressed in both groups. In Denmark, a lot of data is collected to know the inputs and outputs of the farms, which is a great asset if you want to evaluate the output based on the input and costs and evaluate the effect of rising energy costs. This is not, though, the situation in most countries as expressed by the participants. The statistics of such data is rather limited. But there is an increased interest among farmers and advisors to keep records of livestock production to reduce costs. It was mentioned that ventilation system consumes most electricity in relation to poultry production. For dairy, irrigation, farm machines and milking (incl. cooling) consume most electricity. However, it depends on management as well. Briefing of staff to inform on energy saving practices, increase feed efficiency, and improve the energy efficiency in every supply chain on farm. Milking robots may not always be the right solution, but they might be if electricity comes from solar panels locally installed at the farm. Group B also mentioned cooperation between livestock stakeholders in order to obtain better prices both on products

and FEFTS investments. A stakeholder in group B also recommended to change crop rotation towards more diversity of farm products, for instance growing energy crops and growing your own protein. An advisor was recommending that governments have to help to make it easy to produce energy for self-consumption, ease the connection procedures to the electricity and gas grids, decouple the pricing of electricity from natural gas, and finally remove the taxes on the transport of renewable energy related goods. Dutch stakeholders mentioned that the problem starts from the fact that long term investments in FEFTS are not really there yet. It is still very limited knowledge on the extent of achieved savings in the long term. More advanced business models (e.g. about biomethane, selling RES) could clear the situation. Agrivoltaics combining both crops and energy were introduced during workshop and it was in principle acknowledged in a positive manner by the participants. The general impression from the discussion related to question 1.2 was the stakeholders were more focused on what incentives can be externally induced instead of internal induced incentives by farmers themselves.

1.3 Which are the TOP 3 most energy wasteful parameters in open-field agricultural activities?

Regarding question 1.3, the 3 most energy wasteful parameters in livestock production identified by both group A and B were: feed production/efficiency independent of livestock production type, transport and energy used by buildings (incl. milking, heating, cooling, ventilation). Manure handling from stable to storage was also mentioned by stakeholders as an energy consuming operation. Waste of energy specifically for poultry is associated with the heat treatment of feed, cooling of eggs at storage, and heating/cooling of buildings (counts also for pigs). An advisor in group A mentioned that not enough recycling/resourcing of the waste, (e.g. straw, bedding material) from animal production takes place, and it is energy demanding to keep animals indoor all year round. In Poland, it is challenging that investments in less energy wasteful activities are not compensated for. Both groups were questioning whether we know or can determine the waste of energy, and in addition, that is crucial to start analysing the energy consumption in every supply chain and operation on farms. A stakeholder in group B also mentioned poor building insulation, older heat pumps and ventilation systems as sources to energy waste. An advisor in group B made a quick estimation of the diesel fuel consumption on dairy farms and concluded that the diesel consumption in the stables is significant smaller than what is used for field operations in the field. For electricity, the opposite relationship will most likely be the case. In Northern Spain, it is estimated that 85% of livestock total energy consumption is from fossil fuel (always considering only direct energy).

5.2. Livestock Working Groups: 2nd category of questions.

The 2nd category of questions was introduced with a short pitch presentation on the 8 most interesting FEFTS identified according to the feedback gained from the participants of the 7 respective Regional Workshops on livestock production. The theme of the 2nd category of questions was about current European industry solutions and the respective policies promoting them. The figures 15 and 16 below indicate both the introductory questions answered through Mentimeter and the respective voting results.

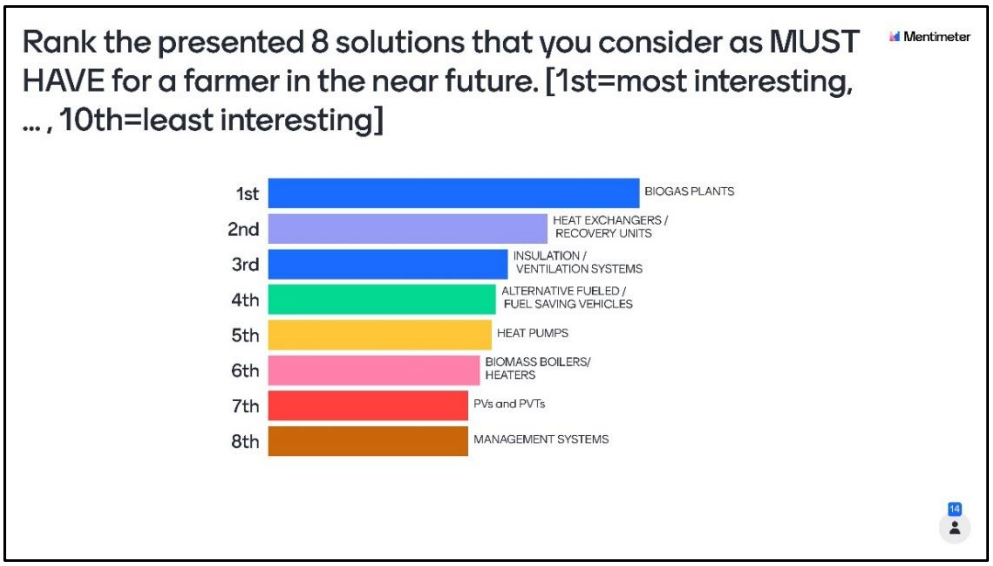

Figure 15. Working Group A Pitch 2 Mentimeter question and voting results

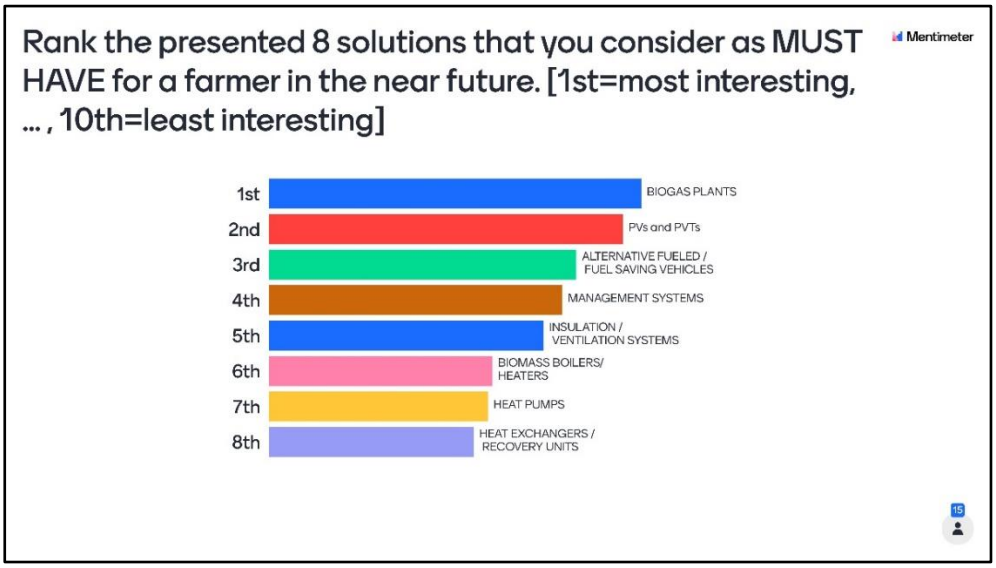

Figure 16. Working Group B Pitch 2 Mentimeter question and voting results

From Figures 15 and 16 it appears that the group A and B agreed that biogas plants are considered as must haves for farmers in the near future. In both groups, biogas plants were ranked first between the FEFTS solutions presented. This was an expected answer but well received by a large set of farming experts, as biogas technology is very mature and the return of investment at economic and environmental levels is worthwhile. It is very interesting to see that in Group A, the 2nd and 3rd FEFTS selected were related to the livestock building energy needs; this was explained by the fact that the participants were mainly European stakeholders from regions that higher heating needs of the buildings are required. In Group B, PV integration in rooftops of livestock building and alternative (biomethane) machinery took the 2nd and 3rd place, considering electricity cost reduction a critical issue of our days, while biomethane upgrading installations combined with the 1st place FEFTS (biogas plants). However, starting from the 2nd most interesting FEFTS there were huge differences in the answers between the groups. Where for group A, a future must have was heat exchanger/heat recovery systems, which are FEFTS that stakeholders in group B considered as least must have for a farmer in the near future. It was the opposite for PVs, where group A considered PVs as lowest degree of future must have, where group B considered PVs as the second must have for a farmer in the near future. The participants in group B had more focus on PV and alternative fuelled and fuel saving vehicles. It is noteworthy that the participants in both groups modestly considered investments in biomass boilers/heaters as a must have for the near future livestock production, which also counts for heat pumps as well.

The second category of questions on the FEFTS solutions consisted of three questions in total, with the first phrased as the following:

2.1 Can you propose 3 ways (national or EU) that would help you familiarize with FEFTS?

Regarding question 2.1, participants in both groups A and B, farmers and advisors in particular, expressed a high interest in practical as well as on-line trainings and demonstrations on pilot platforms and farms, showing how particular FEFTS can be used in practice and how they are successfully used by pioneers. A FEFTS industry stakeholder suggested that governments could participate in a fair to promote some FEFTS, something they rarely do. They could also come to a farm and promote FEFTS. A Greek stakeholder mentioned that training, education, e-platforms and online technologies can really help. Also, extension services and advisors should get in the frontline of promoting FEFTS. However, a Danish advisor introduced in the conversation the fact that the advisors are paid by the farmer and probably state advisory

systems could assist farmers of low income. The farmers and advisors in both groups recommended that the advisory/extension services should raise the awareness, based on providing advisors with facts and numbers to disseminate FEFTS to farmers followed by information campaigns targeting farmers, for instance by social media campaigns and workshops with presentation of successful implemented FEFTS. An industry stakeholder suggested that livestock associations or national federations should be promoting a book of FEFTS solutions to their members. If it is done on a national level, every regional organisation can also take advantage of that. These need to be done transparently. This will provide support to the industry as well because of better understanding of what is going on, what are the current needs of farming and which problems new technology is asked to solve. In Poland, there are gaps between academic and advisors and advisors and farmers and it was suggested to optimise these relationships with national development programs. Farmers in group A also requested their organisations or extension service to make FEFTS related business cases clearer for the actual national situation, FEFTS implementation with full scale farms for construction of practical platforms for farmers to show positive examples with proven effects (demo) on a national level. A Danish advisor noted that it should be remembered that the advisors are paid by the farmer and thus could be a threat to the above mentioned incentives. In group B, there was a comment that when it comes to energy efficiency and fossil free livestock production, then it is an obvious joint affair between farmers and the regional states to train/educate the advisors that train/advice the farmers. In Poland there are dissemination gaps between the public academic institutions and advisors and between advisors and farmers. An advisor in group A mentioned an idea to place an EU level approved graphic/logo/sticker for use with FEFTS for any technology that is actual defined as a FEFTS, based on some criteria. A company representative in group A responded to this idea and agreed that it makes sense, but who is going to set criteria and assess FEFTS? Industry stakeholder probably shouldn't because they have a vested interest. Alternatively, livestock associations should be promoting a book of FEFTS or solutions, national federations, done on a national level, as every regional organisation can take advantage of that. FEFTS criteria and assessment need to be done transparently. This is a support for manufactures and suppliers as well because there will be a commonly understanding of the fossil free and energy efficiency effects of individual or groups of FEFTS.

Participants in group B were more concerned about EU and regional policies for subsidies and the implementation of CAP to lead farmers and advisors to familiarize with FEFTS. Indirectly, local governments give instruction to farming business due subsidies, tax exemptions etc.. The

EU and local governments have to provide subsidies to local businesses that then invest the rest, but somehow it has to be decided who will need the largest subsidies. Tax exemptions or other tax credits could also benefit feminization of FEFTS. It is important to agree in regions on specific obligations to follow in connection with for example biogas plants, solar PV parks etc, for all technologies that need a lot of space. In Ireland there are enabling policies for how to agree on areas for setting up specific technologies.

2.2 A. Are you aware of any novel national or EU policies (or changes to current national/EU policies) that could benefit sustainable investments in certain FEFTS for open-field agriculture production?

Regarding question 2.2a, a Danish advisor and researcher in group A mentioned that CO_2 emission taxes on agricultural production are being heavily discussed in Denmark among policy makers. The policy is to reinvest the tax proceeds for subsequent investment/subsidies for green technologies. A French FEFTS industry representative mentioned that this is also a policy that is adopted in France for taxes on road vehicles and now ongoing lobbying for off-road vehicles takes place which most probably will include agricultural machinery as well. An off-road vehicles tax system should be integrated for agricultural machinery of all types to promote substitution. It was first implemented as road taxes for trucks and there is lobbying to put it off road, but the policy setup is the same, pay emission tax and then the tax proceed is reinvested in green transport technology. A Dutch advisor responded that there are hardly any novel policies on sustainability in NL, but general subsidies on investments (40%). Maybe will be the case on the longer perspective. An advisor was mentioning the CAP where it is a hope that farmers could benefit from (if it's not already included), in relation to investments in FEFTS and available subsidies. An advisor was suggesting rethinking priorities/focus areas for the second pillar of the Rural Development Programme (Ireland), to support only FEFTS investment which will move energy saving technologies to the farms. A farmer responded that such an approach is very difficult in Spain, due to the fact that investments for the farmers focus on all the EU-policies. In Spain, an advisory body can assist farmers concerning all technologies, including FEFTS. In Greece, a new state program is starting with specific subsidies for agricultural PVs for net metering. Some stakeholders in group A requested clear subsidies for installing RES on farm, clear policy to raise bio-economy and national subsidies for modernization of farms. In Poland the Agro-Energy programme was mentioned in relation to investments in renewable energy. In group B, only the enabling policies in Ireland for agreeing on areas for setting up specific RES and FEFTS technologies were mentioned. In Ireland, there are enabling policies of spatial

planning for agreed areas to set up specific technologies (e.g. PV, wind, biogas, etc). The discussion and post-it notes outcome from group B was more concerned about requests for novel policies. A farmer requested policies that combine animal welfare with energy savings, and another concluded that sustainable farming is not supported in any way today. Better access to get a loan from bank and more support from government. In Italy, a farmer stated that there are enough purchasing incentives, but requested simplification of paperwork for smaller RES projects. In Italy, on October 2022 they implemented a policy about renewables with very strong financial support based on an EU project where there is a specific chapter towards livestock. Also, taxation rules, permit procedure etc. was mentioned as parameters that in a non-bureaucratic and easy setup could benefit sustainable investments in certain FEFTS.

2.2 B. Can you write down 3 ideas for new policies?

Regarding question 2.2 B, the most popular ideas for new policies proposed by group A focused on benefits for farmers implementing FEFTS and associated economical rewards (e.g., taxes, reduction credits, green credits) for changing to FEFTS and rewards for reducing CO_2 emission. Labelling livestock products as green, based on a well-established system to avoid green washing, could promote FEFTS adoption. In Italy, such a framework exists, but it is not so standardised. Participants of the discussion would like to see a greater attention given to policy treats that would help stabilizing prices for farmers, implied a guarantee that the investment pays off. Also, policies or incentives to create subsidy schemes to motivate farmers to invest in green technology, followed by investment support for new and sometimes less proven technologies. A farmer mentioned that budgets are typically too small – i.e. too successful/popular – so it is also a matter of weighing the incentives and available budget available, a matter of focus and value for the subsidies. A Greek stakeholder suggested subsidies for RES in return for labelling for products to assess their fossil free level. In Greece, a new state program is starting with specific subsidies for agricultural PVs for net metering. An Italian stakeholder mentioned that in Italy labelling of green production is semi implemented already, but it is not well standardised. In this regard, a need for differentiation of regulations between EU countries are necessary to take into account their geographical differences and climate, and differentiate policies based on the size of the farms, and last but not least to promote family businesses rooted in specific regions. An advisor was mentioning that sometimes new legislation is better than leaving it to the free market to reach an equilibrium. The third theme of new policies was regarding taxes. It was suggested to implement tax policies that push

livestock producers away from reliance on fossil fuel, and where the tax is used to finance a CO_2 emission reduction, in such a way the farmer always obtain a CO_2 reduction, either by investments or by taxes. For instance, in Ireland, Renewable Transport Fuel Certificates (RTFC) have been implemented, wherefrom taxes support for example public infrastructure investments for alternative fuel stations, and in the UK they implemented The Renewable Financing Company (TRFC) which penalises those that don't invest enough in RES and reinvests that in RES. However, as stated by a FEFTS manufacturer stakeholder, it is important to have the infrastructure for renewable energy based fuel or electricity in place, and that it is the government that lead and support the development of such infrastructure. From group B early adopters were mentioned as a focus point for FEFTS related incentives. It is also important to agree for all regions on specific obligations to have e.g. biogas plants, solar panels etc. This applies mostly for technologies that need a lot of surface.

5.3. Livestock Working Groups: 3rd category of questions.

The third category of questions was again introduced with a Mentimeter poll upon the most interesting research project topics (involving FEFTS) to be funded. The following Figures 17 and 18 indicate both the introductory questions answered through Mentimeter and the respective voting results:

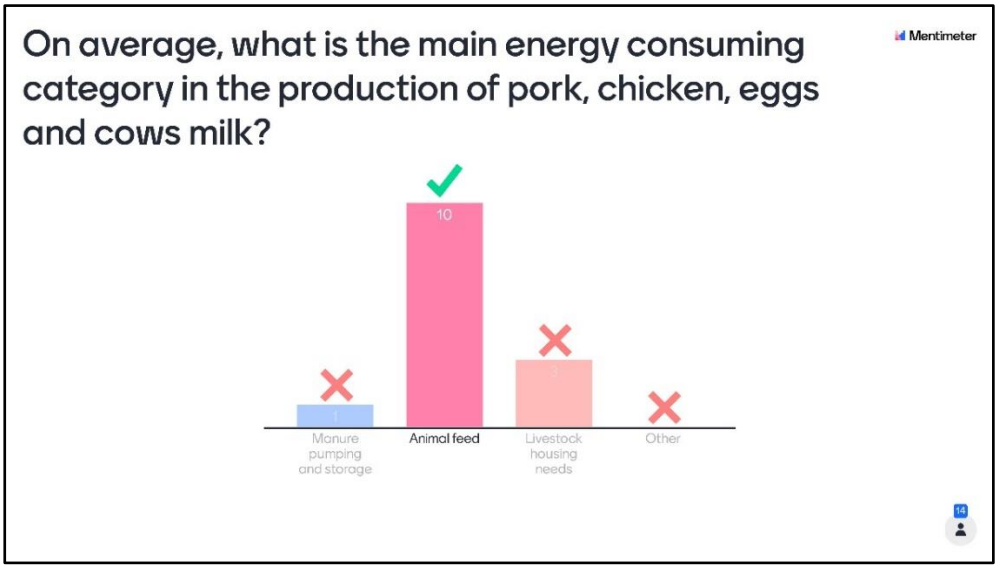

Figure 17. Working Group A Pitch 1 Mentimeter questions and voting results.

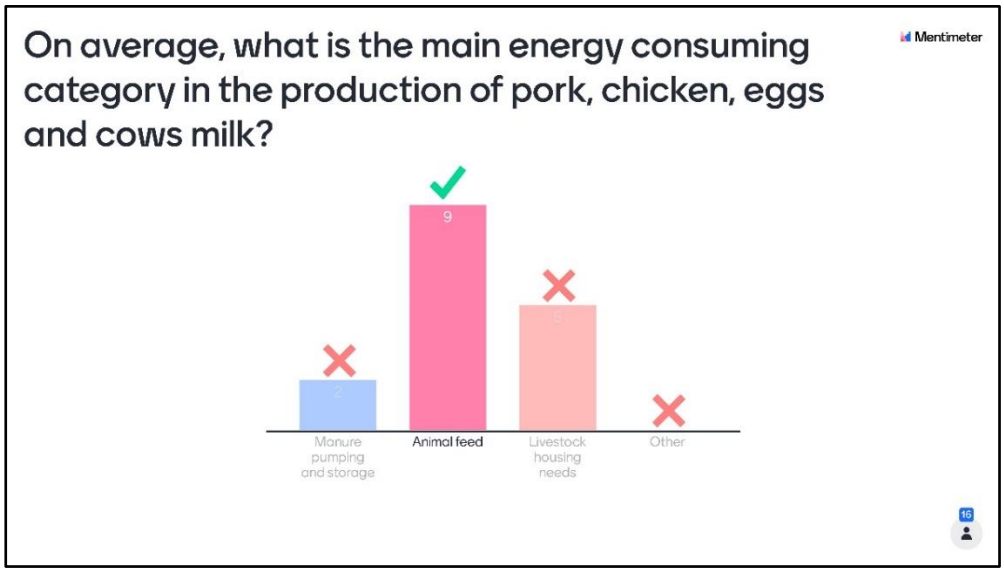

Figure 18. Working Group B Pitch 1 Mentimeter questions and voting results.

Groups A and B in common expressed their high interest and expectation for valuable research results produced by projects dealing with biogas/biomethane production (which is also a solution for RE storage) and development of demonstrations and pilot farms to upgrade training programmes and advisory services related to FEFTS. This fact fortified the opinions that had been expressed up to that point in the workshop. There is consistency observed concerning the policy recommendations, and it is shown that agricultural stakeholders want to primarily see FEFTS in action and especially when their technology readiness level is still low. As expected, biogas technologies that are already in the market for decades require continuous optimisation through research. Precision livestock technologies were ranked in the middle from both groups, as they seem to be expensive and their impact does not seem to be clear enough. However, it was said that feed reduction is something that precision technologies can offer and therefore such research could play significant role for livestock farming indirect energy consumption. Breeding is not considered as a main research topic for FEFTS, as the impact of such improvement will reflect in energy in a very subjective way, based on all other practices of the farm hosting the new breed. Additionally, it was observed that workshop stakeholders tend to gain knowledge from research results regarding FEFTS that are closely related to precision livestock technologies and automation. The most popular answers cover energy production per se and need for dissemination of research and knowledge sharing on a more efficient level than present. There was a disagreement between the two groups for their primary interest in research. For group B, biogas/biomethane production was placed as first priority, but group B placed it on a third place. Overall, the research topics deserving further funding to produce

valuable results for EU's agricultural livestock community were concerning biogas/biomethane production, demonstrations, and pilot farms to upgrade training programmes and advisory services related to FEFTS, and a modest interest in research projects about precision livestock technologies and automation.

The third category of questions on open field agricultural research orientations were initiated by the following first question:

3.1 Why the first 3 ranked research ideas are more interesting for you? If they are NOT, why NOT?

Regarding question 3.1, an advisor from group A expressed a need for demonstration/pilot farms as being very useful for implementation due to farmer-to-farmer communication, which was supplemented by a cultural fact that farmers need to see technology work in practice and the financial statements. An advisor from Spain also mentioned that farmers are very reluctant to change, and it is doubtful that common farmers know about which FEFTS can be used in practice. A farmer will most likely not invest in novel technology if they don't see it working well, and not all farmers are internet literate to find the info themselves. Therefore, the demonstration/pilot farms for FEFTS were considered very interesting for a farmer in group A. In group B, there were also several participants, especially farmers, who commented on the positive effect of demonstration/pilot farms and education, because it can full fill the knowledge delivery gap between the world of science/legislation and the world of real farmers. A manufacturer stakeholder called the attention to the regulation side can be a problem if research projects are not aligned with regulation, alternatively that there is an authority agreement that the research are intended to change the regulation, when research results are published. There were also requests for research topics related to RES storage on farm, for instance an advisor was mention that research is needed for pyrolysis and biochar as a way for storage carbon into the soil. At both groups, there were many oral and post-it notes responses regarding research interest in biogas/biomethane production. However, outcome of exact topics for research needs related to biogas/biomethane production was not revealed, except that it was mentioned that some EU countries are further ahead in research and implementation in agriculture, and there are potentials to share knowhow by European research projects. A researcher in group A was also mentioning that there is still a lot of challenges and theoretical efficiency targets to reach by research for next generations of biogas/biomethane plants. Biogas/biomethane production was highlighted as the most

interesting research topic because the technology is taking maximum CO_2 from atmosphere making manure valuable, it is an available source of renewable energy and handling manure in a climate friendly way, and because it can make a difference on impact on a relatively short term. An advisor was mentioning that research supports the need of giving Biogas/Biomethane solutions a higher relevance for the society in general. A farmer was foreseeing that biogas/biomethane solutions due to the size of the investment will only be a FEFTS for big farms, as smaller farms will have difficulties to participate, which also is a relevant research topic. Finally, there was a single comment on the research topic of precision livestock technologies and automation, where it was mentioned that this FEFTS will be relevant to optimise the utilisation and saving of feed.

3.2 Is it easy for livestock farmers to connect with industry and research in order to solve their problems?

Regarding question 3.2, most farmers and advisors in groups A and B stated that it is modestly easy for them to connect with both researchers and industry in order to find solutions for their problems, but it also depends on personal motivation and capabilities of the farmer. Most participants in both groups mentioned that this connection is a problem. Researchers are mainly dedicated to their research subject working mainly at lab scale. There are researchers with direct contacts with farmers, but they are not the majority and when they work closely with farmers, they do so with specific farmers only. Industry, on the other hand, is more connected to farmers through their local dealers and they receive feedback from practice. Even though, industry's purpose is profit, so new products are not always for the benefit of farmers (especially small-scale holders). Finally, the farmers say that they are busy on their farms, so they do not visit agricultural fairs or workshops very often and they do not have direct contact with research. The scientists that they work with are the advisors, so research should use extension services to approach farmers. Sometimes the regulation side is the problem for not assisting all stakeholders' types to reach each other and solve everyday problems of livestock production. In Denmark, for instance, this collaboration between farmers, contractors, advisors and universities is well established, as well as in the Netherlands. It was mentioned by a Research Institute that they collaborate with advisory services and centres to reach farmers and present research results and recommendations to them. However, when difficulties to connect with industry and research were mentioned, it was obviously country specific. It was also evident that farmers present in both group A and B was reluctant to answer positive to question 3.2.

3.3 Would you participate in a multidisciplinary team in order to conduct a research project? If YES, please explain the reason. If NOT, why NOT?

Regarding question 3.3, both groups A and B expressed a 100% common interest in participation in research projects, if they are likely to find solutions to their problems. The majority of farmers were interested to join a consortium either in national or EU level, but only if the subject is directly connected to their specialisation and needs. However, they pointed out that getting into this domain remains very far away from them. A small portion were negative in participating in research projects, as they believe it is a waste of time and money. Researcher and industry representatives also showed their interest in multi-actor collaboration to move research into real applied scenarios. Though, industry will shift its attention and personnel into research, only if it has direct impact on its future perspectives commercially. It was, however, underlined, that the projects should rather focus on gathering FEFTS knowledge and disseminate to all EU countries, offering practical knowledge and demonstrations, and that multidisciplinary involvement is a key aspect for innovation. Farmers would like to exchange their opinions, consult, and solve problems, and learn about farming techniques and useful technologies. One farmer was mentioning that there is a under representation of small farms in important projects. Multidisciplinary research projects was also mentioned as the way to implement the results of projects and turning them to reality and applicability, meaning that it would be good to work together with different stakeholders. For group B, the oral and post-it notes resulted in numerous suggestions for multidisciplinary topics of collaboration:

- biogas research at farmer + cooperative level,
- defining advice to farmers on FEFTS,
- opportunity to farmers to get easy access to assessments and economic KPI's for FEFTS,
- implementation of small biogas plants on dairy farms,
- measure and analyse energy input at dairy farms,
- online training tool development for advisors,
- biogas or methanol production on farm- not on big plants,
- make it possible to make farmers own energy to tractors an also electricity,
- make it possible to produce energy to the town/net//gas grid like farmers sell milk and grain, energy should be the new business leg such that farmers also produce and sell energy in the future (a farmers idea),
- demonstration of "carbon-free" farms,

- small biogas plants to cover energy need at small farms,
- how to combine agrivoltaics/electric tractors for practical use,
- designing a model sheep farm of 1200-2000 ewes cost energy efficient and fully automated with low carbon footprint using state of art technology and machinery (a farmers idea),
- need to develop common climate action tools – and regulation to avoid competition between countries if different regulations (taxes etc.) are rolled out,
- find usable solutions for the farming of 21th century,
- increase fodder yield while lowering energy consumption in the field by developing new technology,
- utilise registration of all things that we do in the field for Big data approached.

6. Summary of workshops output

The TIW workshops discussions resulted in a number of actions, which are listed as bullet points for each workshop theme and each of the three question categories.Greenhouse production

The main points extracted from the 1st category of questions can be summarized as follows:

a) increased energy prices will likely contribute to decreased greenhouse production.
b) price increases will drive the adoption of Energy efficiency technologies and practices.
c) through a combination of factors, the adoption of FEFTS is accelerating in the greenhouse sector.

The main points extracted from the 2nd category of questions can be summarized as follows:

d) a range of incentives can stimulate FEFTS adoption including, policy, subsidies, effective communication strategies, training and education.
e) some relevant and novel policies exist but that more and more effective policy support is desirable.
f) a range of policies were suggested to help focus on supporting FEFTS adoption and improvements in energy efficiency, it is recommended by multiple stakeholders that these policies focus on supporting returns on investments.

The main points extracted from the 3rd category of questions can be summarized as follows:

g) a wide array of research projects and goals are preferred by different stakeholders.

h) a standardised network can provide clear information and orientation on research and the involvement of different stakeholders.

i) effective disseminations strategies are key to creating and driving research and development of FEFTS.

6.2. Open field agriculture

The main points extracted from the 1st category of questions can be summarized as follows:

a) Stakeholders do not correlate fertilisers (and agricultural inputs) with their embedded energy thinking that energy in farming is related mainly to direct energy consumption.

b) Stakeholders foresee a considerable reduction in fertilization and other operations requiring the use of agricultural vehicles due to increased fertiliser and fuel prices.

c) Reduction or cancelation of investments, with farmers using existing machinery and more circular resources use, even taking risk of lower production to save money.

d) Some see the increased cost situation as a window of opportunity for renewable energy, which unfortunately leaves behind small agricultural holdings due to inability to access the required capital.

e) Precision agriculture and conservation agriculture have increased interest from farmers, to reduce soil cultivation and to optimise production without increasing inputs.

f) Growing energy costs result in high prices of crops (high of production costs / reduced marketed crop amounts), but this is not necessarily translated into higher farmer revenues.

g) Increasing energy use efficiency could be achieved by encouraging contractors to invest in energy efficient machinery to offer energy efficient services to small farmers.

h) Overcoming the rising costs of fertilisation could be possible by introducing cover crops and legumes and also by optimising manure/sludge spreading and absorption.

i) Resilient crop varieties can reduce the use of plant protection products and irrigation.

j) Alternative fuels (e.g. pure vegetable oils) produced within the farm could solve partially fuel dependency, but legislation should cover such initiatives.

k) The 3 most energy intensive operations are fertilisation, tillage and transport. Other energy consuming operations are irrigation, storage of produce, cooling, and drying.

l) There is high need for training (e.g. high loss of nutrients by overfertilisation, alternative cultivation methods, digitalisation, optimisation practices / energy saving with existing machinery).

m) Introduction of bioeconomy policy measures would help in energy use as well. This can be extended to soil carbon sequestration and capture of biogenic CO_2 from biomass processes which can be viewed as a high price side product.

The main points extracted from the 2nd category of questions can be summarized as follows:

n) The main tools identified for better FEFTS integration in agriculture are practical trainings and demonstrations on pilot fields, spreading information through extension services and agricultural advisors (after training them with continuous updates) and applying incentives or subsidies with proper Implementation to avoid low impact.

o) The extension and advisory system is completely different between countries leading to a huge impact on how new ideas (like FEFTS) are integrated in production.

p) There is limited knowledge of national or EU policies, but high willingness to be easily informed.

q) There are existing policy opportunities in most countries, but an interesting comment was that most of them are not suitable for medium and small size agricultural land holders.

r) Ideas for new policies focus on energy efficiency, alternative fuels for machinery, conservation and precision agriculture (difficulty to invest in new technology, focusing on efficient use of existing resources), financial incentives to introduce climate-friendly measures (e.g. carbon taxes and carbon farming) and shifting budget from the energy sector to agriculture.

s) Electricity grids in rural areas are not always ready for increased intermittent renewable energy influxes leading to the need to be upgraded.

t) Combination of different FEFTS should be applied in farms to avoid dependency in one energy source and cover different types of energy needs.

u) Subsidies should not be given to solutions that are profitable on their own.

The main points extracted from the 3rd category of questions can be summarized as follows:

v) Precision agriculture and conservation agriculture can offer the most to those farmers who cannot afford investment in renewable energy technologies.

w) PV and biogas have found their way in the market and should be mainly funded by private investors, as they are already profitable.

x) Even simple, old-fashion techniques (e.g. crop rotation) can make a difference in indirect energy consumption, if it is conducted correctly.

y) There is a need to shift to holistic projects that look agricultural production as part of a circular economy.

z) It is rather difficult for farmers to connect with researchers and industry in order to find solutions for their problems, although it is easier than it used to be.

aa) Farmers prefer to discuss and solve problems with people they know (i.e. advisors).

bb) Applied research should be conducted in a multi-actor approach, in a real sense.

cc) Research into the core of farming issues in a local demonstrating context for small scale (as most EU holdings are) is the key; "not research for research, but for a good reason".

6.3. Livestock production

The main points extracted from the 1st category of questions can be summarized as follows:

a) Data collection about inputs/outputs of livestock facilities are scarce.

b) Many farmers are ready to phase out animal farming due to higher costs of operation, when at the same time a comparable increase in income for the final product is not foreseen.

c) Rising prices may also act as an opportunity to optimize farming.

d) There is a need for extensive training of farmers for optimization to occur.

e) The price for milk and meat have been very low for years, leading consumers to not understand that the price should be higher due to increasing costs (always with a limit though).

f) This situation leads to the possibility of stimulating circular economy and encourage increased collaboration.

g) There are different energy needs across geographic areas.

h) Investments are hindered due to uncertainty, so farmers follow the "wait-and-see" approach.

i) The production of feed is the most crucial part of the livestock supply chain.

j) At poultry farm, ventilation system consumes the most electricity. At mixed dairy farm, irrigation and farm machines consume the most and also milking requires a lot of energy.

k) EU and national legislation have been big issues for FEFTS implementation both in the past and today.
l) Governments are asking the industry for feasible solutions.
m) The main high energy intensity parameters mentioned were feed production, fuel, fertilizers for feed production.

The main points extracted from the 2nd category of questions can be summarized as follows:

n) The main ways to help familiarise with FEFTS are the continuous training (including e-platforms, online technologies) and advising (probably through an increase in state provided advisory services) about new FEFTS, demonstration farms (government supported), funding FEFTS start-ups / spin-offs, multi-actor research projects, informative material from livestock associations or national federations optimise the relationship between research, industry and farmers with national development programs.
o) There are several national policies that try to promote FEFTS adoption, but they are fragmented and do not follow successful lessons learnt from different countries.
p) The main policies suggested were the increase of subsidies and particularly for small and medium farms, the development of spatial planning for RES installation (especially when large surface is required), substitution of machinery through off-road vehicles tax system, labelling livestock products as green based on a well-established system, and improvement of infrastructure from the governments support to facilitate the business environment for investment in FEFTS.

The main points extracted from the 3rd category of questions can be summarized as follows:

q) The main interesting research topics were biogas/biomethane, demo farms and training programs. Agricultural stakeholders want to primarily see FEFTS in action, they want to optimise biogas technologies and ask for high level training. Precision livestock technologies were also interesting to primarily reduce feed use for high production efficiency.
r) The Agricultural Knowledge Information System (AKIS) between researchers, industry, advisors and farmers does not work properly and requires EU support for national and European level optimisation. This is one of the main reasons of research fragmentation and low impact.

s) Most farmers were interested to join a research project, but only if it is directly connected to their needs.

t) Industry also showed their interest in multi-actor collaboration to move research into real applied commercial scenarios.

7. Conclusions

7.1. Greenhouse production

In conclusion, the workshop achieved the active participation of 55 relevant stakeholders. The main relevant points and insights derived from the discussion and workshop in relation to energy consumption in EU greenhouse crop production and factors affecting the adoption of innovative strategies and technologies are summarized in the following.

Stakeholders were aware that a very large variation in energy use and EUE exists, and subsequently agreed that increased energy prices will likely contribute to decreased greenhouse production. While costs increase there will be a correlation to the transition to energy efficiency technologies and practices, undisputed the fact that the transition is very much underway. Nevertheless, the speed of this transition is said to be dependent on the prices of fossil fuels, technological developments, and common efficiency improvement goals on EU partnership level.

The European greenhouse industry solutions and associated policies for reduction of energy direct and indirect energy consumption and for production of energy from RESs was considered as important. A range of incentives was suggested that has potential to stimulate FEFTS adoption including policy, subsidies, effective communication strategies, knowledge sharing, training and education. To some extent and in some countries, applicable and novel policies exist, but more effective policy support is desirable. A range of policies were suggested to help focus on supporting FEFTS adoption and improvements in energy efficiency, and it is recommended by multiple stakeholders that these policies focus on supporting returns on investments.

The main points in relation to current research results and future directions of specific greenhouse related FEFTS a wide array of research projects and goals were preferred by different stakeholders. Focused networks and multidisciplinary knowledge transfer groups was suggested as solutions to provide a clear information and orientation on research and involve different stakeholders. It was pinpointed that effective disseminations strategies are key to creating and driving research and development of FEFTS such that knowledge is always shared with stakeholders.

7.2. Open-field production

In conclusion, the workshop achieved the active participation of 44 relevant stakeholders. The main relevant points and insights derived from the discussion and workshop in relation to energy consumption in EU open-field agricultural production and factors affecting the adoption of innovative strategies and technologies are summarized in the following.

The rising costs of fuel and electricity will negatively affect open field agricultural production, subsequently increase food prices. The 3 most energy wasteful parameters in open field agriculture were stated as fertilization, tillage, and irrigation. Regarding circular bioeconomy measures, it was mentioned that there is a kind of trade-off aspect which makes them difficult to implement. Hence, there are some cases where, from an environmental holistic perspective, even high energy use farms are more acceptable from this perspective, for instance organic farming. In general, participants were aware that it is mainly the indirect (i.e. production) energy consumption that constitutes almost all energy assigned to inorganic fertilisers used in arable farming. The participants were in general surprised about the energy consumption associated with fertilisation was as high as 50%. The introduction of cover crops and legumes instead and the adoption of conservation agriculture practices for saving both fossil fuel and inorganic fertilizers could support overcoming the rising costs of fertilisation. Similarly, the use of plant protection products and the need for extensive irrigation may be overcome by choosing more resilient varieties of crop plants. Another interesting observation was that if legislative actions allow for selling electricity to the power grid and storage will be possible (setting an economical viable framework), then agrivoltaics and/or heat pumps could be a business game changer for large arable landowners (small agricultural holdings were considered excluded due to the magnitude of investments). However, if this trend discontinues, and the investment in renewable energy slows down, the interest may/should shift to digitalization and training of farmers, teaching them optimization practices and energy saving using the machinery they already have.

The main points agreed upon in relation to the main and current European open-field agriculture industry solutions and associated policies was stated as cover crop mixes and agrivoltaics, even though pros and cons were highlighted during the workshop. Proposed ideas for new policies were focused on energy efficiency and carbon storage, however interest in alternative fuels, especially biomethane produced from biogas plants, to power agricultural machinery was also observed. It was claimed that a lot of useful information about FEFTS in agriculture has been produced and is available, but it is not disseminated effectively to benefit

farmers/producers. The most mentioned ways to familiarize with FEFTS were training/education/knowledge/innovation broker programs for advisors, pilot platforms and farms where events and demonstrations can take place, and last but not least well established subsidy schemes that would attract the attention of farmers. Regulations should not complicate the FEFTS or RES after implementation/installation and there should be a reduction of taxes on energy when energy use is provided from a RES, and policies for self-sufficiency of biofuel, biofertilizer (i.e. composting/biofertilizer production/farm scale biogas plants) and electricity. Additional support could be gained be carbon credit schemes to promote any effort of carbon capture (sequestration), cover crop practices, zero emission open field agriculture approach, and finally incentives for self-sufficiency of feed protein from sustainable protein crop cultivation on an EU level. A common request to new policies were result/measurable based subsidy financing of FEFTS and associate/link the subsidies to the output and not to the specific technology.

The main interest in relation to current research results and future directions of specific open-field related FEFTS concerned projects devoted to precision agriculture and conservation agriculture adapted to national or even regional levels, where demonstration/knowledge sharing should play a key role in the research results dissemination. Presently, precision agriculture and conservation agriculture can offer the most to those farmers who cannot afford investment in RES technologies. The prevalence of farmers/advisors cooperation with research institutions and industry was obviously country specific. However, there was a common interest in participation in multidisciplinary research projects if projects are likely to find solutions to the challenges that farmers and advisors are facing.

7.3. Livestock production

In conclusion, the workshop achieved the active participation of 42 relevant stakeholders. The main relevant points and insights derived from the discussion and workshop in relation to energy consumption in EU agricultural livestock production and factors affecting the adoption of innovative strategies and technologies are summarized in the following.

The implication of rising fuel and electricity costs was estimated low for livestock production motivated by fuel and electricity accounts only 5-10% of the production costs. The status quo of the market development of livestock production and higher energy costs are not at all a driver for investments. However, for some countries the rising energy prices are clearly an incentive for RES, for instance solar PV parks, rooftop solar PV's and biogas. The bigger farms or at least

the farms having the economic strength have already done FEFTS investments in the past, and an increase is apparent during the last year. This will drive the change to modifying business opportunities. However, small farms will not invest without subsidies and will have harder time to overcome rising fuel and electricity costs. A general view on smaller farms was that they find increasing costs difficult to deal with, and one obvious solution is to quit livestock production. Small farms seem to go out of business at the moment, because of decrease in sustainability, where too expensive heating and feed can be the simple pivotal factors. Consequently, there was an agreement that increase in energy costs for livestock production will most probably also increase food prices. The workshop discovered that biogas plants was considered as must haves for farmers in the near future in the context of transnational level among EU countries. But, basically, farmers are not sure what the future will bring, and most farmers seem to simply adopt a hesitant attitude. Influence on hesitant attitude of farmers are not necessary related 100% to rising energy costs, but also other matters.

The 3 most energy wasteful parameters in livestock production were identified as feed production/efficiency independent of livestock production type, transport, energy used by buildings (incl. milking, heating, cooling, ventilation). It was questioned whether we know or can determine the waste of energy throughout the livestock supply chain, and in addition, it is crucial to start analysing the energy consumption in every supply chain and operation on farms. The participants acknowledged in general that feed production is the main energy consuming category for livestock meat, poultry, and dairy production. However, across the groups, there were a large group of respondents who was considering energy for livestock housing and manure handling together as the highest energy consuming parts of livestock production. Participants also foresee movement towards increase in business symbiosis for energy production and increased use of alternative energy sources. It may also entail that some farmers will look for other opportunities and ways to optimize farming, and/or need for training and advisory services. Biogas at farm level or in cooperation would be a good solution, but certain regulations can limit what individual farmers can do for energy production and self-sufficiency.

For the internal induced incentives by farmers themselves to overcome rising fuel and electricity costs, the obvious solution was that farmers should invest in energy saving technologies. For instance, energy saving technologies and management regarding pumping and transport of manure, ventilation of stables, efficient insolation of buildings, efficient heating systems and climate control, LED lightning, precision livestock farming, fuel efficient machinery (variable transmission etc.), biofuel driven tractors, and finally more utilisation of

contamination/pollution-free public by-products, like sewage and compost. Also an increase to the efficiency and effectiveness of production processes with a clear focus on analysing the energy costs was mentioned. This could be by turning towards higher energy efficiency measures and tools and monitoring systems, and farmers should measure consumption different places at the farm, with annual evaluation of consumption and costs. The consensus was that the biomethane could be a real new business model for RES produced by farmers. It was requested to make it easy to produce own energy, ease the connection to the electricity grid and gas grid, change the pricing of energy away from underground natural gas, and finally remove the taxes on transport of renewable energy.

The main points agreed upon in relation to the main and current European livestock production industry solutions and associated policies was discovered as a high interest in practical as well as on-line trainings and demonstrations on pilot platforms and farms, showing how particular FEFTS can be used in practice and how they are successfully used by pioneers. There should be a focus on benefits for farmers implementing FEFTS and associated economical rewards (e.g., taxes, reduction credits, green credits) for changing to FEFTS and rewards for reducing CO2 emission. It was also clear that participants would like to see a greater attention given to policy treats that would help stabilizing prices for farmers, implied a guarantee that the investment pays off. Also policies or incentives to create subsidy schemes to motivate farmers to invest in green technology, followed by investment support for new and sometimes less proven technologies. It is also a matter of weighing the incentives and available budget, a matter of better focus and value for the subsidies. An idea was raised to place subsidies for RES in return for labelling on products to assess their fossil free level. It was suggested to implement tax policies that push livestock producers away from reliance on fossil fuel, and where the tax is used to finance a CO_2 emission reduction, in such a way the farmer always obtain a CO_2 reduction, either by investments or by taxes. There were suggestions to reduce taxes for early adopters, and financial support for adopting /reducing investment costs depending on the farm size with higher subsidy for smaller farms. Overall, the most mentioned ideas of new policies were result/measurable based subsidy financing of FEFTS, where the subsidy extent is correlated to the national or regional level of independence on fossil fuel and dependence of production of energy from renewable energy sources (PVs, grid, biogas etc.).

The main interest in relation to current research results and future directions of specific livestock production related FEFTS concerned projects devoted to find solutions to farmers problems. It was, however, underlined, that the projects should rather focus on gathering FEFTS knowledge and disseminate to all EU countries, especially for biogas plants, offering practical knowledge and demonstrations, and that multidisciplinary involvement is a key aspect for innovation. For one of the workshop groups, the oral and post-it notes resulted in numerous suggestions for multidisciplinary topics of collaboration, ranging from research in biogas/biomethane, to carbon neutral livestock farms to big data for smart control of energy consumption.

8. Appendix

8.1. Agenda Greenhouse TIW

Agenda of the

1st Transnational Innovation Workshop for Greenhouses

June 14th, 2022, Multi-purposes room, AUA, Athens

THE TIME SCHEDULE IS BASED ON EEST ZONE

12:30 - 13:30 – Welcome Lunch

13:30 - 13:45 – Introduction
Thanos Balafoutis (CERTH)

13:45 - 14:00 – AgEnergy platform presentation
Michalis Kaminiaris (AGENSO) and Konstantinos Vaiopoulos (CERTH)

14:00 - 14:10 – Greenhouse monitoring and controlling systems
Dominik Bretz (RAM)

14:10 - 14:20 – RES4LIVE - Energy Smart Livestock Farming towards Zero Fossil Fuel Consumption
Dimitrios Tyris (AUA)

14:20 - 14:35 – TheGreefa project – Thermochemical fluids in greenhouse farming
Mireille Nathalie Honoré (University of Almeria)

14:35 - 14:45 – Needs, barriers and incentives of EU farmers on FEFTS adoption
Vaso Kanaki (AUA)

14:45 - 15:00 – Synopsis of the Regional Workshops results for Greenhouses
Michael Norremark (AU)

15:00 - 15:15 – Coffee break

15:15 - 16:15 – Discussion and collaboration
All participants will collaborate, exchange ideas, and express their opinion on several topics

16:15 - 17:00 – Visit to AUA's greenhouse facilities
Georgia Ntatsi (AUA)

8.2. Agenda Open-Field TIW

Agenda

2nd Transnational Innovation Workshop for Open-field agriculture

September 23rd, 2022, IAFE-NRI facilities, Warsaw

THE TIME SCHEDULE IS BASED ON CET ZONE

09:00 - 09:30 – Welcome

09:30 - 09:45 – Introduction
Thanos Balafoutis (Centre for Research & Technology Hellas - CERTH)

09:45 - 10:00 – Remote Sensing in Agriculture
Rafał Pudełko (Institute of Soil Science and Plant Cultivation - IUNG)

10:00 - 10:15 – Support for low carbon agriculture able to adapt to observed climate change in the perspective of 2030 and 2050
Jerzy Kozyra (Institute of Soil Science and Plant Cultivation - IUNG)

10:15 - 10:35 – Cooperation of bioeconomy clusters for the transfer of knowledge based on biotechnology through innovative dissemination techniques in the primary production sector (COOPID)
Adam Wasilewski (Director's Plenipotentiary for International Cooperation)

10:35 - 10:45 – AgEnergy platform presentation
Michalis Kaminiaris (AGENSO)

10:45 - 11:00 – New Holland's view on sustainable farm/circular economy
Gilles Mayer (New Holland)

11:00 -11:15 – Synopsis of the Regional Workshops results for open-field agriculture
Michael Norremark (Aarhus University)

11:15 - 11:45 – Coffee break

11:45 - 13:15 – Discussion and collaboration

13:15 – Lunch

8.3. Agenda Livestock TIW

Agenda

3rd Transnational Innovation Workshop

Focus area: Livestock Farming

December 1st, 2022, 'Sydsalen' room, MCH Messecenter Herning, Denmark

THE TIME SCHEDULE IS BASED ON CET ZONE

08:00	09:30	**Bus transport from Aarhus C**
09:30	10:00	**Arrival and coffee**
10:00	10:15	**Introduction** *Thanos Balafoutis (Centre for Research & Technology Hellas - CERTH)*
10:15	10:25	**AgEnergy platform presentation** *Michalis Kaminiaris (AGENSO)*
10:25	10:45	**Presentation from the industry** *TBA*
10:45	11:00	**CNH methane circular biofuel** *Gilles Mayer (CNH)*
11:00	11:10	**Synopsis of the Regional Workshops results for livestock agriculture** *Michael Nørremark (Aarhus University)*
11:10	13:10	**Workshop**
13:10	14:00	**Lunch**
14:00	17:00	**Guided AgroMek tour**
18:00	20:00	**Dinner at 'Højhuset'**
20:00	21:30	**Bus transport to Aarhus C**

Please fill in the **requested information** in the spreadsheet here

REMEMBER to **register** for **Agromek** ticket here

8.4. Document for collecting participants' information during the TIW workshops.

s/n	Full Name	Profession	Country	Email Address	Signature	*	**	***
1								
2								
3								
4								
5								
6								

* Permission to record the conversation and take photos

** License to register you on the AgEnergy platform (via email)

*** Permission to send the project newsletter to the declared e-mail address

8.5. Pictures of Greenhouse TIW.

Figure 19. *Photograph from the workshop event (I)*

Figure 20. *Photograph from the workshop event (II)*

Figure 21. *Photograph from the workshop event (III)*

Figure 22. *Photograph from the workshop event (IV)*

Figure 23. *Photograph from the workshop event (V)*

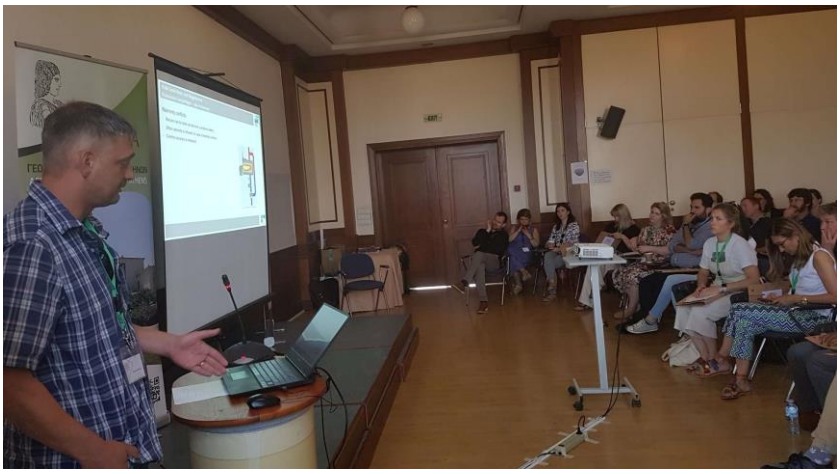

Figure 24. *Photograph from the workshop event (VI)*

Figure 25. *Photograph from the workshop event (VII)*

Figure 26. *Photograph from the site visit (I)*

Figure 27. *Photograph from the site visit (II)*

Figure 28. *Photograph from the site visit (III)*

Figure 29. *Photograph from the workshop canvases (I)*

8.6. Pictures of Open-Field TIW

Figure 30. *Photograph from the workshop event (I)*

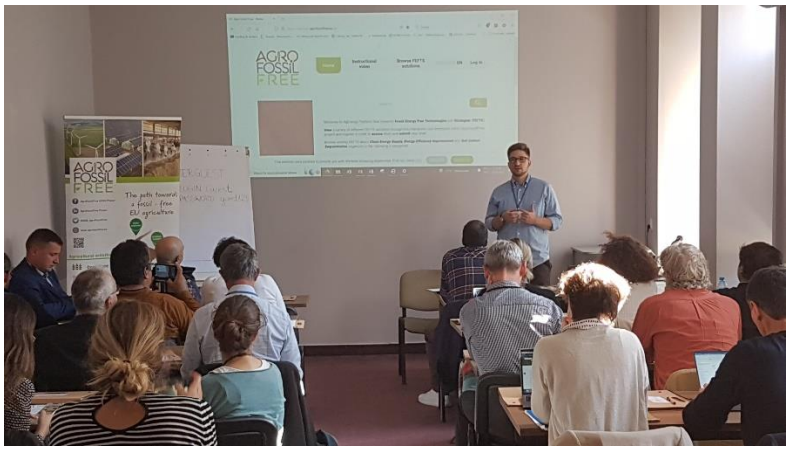

Figure 31. *Photograph from the workshop event (II)*

Figure 32. *Photograph from the workshop event (III)*

Figure 33. *Photograph from the workshop event (IV)*

Figure 34. *Photograph from the workshop event (V)*

Figure 35. *Photograph from the workshop event (VI)*

Figure 36. *Photograph from the workshop event (VII)*

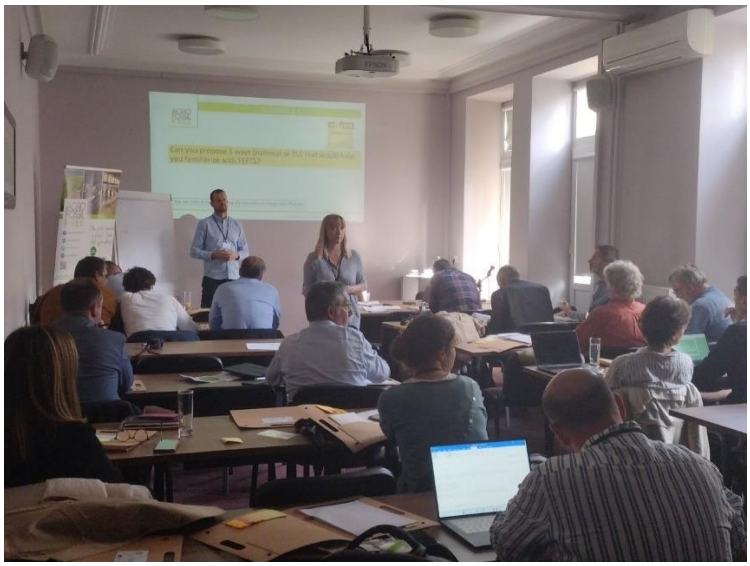

Figure 37. *Photograph from the workshop event (VIII)*

Figure 38. *Photograph from the workshop event (IX)*

Figure 39. *Photograph from the workshop event (X)*

Figure 40. *Photograph from the workshop event (XI)*

Figure 41. *Photograph from the site workshop event (XII)*

Figure 42. *Photograph from the workshop event (XIII)*

Figure 43. *Photograph from the site visit (I)*

Figure 44. *Photograph from the site visit (II)*

Figure 45. *Photograph from the site visit (III)*

Figure 46. *Photograph from the site visit (IV)*

Figure 47. *Photograph from the workshop canvases (I)*

8.7. Pictures of Livestock TIW

The appendix includes a variety of figures and tables including the workshop agenda, photos of the event, and transcribed tables of the canvas answers.

Figure 48. *Photograph from the workshop event (I)*

Figure 49. *Photograph from the workshop event (II)*

Figure 50. *Photograph from the workshop event (III)*

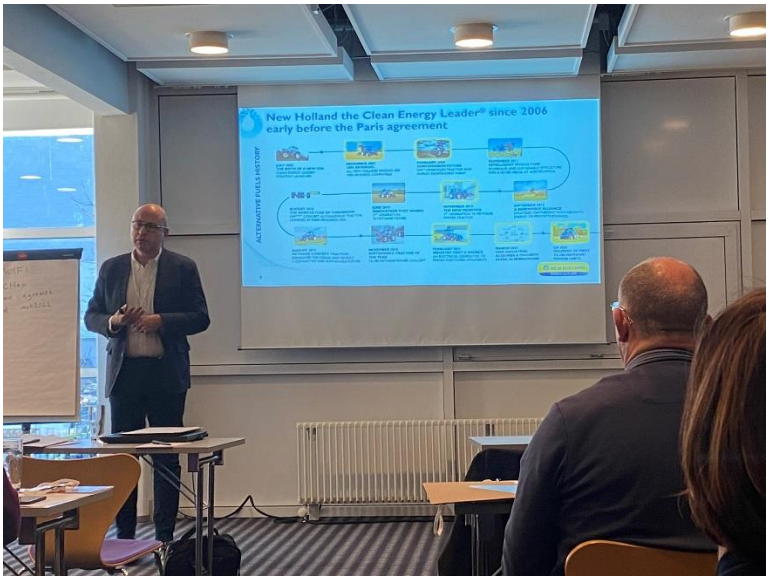

Figure 51. *Photograph from the workshop event (IV)*

Figure 52. *Photograph from the workshop event (V)*

Figure 53. *Photograph from the workshop event (VI)*

Figure 54. *Photograph from the workshop event (VII)*

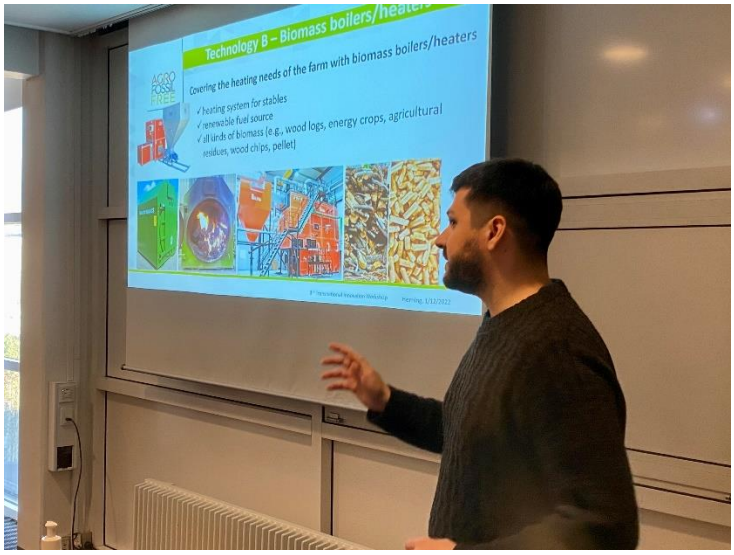

Figure 55. *Photograph from the workshop event (VIII)*

Figure 56. *Photograph from the site visit (I)*

Figure 57. *Photograph from the site visit (II)*

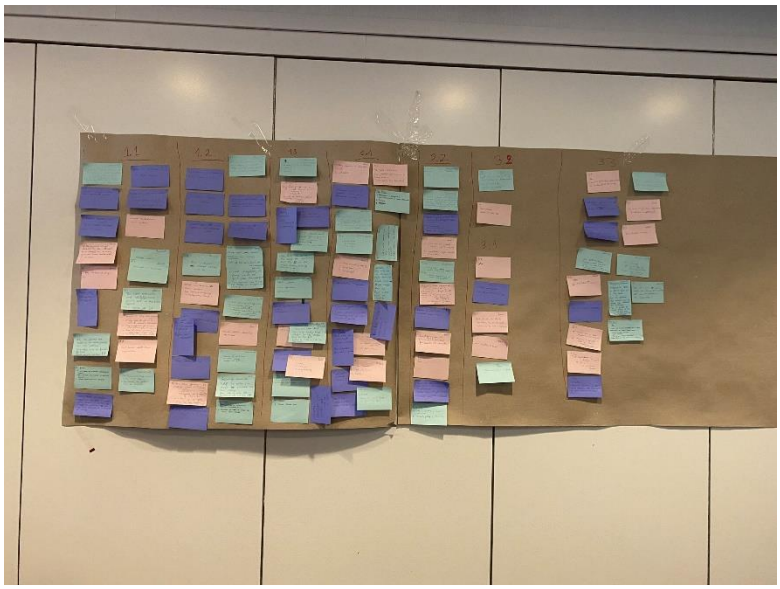

Figure 58. *Photograph from the workshop canvases (I)*

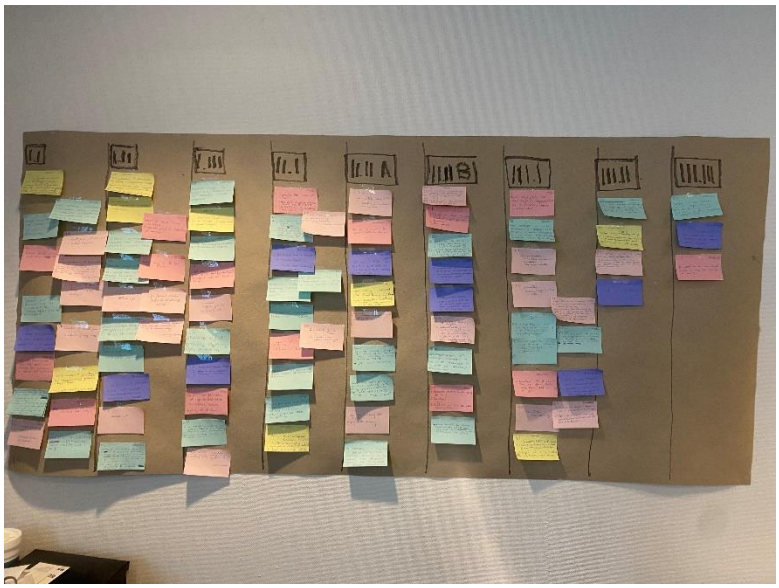

Figure 59. *Photograph from the workshop canvases (II)*

8.8. Canvas content from the TIW on greenhouse production

**The following tables for the TIW on greenhouse production do not indicate the profession/occupation of each respondent (using assigned colours) as in the context of the 1st TIW, respondents were not asked to write down their expertise in each post-it note they were producing. This petition was asked as an improvement to the methodology for future workshops (2nd, 3rd)*

Table 1. *Greenhouse WG A - Text transfer from post-it notes canvas - category 1 questions*

1.1 If fuel and electricity costs continue to rise, how will it affect the production processes, farm logistics, export, etc?	**1.2 A Will this number (of greenhouses) increase or decrease and why?**	**1.2 B How will the energy use efficiency (EUE) develop, increase, decrease or status quo and explain why?**	**1.3 A Do you know what is the current direct energy use (eg. KJ or MJ) per unit (eg. Kg or ha) of a greenhouse product?**	**1.3 B Identify possible wasteful energy parameters showcasing problematic management approaches**
We could use some species with low input requirements	climate that helps the cost reductions (solar energy)	It will increase due to producers need to make the most the high costing energy	Difference among cultivation systems, differs among crops/seasons, differs among countries, differs among constituents	No market to sell the produce heat losses, photosynthesis, N/P and fertilizer
Farmers will look for alternative systems, energy efficiency	small size greenhouses will be closed. Big size greenhouses firms might increase which use geothermal energy as a heating sources, It total GH will decrease.	EUE will increase as less of energy means more money than before. Owners of greenhouses will optimise their management of energy.	MJ	Not efficient buildings
capacity to produce / reproduction of production	decrease (surfaces), why? - the famers can not face to the crisis, they lose money and don't have subsidies from the government or don't invest in new technologies for sustainable agriculture	The south countries of Europe think that the number will not grow because it will become hotter and dry	300-500 KJ/ha	no
Alternative fuels might be able to develop a lot. Product prices will increase	This number will increase because the greenhouse is a good solution to optimise production	Yes it will, big need of subsidies.	guess = 5 my/kg	variability to inputs
Farmers will look for new sources of income. E.g. Processing, manufacturing to make their income high	extension will depend on the approach taken by policy makers to incentivise renewables adoption, there are many opportunities here	The EUE will increase but the farmers will use those technologies only with subsidies (I think). With their s they will optimise some if they don't have money to invest! We can develop lot of technologies about the fairness have o follow the research! The technologies have to be simple to install! no	the need for energy audits, it is a vital first step to ensure energy efficiency	?

		complications! and results with simple ideas.		
Ideas: more taxes for the consumers and industry, politics and loans for the farmers, higher prices, next gen agriculture, contracts with big companies, less choice for transport and co2	South Europe will decrease, north will decrease	High costs of investments may cause decreasing in energy efficiency	23 m3/m2 g Dutch project	greenhouse built envelope (openings/ventilation/shading/etc
Lower production and at the end farms would end their production	It will (in the short term) decrease, due to those less efficient companies unable to cover costs.	The EUE will develop because war in Ukraine proved once again that we need to be independent in our energetic needs.	2000mw/hours/year	waste free energy parameters are materliasing
Rise in the costs of products	it may increase because of lack of suce production in north (because of high costs)	It will increase and develop because the EUE is necessary to ensure the quality, the production of products	m/kg	Not using the energy sufficient
Increasing costs, quality of the product decreases and product prices increase, change cultivation time	It may increase due to reallocation of nowadays outsourced production due to high transport costs and to be independent t, energy, political	more climate tolerant crops to increase EUE, the energy must be mainly to assure yield and quality.	no idea	obsolete production technology
Higher selling prices, lower productive capacity of smaller and less efficient producers, higher appeal of energy supply alternatives	increase because governments will take action with subsidies	EUE should increase to be more sustainable and reduce costs	no idea	production in different times (kg/ha), quantities of inputs and outputs
Reduction sustainable food production, low innovation/optimisation, worse logistics for transport, positive local commerce	energy coop, increase climate/energy, city farming	Increase - policy will drive it in the future years		
The rising input costs have the capacity to drive some growers out of business - it could then result in less domestic produce available	shift due to policies EU/national level, BE/NL to the EU region, SE other crops (less heat asking)	I think the energy use efficiency will develop because it is there were the solution lies		
Will be a catalyst for renewable uptake, less transport, more local products, less meat and more vegetables	Will decrease and replaced by high value crops	Energy use will have to increase., opportunities for awareness raising and promotion of renewable		
Prices will increase, new tolerant species, new profitable crops, reduced other costs (fertilizers)	The policies of the EU can lead to both path, needs of reducing cost of logistics and have centralise the materials can increase grower	Increase - new technologies		
Every cost rises. Production of lesser value agriculture will no longer generate	It may be to increase why the greenhouses is possible the control to all variables crops	increased EUE because no other way		

a useful income for farmers. Export will be feasible for luxury items only.				
Stop production, uncertain future, CHP has to stop, subsidy chp less	It will increase to take food from local farms, reducing logistics costs (if government fosters it)	The political status and the economical difficulties will lead to decrease the energy use/no other way, environment protection		
Increase the costs of the raw materials and the prices of the products will be very high, decrease the production of the products, decrease of the quantity.	increasing prices and sustainability will lead to more environmental awareness - less import from outside Europe	More electrification, heat pumps, exchange of E with firms nearby.		
Will have negative impact if price of final product stays the same	increase - more demand for local/ EU produce due to the experience of current uncertainty around agriculture	Will increase		
Proximity of a local commerce will raise in importance	Increase- more specialised production, standardisation, tech, sustainability	The transition is inevitable, no other way		
Finally it ends with farmers abandoning their job		The EUE will increase because the technologies is continuously growing		
It will affect consumer prices, it will increase significantly production costs, small producers might extinct.				
It will be a driver for change to EE technologies and RES rise.				

Table 2. *Greenhouse WG A - Text transfer from post-it notes canvas - category 2 questions*

2.1 A How to increase awareness of FEFTS solution in order to promote Energy Use Efficiency?	**2.1 B What would you like to learn and how? (ie. what kind of training you prefer?)**	**2.2 A Are there any novel national or EU policies (or changes to current national/EU policies) that could benefit sustainable investments in certain FEFTS for greenhouse production?**	**2.2 Propose new policies!**
Institution or an observatory on local and Europe level. A new profile or profession innovation broker to operate on EU level.	Through practice platforms	green deal	Examples of implemented FEFTS in greenhouses will lead to practical suggestions to farmers, fake new/misunderstanding of greenhouses
Building management system	appropriate FEFT considering localizations to geomorphology to funds and policies.	recycle fees like new subsidies, policies linked with new technologies for sustainable agriculture, loan but with returns and results,	I don't know any new policy
Increase aware through advisors, inform farm, create incentives that will maker farmers aware of eco technologies	I prefer learning by taking classes, workshops, trainings!	growers training obligatory, closed systems	subsidies for heating and cooling
raining, subtilities	Summers schools, videos, trainings, workshops, virtual tours to the facilities	rewards for early adopters of new innovative FEFTS as an incentive	co2 tax, co2 zero rewards policies
famer advisors if trained in energy efficiency are well placed to advise famers because they are familiar with farms and the consumer	learn about available sustainable technologies for agro sector, learn about the cost, learn about technical issue.	Irelands farmers are long awaiting a microgeneration scheme for solar. That scheme when eventually introduced will certainly lead to an adoption increase.	compulsory training, crop management in every form
use demonstration sites, short engaging video,	case study, live presentation neighbour	In Ireland: targeted agriculture modernisation schemes could be a focus and catalyst	support for smaller producers / family farms
exponentially	training in working best practice	Clear and long term national strategies and key factors for sustainable and implementable policies that will encourage investments in new technologies.	minimal price, which will balance costs
despite advertisement on traditional media, internet it is also important to reach farmers, the benefits of FEFTS solutions should be emphasised.	experimental demos, farm visits	long term national strategy	
Doing simulations and validation of models, doing experimental and case studies	sustainability , how to go forward, new technologies sharing through platforms and teamwork	in Poland there is no policy for greenhouses s, famers growers are totally along	
Farmers always ask about donations - it will help	demonstration talk to farmer/user with direct knowledge	sustainability is a must	
show working examples	Join the producer 1 day in his firm, Escan, demo visit, learning networks	Include in CAP subsidies	
real time monitoring of energy use, knowledge to production, management decisions	Self paced course online that farmers can work on when it suits them, local community type groups		

	for knowledge transfer, because farmers have a lot to learn from each other		
long term national strategies, demo activities	learn how to assess waste sources and then reduce waste, short videos, grower groups, peer to peer networking, knowledge transfer groups		
dissemination, self awareness, training	experimental studies, social behaviour		
do not provide tax reduction energy prices!! Rising costs leads to more awareness of FEFTS	video and visiting demo greenhouses to learn about the topic, biomass and simulation software		
internet/social media, training of farmers, policies of EU			
Through the dissemination of benefits in terms of yield			
increase economic incentives, set up advisory services available to farmers			
EU fefts label in the market			

Table 3. *Greenhouse WG A - Text transfer from post-it notes canvas - category 3 questions*

3.1 According to your point of view, which of the following research projects is more interesting to be funded and produce results?	**3.2 What type of research collaborations and cross-border schemes would you consider to realise your research concerns?**	**3.3 How to merge all the growers and how to push the industry to get involved in research and development of FEFTS?**
What about nuclear power plant, in DE they are closed down however the huge power ait produces is attractive	EU-China, EU - USA, EU Africa, PhDs, joint events, pilot cases around the globe	Workshops, trainings, associations, joint PHDs, funding projects with industry
drones in precision agriculture	Joining already established pan EU networks to get support on technical issues	share the results, exhibitions, transparency, open days in universities
more research needed on the positive, negative or neutral financial impact for farmers of adopting technologies	alternative agricultural strategies (conservation, permaculture)	Through local knowledge transfer groups, to learn from each other and collaborate
how best the various renewable energy types can be combined to provide results for producers. Social research!	the collaboration between countries are very interesting and needs to learn. Mainly different type of technologies and method	Knowledge transfer groups, where producers get incentives to join groups and learn, funded under CAP
Re-use of material	EIPs, cost projects, energy consumer associations, community energy projects, sustainable energy communities	Through policies useful for industries that must be understand the profit by the research and developments of FEFTS
combination of nutrient and energy use inefficiency	Solidarity'' consortium of farmers to share costs and help	Invite industry in focus groups, fund living labs in agricultural sector
research in both productivity (agronomical and energy)	Maybe organising of workshops together with other partners of AFF	advisors + confederations +associations unions
robotics	Collaborate with different areas, not only with greenhouses (livestock, industrial processes), create associations (private organisations), the suppliers	The industry doesn't need to get pushed, they are innovative
DSS for irrigation, training for reflecting this GAP		Pointing out the possibility of making profits for the industry
		energy market with seller and buyer
		by collaborating in workshops
		Another union could be possible considering the environmental impacts both have on the soil and water.

Table 4. *Greenhouse WG B - Text transfer from post-it notes canvas - category 1 questions*

1.1 If fuel and electricity costs continue to rise, how will it affect the production processes, farm logistics, export, etc?	**1.2 A Will this number (of greenhouses) increase or decrease and why?**	**1.2 B How will the energy use efficiency (EUE) develop, increase, decrease or status quo and explain why?**	**1.3 A Do you know what is the current direct energy use (eg. KJ or MJ) per unit (eg. Kg or ha) of a greenhouse product?**	**1.3 B Identify possible wasteful energy parameters showcasing problematic management approaches**
Foster transition to RES, immediate EE activities, promotion of biomass for renewable fuels	No's will decrease to larger more efficient systems	Increase, better techs, high prices of energy education, global warming.	No	Electricity of lighting and heating
Food prices will rise, opportunity for bioeconomy in agriculture	Increase, decrease cost and increase productivity	EME will increase because of cost cuts, care about balanced production of glasshouse owners	Only for low tech greenhouses in southern Europe	Inefficient management of heating systems, pumping inefficiencies
Prices will rise	Increase, more people in EU with more money to spend will become more productive in long term	Due to increased energy cost it will make sense to investing EE investments, so an increase is in place	No	Bad management of the heating system, bad efficiency of the water pumping system
Short term major impact in small farmers then it will be a solution with new tech	Food needed will only increase, so: more energy production needed, so: definitely increase	Standardisation of EU production and efficiency improvement are key factors for sustainable production	No	Electricity for heating and colling but crucial
Short term - kind of ambiguous, long term - electrification of agriculture	Decrease (ha) because better technology, for example: hydroponic	EUE will increase through producer groups or cooperative models	No	Heat, fertiliser, transport, lighting
new technology development, shift to electricity technologies	The number will increase to tackle climate change and pressures on soil quality and water resources	Must increase, this is the only option	For consumers energy intensity is not so important but carbon neutrality is increasingly important	Heating and ventilation
Force energy transition, rise cost food, increase imports from third countries, difficult for small and medium farmers	Decrease: need for higher yield but perspective such as permaculture will shape the new sustainable systems	Increase efficiency, decrease inputs per hectare, general line in EU	Farmer growers do not know, advisors also do not know	Heating
Production and logistic costs will rise but faster apps and food waste reduction should be addressed	Increase: controlled conditions against climate change, increase crops/year	Increase of efficiency overall	They don’t know current turbulence so not only increased the awareness stimulation	Low efficiency equipment
Both energy and food independently will be more imported in the EU. Rising food prices will speed up the transition process	Increase	Increase in Greece, high potential	Not exactly, the process of effectively measuring it is pretty complication	Heating/cooling
Faster transition to renewable energy solutions	Increase: due to increase land competition and, food independence, regionality	Increase because of the need for cheap energy, efficiency is the solution	label of energy use in EU and higher prices	Heating and irrigation mismanagement
Production won’t be affected. Eno product prices though will	Will increase due to climate change	Increase	Not good image for growers, we are making them responsible for something they can't control	Bad management of heating and irrigation
Focus on energy efficiency	Increase: climate change adoption, especially in southern countries	In general, it will increase, with a bit different farming in each country	They care mostly about the cost per product	Heating

Production cost will increase, so production process and exports reduce	Increase food prices, EU needs doo independence	Increase, new technologies need to be more efficient	No	Heating
High energy dependent production pushed out	Increase because the demand will be balanced	Increase, modernization of low-tech greenhouses	now it is difficult but some years later it will be possible	
Reduction in food output with higher fertiliser prices	In short term, probably increase	EUE will be increased in all aspects and uses	Greenhouse tomato average 90mj/kg to 100mj/kg	
It will push the policy around renewables in the CAP		Energy use efficiency and resource use efficiency will grow, technology development, reduction in costs of production		
Many smallholders will disappear, less competitiveness to third countries, closed market		Energy use efficiency will certainly increase because it leads to increased income the most important reason)		
Negatively! Direct need for fair transition to RES with country-based criteria for optimisation of results				
The policy transformation will be faster, export will rise				
Increased financial deb, decreased profit margins (even lower), increased food prices without added value				
Changes in fuel technology on RES, electric tractors				
Increased self-consumption in farms (pv), increased energy awareness				
Food prices going up, looking for cheaper alternatives: consumers to food and producers to energy production				

Table 5. *Greenhouse WG B - Text transfer from post-it notes canvas - category 2 questions*

2.1 A How to increase awareness of FEFTS solution in order to promote Energy Use Efficiency?	**2.1 B What would you like to learn and how? (ie. what kind of training you prefer?)**	**2.2 A Are there any novel national or EU policies (or changes to current national/EU policies) that could benefit sustainable investments in certain FEFTS for greenhouse production?**	**2.2 Propose new policies!**
Convince them through technical that they will make more money in the end	Last trends in EU	There aren't national or EU policies in Poland Specific subsidies on increasing energy efficiency	Special database and euro-national actions
Energy policy of the country, financial incentives	Know how to save energy in general	Subsidising modernisation of farm equipment (energy efficiency should be a condition)	phase out fossil fuel boilers
EU should create an independent extension service with branches in each country.	Energy system but also farmers POV	Targeted agricultural modernisation scheme, in Ireland 40% grants for equipment renewable	Capital for grants of mover (demo) plants
Maybe a couple of years ago no, but nowadays farmers will look for solutions. SDO: serve them (platform!)	Workshops, knowledge- know how of technology	Money for energy save	investment subsidies under CAP
Finance substitutions, economic efficiency	Subsidies to buy more efficient equipment's, invest on training to increase farmers awareness	30% subsidies if you change an equipment that saves 10% of energy	Pay farmers to attend energy training
Extension services, special funds for training, universities involvement	To give know how to spend money and to involve famers and politicians to collaborate to find green solutions	Tax deduction for investment in RES\	Programmes on energy (systems, efficient, etc) for advisors.
Interprofessional funding for educational for farmers		Continuous extension of investment support. Program in Germany	
unveracity near the farmers in practice		Subsidies for energy efficiency measure and control mechanisms for their implementation	
Awareness can be mostly increased through investment support programmes		Banning fossil fuel boilers asap	
Farmers should be paid to attend energy training		Education	
We need in every EU country an organised and efficient extension service			

8.9. Canvas content from the TIW on open-field agriculture

Table 6. *Open-field WG A - Text transfer from post-it notes canvas - category 1 questions*

Advisor, Researcher, Farmer, Industry/manufacturer, Other stakeholder

1.1. What are the implications of the rising fuel and electricity costs?	**1.2. Now the fuel and electricity costs are so high, did you take any measures to overcome the implications? What are the possible pathways that a farmer/producer could follow? (e.g. Change of machinery, agricultural practices, renewable energy, energy use efficiency)?**	**1.3 Which are the top 3 most energy wasteful parameters in open field agricultural activities?**
A window of opportunity for more environmentally friendly energy will open and become feasible	use less fertilizer; decrease practices: less irrigation, less tractor use	cultivation; watering; drying e.g. cereals
We have to optimize the use of fertilizers (chemical & organic)	introduce conservation agriculture in fields; reduce use of energy	conventional agriculture: fertilizers; transport; cooling/ lack of heating energy efficiency
save fuel, save electricity, new technology	subcontracting	fertilising, transport, power
decrease open field production	there is a run-on solar energy in the NL; more interest in energy storage since we have a lot of electricity when we don't need it	irrigation; fetilisation; transport
optimisation is a must, food prices going up due to raw materials went up	peer-to-peer learning and knowledge exchange on best on-farm practices; training and education	lack of knowledge on tillage; transportation; old tractors, machines
farmers looking to be more circular and independent of the global chain; working to optimise processes and reduce external inputs	in a small region in Spain, 20% of farmers have a willingness to install solar panels but doesn't have the means to do it; small farmers choosing manual machinery (but effective one) instead of fuel dependent	fertilisation, tillage, irrigation
Scheduling crops; reduce inputs; reduce cultivation; crops with low demand on water	renewable energy; min. fuel conservation tasks; min. tillage; use of cover crops; legumes; lower water use	irrigation, soil preparation, harvesting
the result will be very high cost of crops (and food too) due to high cost of production or due to low amount of crops in the market as production will be limited	direct sales locally, installation of PV; energy efficiency; energy communities with neighbours; PV, wind/CSA	tractors, machinery; use of nitrogen and losses; storage of potato/onions
rise of the use of green manure; more direct sale of products of land instead of use of storage; more winter wheat instead of other crops	more climate friendly machinery, e.g. Irrigation with solar panels	in conventional fertilisers; too low number of farmers;

optimisation in the use of inputs; it doesn't affect the production	cover crops; use of crop waste	fertilisation: don't close cycles and waste the possibility to use slurry to make biogas; small organic farmers (transportation of the product); storage (if there's a need to freeze)
it will affect in 10 years	farmer will consider energy optimisations, like: no-till; stop machine when idle; improve logistics; invest in solar panels, heat pumps, smaller tractor	EC control
more no-tillage production	renewable energy that's the key	irrigation; fertilisation; tillage
change of cultivation methods: tillage, irrigation, precision farming	produce their own energy (biomass); agricultural practices (direct drilling)	ploughing; harvesting; driving (between farm and field, on the field)
higher utilisation of N in the field	change practice to no-tillage	ploughing, harvesting, irrigation
production of green nitrate	postpone investment	
fewer organic products bc consumers save money	change in production methods at farm	
high prices in supermarkets are pressing the price to the farmers	use of more efficient technologies and machines; use of more resistant varieties of plants	
optimisation will trigger awareness of farmers towards state-of-the art technology and practices - which is good	more agro-ecology; own renewable energy; more people working per hectare instead of precision agriculture	
lower production; affect climate change	produce green fertiliser; produce green fuel; produce energy themselves; use contractors with new machinery for also small farmers	
difficulties to export; higher food prices; reduced competition		
greater attention to cultivation and a general reduction in production		

Table 7. *Open-field WG A - Text transfer from post-it notes canvas - category 2 questions*

Advisor, Researcher, Farmer, Industry/manufacturer, Other stakeholder

2.1. Can you propose 3 ways (national or EU) that would help you familiarise with FEFTS?	**2.2(A) Are you aware of any novel national or EU policies (or changes to current national/EU policies) that could benefit sustainable investments in certain FEFTS for open-field agriculture production?**	**2.2(B) Can you write down 3 ideas for the new policies?**
Pilot fields: farmer leaders have/use them; connection with greening subsidy	money are a powerful driver	storage; N-free fertilisers; zero emission production
demonstration by farmers on farms	reduce tax on farmer diesel; reduce electricity price for farmers	fertilisation, tillage, irrigation
promotion through government /non-government org.; financial motives for farmers	legislative facilitation for small electricity plants (photovoltaic, biogas, wind)	connect with greening; simplify R.E; cut off tax on fuels
farmer organisation; technical consultants; identify leader farmers	no	less documentation, more supporting; support of energy storage from PV
local stores (farm sales); seminars in fields; through state	carbon credits	money for farmers who store CO2 in soil; money for farmers who reduced fossil use; money for contractors who use fossil free technology
national: through demonstration, extension, professional magazines; EU: regulation	support for investment (40%) from DK government	
training service; creation of users assoc.; dissemination from public institutions	amortization for specific tech. (France); RTFC for gas production (UK)	
organise training on FEFTS close to the farmer, e.g. cover crops and zero tillage; training effect of energy storage	no I am not aware of any new "official" policies - it is more up to the individual farmer to figure out what to do	
funds for building energy storage	on the paper there are a lot, but really working - not really; a big problem is that all the initiatives are for huge farms, and not for medium and small ones, and at the end everything ens the same.	
subsidies; tax reduction	it is possible to ask for subsidy for new technology in DK with the money from EU	

standards; tests (there are many products test to navigate us); validation (many products are not what is stated on the label)	not well informed, for something really helpful	
training/advice; CO2 accounting; financing mechanisms	no	
advisor organisation, WWW for advisors; demonstration FARMS		
subsidize the EU use of new technology; more knowledge for farmers; demonstrate new technology		
free in-field workshops with farmers; associations (confagricultura) need to be educated & spread news		
interacting directly with groups of farmers or organisations; organise workshops, really practical ones, they need to feel that it's useful for them; once people know about it, make the digital platforms really easier		
TV and internet campaigns; trade fair promotions; bigger promotion of EU-funded projects in the area		
show good examples; pay extra for investments; media campaign		
examples of successful practical experiences from the FEFTS		

Table 8. *Open-field WG A - Text transfer from post-it notes canvas - category 3 questions*

Advisor, Researcher, Farmer, Industry/manufacturer, Other stakeholder

3.1 Why the first 3 ranked research ideas are more interesting for you? If they are NOT, why NOT?	**3.2 Is it eaasy for growers to connect with industry and research in order to solve their problems?**	**3.3 Would you participate in a multidisciplinary team in order to conduct a research project. If YES, pleaase explain the reason. If NO, why NOT?**
in Belgium/Flanders PV is/was supported	not easy	Yes, I am already in a few international projects: new contacts, knowledge exchange
H2 is a future for vehicles, but also for energy storage from PV/wind turbines production	no	From EIXARCOLANT we are already participating in some, and we believe it's really important, that the outcomes are useful and practical (some people who are 100% farmers would for sure do too)
	not very easy because in Greece we don't have farm industry and national research	yes, to further GHG reduction
	no	yes, because we can make a difference
	in NL connection between research, industry and farmers is possible; we have also private-public cooperation	yes, but few countries in consortium, demonstration in practice should be a part
	yes, in EU/national projects. However not all the people want to join or are afraid to	YES!
	personal advisors are needed; making groups and learning from each other, from the people you trust	yes, to learn and share opinions, in order to evolve
	we have very close connection between farmers/contractors and advisors and university in DK	yes, to solve problems, help the agricultural sector, to optimize
	Fortunately, every day it gets easier for farmers to get this info. European projects ask researchers to disseminate technologies and thanks to social media farmers can get more info	yes of course, in order to learn new techniques and technologies
	No, it is difficult! Standards needed to compare products	do not research for research, but for a good reason

Table 9. *Open-field WG B - Text transfer from post-it notes canvas - category 1 questions*

Advisor, Researcher, Farmer, Industry/manufacturer, Other stakeholder

1.1. What are the implications of the rising fuel and electricity costs?	**1.2. Now the fuel and electricity costs are so high, did you take any measures to overcome the implications? What are the possible pathways that a farmer/producer could follow? (e.g. Change of machinery, agricultural practices, renewable energy, energy use efficiency)?**	**1.3 Which are the top 3 most energy wasteful parameters in open field agricultural activities?**
Optimisation of: fertilisation, irrigation	incorporate clover into soil to fix nitrogen; use of protected urea; use of solar PV to generate electricity; increased use of ground limestone; low emission slurry spreading	overfertilisation, overcultivation; loss of methane from degrading biomass
reduced yields due to high prices	energy use efficiency; renewable energy	use of fertilisers; water overconsumption; too much labour
greater resource use efficiency; farmers are incorporating precision farming measures to reduce inputs i.e. Costs	agro practices; energy use efficiency	excessive fertilisation, non-optimal routing; non-optimal irrigation scheduling
fuel prices mean more no-till crops	organic farmers in DK have been very talented in doing N-fixing cover crops to fertilize next years' crops. This has spread to conventional farms this year.	irrigation; no cover crops; improper crop rotation
change of perception, awareness, practices among farmers	doing the job at the right time; lower tillage input - fewer runs in the field means more conservation agriculture	irrigation, agricultural machines, transport
more rational fertilisation planning	more use of manure; solar panels; reduction of less necessary labour; crops use less labour	fertiliser; fuels, electricity for irrigation
danger for small farmers; big farmers look and invest in new opportunities	prescription fertilization; PVs with net metering	cultivate too small or unsuitable (e.g. steep slope) plots
increased production cost; increased logistics cost; more expensive food for consumers; farmers need money to invest in FEFTS decreasing costs	no-till; spray alternative fertilization (e.g. Fish hydrolysate) on broad acre crops as well as orchards	fertilisers, inefficient irrigation; energy storage (bad)
lower production in the future	many crops could be grown exclusively above ground, using alternative methods such as: aquaponics, aeroponics, and hydroponics	wasteful use of irrigation and pesticides; impoverishment of the organic qualities of the soil; use of fossil fuels for tractors

increased food prices	adopt energy efficiency measures and systems	loosing N in slurry application, if the cover crops don't grow as expected (too dry soil)
support a transition, but many factors are significant	funding mechanisms to invest in FEFTS	not using enough organic manures; timing of harvest to reduce grain drying requirement
costs increase; research alternative methods such as precision agriculture; an alternative could be no tillage and minimum tillage	use of pure plant oil (rapeseed) in open field agriculture; press cake - protein source for feed	not rotating crops properly; not liming land adequately
big farmers will try and reach renewable sources, small farms will be damaged; every cost should rise accordingly in order not to close the farms	in TTA we support the development of energy future-proof communities through RE solution & strategies	lack of energy consumption monitoring; lack of crop rotation; wide use of pesticides and fertilisers
higher fertiliser prices: margins are tighter		trade-off between energy intensive tillage practices vs. no-tillage which requires more pesticides
higher pesticide, fungicide, and seed prices		ploughing
danger to small farmers' margin; big farmers will adapt though		improper crop rotation
implications are as soon as the farmers aren't introduced into the green deal and also there are energy problems		
some farmers have realised they could reduce inputs without yield losses		
Pros: altering mindset as far as tillage, overuse of inorganic fertilisers are concerned; Cons: many farmers may collapse financially		

Table 10. *Open-field WG B - Text transfer from post-it notes canvas - category 2 questions*

Advisor, Researcher, Farmer, Industry/manufacturer, Other stakeholder

2.1. Can you propose 3 ways (national or EU) that would help you familiarise with FEFTS?	**2.2(A) Are you aware of any novel national or EU policies (or changes to current national/EU policies) that could benefit sustainable investments in certain FEFTS for open-field agriculture production?**	**2.2(B) Can you write down 3 ideas for the new policies?**
training programs for advisors; developing and promoting pilot practices/procedures; possible EIP operational groups	no	simpler rules; try to get more simple ways to get projects accepted
through local advisors and also key companies	financing mechanisms for "de-risking" investments; regulatory framework that allows for e.g.: use of self-produced fuel; net metering PVs	tax reduction for new ones; advising/teaching; knowledge sharing
innovation brokers; pilots; trials with cooperatives	funding investment in novel machinery, e.g. No-till planters, variable rout fertilisers	promote protected urea, maybe ban CAN (calcium ammonium nitrate)
subsidies; training; advising for a tailored solutions for all entity of farms (not just big farms, but also small)	in organic farming in DK we have recently introduced a crop rotation regulation demanding 20% N-fixing crops or cover crops in the rotation and 50% carbon crops (c-capturing); every culture is designated either C+ or C- and THIS WORKS	promote cover crops and crop rotation; promote afforestation; grant for farmers for any low carbon practices
financial subsidy; advisory service; demonstrations with results	subsidies to rural digitalization	the governmental innovation brokers; help for cooperatives to incorporate technologies and experts; practical education and pilots
tax reduction/exemption when using FEFTS; including FEFTS in the CAP scheme; mandatory targets	FaST - Farm Sustainability Tool	allow the production , self-use and sale of renewable fuels (e.g. renewable gas); result-based financing of FEFTS
financial incentives to the farmers to change from conventional practices; success stories; farmer schools and open field demonstrations		carbon credits scheme
information and events; training; lower costs for farmers		Germany: a barrier was that farmers lost their subsidy - premium if agri-PV was installed. New policy: if they install agri-PV they will not lose the premium
substitutes; simpler rules; demonstration before investment		agrobiomass use regulation (national); irrigation - promotion and support

precision agriculture: greening; micro biogas power plants		incentivise/support an oil crop-protein strategy, PPO use in tractors
subs. Through CAP		fees for carbon emission; IPS for crops dedicated to carbon sequestration; incentives for renewable energy
demo projects; workshops; targeted activities by agri consultants		support composting/fertiliser production
education; share experience; innovation		develop policies that facilitate connection of PV to grid; microgeneration support schemes
		subsidize farm scale biogas plants; subsidize good crop rotations; subsidize companion cropping/multicrops

Table 11. *Open-field WG B - Text transfer from post-it notes canvas - category 3 questions*

Advisor, Researcher, Farmer, Industry/manufacturer, Other stakeholder

3.1 Why the first 3 ranked research ideas are more interesting for you? If they are NOT, why NOT?	**3.2 Is it eaasy for growers to connect with industry and research in order to solve their problems?**	**3.3 Would you participate in a multidisciplinary team in order to conduct a research project. If YES, pleaase explain the reason. If NO, why NOT?**
precision agriculture - it needs a lot of work yet to get mature and be easily implemented	in Denmark it is quite easy I think, but facilitating is needed	yes of course, I'm engaged in several
conservation agriculture, because it is easily perceived by farmers but needs adaptation at different regions/crops/climates	sometimes, but many rules	yes, it is our business!
bad: drones are expensive; agrivoltaics "trap" the field for more than 30 years; hydro technique too expensive; good: PA is the easiest way to get started, CA saves energy	no, not in Greece	yes, I think that PA is very interesting
conservation agriculture; more research on cover crop mix	no	yes, we need the information
biogas; agrivoltaics - these will have the biggest climate impact	only for large producers	research collaboration schemes (EU projects); networking circle/triage: farmers/ extension services/ industry
projects connecting "silos" of research in developing circular economy	Thematic networks on sustainable energy production for biogas plants	yes, because multidisciplinarity is a key aspect for innovation
I would put biogas in top 3 ahead of agrivoltaics		indeed, we must think to the future and learn to produce respecting the environment around us
sustainable tractor propulsion technologies are the most important, but also challenging issue for open field agriculture		EIP operational groups are opportunity of getting involved in research
precision agriculture: development of spatial analysing, software development		
more potential for efficiency; easier to implement		

8.10. Canvas content from the TIW on livestock production

Table 12. *Livestock WG A - Text transfer from post-it notes canvas - category 1 questions*

Advisor, Researcher, Farmer, Industry/manufacturer, Other stakeholder

1.1 What are the implications of the rising fuel and electricity costs? How will it affect livestock production in EU?	**1.2 Have you taken any measures to overcome the implications? If YES, which are they? If NO, what are the possible pathways that a livestock farmer could follow? (e.g., change of machinery, farm practices, renewable energy, energy use efficiency)?**	**1.3 Which are the TOP 3 most energy wasteful parameters in your livestock farming activities?**
Advisor: Not sure it will have influence on short notice. (Not in NL).	Advisor: Dutch farmers need perspective at all in order to invest.	Advisor: Manure could be used for production of biogas, green energy.
Researcher: Accelerate the transition to RES. Difficult for farmers to stay competent.	GR?: More focused on EU than before.	Advisor: 1 = ploughing fields 2 = Buildings (not energy saving) 3 = Transport
Researcher: Investment in new technology, PV panels and biogas.	Advisor: Farmers could invest in energy saving technologies. For instance: Manure pumping, Ventilation of stables, Lightning	Advisor: 1 Heating/Cooling 2 = Feed production / transport 3 = Non mention of manure
Advisor: Implications of rising fuel- and electricity cost and the effect on livestock production in average of prices for the producer. Also, a possibility for changing how the production system works, and look for alternative energy sources. On the other hand, for some farmers situation is to reduce production of animals.	Advisors: Support schemes for farmers who invest in energy saving technologies.	Researcher: 1 = Heat loss 2 = Poor quality feedstuff production 3 = Insufficient organized logistic at the farm.
Advisor: Large scale farms invest while the smaller can't overcome the expenses nor develop self-sufficiency.	Advisor: Use by-products, sewage and composting.	?: 1 = Manure 2 = Organic fertilizer 3 = Logistic cost
Advisor: LSU number = continuous or little decreasing but more concentrate production in bigger farms. Problem with exports = higher prices for EU products.	Advisor: Feed production = Precision farming, Conservation tillage. New buildings with restore energy (recovery from slurry. Renewable energy, photo voltaic.	Advisor: 1 = Production of feed 2 = Heating pig / poultry 3 = Fuel for machinery
? Reduction of small farms, concentration of bigger ones.	Advisor: Farm practices and renewable energies.	Advisor / Researcher: 1 = Feed production / transportation 2 = Energy used by buildings (heating/cooling)

		3 = Machinery powered by fuel.
Farmer: I think the implication is low because only effect on 5-10% of the production cost in Spain.	Farmer: Biogas and photo voltaic. Each time more implementation but technology is scarce.	Advisor: 1 = Not recycling/resourcing the waste, (e.g. straw, bedding) from animal production 2 = Keep animals indoor all year round
Advisor: Higher cost of final product for the consumer, fewer sales for the producer.	?: Reduce cost.	Advisor: 1 = Egg production DK: Cooling of eggs for food safety 2 = Litter/manure handling 3 = Heating of all feedstuffs
? Large farm will drive the change modifying business opportunities.	Advisor: Change of certain practices, if financing possible invest in efficient machinery and use renewable energy to reduce dependency on fuel based energy. Look for sustainable alternatives / change production focus.	Farmer: 1 = Production animal feed 2 = Pumping and transport of slurry 3 = Management
Advisor/Researcher: Rising fuel prices are the biggest problem for now. It may be a good moment for some farmers to use financial help from government programs to modernise and increase energy efficiency.	?: Get financial incentive, therefore better embedded.	
Advisor: The strong livestock producers will invest in green electricity production, e.g., Solar panels and biogas.	Advisor / Researcher: They invest in new machinery e.g., for manure handling, spreaders. Larger farms solve advantage of the subsidy for renewable energy.	
Advisor: Higher costs and therefor higher prices on agricultural products.	Researcher: Produce energy at the form of PV and biogas.	
Advisor: The farmers will search new technology, mostly energy saving, precision farming, conservation agriculture, using renewable energy for concentrated livestock production, prices for growing wheat raises.	Advisor: Invest in energy-efficient machinery, if possible, invest in production of energy.	
Researcher: Reduced number of units, (small farms close down)		
? Small farms will not invest without subsidies.		

Table 13. *Livestock WG A - Text transfer from post-it notes canvas - category 2 questions*

Advisor, Researcher, Farmer, Industry/manufacturer, Other stakeholder

2. Can you propose 3 ways (national or EU) that would help you familiarize with FEFTS?	**2.2 A. Are you aware of any novel national or EU policies (or changes to policies) that could benefit sustainable investments in certain FEFTS for livestock production?**	**2.2 B Can you write down 3 ideas for the new policies?**
Advisor: 1 = Graphic / logo that is used at EU-level 2 = Make politicians / high influence people say the word 3 = Use FEFTS on any technology that are FEFTS	Advisor: In DK a CO2 tax is being discussed heavily among policy makers. The proceeds should be invested in green technologies	Advisor: Subsidy upfront for investments, not as a payback (some farmers are not able to invest money and wait for return, some are afraid to invest large sums). A policy treat would help stabilizing prices for farmers, a guarantee that the investment pays off.
Advisor: 1 = Promote between farmers: Channels to connect Government / Industry / Farmers 2 = Advisors should have facts and numbers to disseminates this alternative to farmers	?: Clear substitute for installing RES on farm. Policy to raise bio economy.	Researcher: 1 = Payment for reduced CO2 emission 2 = Investment support for new technology 3 = Green credits
Advisor / Researcher: 1 = Promoting and teaching in practice 2 = At workshops / trainings 3 = Promoting by subsidizing	Advisor: Hardly any novel policies on sustainability in NL. Only general subsidies on investments (40%). Maybe in longer future?	Advisor: 1 = Sometimes new legislation is better than leave it to the free market 2 = We have good subsidy program in NL, but hey are too popular (overwritten many times) 3 = Make more budget available
Farmer: 1 = Dissemination online 2 = Newsletters 3 = Show real example and rule principle	Advisor: The CAP should benefit, (if it's not already included), that could benefit investments on FEFTS. Governmental subsidies.	Farmer: 1 = Differentiate some regulations in different countries taking into account their geographical situation and climate 2 = Differentiate policies based on the size of the farms 3 = Help more family businesses rooted in the territory
Advisor: 1 = Establishment of demonstration FEFTS in full scale farms 2 = Financial support schemes implemented for FEFTS investment 3 = Information campaigns targeting farmers	?: National subsidy for modernization of farms. Agro energy programme in Poland: For investments in renewable energy	Advisor: 1 = Return benefits for farmers implementing FEFTS and conversion into more sustainable farming, (e.g., taxes, reduction credits)

?: 1 = Subsidies standing still 2 = Livestock annotation promoting book of support	Advisor: Move money in second pillar Rural Development Programme, support only this investment which move energy saving technology	Advisor: 1 = Economic reward for changing to FEFTS 2 = Tax break 3 = Extra reduction in CO2 tax when owning FEFTS
Researcher: 1 = Support the system 2 = CO2 tax 3 = Information / demonstration	Farmer: Is very difficult in Spain: Due to the investments for the farmers that focus all the EU-policies	Advisor: 1 = Implementation of subsidy schemes to motivate farmers to invest in green technology
Advisor: 1 = Demonstrations from experts 2 = Case studies on the internet 3 = Training	Researcher: Tax on CO2 emission from agricultural production (Denmark).	?: 1 = Support methane returned from atmosphere 2 = Punish stakeholders producing on fossil fuel to finance CO2 reduction 3 = Implement RTFC (UK) 4 = Support infrastructure investments for alternative fuel stations
Advisor: 1 = Make business case clearer for the actual national situation 2 = More practical plots for farmers	?: Yes, Italy October 2022: Alternative fuel production and ha ?	
Advisor: 1 = Money in Rural Development Programme, EU / net 2 = Positive examples with proven effects (demo), National 3 = Good advisory national		

Table 14. *Livestock WG A - Text transfer from post-it notes canvas - category 3 questions*

Advisor, Researcher, Farmer, Industry/manufacturer, Other stakeholder

3.1 Why the first 3 ranked research ideas are more interesting for you? **If they are NOT, why NOT?**	**3.2 Is it easy for livestock farmers to connect with industry** **and research in order to solve their problems?**	**3.3 Would you participate in a multidisciplinary team in order to conduct a research project?** **If YES, please explain the reason. If NOT, why NOT?**
Advisor: Demonstration/pilots are very useful for implementation due to farmer-to-farmer communication	Advisor: Yes, but it depends on personal motivation and capabilities of the farmer. In NL it shouldn't be a problem	Advisor: I participated in 2 teams: 1 = Home Standard 2 = Slurry Acidification
Advisor: RES storage on farm: Research is needed for pyrolysis and biochar as a way for storage carbon into the soil	Advisor: Rather easy Industrial / family companies (feed, machinery, buildings have good specialist / advisors). Research = Not easy	Advisor: DELPHY can be helpful for NL, especially in arable farming. We can bring farmers together or gather data
?: Biogas / Biomethane. 1 = Because taking maximum CO2 from atmosphere making manure valuable 2 = Demonstration, because farmers need to see (its cultural)	?: It is not easy to connect with industry advisory services facilitate that….. As a Research Institute we collaborate with Advisory Centres to reach farmers and present them with our results, recommendations e.g.,	Farmer: Yes, because I think that there is more technology in EU, that not arrive to Spain
Advisor: Biogas, demonstration, and RES. 1 = Because they can make the difference in impact on relatively short notice (like breeding programs) 2 = Because especially biogas is not clear for situation in NL (some opportunities as Denmark?)	Farmer: No, it is difficult	Researcher: Yes, want to do some relevant research of value for both farmers and community
Researcher: Biomethane- lots of research items, e.g., efficiency total green hours gas effect?		Advisor: Yes! Because multidisciplinary is the way to implement the results of projects and turning them to reality and applicability
?: 1 = RES stage 2 = Storing electricity		
Advisor: 1 = Presentation FEFTS and RES storage 2 = Solved problems for animal farms (various solutions) 3 = Biogas, NO, its investment only for big farms, smaller needs money		

Advisor: 1 = Demonstration needed in Spain; farmers very reluctant to change! 2 = Biogas demonstration needed, and effectiveness combined with other RES to be shown		
?: Biogas and Biomethane, - 1 = available source of renewable energy and handling manure in a climate friendly way 2 = Demonstrations and pilot applications of FEFTS, NO common farmers know FEFTS can be used in practice, not every farmer is likely to invest in novel technology if they don't work it well, not everyone is internet literate to find the info themselves		
Advisor: Because there is a need of giving Biogas / Biomethane solutions a higher relevance for the society in general		
Farmer: The 3 first ranked are very interesting for me, because I think that the 3 are linked to each other in Spain		

Table 15. *Livestock WG B - Text transfer from post-it notes canvas - category 1 questions*

Advisor, Researcher, Farmer, Industry/manufacturer, Other stakeholder

1.1 What are the implications of the rising fuel and electricity costs? How will it affect livestock production in EU?	**1.2 Have you taken any measures to overcome the implications? If YES, which are they? If NO, what are the possible pathways that a livestock farmer could follow? (e.g., change of machinery, farm practices, renewable energy, energy use efficiency)?**	**1.3 Which are the TOP 3 most energy wasteful parameters in your livestock farming activities?**
The most sustainable and self-sufficient farms will be the least affected – the weak will fall (advisor)	More investment in renewable energy More focus on analysing the energy costs.	Milking, Cooling the milk, machinery for crop production (feed)
Minimize the production – lower the quality	Investment in renewable energy	Cooling, milking, feed production
Need for increase prizes for Agri products	Rapidly increase of biogas production in som EU countries where the livestock production is concentrated on bigger farms. (advisor)	Heating, ventilation, fodder management, slurry pumping
Decrease livestock production – lower quality of products	More energy use efficiency (researcher)	In dairy: Lack of efficient heating practices Milk cooling pig/poultry: heating + cooling systems, insulation heat pumps
Negatively, leading to pressure of final prod. Prize . Positively: industrial symbiosis and increased use of alternative energy sources. (Agronomist)	More use of FEFTS ie. LED light, isolation, efficient heating systems and climate control	Feed impact low efficiency irrigation (Advisor)
As the framework changed considerably, the CAP needs to be changed too, to make agriculture more sustainable in Europe (Researcher)	Only consequence is lower production and higher costs maybe better management.	Feed imports low efficiency Irrigation (Advisor)
Higher production costs – OK if higher income neg if not	Increase efficiency and effectiveness of production processes. Use innovative machinery. Cooperation in order to buy products at best prices.	Climate system/ventilation
Small famers stop production	Government has to help to make it easy to produce over own energy. Let's use the electricity net and gas net.	Bad insulated houses (heating/cooling)

High prices of feeding. Farmers will have to adapt their production system to increase the link of the feeding of ruminant to grass.	Building with bigger energy efficiency. Farms will get bigger. Feeding autonomy	Increase efficiency of cooling More insulation of livestock buildings needed transport costs.
It will affect the financial standing of farmers. Many will dicide to step out of business. Animal production will decrease (Farmer)	Diesel/Machinery use?	Thermoregulation transport
If the prices are raising on milk, cereals etc. no problem – if not lots of farmers go broke and banks loose money	Grow your own protein Become energy producer Ride off the wave (wait with big investments) (Advisor)	Lighting and cooling of housing feeding Lamps (Agronomist)
Closure of small family farms. Increase process an final products Increase renewable energy use.	Photovoltaic installations that last for many years helps to survive. (Farmer)	Crucial to analyse the energy uses on farms
Big farms will grow bigger – take over small family farms. Decline in livestock production. (advisor)	Implementation of photovoltaic panels. Briefing of staff to inform on energy saving practices.	Milking cooling Mixing of feed
Many small farms will give up (Farmer)	Increased feed efficiency	
The farms with high indirect costs will close. The quality of products can be reduced.	Stop calculating the energy prices from gas from underground. The government have to stop the taxes on transport of energy (advisor)	
Farmers will look for renewable energy alternatives May be difficult for less efficient farmers to exist Rising product prices and rising input costs. Viability of some farms affected	Increase efficiency Variable speed drive lighting monitor energy use increase use of solar energy and geothermal machinery: i.e. biofuel driven tractors Diversify farm products. Eg. Farm energy crops	
Better prices for products	Improve energy efficiency	
	Financial grants for investments Public advisory for the technology choice and investment grant application.	
	Change of machinery to renewable energy higher energy efficiency	

	Farmers turning for higher energy efficiency measures and tools and monitoring systems. (Advisor)	
	Financial support to increase use of FREFTS and reduce fossil energy.	
	Extending grazing season	

Table 16. *Livestock WG B - Text transfer from post-it notes canvas - category 2 questions*

Advisor, Researcher, Farmer, Industry/manufacturer, Other stakeholder

2. Can you propose 3 ways (national or EU) that would help you familiarize with FEFTS?	**2.2 A. Are you aware of any novel national or EU policies (or changes to policies) that could benefit sustainable investments in certain FEFTS for livestock production?**	**2.2 B Can you write down 3 ideas for the new policies?**
EU policy subsidies Local governments give instruction to farming business (subsidies, tax exemptions)	Policies that combine animal welfare with energy savings (Farmer)	Consider Livestock farms as unique energy systems (Farmer)
Advisory should raise the awareness social media Demo farms	I don't agree that sustainable faring is supported in any way today. (Farmer)	Facilitate the creation of societies with different stakeholders demo cases) ("light house" projects) Grants for investments
Fossil free fertilisers (Wind energy) biogas	Better access to get a loan from bank and more support from government	Training farmers, support sustainable produced food (Farmer)
Schools – my kids know more about fossil free energy than me…	No Advisor	Better finances, fewer regulations, better communication
Less rules from government Cheaper FEFTS more competition from the companies	EU -> PSR Italy: enough purchasing incentives. (Farmer)	Reduction in taxes for adopters Financial subsidy for adopting /reducing investment costs depending on the farm size with higher subsidy for smaller farms. Creation of cooperatives of farms (agronomist)
Policy and legislation at national level CAP Subsidies (researcher)	Simplifying paperwork for smaller RE projects Taxation rules, permit procedure etc.	New subsidies for biogas plant projects Removal of planning for solar energy on farm buildings Support for Demo farms
Internet workshop TV program (Researcher)	EU -> PSR Italy: enough purchasing incentives. (Farmer)	subsidies

Advisory service workshops Demonstration journeys		Subsidies to reduce GRH Legislation improvement
Demonstrations Advisory service (Independent) Financing benefits		
Incentive Access for smaller farms to financing system (farmer)		
Educate farmers financial support (farmer)		
Find better name than FEFTS (:-)) Engage local advisors and scientists Hosting infomeetings (advisor)		
Incentives Advertising		
Demonstration programs		
Informative workshops with presentation of latest technologies. Platform (Farmer)		
Learn farmers, school/courses. Education firm Credit (farmer)		

Table 17. *Livestock WG B - Text transfer from post-it notes canvas - category 3 questions*

Advisor, Researcher, Farmer, Industry/manufacturer, Other stakeholder

3.1 Why the first 3 ranked research ideas are more interesting for you? **If they are NOT, why NOT?**	**3.2 Is it easy for livestock farmers to connect with industry** **and research in order to solve their problems?**	**3.3 Would you participate in a multidisciplinary team in order to conduct a research project?** **If YES, please explain the reason. If NOT, why NOT?**
Demos, Education, can fulfil the gap between the world of science/legislation and the world of real farmers (Farmer)	More efficiency Easy implementation	Application of biogas research at farmer + cooperative level.
Known equipment From research to real life is needed.	People want to see actual and live results in demonstrations and get trained- adoption by example.	Advice farmers on FEFTS Give farmers the opportunity to have knowledge about FEFTS
Conversion of CO2 into fuel		Implementation of small biogas plants on dairy farms. Calculation of energy input at dairy farms
More education to farmers		Online training tool development for advisors monitory + reporting tools for carbon reduction and sequestration
		Biogas/ methanol production on farm- not on big plants Is it possible to make our own energy to tractors an also electricity? Is it possible to produce energy to the town/net//gas pipe like we sell milk and grain we should also sell energy in the future? (Farmer)
		Yes, applied research for knowledge application. (agronomist)
		Yes demonstration of “carbon-free” farms small biogas plants to cover energy need at small farms.
		Yes, agri PV / electric tractors. (research)

		Yes, I would like to end up designing a model sheep farm of 1200-2000 ewes cost energy efficient and fully automated with low carbon footprint using state of art technology and machinery. (farmer)
		Yes, indirectly by CONFAGRICULTURA (reason very interesting research sectors for farmers (Claudio)
		Yes, need to develop common climate action tools – and regulation to avoid competition between countries if different regulations (taxes etc.) are rolled out.
		Yes, because I think there is underrepresentation of small farms in important projects.
		I want to find usable solutions for the farming of 21st century
		Higher our yield – lower Energy use in the field while using new technology. Registration of all things that we do in the field like we already have with the cows. We should use field data already logged in “crop-manager”. (Danish IT tool)