Report on research projects on FEFTS

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Abstract

The aim of the current document is to present the report on methodology and standards regarding the performance of systematic review of research results from projects on FEFTS application in agriculture or related domains.
This report is organized and structured in four distinct chapters, each one addressing a specific aspect regarding FEFTS identification, screening and analysis that were performed in the first part of research projects collection. In the first section, an initial assessment of the identified projects was carried out. The second part of the report describes the survey conducted and the third part performs the analysis of the projects characteristics. A summary of the works and results is provided in the fourth part.

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1. Introduction - Identification Process

In the framework of Task 2.4 of WP2, and based on the instructions provided in Deliverable 2.1, the AgroFossilFree team identified over 100 research projects to be included in the AgEnergy Platform. The task was carried out in cooperation with all the project partners and was coordinated by IUNG-PIB. Realization of the task included preparation of a video tutorial, which helped the project partners in selection and submission of identified research projects on FEFTS using a dedicated questionnaire. Selection of research projects was conducted according to the Rogers's method for evaluation of innovations, in a five-step decision-making process. In the first stage, general information such as project title and abstract were checked. In the second stage, detailed information about the project was studied, including specific objectives and results achieved. In the third stage of the procedure, innovativeness of each project in regards to agricultural defossilisation was investigated together with advantages and disadvantages of the solutions offered. In the fourth stage, the decision about the relevance of a given project was made. Finally, the project validation and submission was executed.

1.1. Sources' Definition of Research Projects on FEFTS and Search Limits

In order to collect research projects on FEFTS, the following repositories were chosen: CORDIS, EIP-AGRI, Interreg and LIFE projects databases, identified as the biggest and covering the widest scope of topics, hence the most probable to provide relevant search results for FEFTS identification for the purpose of AgEnergy Platform.

CORDIS stands for the Community Research and Development Information Service, which aims to foster accessibility of research results to researchers and other professionals and thus stimulate development of innovative products and solutions. CORDIS offers a repository[1] of project results provided by the European Commission, consisting of the projects funded by the EU framework programmes for research and innovation. It was the primary source used in the first stage of building the AgEnergy Platform for the identification of research projects on FEFTS. CORDIS repository proved to offer a vast range of results that matched the anticipated outcome.

EIP-AGRI is the agricultural European Innovation Partnership for Agricultural productivity and Sustainability that aims to foster competitive, innovative and sustainable agricultural and forestry practices in accord with protection of environment and its natural resources. The EIP-AGRI project repository[2] was, therefore, chosen as a source of projects offering innovative solutions for European fossil free agriculture as it aims to "achieve more from less" when it comes to management of natural resources, and works to bring together research and practice in finding new innovative solutions for European agriculture.

The LIFE programme repository[3] was selected for its climate-oriented projects focusing on nature protection, clean energy transition, circular economy and climate change mitigation and adaptation – all of which are closely related to the aim of fossil energy free agriculture. LIFE programme takes up numerous initiatives with the aim to foster development of clean technologies and protection of natural environment.

Interreg is a European Union programme encouraging cooperation between countries and regions jointly addressing common problems and finding solutions in many relevant areas. The Interreg project database[4] was chosen with the aim to find universal solutions for fossil free agriculture in Europe.

[1] https://cordis.europa.eu/projects
[2] https://ec.europa.eu/eip/agriculture/en/find-connect/projects
[3] https://webgate.ec.europa.eu/life/publicWebsite/search
[4] https://www.interregeurope.eu/projects/

The EIP-AGRI/LIFE/Interreg project databases will be included in the next stages of project search for the AgEnergy Platform creation & updating.
However, eligible sources for research projects are also the ones that are available in each country of AgroFossilFree partners and contain national projects of that kind.

1.2. Search Queries Methodology

In order to conduct a search in the CORDIS repository, a search engine provided by CORDIS was used: https://cordis.europa.eu/search. The search queries methodology applied to research projects was based on the description provided in Deliverable 2.1, and, more specifically, on the FEFTS categories presented in the Chapter 3.2 - Description of FEFTS. The Chapter presented FEFTS as divided into main categories, level 1 sub-categories and level 2 sub-categories. Based on that categorisation, the queries for each clean energy supply, energy efficiency and soil carbon sequestration were produced. Indicatively, Table 1 shows the queries about Renewable Energy Sources. For the rest, please follow Annex 1.

Table 1. RES categories with assigned keywords

Level 1 RES category	Level 2 sub-categories	Keywords (to be included in the query)
Solar		agriculture/farming/farmer, energy, solar/photovoltaic
Wind		agriculture/farming/farmer, energy, wind
Hydro		agriculture/farming/farmer, energy, hydro
Biomass	Pellets	agriculture/farming/farmer, energy, biomass, pellets
	Woodchips/ woodlogs	agriculture/farming/farmer, energy, biomass, woodchips/woodlogs
	Energy crops	agriculture/farming/farmer, energy, biomass, energy crops
	Agricultural residues	agriculture/farming/farmer, energy, biomass, agricultural residues
Landfill gas		agriculture/ farming/farmer, energy, landfill gas
Biogas		agriculture/ farming/farmer, energy, biogas

1.2.1. Queries creation (CORDIS Methodology)

For each of the Level 1 categories, a query was created containing the keywords (e.g. Table 1). For each specific query, the following filters provided by the CORDIS search engine were also chosen:
Collection: Projects
Programme: H2020 OR FP7
Start date: after 01/01/2011
For most of the Level 1 categories, only one query was prepared, which provided a reasonable number of results for screening. In case of the “biomass” category, a further detailed sub-categorization was necessary, since the high number of results obtained and the initial screening suggested a large portion of research projects that may not address agricultural biomass. Therefore, a sub-categorization was introduced, specifying the biomass categories relevant for agriculture and forestry. Specific queries used for project search in each category are presented in Annex 1.
The search based on the abovementioned queries provided 457 research projects records (of European scope), out of which 68 projects were selected as relevant in the context of achieving fossil energy free agriculture. As it is presented late on in section 2.3, there is an

amount of research projects (39) that was directly identified from other multiple sources and available platforms of national scope.

2. Survey

The conducted survey consisted of four sets of questions described initially in Chapter 4 of Deliverable 2.1. Questions from **Section 1** referred to general information about the identified FEFTS and the person submitting the survey: organisation, contact email, FEFTS category. **Section 2** questions were project specific such as project abstract, language, coordinator and their contact information, project status and funding. **Section 3** regarded FEFTS specifications such as its purpose and application field. **Section 4** consisted of specific information depending on the type of FEFTS: Clean energy production, Energy efficiency improvement or Soil carbon sequestration, followed by specific sub-categories regarding energy type, technology used etc. The last one, **section 5**, grouped questions referring to FEFTS assessment – environmental and socioeconomic - provided by the person submitting the survey and performed to the best of their knowledge, based on the available information.

The aforementioned structure of the survey as well as the analysis of the results on research projects on FEFTS, presented in Chapter 3, are based on the structure established on D2.1. A basic schematic of this structure is presented in Table 2.

Table 2. FEFTS categories and level 1 and level 2 subcategories

FEFTS category	Level 1 sub-category	Level 2 sub-category
Energy User/Consumer	**Agricultural technology applications**	heating and cooling of buildings
		process heat/cold
		lighting
		agricultural field practices
		vehicles
		tools
		energy sales to external consumers
Clean Energy Supply	**Renewable Energy Sources**	solar
		wind
		hydro
		geothermal
		bioenergy
		free energy
	Energy types	heating
		cooling
		electricity
		mechanical energy
		chemical energy
	Energy Technologies	photovoltaics
		solar thermal
		wind mills
		hydropower
		heat pumps
		geothermal
		solid biomass conversion
		biogas / biomethane production
		liquid biofuels production

	Energy Storages	heat storage
		electricity storage
		cold storage
		intermediate bioenergy carriers
Energy Efficiency Improvement	**Energy savings**	efficient buildings
		efficient vehicles
		efficient tools
		precision agriculture
		precision livestock farming
		conservation agriculture
Carbon sequestration	**Carbon sequestration**	soil organic cover
		tillage (Conservation Agriculture + CTF)
		nutrient management
		crop diversification
		soil and water conservation techniques
		fire management
		grassland management

Annex 3 contains the link of the online survey that was conducted for the Research Projects.

2.1. Data Collection

Identification of research projects on FEFTS was a joint task of all project partners under the coordination of IUNG-PIB. This condition was formulated in order to make sure all countries involved in the project are well represented in terms of collected FEFTS.

All project participants have been responsible for the collection and reporting of research projects about FEFTS. As the Task Leader, IUNG-PIB was responsible for registering European projects. The rest of the partners were assigned to identify and register research projects of their countries (national scope). The target (100 research projects until September 2021) that had been set in the project's 2nd plenary meeting (25/5/2021) and the collected research projects are shown in Table 3.

Table 3. Specific targets of FEFTS

FEFTS TYPE	Partner	Target set	Collected
Scientific Papers	CERTH	493 (approx. 500)	490
	All other partners		
Research Projects	IUNG-PIB	100	107
	All other partners		
Commercial Technologies	WIP	200	178
	All other partners		
Training Material	WIP	36 (approx. 40)	37
	All other partners		
Financing Mechanisms	AU	48 (approx. 50)	46
	CERTH		
	All other partners		
	Total	**877 (approx. 900)**	**858**

The whole identification and registration process was supported by an online thread for Task 2.3, which was created in Microsoft Teams platform to host Q&As about research projects, between the Task Leader and partners.

2.2. Screening of Research Projects on FEFTS

The selected results were submitted by filling a questionnaire in Google Forms, and then downloaded in excel file. All the records were subjected to initial screening in order to remove duplicates or incomplete FEFTS.

As it is commonly stated to all reports of FEFTS types registration (D2.2, D2.5, D2.8, D2.11), after the beginning of FEFTS registration process and the successful achievement of our first internal milestone of submitted research projects about FEFTS in the inventory (until the end of September 2021), the screening process is scheduled to begin before the launch of the platform. In this way, the AgEnergy platform will be filled with high quality and relevant innovative projects. However, a first step has already been done, as all records were screened in order to delete duplicate, malicious and incomplete entries. "Incomplete entries" were considered those lacking an exhaustive description and information, thus making their evaluation impossible. For these records, partners were asked to insert additional information. If not available, those entries were completely deleted from the inventory. This initial screening round was carried out for each FEFTS category by the corresponding Task Leader. In the case of research projects, IUNG-PIB was responsible for the procedure.

In order for all the Task Leaders to complete the screening process, acceptance and exclusion criteria had to be set. To do so, frequent meetings between the Task Leaders were arranged (through Microsoft Teams platform), in order to discuss this matter and agree on the screening procedure. During these meetings, it was decided that a FEFTS Quality Committee consisting of the Task Leaders of WP2 would be set for the aforementioned purpose. The main role of this Committee is the screening of all the FEFTS submitted on the platform.

It should be mentioned though, that the FEFTS submitted from each Task Leader (and by all research projects) were already checked for their appropriateness, to be uploaded in the inventory, based on the methodology followed by each Task. However, our database will be open for public entry so that interested stakeholders will also be able to input additional data. Their entries will be unpublished until they are validated by the FEFTS Quality Committee. By doing so, the accuracy and reliability of the platform's information regarding its relevance with the objectives of the AgroFossilFree project is guaranteed.

2.2.1. Acceptance Criteria

The applied queries gave us a result of nearly 500 international projects related to the topics determined by the keywords and realized in the period of 01/01/2011–01/01/2021 (recent projects). The screening process was conducted based on particular acceptance criteria. More specifically as appropriate entries were thought of projects which:

- Describe innovative energy saving or RES-based solutions and limiting the carbon dioxide emissions from agriculture;
- Offer practical solutions rather than theoretical knowledge;
- Are of high applicability & availability of FEFTS to farmers;
- Have TRL (technology readiness level) of at least 7 and above, offering a solution ready for implementation;
- Relevance for the context of European agriculture;
- Offer clear benefits for farmers.

Any research project that does not follow the aforementioned criteria and does not clearly provide an alternative solution on the fossil fuel use in agriculture is excluded from the inventory.

2.3. General characteristics on research projects on FEFTS

After the initial round of screening process, 5 projects were eliminated as they were recognised as duplicates or incomplete/test entries. Therefore, a number of 102 projects were selected for submission on the AgEnergy Platform. This number consists of 68 international projects selected from the CORDIS repository and 34 out of 39 identified and registered national projects selected by each project partner. The diagram below shows the share of selected projects according to project languages.

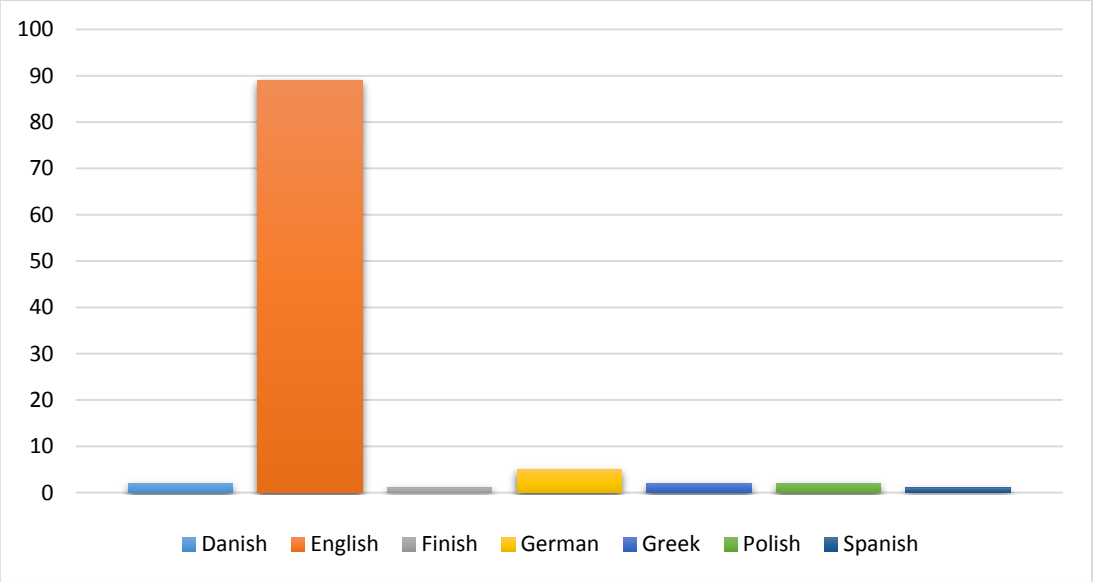

Figure 1. Classification of the selected research projects based on the project language

English language projects constitute the largest group (Figure 1), which is made up not only by the international projects selected from the CORDIS repository, but also by 21 national projects that chose English as the language of their work environment. This may be an asset in making the selected FEFTS available to a larger audience. However, most of the international projects offer descriptions of FEFTS in several languages, depending on the project partners/coordinators.

Regarding the classification of the research projects based on the country of the coordinator, it is evident from Figure 2 that there is a wide range of European countries with Spain having the most entries followed by Germany, France, Greece and The Netherlands.

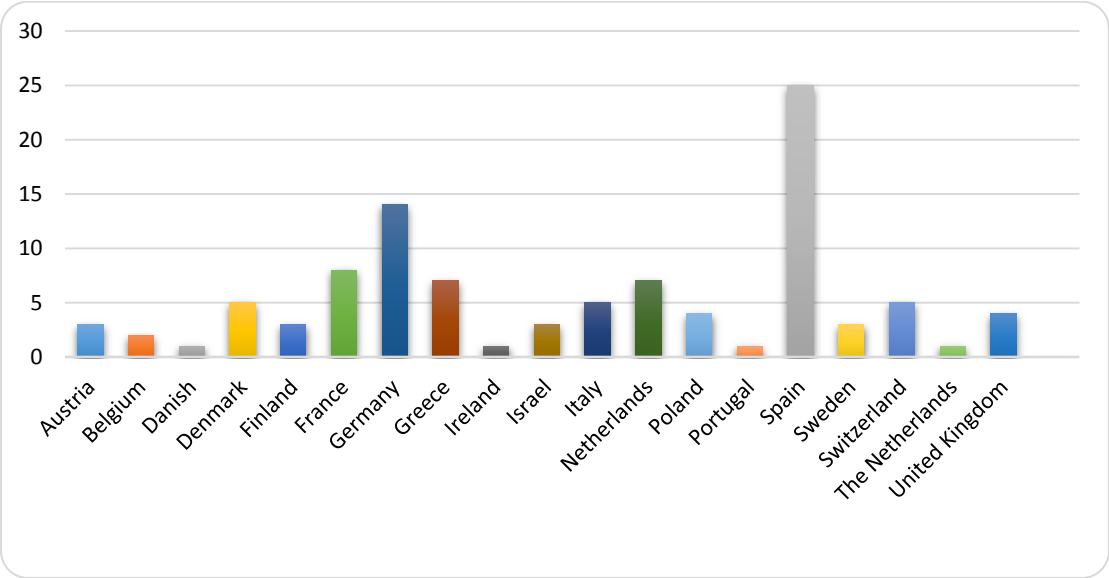

Figure 2. Classification of the selected research projects based on the country of the coordinator

All the selected projects are recent projects, and 33 of them have an ongoing status (Figure 3). This ensures high relevance of FEFTS in terms of finding state-of-the-art answers to the current problems and avoiding outdated solutions.

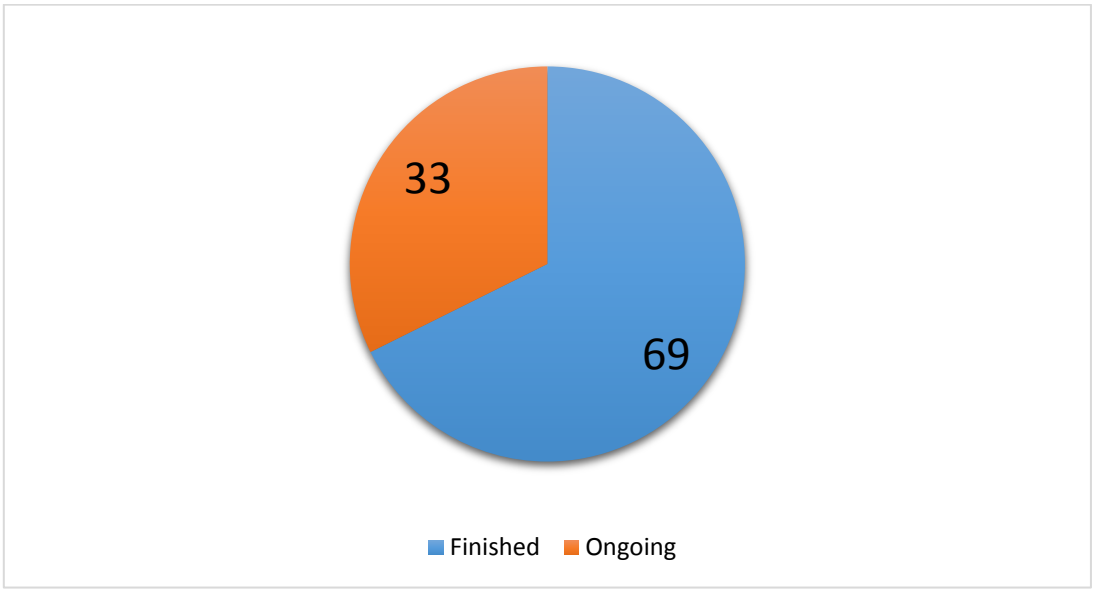

Figure 3. Classification of the selected research projects according to their status

The grand majority of research projects received funding from the Horizon 2020 research and innovation programme (Figure 4), namely 75% of all research projects. It resulted from the fact that H2020 was one of the largest recent EU funding programs but also from the fact that the main search was conducted in the CORDIS repository. In the next stages of the AgEnergy Platform creation it is expected that the numbers of projects funded from LIFE, EIP-AGRI and Interreg programs will significantly increase.

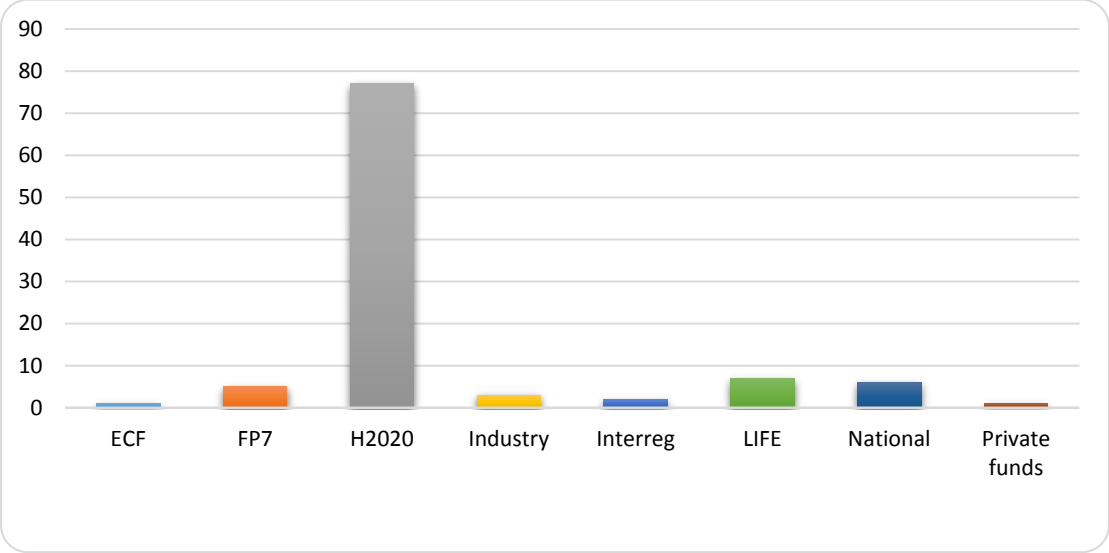

Figure 4. Classification of the selected research projects according to their funding source

3. Projects' FEFTS Analysis

The selected projects comprise a wide range of FEFTS in terms of different types of solutions, types of clean energy sources, application field etc. This way we can ensure that the collected information will fulfil expectations of the AgEnergy Platform users and offer suitable solutions to various problems, depending on specific needs and capacity of each Platform user.

As the main objective of the project is to move towards fossil energy free agriculture, all the FEFTS had to be related to clean energy supply or increased energy efficiency, or enable emissions reduction through soil carbon sequestration. The **clean energy supply** category was the most numerous as it collected 69 FEFTS, 19 FEFTS were devoted to **energy efficiency improvement** and another 14 allowed for increased **soil carbon sequestration** (Figure 5). Since clean energy supply is the largest. this category was further sub-categorised into specific sources.

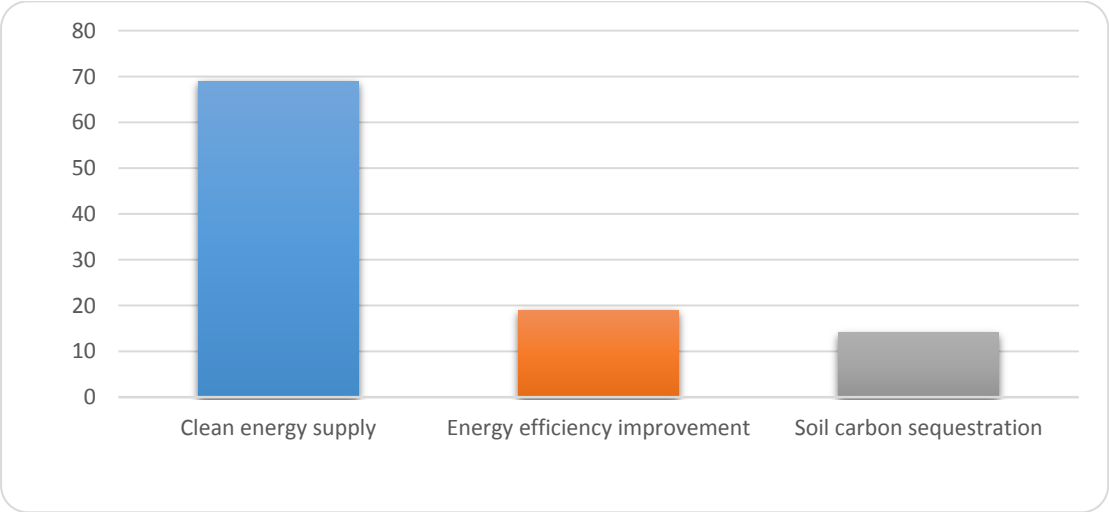

Figure 5. Classification of the selected FEFTS according to their type

When it comes to clean energy sources of the above 69 FEFTS, the largest group constituted FEFTS involving **solar energy** (27 FEFTS), then **biomass** (17 FEFTS), and **sewage treatment**

plant gas or biogas (10 FEFTS). The high number of solar FEFTS projects may be explained by the fact that such solutions are becoming more popular and are universal and possible to be applied in agriculture, whilst more agriculture-specific solutions appear as well. The increased number of projects about biomass, biogas and waste treatment mostly matched our expectations since biomass for energy production is highly available in agriculture and biogas plants often use input material from agriculture. Seven (7) FEFTS are still uncategorised, due to their multiple application possibilities, which also implies that they may involve multiple energy sources. Those FEFTS will undergo a closer analysis during the screening process, which will enable their further categorization. Figure 6 presents only those FEFTS that have been categorized so far.

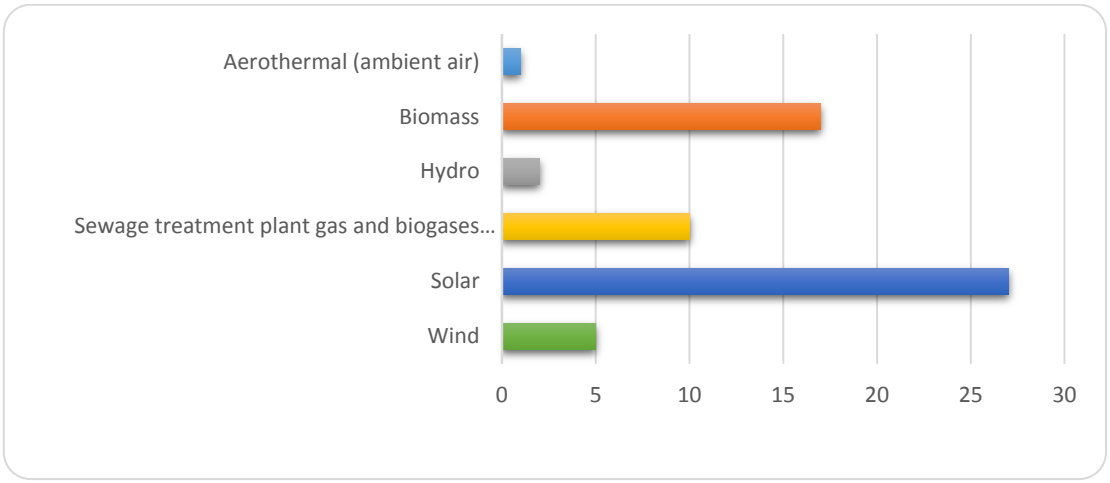

Figure 6. Classification of the selected FEFTS according to clean energy sources

When it comes to FEFTS' users to whom specific FEFTS are dedicated, the largest group constitute farmers (in 99 out of 102 projects). This was expected as FEFTS were selected with the aim to bring benefits primarily to farmers and thus encourage adoption of fossil free solutions among this group. Many projects offer FEFTS dedicated to various groups of users, therefore, a multiple choice was possible in the case of this question. Specific numbers are presented in Figure 7.

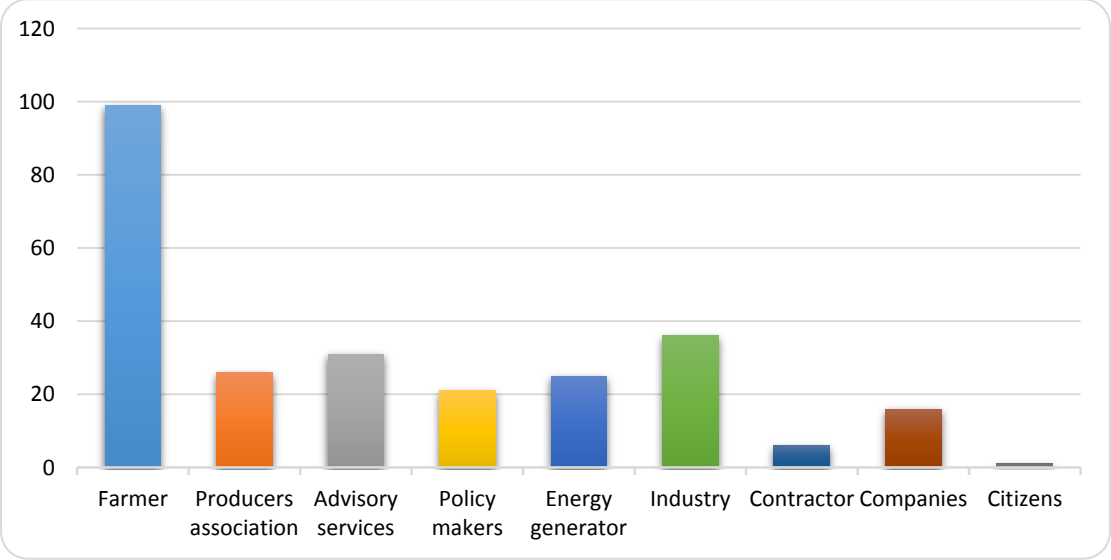

Figure 7. Classification of the selected research projects according to FEFTS' users addressed

All FEFTS were classified into three categories depending on their application field in the context of agricultural activity (Open field agriculture, livestock and greenhouses). The largest group was dedicated to open field agricultural practices (78 out of 102), then FEFTS devoted to livestock farming (43 out of 102) and almost equally large group of FEFTS were applicable in greenhouses (40 out of 102). A multiple choice of categories was possible in this case. As it can be seen in Figure 8, a considerable group of FEFTS constituted solutions applicable in two or all three of those categories.

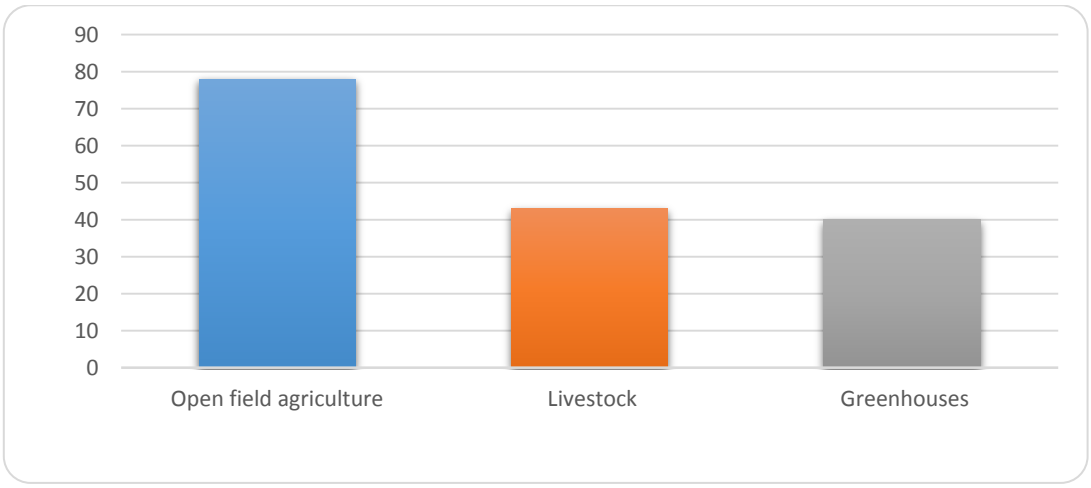

Figure 8. Classification of the selected FEFTS according to application field

The universality of collected FEFTS is well depicted by the categorisation based on the agricultural application type (Figure 9). Almost half of the selected projects offer FEFTS with multiple application possibilities in a wide variety of agricultural activities.

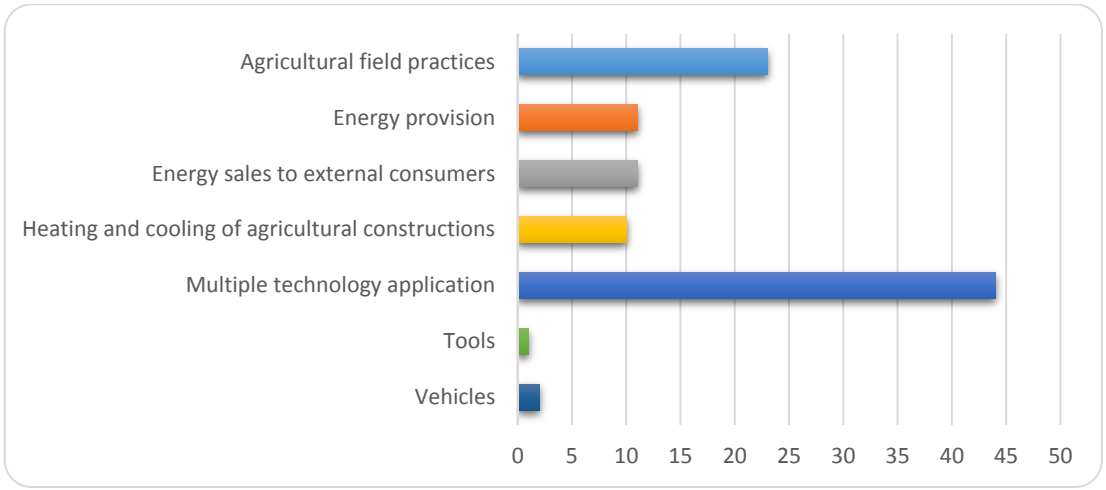

Figure 9. Classification of the selected research projects according to FEFTS' application type

The most numerous among the specific application areas was "Buildings' electricity consumption" with the result of 36 FEFTS, and the second most numerous application was "Tools and equipment's electricity consumption" with 29 FEFTS. Less numerous but also significant groups constituted "Buildings' heat use" and "Tractors and vehicles' fuel consumption" with 24 and 23 FEFTS, respectively. "Tools and equipment's fuel consumption" as well as "Building cooling needs" categories were less numerous, but also well represented: by 13 and 10 FEFTS, respectively. A considerable group was made up by

"Other" areas of fossil energy use reduction, with examples such as nutrient recycling, bioenergy production, pellets production, to name a few. As it can be seen in Figure 10, electricity is the biggest direct energy consumer in agriculture, both in building's needs (controlled environment agricultural constructions) and tools equipment consumption.

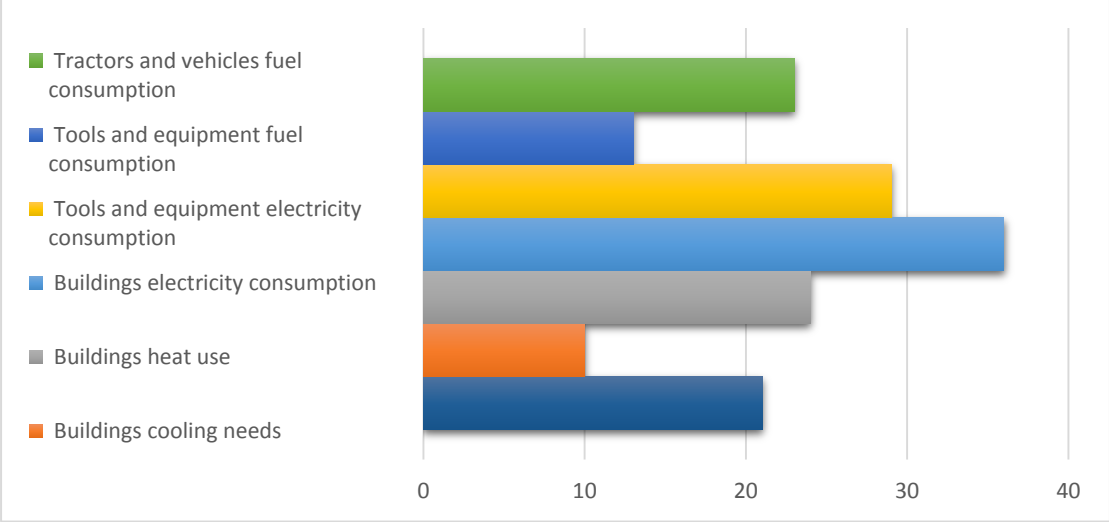

Figure 10. Classification of the selected research projects according to the area of fossil energy use reduction

Besides the above direct energy use reduction, many of the collected FEFTS offered also indirect fossil energy reduction possibilities, such as fertilizer use reduction (30 FEFTS), manure reduction (14 FEFTS), pesticide reduction (14 FETS) or tillage reduction (12 FEFTS). Less numerous, but also significant fossil energy reduction possibilities are the following categories: water reduction, seed reduction, medicine reduction, lime reduction, fuel reduction, feed reduction and improvement of animal healthcare. The results shown in Figure 11 follow the results of D1.1 of AgroFossilFree, where fertilizers were found to have the biggest indirect energy consumption input in agriculture, whilst pesticides, manure and tillage, together with fertilizer, constitute the four basic pillars of indirect energy inputs.

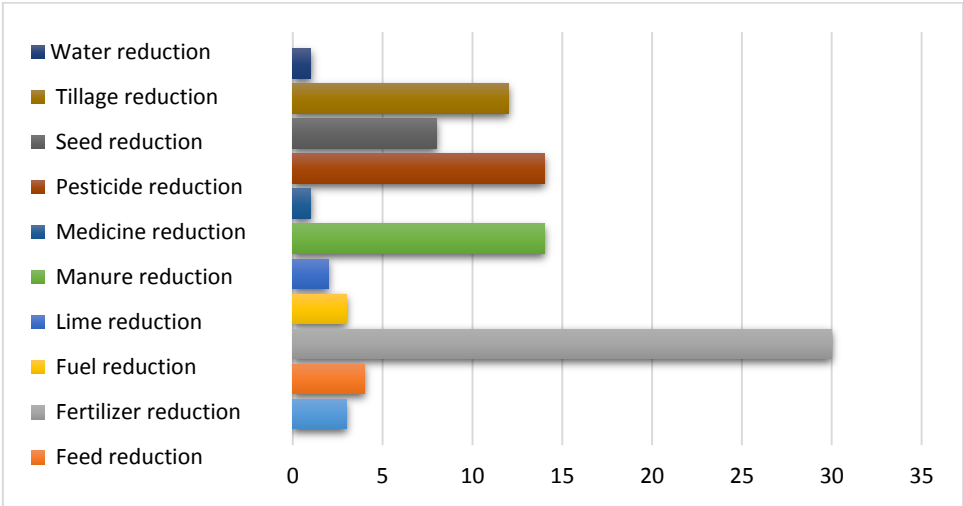

Figure 11. Classification of the selected research projects offering additional (indirect) fossil energy reduction possibilities

The selected research project FEFTS were also categorised according to the type of solution. The three largest groups were methodology, hardware and complete solution, with the respective results of 43, 40 and 39. Software constituted the smallest group of selected FEFTS (see Figure 12).

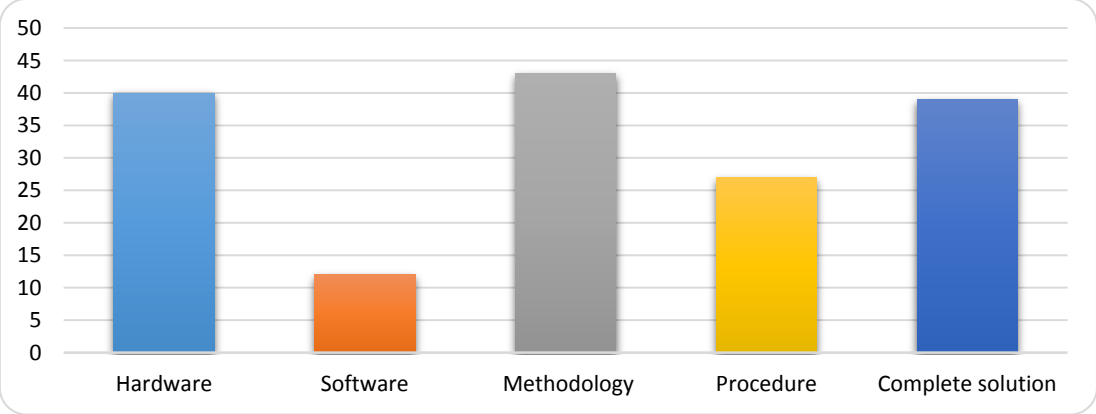

Figure 12. Classification of the selected FEFTS according to the type of solution

It is a fact that a proportion of research projects tend to present and analyze methodologies and procedures which are mostly dedicated to energy efficiency improvement and soil carbon sequestration purposes. On the other hand, the majority of the collected research projects are related to clean energy supply (Figure 5) where, most likely, either already complete solutions or hardware for producing green energy are proposed.

3.1. FEFTS types – clean energy supply

Within the clean energy supply category, the most numerous energy sources turned out to be solar and biomass – and those are further characterized below.

When it comes to **solar energy** source, the majority of FEFTS concern electricity production, while only 11% heat production. This results show that in 20 out of 27 FEFTS electricity production prevailed, whilst keeping in mind that only one type of energy produced could have been chosen in this category for the time being. However, 15% stand for uncategorized FEFTS, for which it was not possible to determine the prevailing energy type – those can involve both heat and electricity production, which depends on the specific use of FEFTS. Figure 13 presents the share of energy types produced from solar energy source.

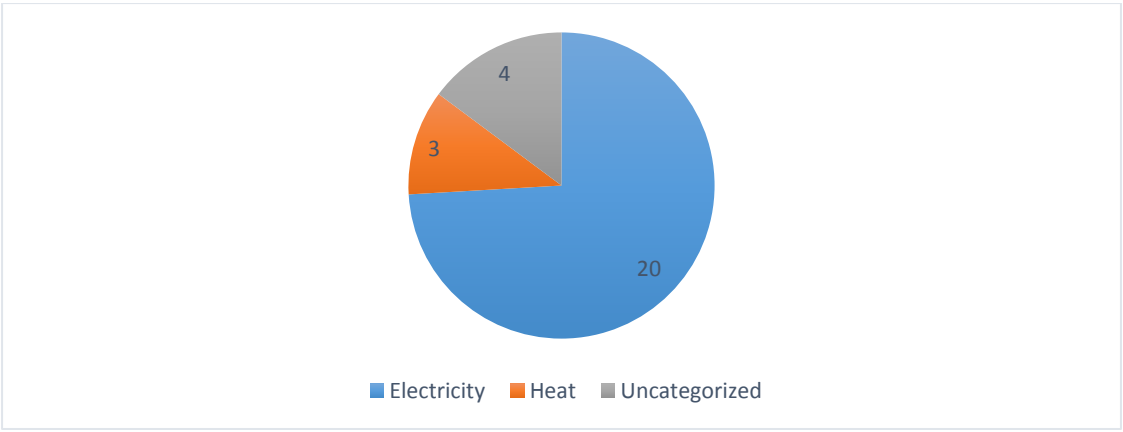

Figure 13. Classification of the selected FEFTS according to the type of energy produced from solar energy source

Considering all the categorized FEFTS in this group, almost all of them (22 out of 23) involved photovoltaics as the main technology used for energy production. Among them, four groups could be distinguished: agri-PV systems (combined with agricultural production), PV on tools and vehicles, PV-arrays, and PV-panels (windows), which collected 8, 7, 4 and 3 FEFTS, respectively. Figure 14 shows the categorization of FEFTS according to the technology used.

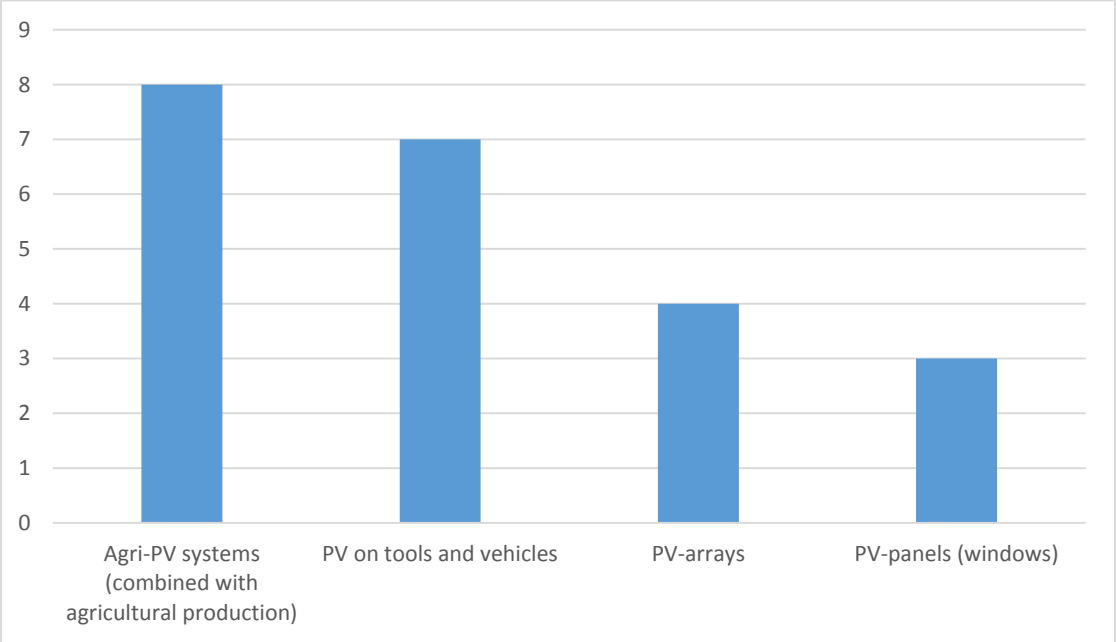

Figure 14. Classification of the selected FEFTS according to the technology used for solar energy production

Considering that the most numerous categories are agri-PV systems and PV on tools and vehicles, it can be concluded that most of the FEFTS constitute solutions that could be easily implemented in a wide variety of agricultural applications, or such that can be easily adjusted to specific agricultural purposes. However, the fact that PV-arrays and PV-panels for windows were also found in this category proves that farmers can look for relevant solutions among more universal products already existing on the market.

The other most numerous category regarding renewable energy sources was **biomass**. When it comes to biomass available from agricultural sources, five categories have been identified: agricultural residues, energy crops, pellets, wood chips, and wood logs. In this category, a multiple choice of biomass sources was possible. The most numerous among them proved to be agricultural residues, which collected 14 FEFTS dedicated for this kind of biomass, and the second most numerous were energy crops, with 9 dedicated FEFTS. Categories such as pellets, wood chips and wood logs were less numerous, but also represented – by 2, 4, and 1 FEFTS, respectively. Figure 15 presents categorization of FEFTS according to the type of biomass used for energy production.

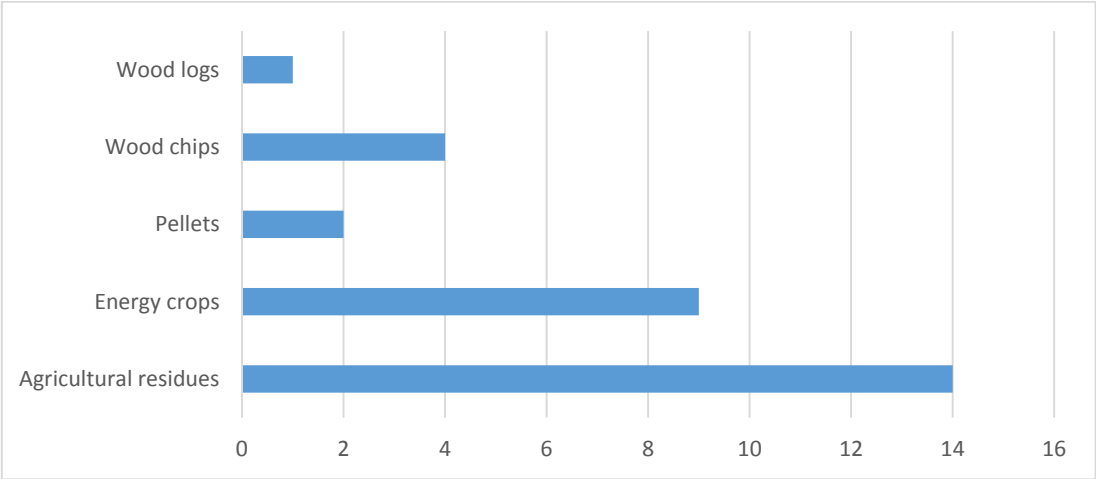

Figure 15. Classification of the selected FEFTS according to the type of biomass used for energy production

Such allocation of FEFTS is quite reasonable, since the two most frequently chosen options constitute the largest sources of biomass at farmers' disposal. Such FEFTS, therefore, can have numerous potential applications in agriculture. However, agricultural farms with fruit shrubs and trees, or introducing woody perennials in a form of shelterbelts, may also find the other FEFTS quite useful, as they allow utilisation of woody biomass or a combination of its several types.

When it comes to types of energy produced from biomass, the two most numerous categories is chemical energy constituting 50% of all FEFTS categorized in this regard. Chemical energy here stands for biogas/biomethane production. The send most numerous category is electricity production with the result of 30% and the least numerous is production of heat constituting 20% of all categorized FEFTS. This result shows that recent research projects are focused on biomass conversion techniques and not on heat produced from biomass, which is the most traditional biomass use. Figure 17 presents categorization of selected FEFTS based on types of energy produced.

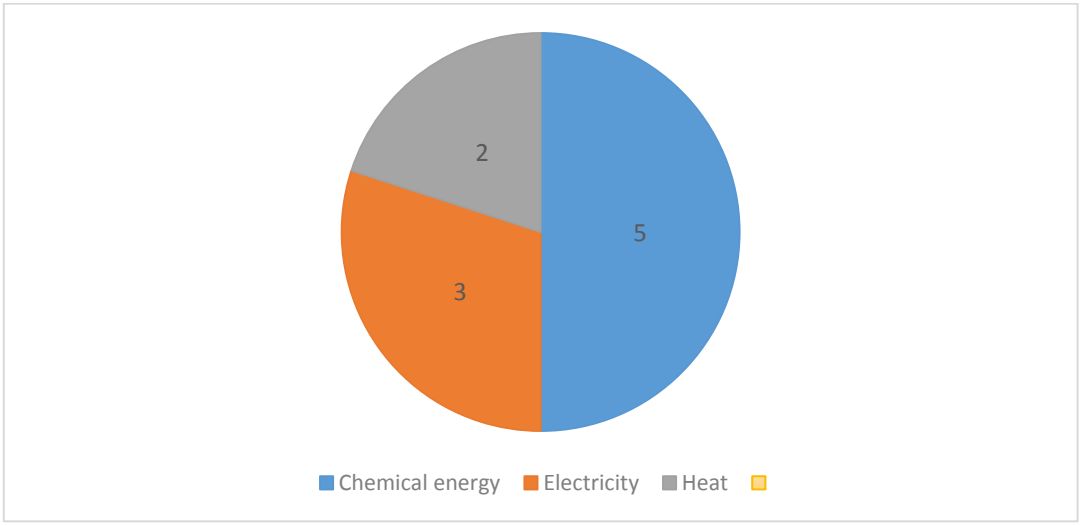

Figure 16. Classification of the selected FEFTS according to the type of energy produced from biomass

In case of types of energy produced from biomass, 7 FEFTS remained uncategorized, as they may involve more than one type. In this category, multiple choices were not possible.

3.2. FEFTS types – energy efficiency improvement

As it was presented in Figure 5, as many as 19 FEFTS were devoted to energy efficiency improvement. Among the represented energy efficient measures were: precision agriculture with a result of 5 FEFTS, efficient buildings with 3 FEFTS, efficient tool and efficient vehicle, which collected 2 FEFTS each, and conservation agriculture with only 1 result. 6 FEFTS on energy efficiency improvement remained uncategorized. The remaining FEFTS representing more than one possibility of energy efficiency improvement will be further categorized after a closer study of their descriptions.

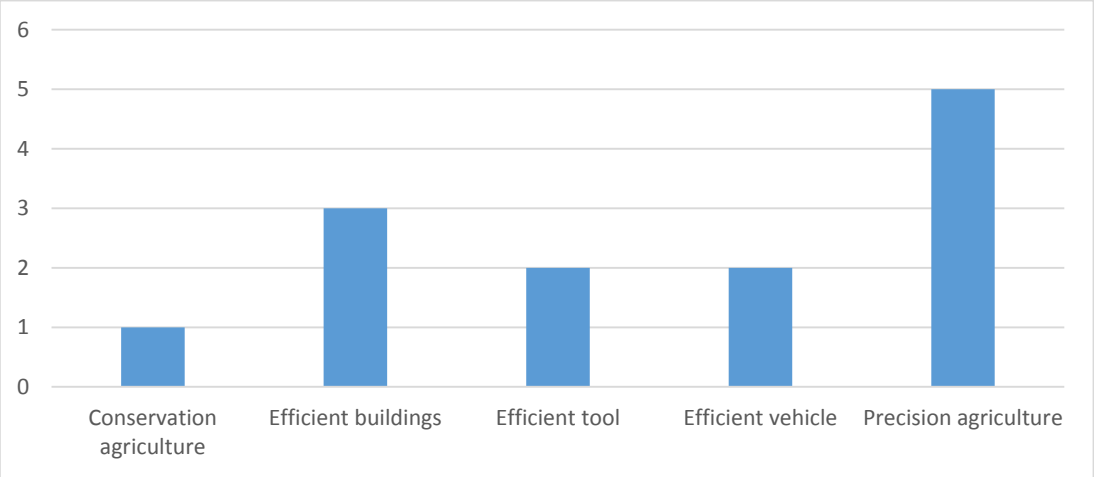

Figure 17. Classification of the selected FEFTS according to the specific measures of energy efficiency improvement

3.3. FEFTS types – soil carbon sequestration

Soil carbon sequestration was the least numerous, yet equally important, category of FEFTS types. Among the 14 collected FEFTS, 5 were devoted to tillage (involving tillage reduction and controlled traffic farming) and another 5 to nutrient management practices. FEFTS on grassland management collected 2 results, and soil organic matter and soil and water conservation techniques were represented by 1 FEFTS each.

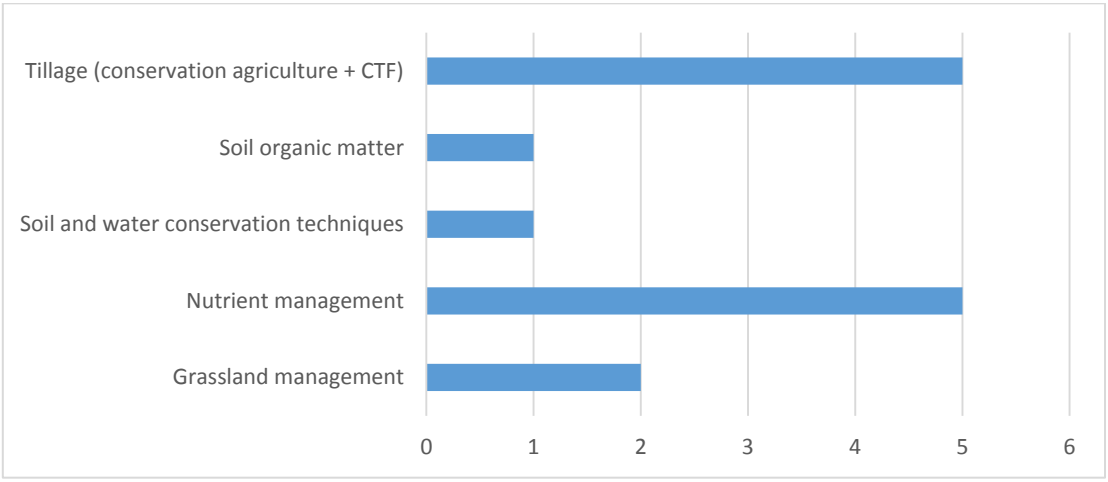

Figure 18. Classification of the selected FEFTS according to the specific measures of soil carbon sequestration

FEFTS on soil carbon sequestration did not involve further categorization.

4. Conclusions

The first stage of identification of research projects on FEFTS was quite successful and provided satisfactory results, covering various categories and providing a wide range of solutions for fossil energy free agriculture. During the identification process, several improvements were introduced regarding the questionnaire for research projects submission that allowed for better categorisation of identified FEFTS. However, the creation of the AgEnergy Platform is a continuous process that will enable not only enlarging the repository of FEFTS but also further improving the quality and availability of information to the future users of this tool.

Among the research projects identified so far, the most numerous are English language projects and the major funding source is the Horizon 2020 research and innovation programme, which is mainly the result of conducting the first project search in the CORDIS repository. Most of the collected projects are dedicated directly or indirectly to farmers and to improving the condition of agricultural environment in general. The most numerous among the presented solutions are hardware, methodology, procedures, and complete solutions, which may be used mainly in open field agriculture, but also in livestock farming and greenhouses. Many of the identified FEFTS can find multiple applications in agriculture. Implementation of those solutions may have a significant positive effect on the reduction of fossil energy use in buildings' electricity and heat use or tools and equipment electricity consumption. Among the indirect methods of fossil energy reduction, the selected projects can influence fertilizer reduction to the highest extent.

Last but not least, the consortium worked as a unified partnership with all beneficiaries contributing with their maximum effort. We achieved 102 registered research projects out of 100 that was our target set on the AgroFossilFree project's 2nd plenary meeting on May 25th 2021, thanks to teamwork and the overall diverse contribution. Given the KPI of 1700 FEFTS (of any type) for our repository until the end of the project, both the initial goals that had been set and the vivid reaction of all partners, led to the collection of more than the half FEFTS in total.

Annex

In this section, the material used for the registration is provided in order to support what has been described in the above chapters.

Annex 1: Queries

Queries used for each RES category based on the corresponding keywords and filter options provided by CORDIS

Level 1 RES category	Level 2 sub-categories	CORDIS Query
Solar		contenttype='project' AND (programme/code='H2020' OR programme/code='FP7') AND startDate>=2011-01-01 AND (('agriculture' OR 'farming' OR 'farmer') AND 'energy' AND ('solar' OR 'photovoltaic'))
Wind		contenttype='project' AND (programme/code='H2020' OR programme/code='FP7') AND startDate>=2011-01-01 AND (('agriculture' OR 'farming' OR 'farmer') AND 'energy' AND 'wind')
Hydro		contenttype='project' AND (programme/code='H2020' OR programme/code='FP7') AND startDate>=2011-01-01 AND (('agriculture' OR 'farming' OR 'farmer') AND 'energy' AND 'hydro')
Biomass	Pellets	contenttype='project' AND (programme/code='H2020' OR programme/code='FP7') AND startDate>=2011-01-01 AND (('agriculture' OR 'farming' OR 'farmer') AND 'energy' AND 'biomass' AND 'pellets')
	Woodchips/ woodlogs	contenttype='project' AND (programme/code='H2020' OR programme/code='FP7') AND startDate>=2011-01-01 AND (('agriculture' OR 'farming' OR 'farmer') AND 'energy' AND 'biomass' AND (‘woodchip’ OR 'woodlog'))
	Energy crops	contenttype='project' AND (programme/code='H2020' OR programme/code='FP7') AND startDate>=2011-01-01 AND (('agriculture' OR 'farming' OR 'farmer') AND 'energy' AND 'biomass' AND 'energy crops')
	Agricultural residues	contenttype='project' AND (programme/code='H2020' OR programme/code='FP7') AND startDate>=2011-01-01 AND (('agriculture' OR 'farming' OR 'farmer') AND 'energy' AND 'biomass' AND 'agricultural residues')
Landfill gas		contenttype='project' AND (programme/code='H2020' OR programme/code='FP7') AND startDate>=2011-01-01 AND (('agriculture' OR 'farming' OR 'farmer') AND 'energy' AND 'landfill gas')
Biogas		contenttype='project' AND (programme/code='H2020' OR programme/code='FP7') AND startDate>=2011-01-01 AND (('agriculture' OR 'farming' OR 'farmer') AND 'energy' AND 'biogas')

The queries for all FEFTS categories are given in the following link (please follow the Sheet named “Research Projects QUERIES”):
https://docs.google.com/spreadsheets/d/1kdl7ZSUUMnZ8jg7pSQurx2wf7sm7G9sYoxwnRDcawsI/edit#gid=1518004197

Annex 2: Research Projects retrieved from survey

The following table presents the research projects submitted, with the project acronym and the title

No	Project acronym	Project title
1	3Bee Hive-Tech	3Bee Hive-Tech
2	agrEE	Agriculture and Energy Efficiency
3	AGRI 4 POWER	For a sustainable future
4	agriCOlture	Livestock farming against climate change problems posed by soil degradation in the Emilian Apennines
5	Agri-PV	Agri-PV Insolight's demonstrator
6	AGROinLOG	Demonstration of innovative integrated biomass logistics centres for the Agro-industry sector in Europe
7	AgroRES	Investing in Renewable Energies for Agriculture
8	AgroStrat	Sustainable strategies for the improvement of seriously degraded agricultural areas: The example of Pistachia vera L.
9	AgrowFab (2018)	Far Infrared Radiation Smart Fabric Heating Element for GreenHouses
10	APV Obstbau	Agrophotovoltaics as a resilience concept for adapting to climate change in fruit growing
11	BABET-REAL5	New technology and strategy for a large and sustainable deployment of second generation biofuel in rural areas
12	BacBio	Mechanistic and functional studies of Bacillus biofilms assembly on plants, and their impact in sustainable agriculture and food safety
13	Bazydrill	Innovative technical solutions for grassland reseeding to improve quantity and quality of fodder for ruminants and to protect soil, water and climate.
14	BEST4SOIL	Boosting 4 BEST practices for SOIL health in Europe
15	BESTF3	Bioenergy Sustaining the Future (BESTF) 3
16	BioEcon	New Strategies on Bio-Economy in Poland
17	Biofrigas	Turning manure into fuel: a container based LBG plant for small to medium scale farms
18	BioFuel Fab	Biogas production from non-food lignocellulosic biomass waste
19	BIOGASTIGER	BIOGASTIGER® system – turning global organic waste streams into smart and clean energy
20	BioHotiTech	"Improved bio-inoculation and live plant mulching technologies for integrated horticultural crops"
21	BIOMAN	Economically efficient biogas production from manure fibres and straw
22	BioMet2020	BioMet2020
23	BioVill	Bioenergy Villages (BioVill) - Increasing the Market Uptake of Sustainable Bioenergy
24	biowave	Upscale and demonstration of a integrated novel microwave pre-treatment system for efficient production of biogas from anaerobic digestion of pig manure to create a sustainable waste management system
25	BISON	BIOMASS INTEGRATION FOR SYSTEM OPTIMISATION IN THE HÜMMLING ENERGY REGION

26	BoostCrop	Boosting Crop Growth using Natural Product and Synthesis Enabled Solar Harvesting
27	Citizen led-renovation	Citizen led-renovation
28	DualMetha	A cost-effective process for methanisation of unexploited agricultural waste.
29	Eciwind	Cost effective wind turbine of 40 kW of rated capacity
30	EKoTech	EKoTech project
31	Energy efficient straw boiler with low NOx emission	Energy efficient straw boiler with low NOx emission
32	ENORASIS	ENvironmental Optimization of IRrigAtion Management with the Combined uSe and Integration of High PrecisIon Satellite Data, Advanced Modeling, Process Control and Business Innovation
33	FLEXcoop	FLEXcoop
34	FTI Cocoon	Optimization of the production line of an innovative biodegradable water reservoir to be applied in efficient landscape-scale ecosystem restoration plans
35	Future Cropping	Future Cropping
36	GASFARM	SMALL-SCALE ANAEROBIC DIGESTION FOR AFFORDABLE, EFFICIENT AND SUSTAINABLE MANAGEMENT OF FARMS WASTE
37	GASMETRIC	New multi-parameter automaton for measurement of indoor environmental conditions in livestock exploitations
38	GRECO	Fostering a Next Generation of European Photovoltaic Society through Open Science
39	GREEN SHEEP	Demonstration and dissemination actions to reduce the carbon footprint in sheep farming
40	Green-DROP (2018-2020)	Precise subarea specific irrigation and fertilization system
41	GW-FortyForty (2016)	Gaia-Wind's Advanced Small Wind Turbine FortyForty
42	H2AD-aFDPI	Innovative and scalable biotechnology using Microbial Fuel Cell and Anaerobic Digestion for the treatment of micro-scale industrial and agriculture effluents to recover energy from waste
43	H2Agrar	Development of a green water supply for the agricultural region of Lower Saxony - Model Region Haren (Ems) / Emsland
44	HarvPell (2017)	Upscale and redesign of a mobile harvesting and pelletizing disruptive all-in-one machine
45	HyPErFarm	HYDROGEN AND PHOTOVOLTAIC ELECTRIFICATION ON FARM
46	HyPump (2016-2017)	Enabling Sustainable Irrigation through Hydro-Powered Pumps for Canals
47	HyPump (2017-2020)	Enabling Sustainable Irrigation through Hydro-Powered Pumps for Canals
48	ICaRE4Farms	Increase the capacity of Renewable Energies (RE) in Farms in the North West Europe Region by using Solar Thermal Energy
49	Impacts of Renewable Energy on European	Impacts of Renewable Energy on European Farmers

	Farmers (2338 ID)	
50	INNOWIND (2018)	Low-cost and low-maintenance innovative mid-power horizontal axis wind turbine operable with low winds and small installation areas.
51	INSYLO	Disruptive IoT solution for optimising the animal feed supply chain
52	IoF2020	INTERNET OF FOOD & FARM 2020
53	ISAAC	Increasing Social Awarness and ACceptance of biogas and biomethane
54	KUDURA	Upscaling of a portable hybrid solution for power supply, smart waste-to-energy
55	AGROMITIGA	Development of climate change mitigation strategies through carbon-smart agriculture
56	GAIA Sense	Innovative Smart Farming services supporting Circular Economy in Agriculture
57	AGRICARBON	Sustainable agriculture in Carbon arithmetics
58	CLIMAGRI	Best agricultural practices for Climate Change: Integrating strategies for mitigation and adaptation
59	LIFT	Low-Input Farming and Territories Integrating knowledge for improving ecosystem-based farming
60	MacroFuels	Developing the next generation Macro-Algae based biofuels for transportation via advanced bio-refinery processes
61	MASLOWATEN	MArket uptake of an innovative irrigation Solution based on LOW WATer-ENergy consumption
62	MUBIC	Mushroom and biogas production in a circular economy
63	MYFOOD (2018)	An Innovative Smart Greenhouse System based on Aquaponics, Bioponics and Permaculture for Self-Production of Safe and Ultra-Fresh Food
64	N/A	Solar pumping for irrigation with solar trackers
65	NoAW	Innovative approaches to turn agricultural waste into ecological and economic assets
66	Olefine	Safe replacements for insecticides enabled by biotechnology
67	OPTIFERT (2011-2013)	Development of an automatic irrigation and fertilization system
68	PanePowerSW (2017)	Transparent Solar Panel Technology for Energy Autonomous Greenhouses and Glass Buildings
69	PanePowerSW (2020-2022)	Transparent Solar Panel Technology for Energy Autonomous Greenhouses
70	PELLETON	PELLETON – a device for production of pellets from biomass and agricultural waste for energy purposes
71	Poul-AR	Poultry manure valorization
72	Proxipel	Mobile pelletizing unit
73	PVCROPS	PhotoVoltaic Cost r€duction, Reliability, Operational performance, Prediction and Simulation
74	RES4LIVE	Energy Smart Livestock Farming towards Zero Fossil Fuel Consumption
75	RESFARM	Developing and implementing financial instruments for the mobilisation of investments in renewable energy in the agrarian sector
76	SEEMLA	Sustainable exploitation of biomass for bioenergy from marginal lands in Europe
77	SEFI	Solar Energy for Food Industry

78	SET-Nav	Navigating the Roadmap for Clean, Secure and Efficient Energy Innovation
79	SmartAgriHubs	Connecting the dots to unleash the innovation potential for digital transformation of the European agri-food sector
80	Smart-AKIS	Smart-AKIS: European Agricultural Knowledge and Innovation Systems (AKIS) towards innovation-driven research in Smart Farming Technology
81	Smartmushroom	Smart MAnagement of spent mushRoom subsTrate to lead the MUSHROOM sector towards a circular economy
82	SolAqua	Accessible, reliable and affordable solar irrigation for Europe and beyond
83	Solar-Win	Next generation transparent solar windows based on customised integrated photovoltaics
84	SPIRE	A Photovoltaic Plant with thermal co-generation
85	SPRHOUT (2018)	SPRHOUT (Solar PoweRed Horticultural Off-grid UniT) – the first economically viable off-grid energy system to power horticultural projects, boosting the transition towards sustainable food provision
86	SULTAN	SUstainabLe Tunnel Agriculture with light cascade techNology
87	SUN4GREEN (2015)	MAXIMISING SUNLIGHT RESOURCES FOR COST, ENERGY AND YIELD EFFICIENT GREENHOUSES
88	SUN4GREEN (2017-2019)	MAXIMISING SUNLIGHT RESOURCES FOR COST, ENERGY AND YIELD EFFICIENT GREENHOUSES
89	SUNINBOX (2015)	Portable SolUtioN for dIstributed geNeration in a BOX
90	SUNINBOX (2017)	Portable solar energy system powers rural development
91	sunlight2.0	Highly efficient, solar-powered irrigation pump
92	SWITLER (2016)	SWITLER: Small WInd Turbine Lightwight Efficient generatorR
93	SX1.3	Earth Observation by Autonomous Solar UAV
94	SYSTEMIC	SYSTEMIC - Circular solutions for biowaste
95	TheGreefa	Thermochemical fluids in greenhouse farming
96	TPX-Power	Waste Heat Recovery Through Near-Field Thermophotonics
97	uP_running (2016-2019)	Take-off for sustainable supply of woody biomass from agrarian pruning and plantation removal
98	Venturas (2018)	SMALL WIND ENERGY, A HIGHLY EXPLOITABLE RESOURCE
99	WASTE2WATTS	Unlocking unused bio-WASTE resources with loW cost cleAning and Thermal inTegration with Solid oxide fuel cells
100	WATERAGRI	"Water Retention And Nutrient Recycling In Soils And Streams For Improved Agricultural Production"
101	WiseGRID	WiseGRID
102	ZeoBio-NG	Innovative biogas upgrading system based on novel Zeolite adsorbent technology for producing Bio-based Natural Gas

A full detailed spreadsheet containing all the information gathered for each entry is available in the following link:
https://docs.google.com/spreadsheets/d/12QdJ9odzbcXzNKPxozWLo4Bz_Hln3P_cbyqyzg9TYUw/edit#gid=577148393

Annex 3: Research Projects Survey

The following link is the online survey that was used to submit all the categories of identified FEFTS.
https://docs.google.com/forms/d/e/1FAIpQLSfMpFweapaUYlkquzbm6PUHEBzH0QjGetQop0jD2TJDEV1OPA/viewform