FET traces

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VISIONARY AND COLLABORATIVE RESEARCH IN EUROPE.

PATHWAYS TO IMPACT OF USE-INSPIRED BASIC RESEARCH

Fraunhofer ISI

AIT AUSTRIAN INSTITUTE OF TECHNOLOGY

CONTENT

1 EXECUTIVE SUMMARY

Breakthrough research with high impacts increasingly relies on collaborative, interdisciplinary and application-oriented contexts. The Future Emerging Technologies (FET) programme of the European Commission provides the funding environment for this new mode of research. The FET programme supports "use-inspired basic research", which is curiosity-driven with a potential application in mind. In this report, we analyse the impacts of the FET programme using bibliometrics, an online-survey and case studies. We found that FET research has relevant impacts on the areas of knowledge production, the economy, people and society.

IMPACTS ON KNOWLEDGE PRODUCTION

FET research has strong impacts on knowledge production and triggers reverberations in many different disciplines. Researchers involved in FET projects are very active in publishing their results in scientific journals. Their publications are of high quality and outstanding relevance as demonstrated by the large number of publications in high-profile journals like *science* or *nature*.

Other researchers frequently cite FET research results. The average citation rate of FET publications is higher than the citation rate of physics, which is used as a benchmark. The citation analysis also shows that FET results are cited in many different scientific fields: 36 percent of the FET projects in our sample have an impact on more than 20 scientific fields. This is a very high figure and reflects the interdisciplinary nature of FET.

Novelty is another central feature of FET research. In the bibliometric analysis, we found that the overwhelming majority of FET projects (83 percent) deals with research ideas not present in the scientific community before and could therefore be termed "radically new".

The novelty aspect of FET and the attempt to try something that has not been done before is also very present in the perceptions of FET researchers. The survey showed that FET researchers believe the programme offers the opportunity to do research that goes beyond the mainstream.

IMPACTS ON PEOPLE

Interdisciplinarity in FET projects is characterised by a partnership of equals and is not dominated by any one discipline: We found a high level of interdisciplinarity in 68 percent of all projects. In addition, FET projects allow researchers to take their work in new directions: 31 percent of FET researchers in our survey said that FET allowed them to branch into a new area and try out exceptionally innovative, high-risk projects.

FET projects have relevant impacts on the researchers involved. In our survey, 88 percent of participants said that FET had promoted their scientific career.

FET projects triggered follow-up projects in 86 percent of cases and resulted in scientific awards in 29 percent of cases. These are impressive figures for high-risk research.

The case studies revealed that researchers involved in FET projects develop a certain attitude towards scientific, economic or other impacts: They actively seek opportunities where their research can be used to solve problems even outside their own field. As such, the impacts of FET go beyond merely scientific or industrial impacts, because FET projects encourage a certain way of carrying out and applying research.

IMPACTS ON THE ECONOMY

FET projects have relevant impacts on the economy. The portfolio analysis revealed that 40 percent of projects had at least one partner from industry.

Another good indicator of economic impact is the number of co-publications with industry: In our sample, at least one publication was written with the participation of an industrial partner in 32.6 percent of all projects. Again, this signals a high level of cooperation with industry.

The number of patent applications also demonstrates the potential economic impact of FET projects. A quarter of the analysed FET projects reported at least one patent application based on FET results.

12 percent of FET projects led to the founding of a spin-off company. Again, a remarkably high figure when comparing this with experiences in academia and other public research funding programmes.

FET researchers are very active in communicating their results to industry: 83 percent of the respondents to our survey said that they had contacts with industry in the context of their FET research. These contacts included presenting results at industry conferences or direct contacts with industry.

IMPACTS ON SOCIETY

FET projects have relevant impacts on society. As FET researchers still define themselves as being part of a technology development community rather than a community solving societal challenges, we did not expect a high awareness of societal impacts in our survey. However, contrary to our expectations, we found a relatively high share (17 percent) of researchers reporting societal impacts of their FET projects: Nine percent said that their research in FET contributed to tackling Europe's grand challenges and eight percent reported "other societal impacts".

According to our survey, there are other societal impacts in the areas of technology assessment, mobility, healthcare, regulation, education, air quality and others.

CONCLUSION

Supporting a specific mode of research that can be characterised as "use-inspired basic research", the FET programme is a unique research funding programme within the European research funding landscape. Its uniqueness is due to its emphasis on novelty, interdisciplinarity and collaboration, as well as its specific focus on technology and application relevance. As such, the FET programme is an important part of the European research funding landscape. The results of this impact study suggest that FET research should be strengthened in the future as it has specific and highly relevant impacts in all four impact areas considered.

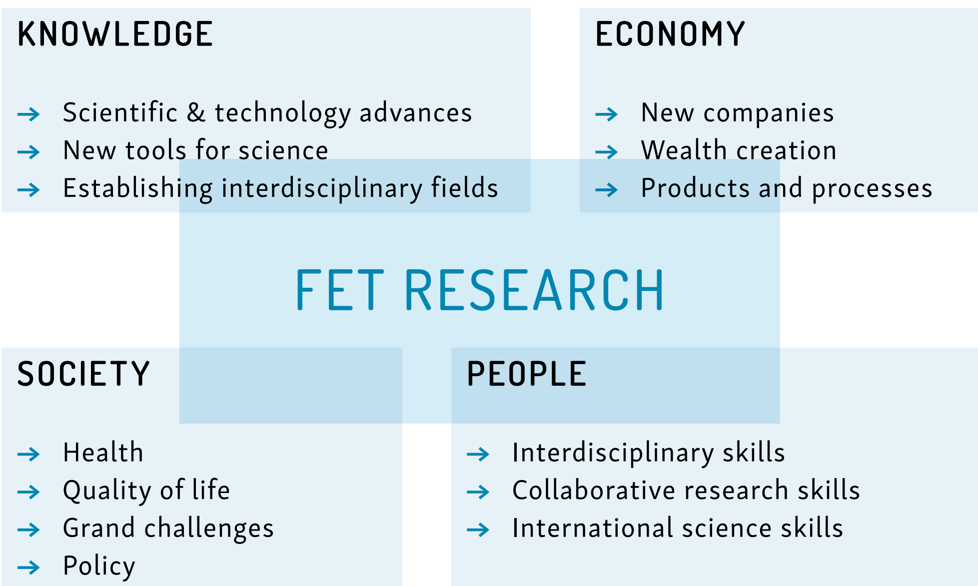
1 STRUCTURE OF THE REPORT AND METHODS USED FOR THE IMPACT ASSESSMENT

This report summarizes the results of an impact assessment of 224 FET Open and FET Proactive projects. The following research questions were explored: What impacts did these projects have in academia, industrial contexts and beyond? Which developments did the projects trigger? What is the best way to trace the impacts of the projects and map the programme's specific approach?

Starting as a traditional impact assessment exercise, we used bibliometric methods to track the impacts of the projects according to the programme's mission. The analysis focused on the three impact dimensions of novelty, interdisciplinarity and starting innovation eco-systems. Over the course of the project, our understanding of impacts widened. Thus, in the following, we use a multi-perspective concept to trace the impacts of FET. The new model consists of the four impact dimensions "Knowledge", "People", "Economy" and "Society" and is better suited to map the diversity of approaches followed in the different FET projects.

As figure 1 illustrates, the FET programme's impacts are driven by technology. However, the technology focus in our concept does not imply a technology-push approach, but emphasizes the mediating role of technology.

Figure 1: The four impact dimensions of the assessment



Source: FET_TRACES 2017

The sample for our impact assessment consisted of 224 FET Open and FET Proactive projects, which were completed between 2007 and 2014 (under FP6 and FP7, see Figure 2).

Because impacts need time to develop, we did not include projects that were still ongoing at the time of the assessment, so that no H2020 FET-projects were included in the sample. This means that the projects analysed in this study were carried out at a time when FET was related to Information and Communication Technologies (ICTs).

Figure 2: Projects analysed

FET OPEN AND FET PROACTIVE DISTRIBUTION

TIME SLOT DISTRIBUTION

Source: FET_TRACES 2017, portfolio analysis

The Fraunhofer ISI and the Austrian Institute of Technology AIT carried out the impact assessment between 2015 and 2017 as a Coordination and Support Activity (CSA) project called FET_TRACES. The deliverables can be downloaded from the project website www.fet-traces.eu/traces. Our analysis relates to the FET Open and FET Proactive schemes and excludes FET Flagships.

We used five different methods for the impact assessment, which are detailed as follows:

Portfolio analysis	Based on administrative data (number and country of partners, duration, budget, etc.), we analysed a total of 224 FET Open and FET Proactive projects which were completed between 2007 and 2014. Of special interest were the composition of the consortia (input enterprise relevance) and the identification of publications resulting from the projects in our sample (see Deliverable 4).
Novelty analysis	For each project in our sample, the most relevant early publication was identified, which then formed the starting point for the novelty analysis. In order to determine the novelty level of the FET idea, we searched for similar publications in the preceding five years. Here, we used bibliographic coupling, a method based on reference pattern analysis. For some publications that reached a certain level of similarity, we additionally used TF Idf (Term frequency Inverse document frequency) in order to check for similarities between abstracts. We combined the two methods as a variation of the LDA (Latent Dirichlet Allocation) analysis, which was originally foreseen for the novelty analysis (see Deliverable 5).
Bibliometrics	In order to assess the academic output and relevance of the selected FET projects, we used bibliometric methods to analyse a total of 4,063 publications and 24,709 related citations. The databases used were the Web of Science (WoS), the EU-site Cordis and the EUPRO-database of AIT (see Deliverable 6).
Survey	Between December 2016 and February 2017, we carried out an online survey asking 4,720 FET project coordinators and participants about their experiences and the impacts of their respective FET project. In the end, 278 participants (5.9 percent) completed the questionnaire containing 21 questions. The number of answers was sufficiently high for statistically relevant tests. The survey participants covered 196 different FET projects, which means that the survey covered 87.5 percent of our sample (see Deliverable 7).
Case studies	To identify success factors and obtain a detailed picture of the motivations, processes and practices in FET projects, we conducted case studies for which we collected publicly available information and carried out interviews with project coordinators. The case studies highlight the variety of FET projects and include different phases of the projects (initial idea, forming of the consortium, carrying out research, etc.) as well as our impact dimensions (excellence, novelty, interdisciplinarity, innovation eco-system) (see Deliverable 9).

The report is structured as follows. First, we characterise FET-research as “use-inspired basic research” and show the consequences of this kind of research for the impact assessment. The main part of the report describes the most important impacts of FET in the areas of knowledge production, people, the economy, and society. In the conclusions, we recommend strengthening FET research in the European research funding landscape because of its unique features and relevant impacts.

2 FUTURE EMERGING TECHNOLOGIES: WHAT KIND OF RESEARCH ARE WE LOOKING AT?

According to the mission of the FET programme, the following statements characterise the two FET schemes:

"**FET Open** funds projects on new ideas for radically new future technologies, at an early stage when there are few researchers working on a project topic. This can involve a wide range of new technological possibilities, inspired by cutting-edge science, unconventional collaborations or new research and innovation practices."

"**FET Proactive** nurtures emerging themes, seeking to establish a critical mass of European researchers in a number of promising exploratory research topics. This supports areas that are not yet ready for inclusion in industry research roadmaps, with the aim of building up and structuring new interdisciplinary research communities."

Source; FET-Website 2016[1]

As such, FET-research is a specific kind of research that can be characterised as differing from mainstream research in various ways (see Table 1).

Table 1: What FET-research is and is not

WHAT IS FET-RESEARCH?

- → it focuses on new ideas which are foundational and may have a transformative character,
- → it is risky (possibility to fail),
- → it is bottom-up (defined by researchers),
- → it is interdisciplinary,
- → it is purpose-driven and aims at technology development,
- → it is collaborative and involves researchers from different countries.

WHAT IS IT NOT?

- → it is not mainstream research,
- → it is not about small changes to existing models or approaches,
- → it does not rely on track record alone,
- → it is not pure basic science,
- → it does not follow a policy agenda or pre-defined topics,
- → it is not discipline-oriented research.

Source: FET_TRACES 2017

1 https://ec.europa.eu/programmes/horizon2020/en/h2020-section/future-and-emerging-technologies

WHAT IS FET FROM A CONCEPTUAL POINT OF VIEW?

FET-research is research in complex science-based technologies in the early stages of their development. This kind of research follows specific patterns, which have to be reflected accordingly.

On a conceptual level, FET-research is characterised as "use-inspired basic research", a term introduced by science researcher Donald Stokes, who analysed different kinds of research approaches in his book "Pasteur's Quadrant: Basic Science and Technological Innovation" (1997). Stoke describes three types of research, "pure basic research" illustrated by the example of Bohr, "pure applied research" illustrated by Edison, and "use-inspired basic research" illustrated by Pasteur (see Figure 3).

Figure 3: Pasteur's Quadrant according to Stokes (1997)

APPLIED AND BASIC RESEARCH

Quest for fundamental understanding	YES	Pure basic research (Bohr)	Use-inspiered basic research (Pasteur)
	NO	–	Pure applied research (Edison)
		NO	YES
		Considerations of use?	

Source: Wikipedia "Pasteur's quadrant"

According to Stoke's characterisation, "use-inspired basic research" is basic research expected to produce findings of practical use. Concerning the impact assessment of the FET-programme, this conceptual characterisation has specific implications:

Types of researchers: FET-researchers have a certain awareness of the potential uses of their research. They are working at the borderline of science and technology. Their research is not motivated by curiosity alone. In successful FET projects, we expect to find researchers who are good researchers, good communicators and good networkers at the same time, and who try out their ideas in different research and development contexts.

Novelty: Whereas novelty is a central requirement for FET projects, we also look at new combinations of existing approaches to develop new technologies or unconventional devices in the impact assessment. In cases where existing technologies or methods are combined, radical novelty is therefore complemented by "relatively new but not yet well-known". In general, however, we expect a high degree of novelty because even the combination of already existing research results can be considered "new" if it has not been tried before. Concerning the impacts of new and original ideas followed in FET projects, it must be noted that novelty does not automatically imply success in the marketplace.

Time lag between research and impacts: New approaches or research ideas often do not fit into mainstream research and need time before they are taken up. This narrows the scope of impacts that would be possible in principle. In addition, there is no linear development from science to application; in fact, as well known from innovation research, such development takes place in loops.

Interdisciplinarity: Typically, new scientific insights are generated at the fringes or by crossovers of different disciplines and research fields. Accordingly, interdisciplinarity is a central feature of FET projects. Usually, in FET projects, a more theoretical discipline is combined with a more applied one to achieve the joint genesis of a new technology. Several conceptual approaches and bibliometric possibilities are used to capture the level of interdisciplinarity.

In the following, we present selected impacts of the FET programme in the areas of knowledge, people, the economy and society.

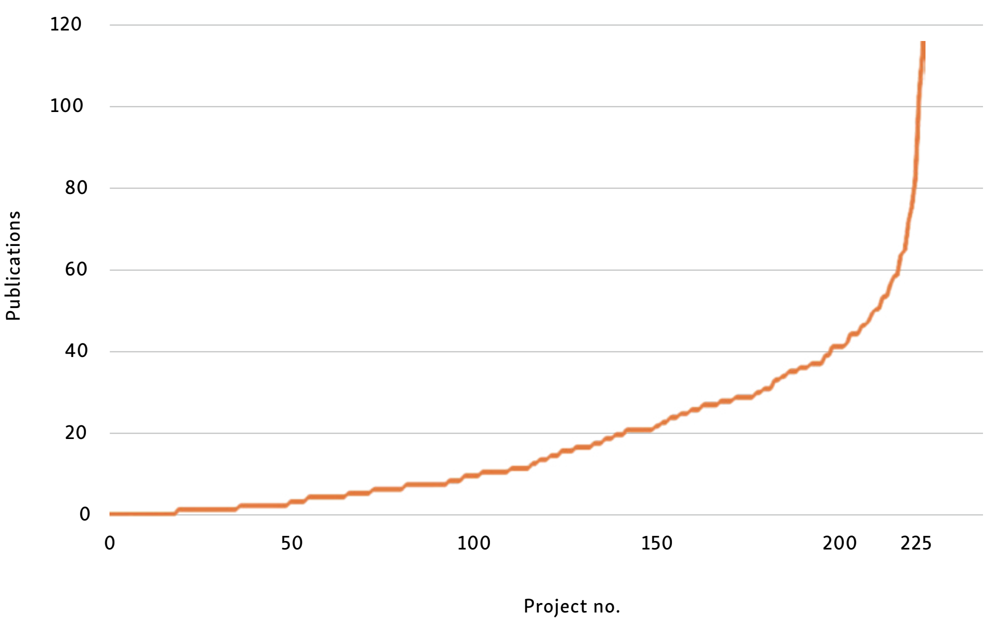
3 IMPACTS ON KNOWLEDGE

PUBLICATIONS

A common method for tracing impacts on knowledge creation is to count the number of scientific publications related to the programme. We identified a total of 4,063 publications for the 224 FET Open and FET Proactive projects in our sample. As the project consortia consisted of 7.5 partners on average, there is an average number of 18 publications per project, which is quite high for scientific output.

Looking at the distribution of publications across our sample of projects, we find that many projects published fewer than the average of 18 scientific articles. However, those projects publishing more than the average produced a very large number of articles (see Figure 4).

Figure 4: Number of publications per project in the FET programme

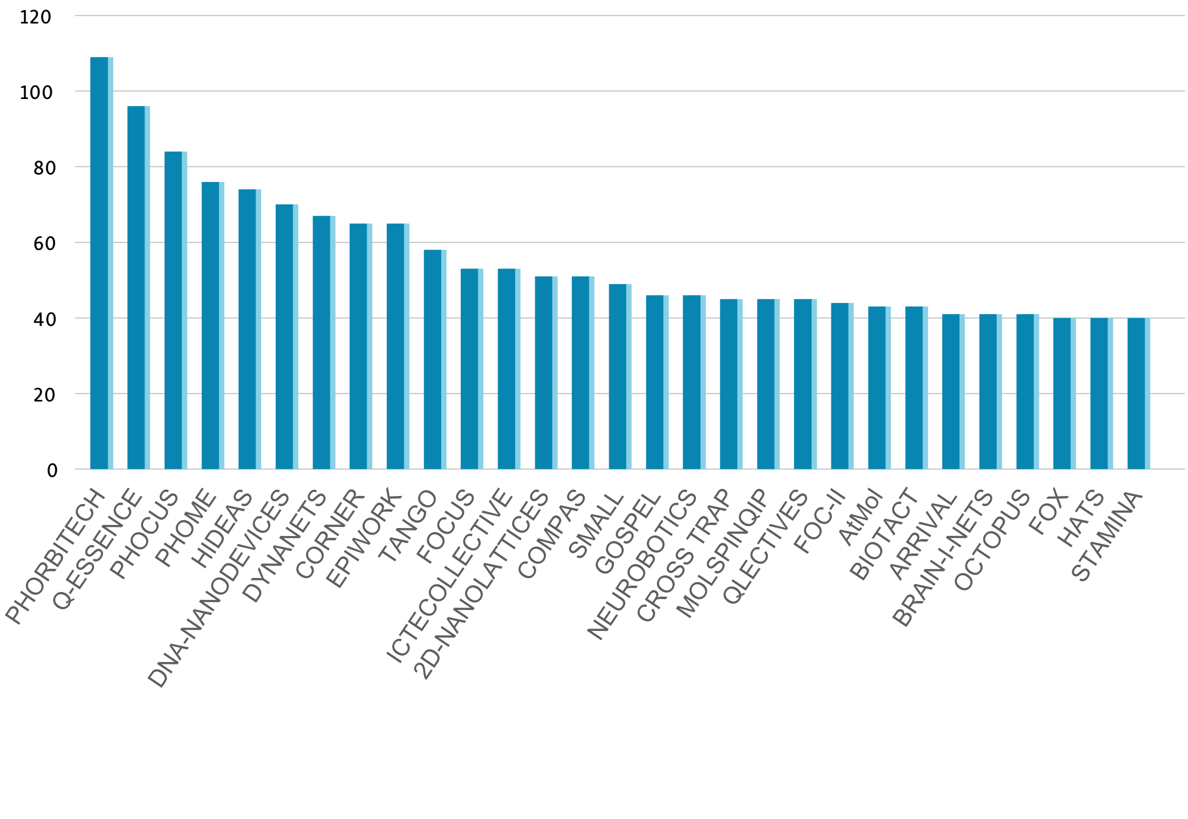


Source: FET_TRACES 2017, Web of Science, own compilation

This means that not all FET projects contribute to knowledge production in the same way. The skewed distribution reflects the high-risk character of the programme, which means that some attempts fail, but those that do succeed have a tremendous impact.

Highly relevant projects show an extraordinary output of publications: The PHORBITECH project featured the highest number of publications in our sample with 112 (Figure 5).

Figure 5: Top publishers: FET projects with 40 or more publications



Source: FET_TRACES 2017, Web of Science, own compilation

Although the number of publications does not always imply an equally high output quality, in our case it does, because we only included peer-reviewed journals in our calculations. A special indicator for high quality and outstanding relevance is the publication of research results in the journals *nature* and *science*. We found as many as 34 FET-related publications in *nature* and *science* from 10 different projects.

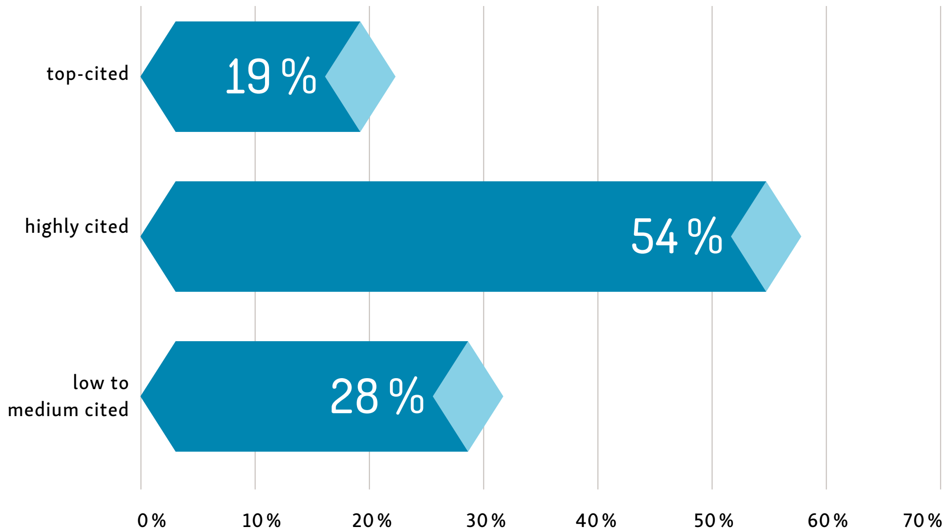
CITATION RATES

Citations indicate the quality and relevance of research results. In our case, this means that the more citations, the larger the footprint of FET-induced research within the scientific community. To ensure comparability of the citation scores of different years, we only counted citations within the first three years after the respective FET publication.

The total number of observed citations in our sample is 24,709. With a total of 4,063 relevant publications, the average citation rate per publication is 6.1. In order to assess these figures, we selected the top 800 FET publications and compared these with citation patterns in physics as a benchmark. We found that the average citation score for FET-related publications is very high, even higher than the score for physics.

In order to find out about the specific impact of FET projects on knowledge production, we selected the most cited publication of each FET project in our sample, corrected the scores according to the average citation rates of the respective disciplines and compared them with the average citation rate in physics. As a result, we found that 19 percent of FET projects had an exceptionally high academic impact (see Figure 6).

Figure 6: Citation scores of FET publications



Source: FET_TRACES 2017, Web of Science, own calculation, based on the highest observed citations per FET project, physics-adjusted, 3-years citation window

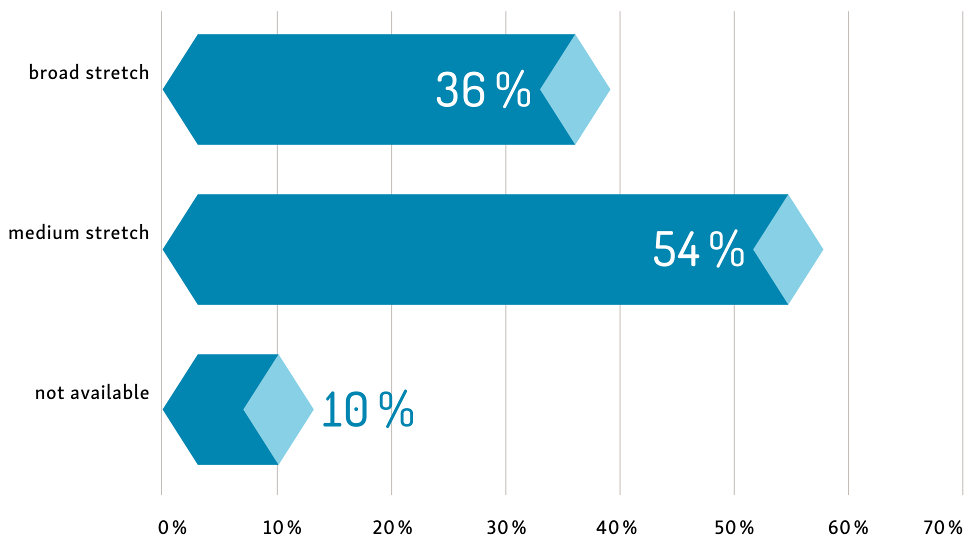
High risk is a special characteristic of FET projects, and uncertainty a main attribute of emerging technologies. It is possible to compare the risk distribution in risk-oriented research to that of risk-oriented investments in venture capital. In venture capital investments, there is the following typical distribution: About 10 percent of investment projects fail, 20 percent fail partially, 50 percent are successful but with average results, 10 percent have results distinctly above average, and only 10 percent are outstanding.

The comparison showed that the share of successful FET projects surpasses the expectations of risk investments because 54 percent of the analysed FET projects achieved citation rates above 20, and 19 percent had citation rates above 50. The share of FET projects with excellent results is clearly above the average risk distribution. These figures show that, even though there is a number of unsuccessful cases, the share of successful cases is extremely high, which justifies the investments in this type of research.

UPTAKE IN DIFFERENT DISCIPLINES

In order to measure the uptake for FET research results in different disciplines (disciplinary stretch) we counted the scientific fields in which FET publications were cited. In order to do so, we used a specific pattern of 27 scientific fields aggregated from the subject categories of the Web of Science database. As a result, we found that 80 projects in our sample (36 percent) have an impact on more than 20 scientific fields, and thus have a broad impact or "stretch" across different scientific communities (Figure 7). "Medium stretch" in Figure 7 means that these project results receive attention in fewer than 20 different fields of science.

Figure 7: Overview of the number of fields citing FET publications per project (stretch)



Source: FET_TRACES, Web of Science, own calculation

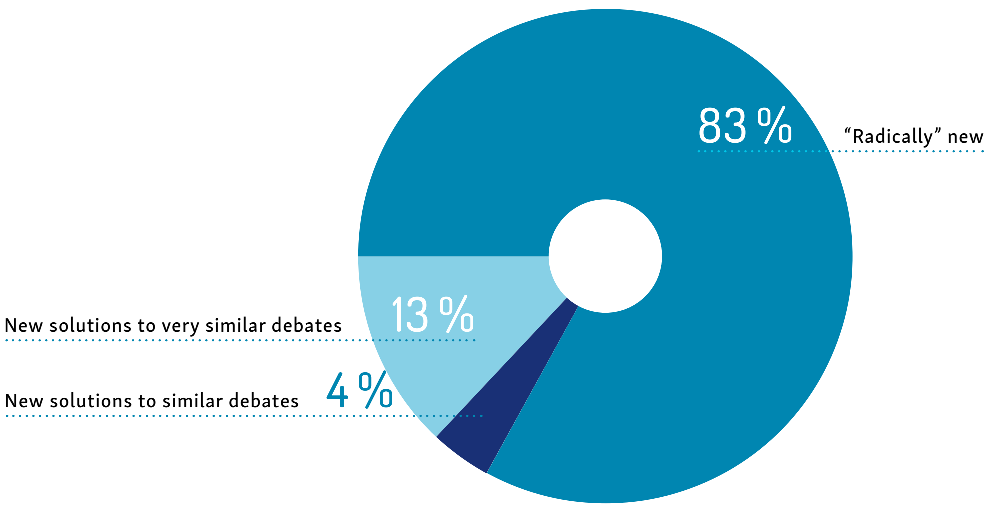
To achieve this high level of interdisciplinary impact, large efforts were necessary in the respective projects. From the case studies, we know that the project partners had to develop a creative collaboration culture to define a common language and to integrate their inputs into one common framework in order to realize their research goals.

NOVELTY

The novelty and originality of research ideas are central requirements for FET projects. FET projects are expected to run counter to mainstream tendencies and explore new research avenues. How can we measure novelty and originality? We chose a multi-dimensional approach that included bibliometrics, an analysis of the composition of project consortia, and survey results.

Applying a specific bibliometric method, which combines bibliographic coupling and LDA (Latent Dirichlet Allocation), we searched for publications with similar content within a period of five years before the respective FET publications. We found that there was no similar precursor publication for 83 percent of relevant FET publications in our sample (see Figure 8). We therefore concluded that the overwhelming majority of FET projects do indeed deal with “radically” new research ideas.

Figure 8: Results of the novelty analysis

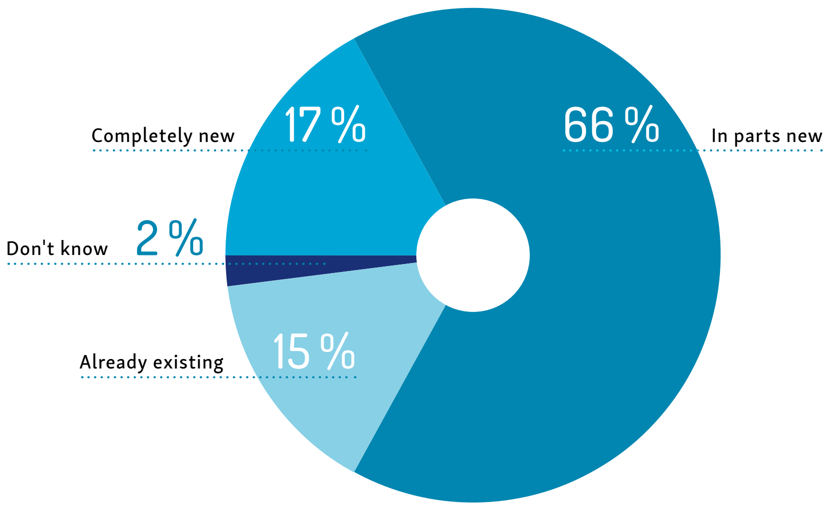


Source: FET Traces 2017, LDA analysis

In a smaller share of projects, the idea pursued was not completely new, but researchers started from an existing debate of how to solve a certain problem. Some similar publications already existed, but the FET publication contributed a new approach.

Another indicator for novelty is whether the FET consortium simply mirrors existing collaboration between research groups or includes new partners who have not worked together before. In our survey, we asked project coordinators and participants about the composition of the FET consortium and received the answers shown in Figure 9.

Figure 9: Novelty of consortium of FET projects



Source: FET_TRACES 2017, online survey, n=239

The survey results clearly show that the vast majority of the projects induced the formation of completely or partly new consortia (83 percent).

Asked about what it was that they considered new in their FET project, researchers gave us many interesting pointers, of which we selected the most informative:

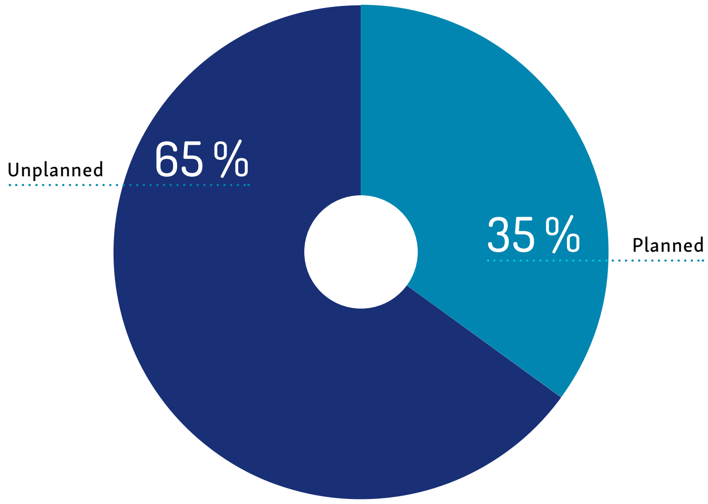
Table 2: Most remarkable novelty aspects from selected FET projects

"A paradigm shift in how in-vitro neuroscience should be done. New tools, techniques, and equipment were developed to realize this."
"The combined impact of the consortium, which was truly cross disciplinary."
"New device type made possible by combining different top-level techniques."
"New techniques, new dynamics/computations arising from interfacing biological with electronic neural processing systems."
"New technologies, new integration of existing technologies, new theoretical formalisms, new basic research."
"New ambition: to reach fundamental limits in energy dissipation."
"Radically new concept requiring the design and fabrication of novel devices and processes and new analysis techniques."
"Disruptively new technology (soft robotics)."
"New techniques and merging new concepts from different fields of research like machine learning (reservoir computing) and nonlinear dynamics."
"A new physical mechanism (Gunn effect in GaN diodes)."
"New device of fundamental interest in many frontier research areas currently limited by instrumentations."
"Biological methods and tools in communication networks."
"Stimulating the brain in order to transmit thoughts."
"New paradigm in data analysis: Instead of building a suitable model, perform a query for all models that conform to the specifications."
"New device concept, although based on existing technologies."
"New theory with high impact on applications: Paradigm change for constructing optimized basic functions in signal/image processing."

Source: FET_TRACES 2014, survey, selection of statements

Many of the FET research results were not foreseen or planned in the project proposal, but emerged during the process of pursuing the original idea. When asked about unplanned results, survey participants told us that 65 percent were unplanned and only 35 percent were as planned in the proposal (see Figure 10).

Figure 10: Percentage of planned and unplanned outcomes of FET projects



Source: FET_TRACES 2017, survey, n=72

This indicates that FET projects give researchers the chance to follow research avenues that were unexpected and unplanned at the beginning of the project.

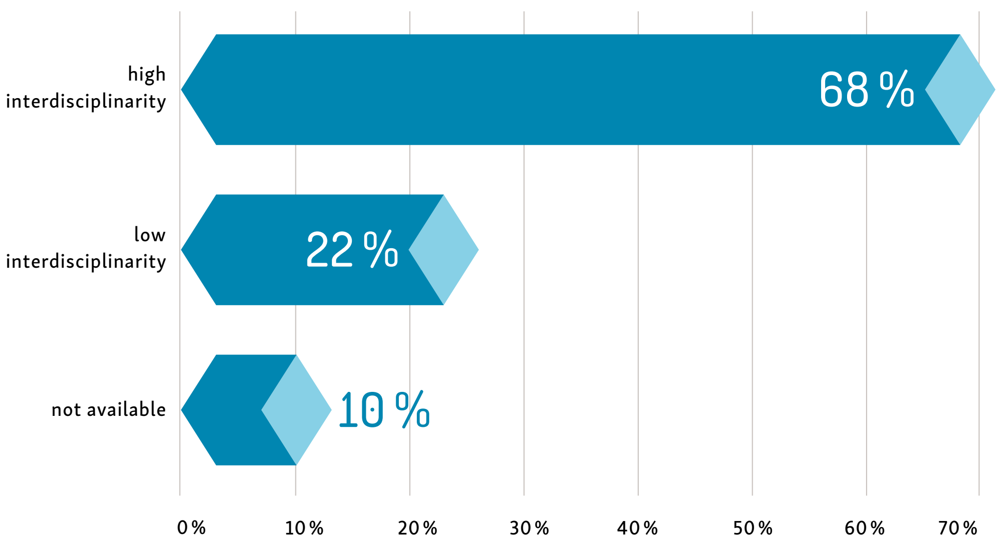
The case studies show that FET projects can make an important contribution to changing the knowledge system itself by developing “common languages” between disciplines. Thus, the collaborative and interdisciplinary approaches originally tried out in FET projects lend considerable support to the emergence and implementation of new interdisciplinary research fields, such as quantum chemistry, neuro computing, biophysics or computational social science.

4 IMPACTS ON PEOPLE

Researchers in FET projects are required to work in interdisciplinary research teams. In our assessment, we wanted to find out whether the interdisciplinarity in FET projects is characterized by a partnership of equals or whether one discipline dominates the others. To find out about high and low degrees of interdisciplinarity, we calculated the ratio between the highest and the second highest citations, assuming that balanced distributions signal equal importance, whereas skewed distributions signal the domination of one discipline over the other.

Our results showed that 68 percent of FET projects display a high degree of interdisciplinarity and a relatively low degree in only 22 percent of the projects (Figure 11).

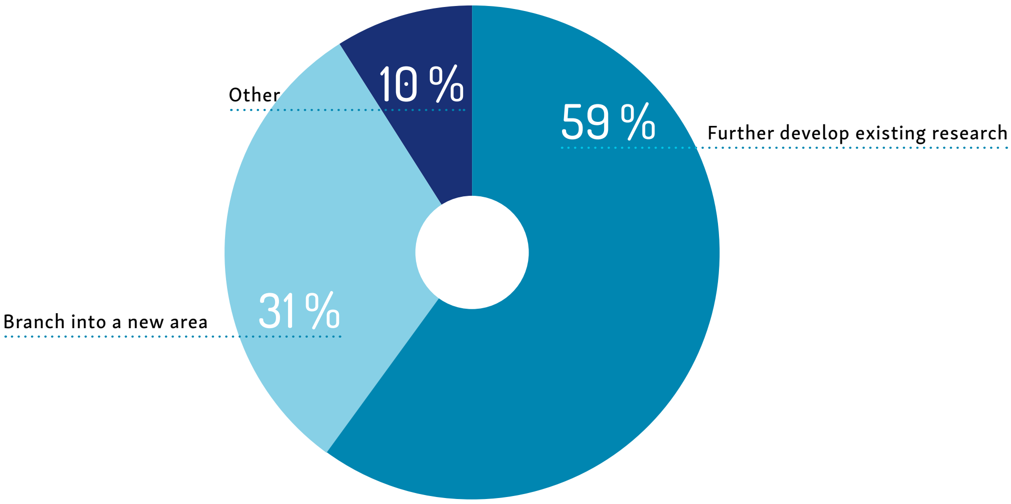
Figure 11: Overview of citations to the first and second most frequent field



Source: FET_TRACES 2017, Web of Science, own calculation

FET projects not only allowed researchers to work in interdisciplinary contexts, but also to take their research in new directions, as our survey results show (see Figure 12).

Figure 12: Impact of FET projects on individual research agendas

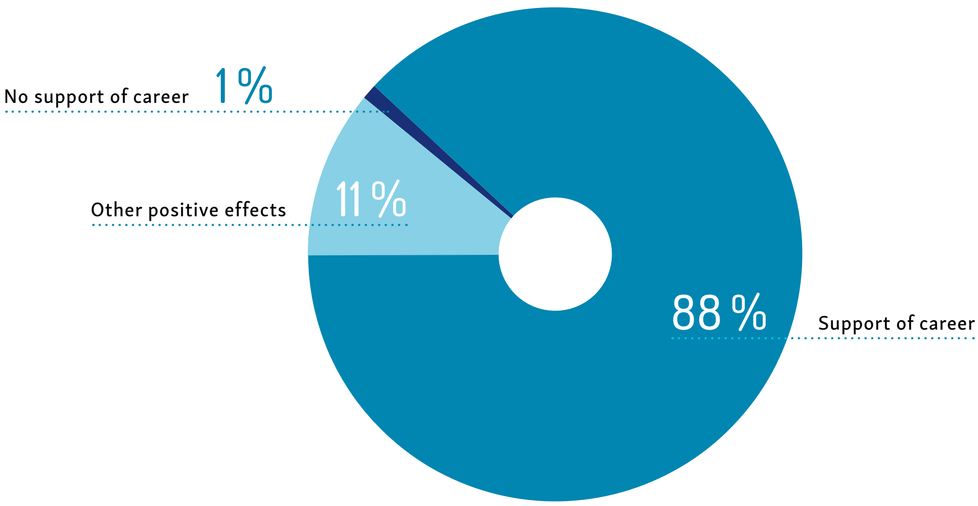


Source: FET_TRACES 2017, survey, question 9, n=297

Especially mid-career researchers with a proven scientific track record use FET-funding to take their research in new directions and pursue exceptionally innovative or high-risk projects.

FET projects also have relevant impacts on the careers of the researchers involved. In our survey, 88 percent of the participants said that FET had promoted their scientific career (see Figure 13).

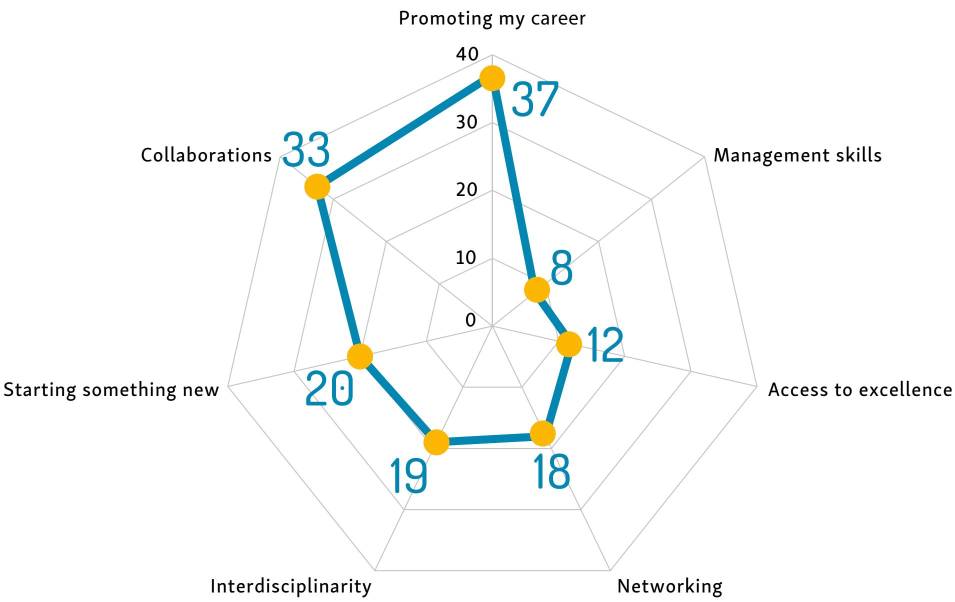
Figure 13: Impact of FET project on the career of the researcher



Source: FET_TRACES 2017, survey, question 21, n=211

When asked what the "other positive effects" were, respondents detailed "promoting my career" aspects like "visibility, reputation, partnership" or "invitations from prestigious institutions to present the results from my FET project" or other aspects as shown in Figure 14.

Figure 14: Other effects of FET projects according to the survey respondents



Source: FET_TRACES 2017, survey, 132 comments in the "other effects" category were clustered into the topics shown above

Further indicators for impacts of FET projects on researchers are follow-up projects and scientific awards. In our survey, we found that 86 percent of FET participants were successful in acquiring follow-up projects related to the idea developed in the FET project. The follow-up projects were financed either by the European Commission (46 percent), national agencies (25 percent) or other funding sources (15 percent).

In a separate question, we asked about follow-up funding by the European Research Council (ERC), which is a clear indicator of excellence. According to our survey, 11 percent of FET participants obtained an ERC grant after completing the FET project.

Concerning scientific awards, 29 percent of the respondents stated that they had received a scientific award for the work carried out in their FET project. This is an impressive figure in the area of high-risk research where failure is also a possible outcome.

In the case studies, researchers emphasized that, for PhD-students, FET projects are characterised by the chance to work together with internationally renowned scientists from different disciplines. The positive experience of collaboration has the effect that young researchers are motivated to do their own future research in an international, interdisciplinary, FET research manner.

5 IMPACTS ON THE ECONOMY

One indicator for the relevance of FET research for the economy is the participation of enterprises in FET projects. In our sample of 224 projects, eight projects (3.6 percent) were initiated and coordinated by an enterprise (see Figure 15). This signals a very high relevance of the research for application in an industrial context.

Figure 15: Enterprise participation in FET

INCREASING INDUSTRY RELEVANCE

- → Share of projects coordinated by an enterprise: 3.6%
- → Share of enterprises among all unique organisations: 17%
- → Share of projects with at least one partner from an enterprise: 40%

Source: FET_TRACES 2017, portfolio analysis

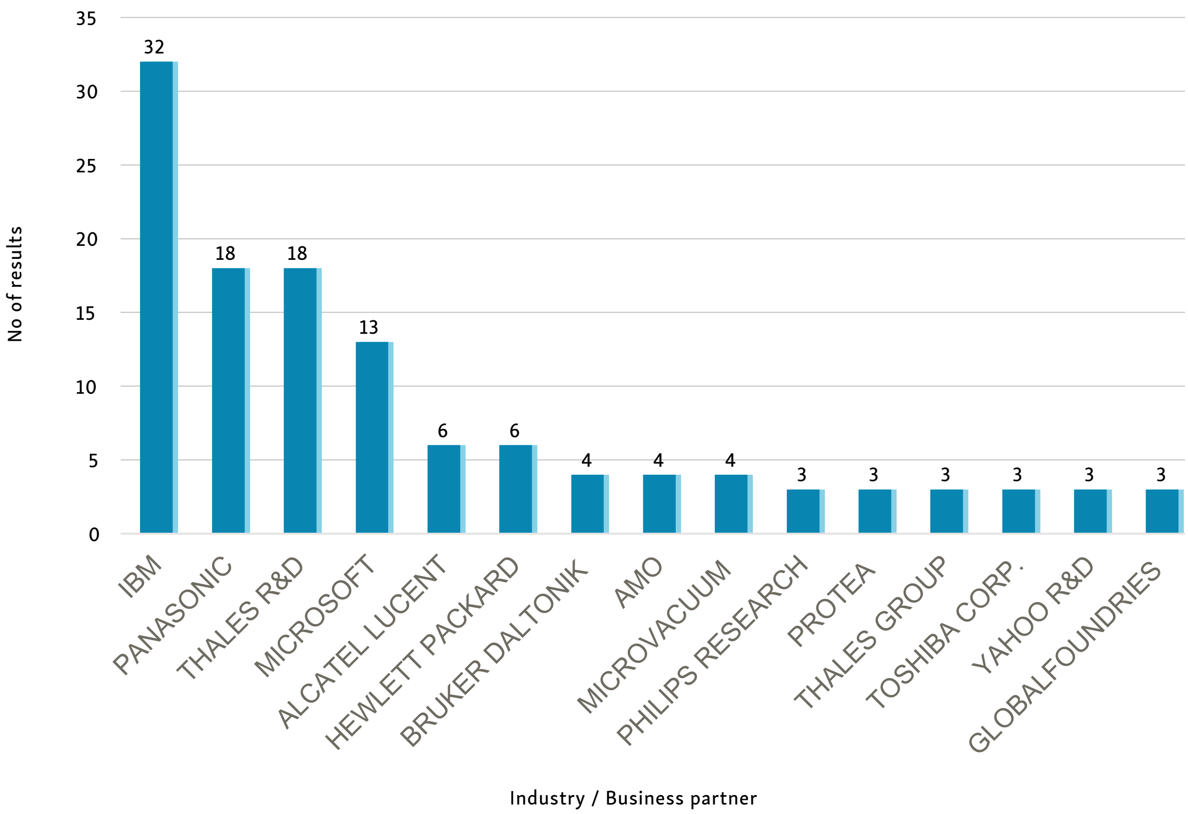
A relevant economic impact is also shown by the total number of enterprises participating (not as coordinators) in FET as a share of the total number of participating organisations. In our sample, we find 105 unique enterprises, which constitute a share of 17 percent of all participants. The absolute enterprise participation is even higher because some enterprises are involved in several FET projects.

Another important figure for economic relevance is the number of FET projects with at least one partner from industry in the project consortium, which indicates that the research topic is to some extent relevant for future applications. In our sample, we find 89 such projects (40 percent of all projects). Enterprise participation is significantly higher in FET Proactive projects than in FET Open projects.

CO-PUBLICATIONS WITH INDUSTRY

Co-publications with industry are a good indicator of the actual impacts of FET projects on the economy (output industry participation). In our sample, 73 projects (32.6 percent) had at least one publication written with the participation of an industrial partner. This finding can be assessed as indicating a high level of cooperation with industry. Figure 16 displays the names of the companies involved in more than two FET publications, which are the most active dissemination partners of FET projects with industry relevance.

Figure 16: Companies participating in more than two FET projects



Source: FET_TRACES 2017, Web of Science, own compilation

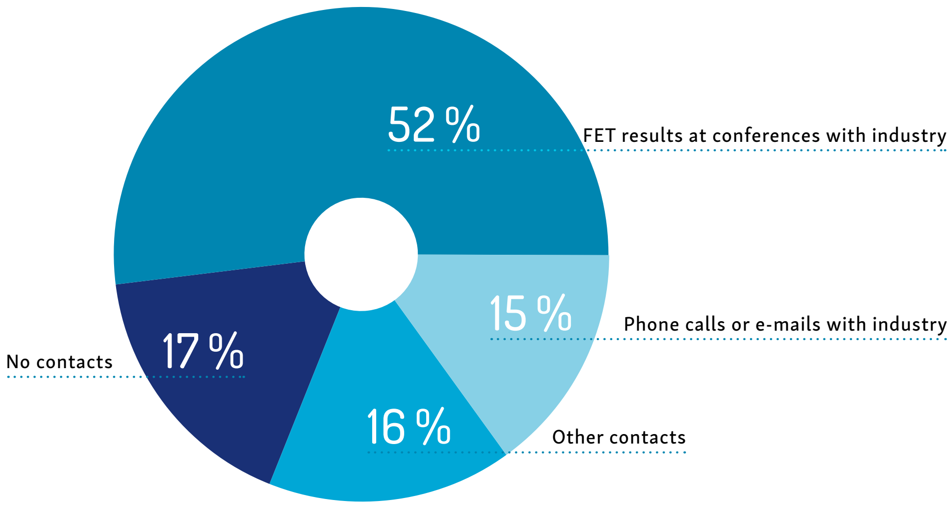
PATENT APPLICATIONS

Patent applications are another indicator of economic relevance and especially of research that may trigger an innovation eco-system. In our survey, we asked FET project coordinators and participants whether they had applied for one or more patents based on the results of their FET research. 25 percent of the respondents reported at least one patent application, indicating the considerable applied impact of their scientific project.

COMMUNICATING FET RESULTS TO INDUSTRY

In order to trigger an innovation eco-system based on FET research, we would expect FET researchers not just to publish their idea in scientific journals, but also to launch communication and diffusion activities to get their idea known in engineering and technology development communities. We would also expect them to collaborate with industry R&D to further develop, refine or apply the FET project's idea. Our survey found that FET researchers are indeed very active in communicating their results to industrial contexts (see Figure 17).

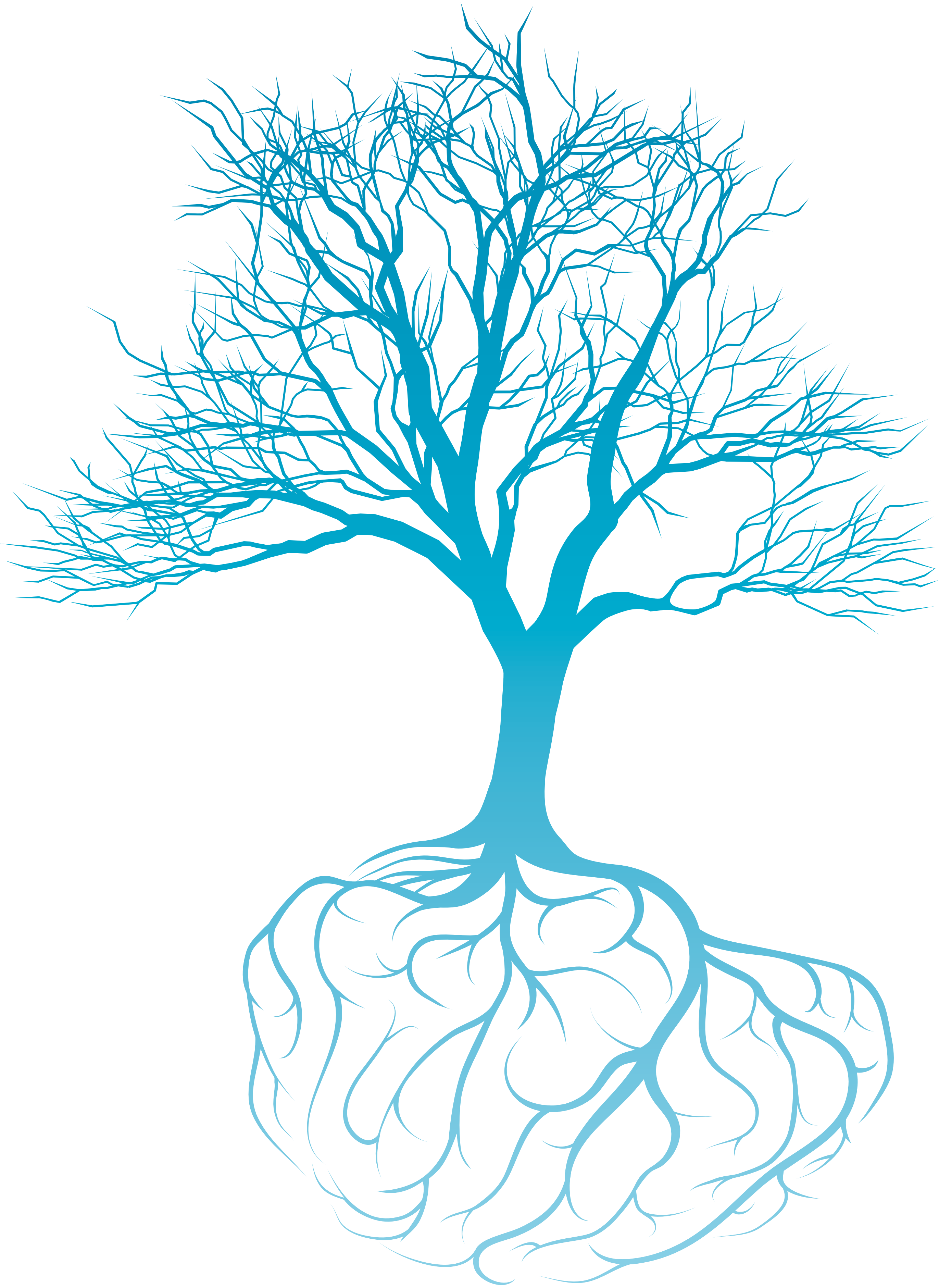
Figure 17: Communicating FET results to industry



Source: FET_TRACES 2017, survey, n=294, multiple answers possible

The answers to this question show that the majority (83 percent) of respondents actively sought contact with industry to communicate FET results: 52 percent said that they presented FET projects at conferences with industry participation; and 15 percent said that they used informal channels such as phone calls or e-mails to contact industry R&D colleagues.

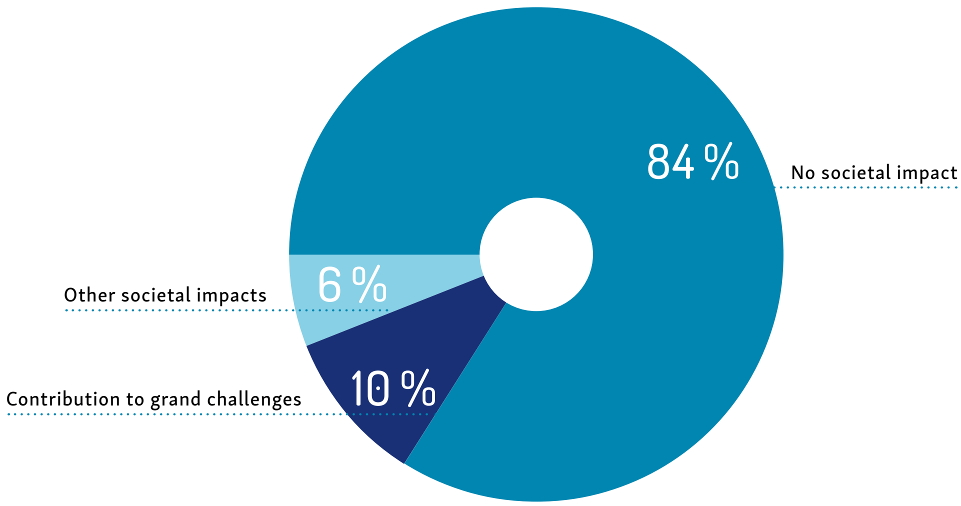
In the case studies, FET researchers emphasized that FET projects do have economic impacts, even though they are not required to outline a business plan at the outset. Researchers involved in a FET project acquire a certain attitude towards broader scientific impacts as well as future economic impact. The collaborative and interdisciplinary mode of research broadens their perspective and sharpens their focus on issues concerning future product and process innovations that become possible through their research. Researchers state that FET projects have different aims – even those focussing on basic research have a long-term indirect economic impact because of their specific technology orientation.



6 IMPACTS ON SOCIETY

When asking about the societal impacts of their research in our survey, we expected researchers to have a low level of awareness of such impacts because they predominantly define themselves as part of a technology development community rather than a community solving societal challenges. Focusing research policy on solving grand social challenges (instead of just a technological focus) is a relatively new trend. However, contrary to our expectations, we found a relatively high share (16 percent) of researchers reporting societal impacts of their FET projects: 10 percent said that their FET research contributed to the grand challenges of the European Commission, and six percent reported "other societal impacts" (see Figure 18).

Figure 18: Social or political impacts of FET projects



Source: FET_TRACES 2017, survey, n=209

Table 3 lists the most relevant "other societal impacts" mentioned by the respondents.

Table 3: Other societal impacts of FET as seen by respondents of the survey (examples)

APPLICATIONS IN DIFFERENT FIELDS

Mobility

"Yes, it contributed to understanding the feasibility (and ecological sensibleness) of massive EV [electric vehicles] introduction and differences between different member states."

"Some partners apply the research in the transportation field."

Energy

"It helped to take a new perspective on the problem of energy consumption using computers."

Health

"Hope it will help therapeutic management of spinal cord injury."

IMPACT ON REGULATION AND POLICY

"Our paper was rewritten as an executive abstract and was considered as a foundation for new banking laws by the EU Commission."

"New health policies in several countries."

"It triggered wide interest in the media and among patients associations."

"Data protection regulation and medical science derogations reinstated before approval."

"Local action on air quality studies in London that we continue to do."

"It is a security-related project; we are sure it will have a wide impact on the security of mobile devices."

"It raised concerns about the reliability of multimedia forensic tools."

KNOWLEDGE PRODUCTION

"Education (we applied the approach to the way work is organized within a university as a social community, from many points of view, e.g. organizational)."

"We were among various movements talking about data publishing, better support for open access, better credit for peer review and in general–beyond paper writing. It all happens now. We were ONE of the triggers, not THE trigger."

"A new attitude to sound design among practitioners."

"A strong unifying focus of the quantum physics community on Europe – this also has significant international impact."

"New approach to economic growth."

"Too early to say."

Source: Survey on FET impacts, 2017, selection of comments

FET researchers interviewed for the case studies generally expressed high awareness of the indirect impacts of their research on society. In particular, FET projects establish an open culture of experimentation, which also results from the specific approach of combining basic research with applications.

The researchers expect high impacts if their specific approach succeeds in the future; they are aware of the fact that, in every field of research, there are competing communities and competing interests.

Furthermore, it became clear that there is a time lag between the research and its societal impacts. Use-inspired basic research clearly broadens the options for future technologies with wide societal impacts. However, the specific societal impact is difficult to determine in an early phase because it usually takes more than ten years to reach the marketable application stage.

7 CONCLUSION: THE FET PROGRAMME WITHIN THE LANDSCAPE OF EUROPEAN RESEARCH FUNDING

"People who have the opportunity to take part in a FET project grow with the collaborations, the interdisciplinary work and the exchange."

(FET Researcher)

The FET programme of the European Commission is positioned between the European Research Council (ERC), which is purely academic, and the directed research in H2020, which is mostly application-oriented. FET relies on the opportunities offered by collaborative and interdisciplinary research. As such, FET is a globally unique programme.

FET researchers we asked about the programme emphasized that it is unique because it allows the development of original ideas that need excellent use-inspired basic research to realise their potential applications. FET is positioned in-between basic research and engineering and gives researchers the freedom and opportunity to try out new things and experiment with different approaches. According to the FET researchers, other national and European research funding programmes are more formalized, while FET gives them the freedom to pursue unexpected developments when they occur.

Furthermore, since the FET programme encourages researchers from different disciplines and backgrounds to work together, it contributes to building new scientific communities. The participants of our survey emphasized that national programmes cannot achieve this. Nor can this be achieved by promoting the principal investigators mode alone, as the ERC does.

Although the term "use-inspired basic research" suggests certain tensions (curiosity-driven and at the same time application oriented), the impact assessment revealed that combining both aspects can generate productive environments for manifold innovations. FET projects with remarkable outcomes were able to use the potential tension between excellence science and application orientation as a driver to push their research forward.

In the workshop with national funders of high-risk research, it became clear that FET research is of increasing relevance in several national contexts, too. Many research funding agencies have intensified their respective programmes in recent years. The participants stated that FET as the corresponding programme at European level functions as a multiplier with its focus on international collaboration. The need for FET funding will increase in the future due to the growing importance of a collaborative and interdisciplinary culture of science in Europe.

Against this background, the current oversubscription of the FET programme is sending the wrong signal. As the FET programme is seriously underfunded, resulting in very low success rates for applicants, the result is that excellent researchers are being discouraged from applying for FET funding. The European Commission must find a remedy to this situation in order to realise the full range of possible impacts in the future.

Another conclusion from our analysis is that we need to consider new methods to trace a project's impacts. We found a great variety of impact pathways and recommend tracing "project journeys", taking into account a longer time horizon and including additional qualitative methods. Whereas some want to strengthen impact planning and even want to include detailed innovation roadmaps as a requirement for funding, we instead recommend introducing follow-up documentation regarding the specific impact pathways.

FET is a unique funding instrument for new scientific and technological insights, which has relevant and substantial impacts. Looking ahead, the results of this study suggest that FET should not only complement the European research funding landscape, but that it should be increased in size and budget to become a major pillar of European research funding.

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