# FET_TRACES

## Tracing impacts of the FET programme

Project number 665083

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## D4.2 Level-1 analysis

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## About FET_TRACES

FET_TRACES is a research project for the European Commission which analyses and measures the impacts of the research funding scheme "Future and Emerging Technologies Open" (FET Open and FET Proactive). Within the European research funding landscape, the FET scheme acts as a pathfinder for new ideas and themes for long-term research in the area of information and communication technologies and beyond. Its mission is to promote high risk research, offset by potential breakthrough with high technological or societal impact (see http://CORDIS.europa.eu/fp7/ict/fet-open/home_en.html).

In the FET_TRACES project we will investigate and measure direct and indirect impacts of these two schemes on the science and technology landscape and its perception by individual researchers who are potential proposers for FET Open and FET Proactive projects. Results from innovation research will be used to develop a targeted indicator set covering central aspects of the FET mission (novelty, trans-disciplinarity, innovation-ecosystem). For the data collection we use sophisticated impact assessment methods like bibliometrics, patent analysis and online surveys. In addition to the impact assessment we will analyze selected breakthrough-projects to find out about necessary components for "breakthrough"-research. The study will also include insights from FET-like funders on national levels in Europe.

## Terms of use

This document was developed within the FET_TRACES project (see www.fet-traces.eu), funded by the European Commission within Horizon 2020, by a consortium consisting of two partners, the Fraunhofer ISI in Karlsruhe, Germany (coordinator) and AIT in Vienna, Austria.



## Document history

| Version | Date | Changes |
|---|---|---|
| 1.0 | August 2016 | |
| 2.0 | November 2016 | Added number of FET Open and FET Proactive projects assigned to FP6 and FP7, average number of project partners, budget of projects analysis, enterprise participation. |

# Contents

# 1 Introduction

This report provides the basic data required for the impact assessment of the 224 FET Open and FET Proactive projects that are identified for the sample. The report provides an overview and background of FET projects; both on the level of the program and the level of the individual projects. This Level-1-analysis is a portfolio analysis that represents the basic data collection of the selected FET projects.

Sources of the following analysis are:

- CORDIS database,[1]
- EUPRO database of AIT,[2]
- the FET projects portfolio, and the
- Web of Science.[3]

Searching and collecting the basic information of the relevant projects from CORDIS, EUPRO, Web of Science, project websites, and additional sources is a prerequisite for more detailed analysis which is to follow in the next work packages. For each of the identified projects we determined a set of basic information relevant for the impact assessment. The information is partly available in CORDIS and in the Web of Science (publications) and must be standardized and assigned to the individual projects. The data include the start and end date of the project, the duration of the project, the number of partners, the countries where coordinators and project partners come from, and the EU contribution.

Also, CORDIS as well as the AIT database EUPRO provide selected publications related to the respective projects, including authors, year of publication, title of the paper and journal title. Most of these scientific articles are Open Access articles. The bibliometric data gained from CORDIS and EUPRO were cross-checked and supplemented by publication data from the Web of Science and through online research.

The first part of this report is an overview on the level of the program and the second part contains information related to the individual projects.

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1 http://cordis.europa.eu/

2 The EUPRO database is constructed and maintained by the AIT Austrian Institute of Technology. The database comprises systematic information on R&D projects and all participating organizations funded by the European Framework Programmes (EU FP). It enables the analysis of participation patterns of organisations, but also the investigation of collaborative network structures. http://risis.eu/wp-content/uploads/2014/08/EUPRO-Poster-RISIS.pdf

3 http://apps.webofknowledge.com

# 2 Total number of relevant projects

We have identified 224 FET projects to be considered for this project. For the identification of projects we used different sources which are described in detail in D4.1 List of relevant projects: First, we analysed the total number of projects listed at the FET Website within the 12 topical areas (AI & cognition, Bio-&Neuro-ICT, Complexity, etc., see https://ec.europa.eu/digital-agenda/en/fet-projects-portfolio). This set of projects contains 184 projects (+38 CSA, 3 of them ending in 2015). Altogether 94 of this projects are from the FET Open scheme, 81 from FET Proactive, SMEs in FET are 6 Projects and Young Explorers are 3. These projects are only from FP 7[4]. As we aim to explore the impact of FET projects and given the fact that impact needs time to materialize, we added projects which were started within FP6[5] and which were finished between 2007 and 2010. To identify these, we used different search strategies in CORDIS and chekced lists provided from the FET website.

Altogether, we identified 93 FET projects which could be assigned to FP6 (in the Information Society Technologies (IST) part of the programme) and 131 FET projects which were started in the FP7-period (in the Information and communications Technologies part).

Table 1: Assignment of projects to FP6 and FP7

| Programme | No of Projects |
|---|---|
| FP6-IST | 93 |
| FP7-ICT | 131 |

Within the timeframe considered in our analysis (projects ending between 2007-2010 and 2011-2014) we found more FET open projects than FET Proactive projects (see table):

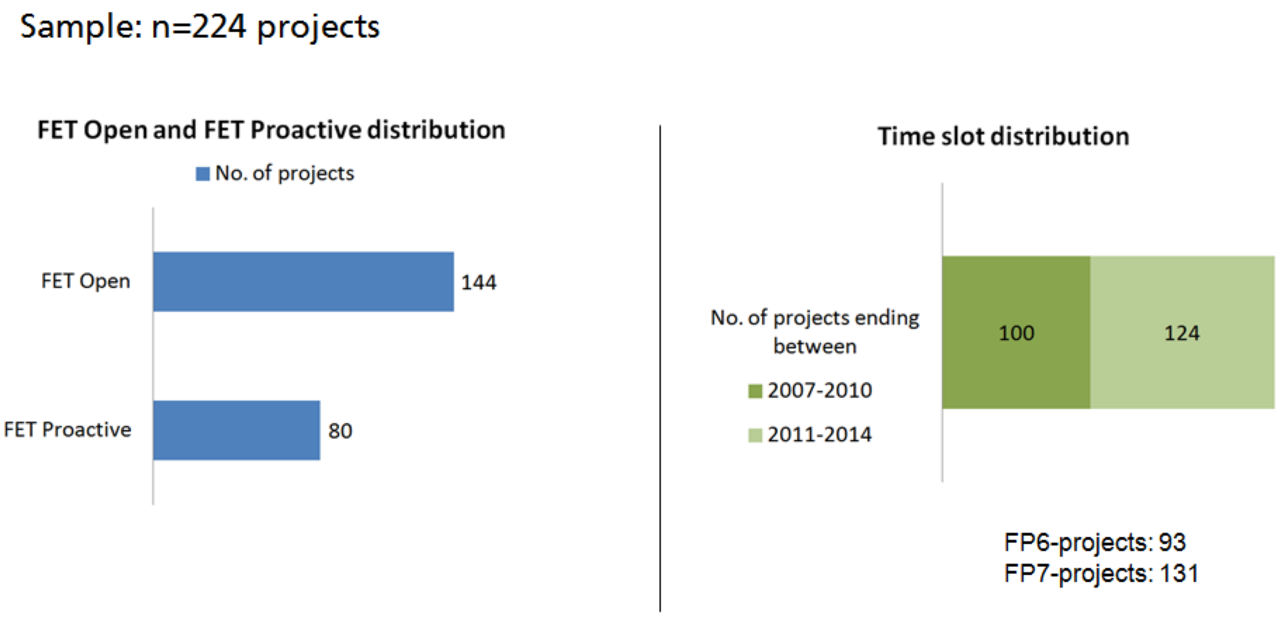
Table 2: Number of FET Open and FET Proactive projects in our sample

| FET scheme | No of projects |
|---|---|
| Open | 144 |
| Proactive | 80 |
| Total | 224 |

[4] Framework Programme 7 (FP7) was the European Union's Research and Innovation funding programme for 2007-2013.

[5] Framework Framework Programme 8 (FP6) period was from 2002-2006.

Figure 1: Basic data of our project portfolio




The distribution of FET open and FET Proactive projects assigned to FP6 and FP7 shows the following table:

Table 3: Number of FET Open and FET Proactive projects in FP6 and FP7

| **FP6 or FP7** | **Scheme** | **No of projects** |
|---|---|---|
| 6th Framework Programme | FET Open | 67 |
| 7th Framework Programme | FET Open | 77 |
| 6th Framework Programme | FET Proactive | 26 |
| 7th Framework Programme | FET Proactive | 54 |
| **Total** | | **224** |

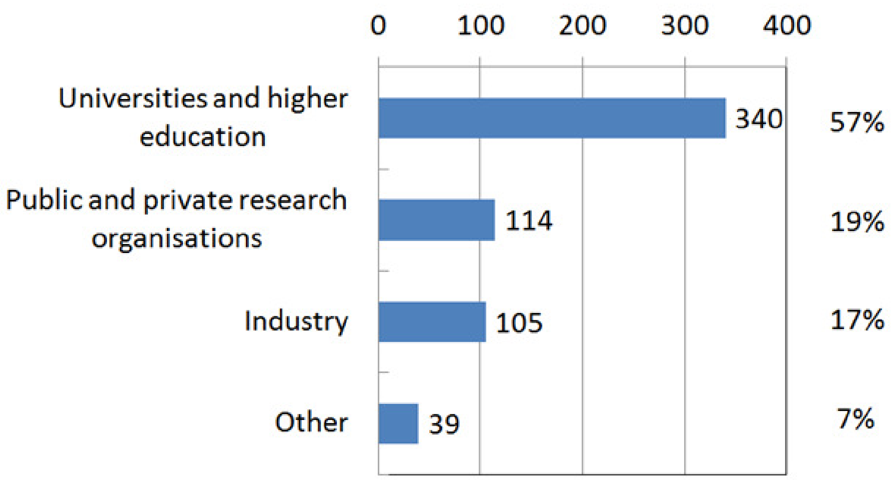
# 3 Number of unique organizations

Altogether, 598 different (unique) organisations participated in our selected 224 FET projects.[6] Universities and other educational institutions are the most important organizations with 340 of the 598 partners. 114 public and private research organisations participated in the projects, 105 partners came from industry.

Table 4: Number of unique organizations

| | | |
|---|---|---|
| Universities and higher education | 340 | 57% |
| Public and private research organisations | 114 | 19% |
| Industry | 105 | 17% |
| Other | 39 | 7% |
| **Total** | **598** | **100%** |

Figure 2: Number of unique organizations




n=224 projects (FET_TRACES sample)

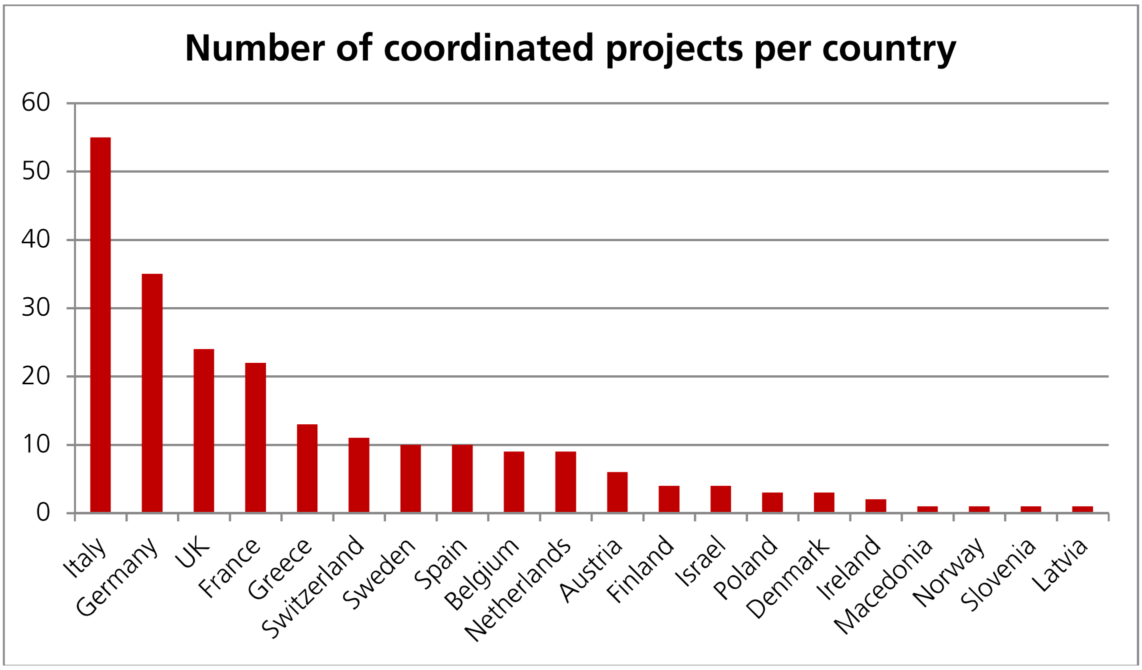
[6] The total number of unique organisations includes organisations which have local offices at different places. This was the case with IBM, Intel, and Sony which participated with offices in 2 different countries and with STMicroelectronics NV which was present with offices located in 3 different countries. We counted the local offices of these companies as unique organisations. In addition, in 2 projects (DELIS and I-SWARM), the partners were not defined.

All other organisations make up less than 7 per cent of participants. In the “others”-category there are: 9 governmental institutions, 4 consultants, 2 non-commercial/non-profit organisations and 24 special interest groups, like unions, chambers, inter-trade organisations, associations, etc.

# 4 Country of project coordinators

Concerning country distribution, we first look at country origin of project coordinators. Here, we found 55 FET projects which were coordinated by organizations from Italy. German organisations coordinated 35 FET projects, United Kingdom (UK) 24, France 22, Greece 13, Switzerland 11, Sweden 10, and Spain 10. All other countries listed below coordinated less than 10 of the 224 FET projects.

Figure 3: Number of coordinated projects per country




n=224 projects (FET_TRACES sample)

# 5 Organisations coordinating or more than one FET project

When looking at the number of organisations coordinating more than one project, we find that the *Consiglio Nazionale delle Ricerche - CNR* in Italy and *Centre National de la Recherche Scientifique - CNRS* France in France are especially present in our sample. In fact, of the 17 organisations that coordinate 3 or more FET projects, 5 are from Italy (23 projects in total), 3 from France (14 projects in total), and 3 from Germany (9 in total, see table below).

Table 5: Organisations coordinating 3 or more FET projects

| **Coordinator** | **Country** | **OrgType [7]** | **No[8]** |
|---|---|---|---|
| Consiglio Nazionale delle Ricerche - CNR | Italy | ROR | 9 |
| Centre National de la Recherche Scientifique – CNRS | France | ROR | 8 |
| Chalmers University of Technology | Sweden | EDU | 4 |
| Universita degli Studi di Trento/University of Trento | Italy | EDU | 4 |
| Scuola Superiore di Studi Universitari e di Perfezionamento S. Anna di Pisa (SSSUP) | Italy | EDU | 4 |
| Royal Institute of Technology - Kungliga Tekniska Högskolan (KTH) | Sweden | EDU | 4 |
| Politecnico di Milano | Italy | EDU | 3 |
| Universität Ulm/University of Ulm | Germany | EDU | 3 |
| Universität Stuttgart/University of Stuttgart | Germany | EDU | 3 |
| Universitat Politecnica de Catalunya (UPC) | Spain | EDU | 3 |
| Universite Libre de Bruxelles (ULB) | Belgium | EDU | 3 |
| Research Academic Computer Technology Institute - RACTI | Greece | ROR | 3 |
| Institut National de Recherche en Informatique et en Automatique (INRIA) | France | ROR | 3 |
| COMMISSARIAT A L'ENERGIE ATOMIQUE (CEA) | France | ROR | 3 |
| Fondazione ISI | Italy | ROR | 3 |

[7] OrgType of coordinator, ROR: public or private Research Organisations, EDU: Universities and higher education.

[8] No of projects coordinated

| | | | |
|---|---|---|---|
| Delft University of Technology | Nether-lands | EDU | 3 |
| Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. | Germany | ROR | 3 |

# 6 Coordinators: Types of Organisations

Most FET projects are coordinated by universities and other educational institutions (152 of the 224), 61 projects are coordinated by public and private research organisations and 8 by industry.

Table 6: Organisations coordinating more than 2 FET Projects

| Orgtype of coordinator | | No of projects |
|---|---|---|
| EDU | universities and other educational institutions | 152 |
| ROR | public and private research organisations | 61 |
| IND | Industry | 8 |
| OTH | Others (for example special interest groups, unions, chambers, inter-trade organisations, associations) | 2 |
| CON | Consultants | 1 |

# 7 Industry participation in FET projects

Of special interest is the role of enterprises in FET projects. As the table above shows, there are 8 projects in our sample which were coordinated by industry. Of all 224 projects, this makes up for a share of 3,6%. The coordination of a FET project is a strong indicator for industry relevance of the research topic. We assume that the partner coordinating a FET project is also the partner who initiated the project or who at least plays a central role in the project. In the course of the further analysis of the FET_TRACES project we will look closer at enterprise-led FET projects.[9]

Another indicator for application orientation is the total number of enterprises participating in FET as a share of the total number of participating organisations. As stated in section 1.2, most of the FET participants are from universities or research organisations (76%). However, in our sample we also find 105 unique enterprises (participants, including coordinators), which makes a share of 17% of all participants (n=398, see table in section 1.2)[10]. The absolute number of enterprise participation is even higher because some enterprises are involved in several FET projects. For example Thales participated in 12 FET projects, STMicroelectronics NV in 6, Philips NV in 5, IBM Corporation and Ericsson AB each in 4, etc. (see table of enterprises in appendix A which shows that there are 147 absolute participations of enterprises in FET projects).

A third indicator for application orientation is the number of FET projects with at least one partner from industry in the project consortium. Having at least one industry partner in the consortium indicates that the research topic is of some relevance for future applications. In our sample we find 89 projects (out of 224) having a least one industry partner which makes for a share of 40% of all projects (see table). This is a relatively high share. It shows that in the FET programme, the whole range of research - from basic research to applied science - is being supported. It has to be noted that in FET Proactive, enterprise participation is significantly higher than in FET Open projects.

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9 Enterprises coordinating a FET project were: Telecom Italia SPA Italy (two projects), Alcatel-Lucent France, Atmel Roma SRL Italy, Atos Origin SA Spain, Rainbow Photonics Ag Switzerland, Thales Group France, and Thomson SA France.

10 This share seems to be in line with figures from other time periods, also when including CSAs and FET Flagships. For example, the first two call periods of H2020 projects (counted up to June 2016) shows a participation of enterprises of 11 percent (Source: FET Unit (2016): Future Emerging Technologies. Approach, facts, figures and success stories. Internal paper, p. 4). This means that out of a total of 971 participants in this time period, there were 107 SME participating. According to the same source this means an increase of enterprise participation compared to FP7 FET projects: There, enterprise participation has only amounted to 5%.

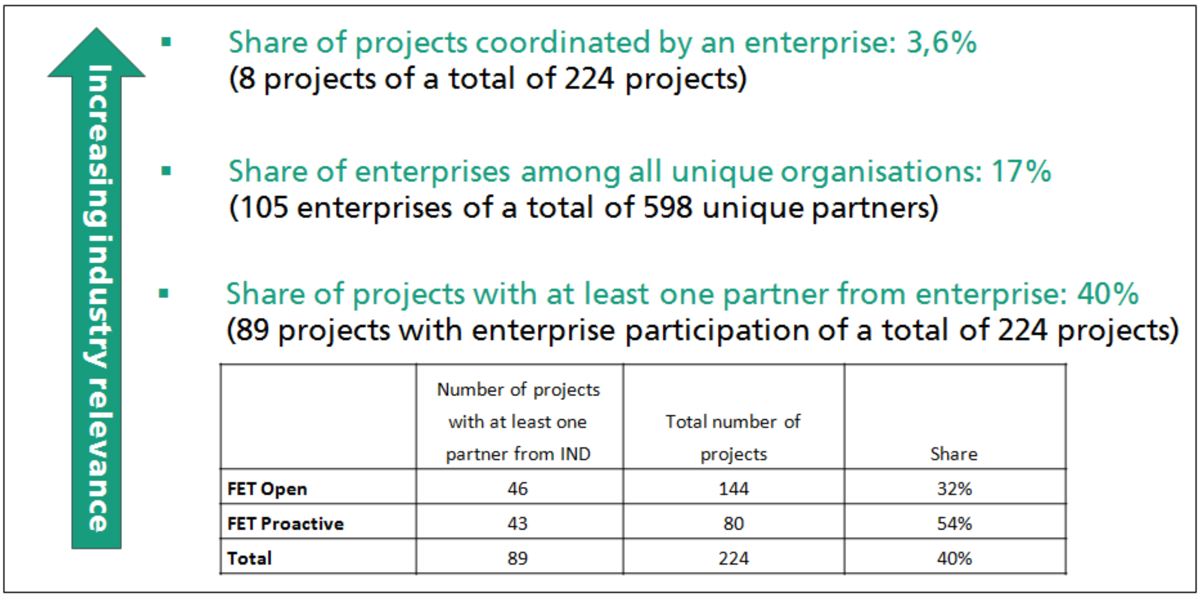
Table 7: Enterprises in FET Open and FET Proactive projects

| | Number of projects with at least one partner from IND | Total number of projects | Share |
|---|---|---|---|
| **FET Open** | 46 | 144 | 32% |
| **FET Proactive** | 43 | 80 | 54% |
| **Total** | 89 | 224 | 40% |

n=224 projects (FET_TRACES sample)

The figure below shows the three indicators for application orientation in an overview.

Figure 4: Enterprise participation in FET

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| **Total** | 89 | 224 | 40% |

n=224 projects (FET_TRACES sample)

# 8 Countries of project partners

FET project partners came from a variety of European Member States, where Germany France, Italy, and the United Kingdom (UK) are most visible. In fact, where Italy was the country with the most projects *coordinated* (see section 1.3), we find Germany to be the country with the highest number of organisations *participating* in FET projects.

We counted count each partner participation. This means that in projects with more than one partner form the same country we counted the actual number of participants which is different from a “unique participation”-counting. The results using actual participations are: German organisations have participated 289 times, France follows with 218, Italy with 207 and paricipants from United Kingdom were involved 190 times. Switzerland is very visible and ranked already next to the United Kingdom with 118.

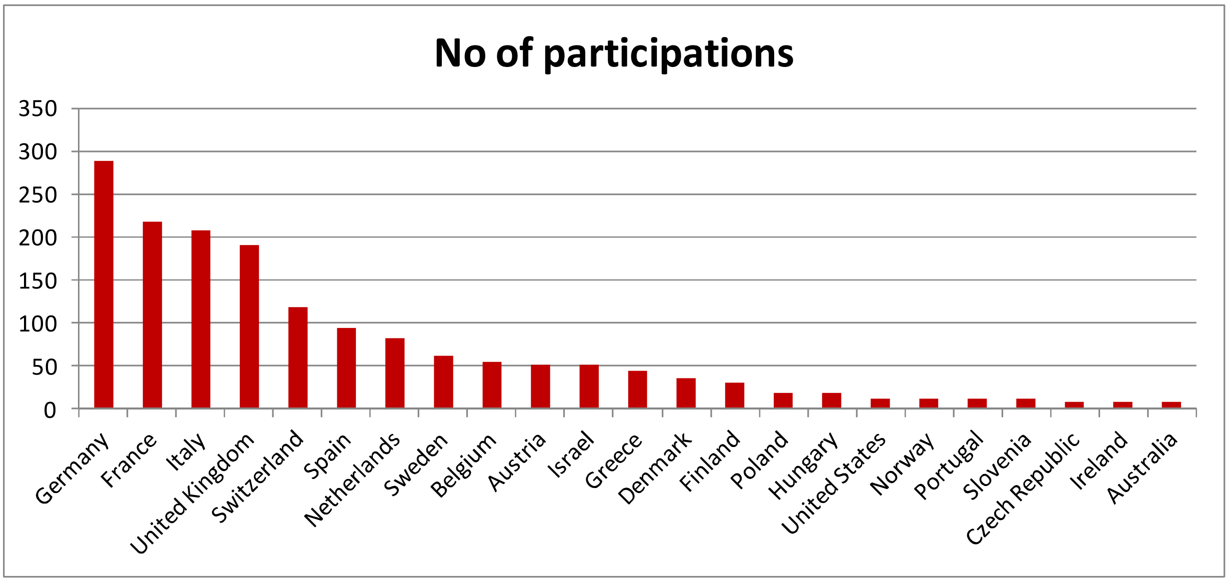
All other European Member States participated in less than one hundred times: Spain in 95, the Netherlands in 83, Sweden in 61, Belgium in 55, Austria in 52, Greece in 45, Denmark in 36, Finland in 30, Poland 19, Hungary 18, Slovenia 11, Portugal 11, Ireland 10, Czech Republic 9 (see chart).

Countries which participated fewer than 5 times are Cyprus with 4, Slovakia with 3, Lithuania with 3, Romania, Latvia and Bulgaria with 2 each and Malta, Estonia, and Croatia participated in 1 project each.

Regarding European Countries that are not EU Member States, Switzerland with its 118 participants is followed by Norway involved 11 times, Turkey with 5 and the Russian Federation participating 4 times. Ukraine, Serbia, Macedonia, Liechtenstein and Belarus were each present in 1 project.

Partners from outside Europe were involved in the FET projects of our sample 90 times. Partners from Israel were involved 52 times, partners from the United States in 12, Australian partners in 8, Canadian in 5, Japanese in 3. For Uruguay, Singapore and Brazil 2 participations were counted each and the Republic of Korea, Mexico, India, and Egypt participated each in one project.

Figure 5: Number of participations per Country (listing EU and non-EU-countries) countries with more than 5 participations)




n=224 projects (FET_TRACES sample)

# 9 Organisations participating in more than 15 FET projects

In this section, we again look participants including coordinators and identify those organisations which were most active in the FET projects in our sample. Altogether, 278 organisations participated in more than 2 FET projects, 12 organisations in more than 15 FET projects.

The most active organisations with more than 15 FET projects are firstly national umbrella organisations. The French Centre National de la Recherche Scientifique (CNRS) is leading the list with the involvement in 56 FET projects. In Italy, the umbrella organization *Consiglio Nazionale delle Ricerche - CNR* is involved in 27 FET projects. Two German umbrella organizations, the *Max-Planck-Gesellschaft zur Förderung der Wissenschaften (MPG)* and the *Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung (FhG)* were participating in 25 respectively 21 projects. Beside national umbrella organisations, some universities are very active in the selected FET projects.

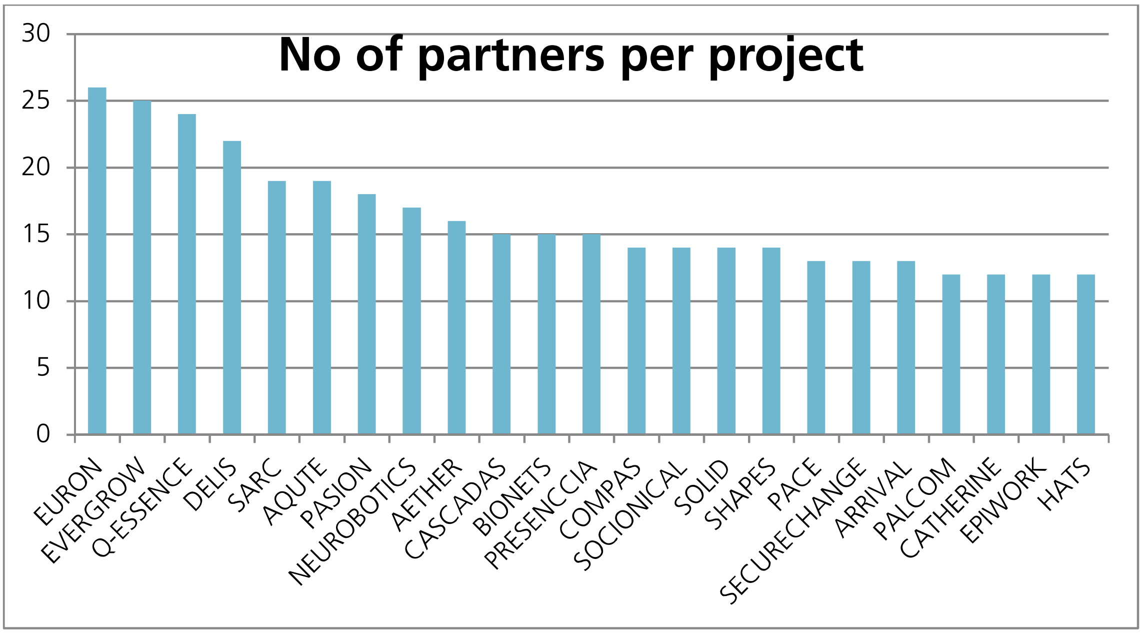
Table 8: Organisations involved in more than 16 FET Projects

| Organisation | Country | Number |
|---|---|---|
| Centre National de la Recherche Scientifique – CNRS | France | 56 |
| Ecole Polytechnique Federale de Lausanne - EPFL - Swiss Federal Institute of Technology, Lausanne | Switzerland | 32 |
| ETH Zürich - Eidgenössische Technische Hochschule - Swiss Federal Institute of Technology | Switzerland | 32 |
| Consiglio Nazionale delle Ricerche - CNR | Italy | 27 |
| Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V. (MPG) | Germany | 25 |
| Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. | Germany | 21 |
| Delft University of Technology | Netherlands | 19 |
| Institut National de Recherche en Informatique et en Automatique (INRIA) | France | 18 |
| Royal Institute of Technology - Kungliga Tekniska Högskolan (KTH) | Sweden | 17 |
| Imperial College London - ImperialCL | UK | 16 |
| Chalmers University of Technology | Sweden | 16 |
| COMMISSARIAT A L'ENERGIE ATOMIQUE (CEA) | France | 16 |

# 10 Number of partners in FET projects

The number of partners in FET projects differs highly, ranging from 3 partners up to 26 partners in a single project. With 26 partners, the FET-proactive project EURON, the European Robotics Network involves the broadest variety of partners. Projects with more than 11 partners are presented in the next figure.

Figure 6: FET Projects with more than 11 partners




n=224 projects (FET_TRACES sample)

# 11 Typical number of participants in FET projects

FET Open projects usually are smaller than FET Proactive projects. This is also reflected by the typical number of project partners: In FET Open, the typical number of partners is around 6 whereas in FET Proactive projects it is around 9 partners.

Table 9: Average number of project partners in FET Open projects

| **FET Open** | **Number of partners** |
|---|---|
| average | 6.4 |
| median | 6 |

Figure 7: Number of project partners in FET Open projects

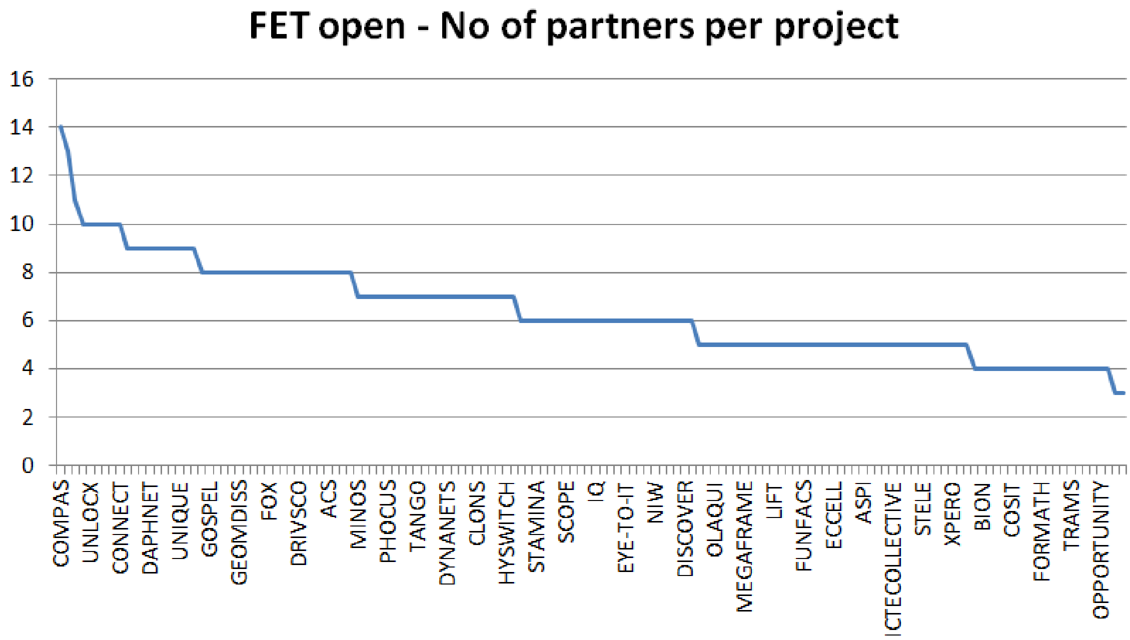
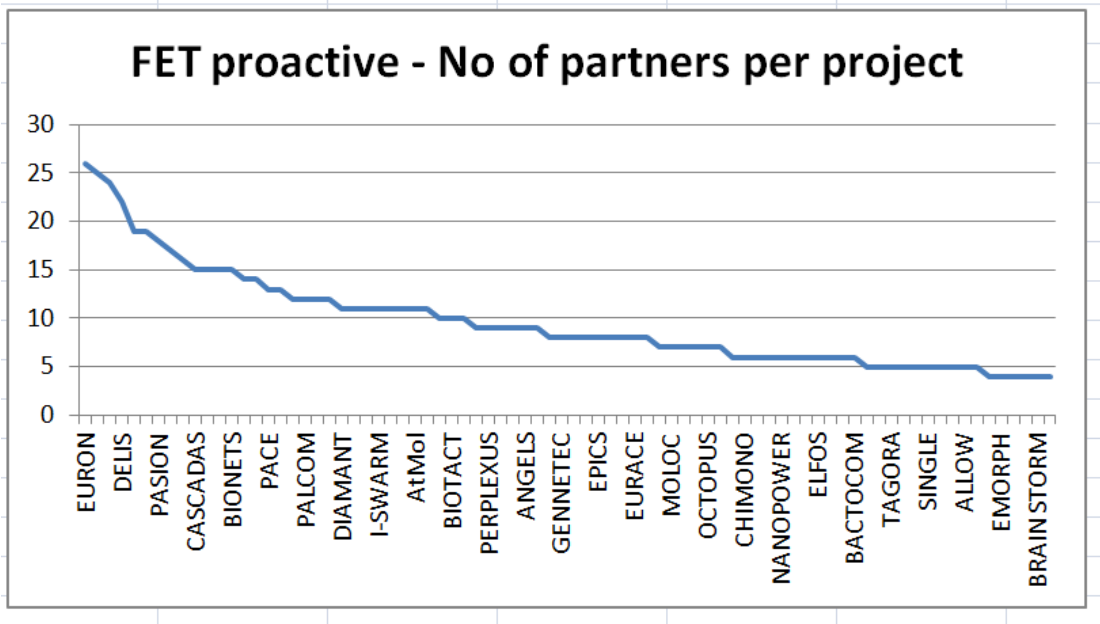



Table 10: Average number of project partners in FET Proactive projects

| FET Proactive | Number of partners |
|---|---|
| average | 9,7 |
| median | 8 |

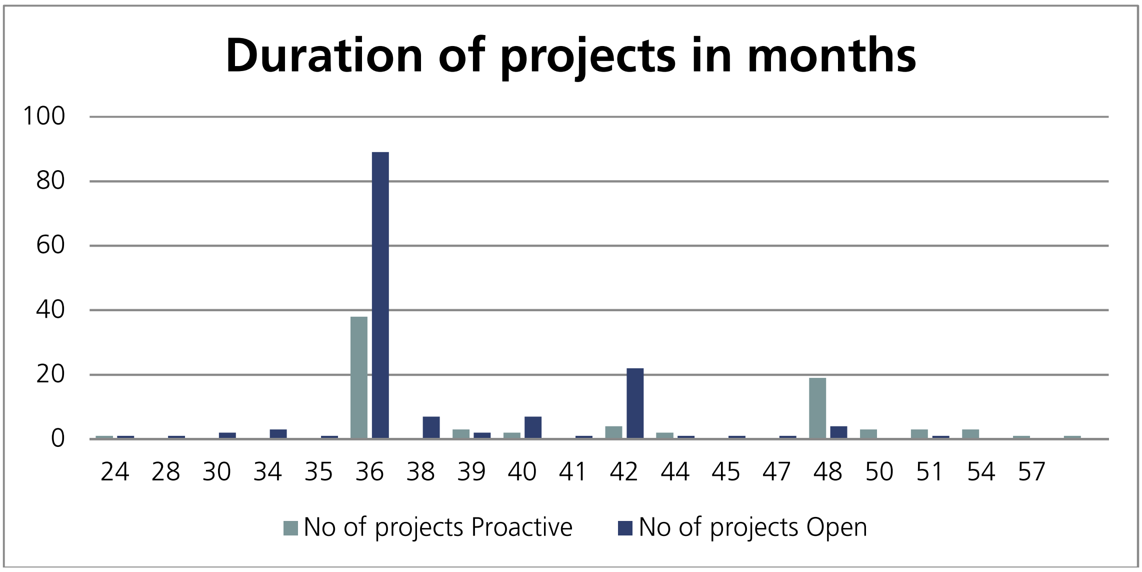
Figure 8: Number of project partners in FET Proactive projects



# 12 Duration of FET projects

The analysis of the duration of FET projects has revealed a heterogeneous picture. The duration of FET projects ranges from 24 month up to 66 months. The average project duration of FET Open projects is 37,65 months, whereas the average duration of a FET Proactive project is 41,8 months. A typical duration of FET projects is 36 months whereas we find 89 FET Open projects with this duration and 38 FET Proactive projects with this duration.

Figure 9: Duration of FET projects in our sample




n=224 projects (FET_TRACES sample)

# 13 Distribution of project budgets between FET Open and FET Proactive projects

Altogether, 144 of the projects in our sample were funded in the FET-Open scheme[11] and 80 projects were funded within FET-Proactive. The sum of the project costs of all 224 projects is roughly 756 Mio Euro (756.385.916 €) and the sum of EU funding of these projects is roughly 568 Mio Euro (568.096.621 €).[12]

We can however note that the 80 FET Proactive projects have received in total more EU funding (297.966.950 €) than the 144 FET-Open projects (270.129.671 €).

Table 11: Budgets of FET projects (in Euro)

| FET | No of projects | Project costs | EU funding |
|---|---|---|---|
| Open | 144 | 357.911.756 | 270.129.671 |
| Proactive | 80 | 398.474.160 | 297.966.950 |
| **Total** | **224** | **756.385.916** | **568.096.621** |

Table 12: Smallest and highest budget and typical project budget: FET Open

| FET Open | EURO |
|---|---|
| smallest budget | 986.000 |
| highest budget | 4.575.602 |
| average | 2.485.498 |
| median | 2.454.190 |

11 Only one project was funded in the subscheme "SMEs in FET" of FET Open. It is the COSIT project (Compact High Brilliance Single Frequency Terahertz Source) from the Call ICT-2011.9.2

12 Whereas the cost for EURON (Record Control Number 71111) is not available (only the EU-funding is available).

Figure 10: Budget distribution of FET Open projects in our sample

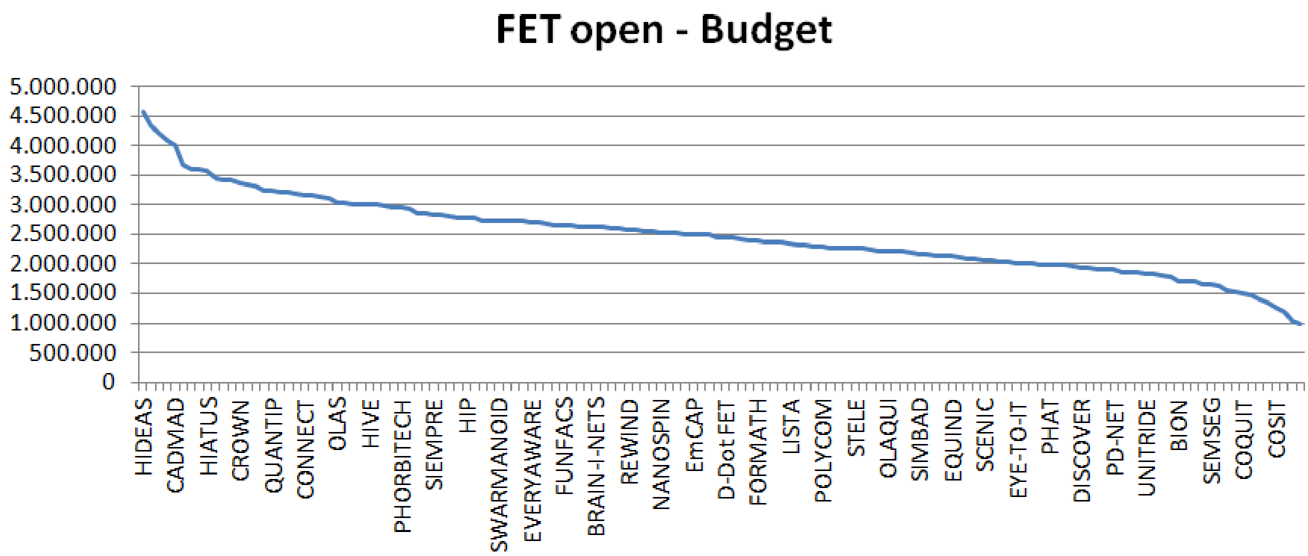
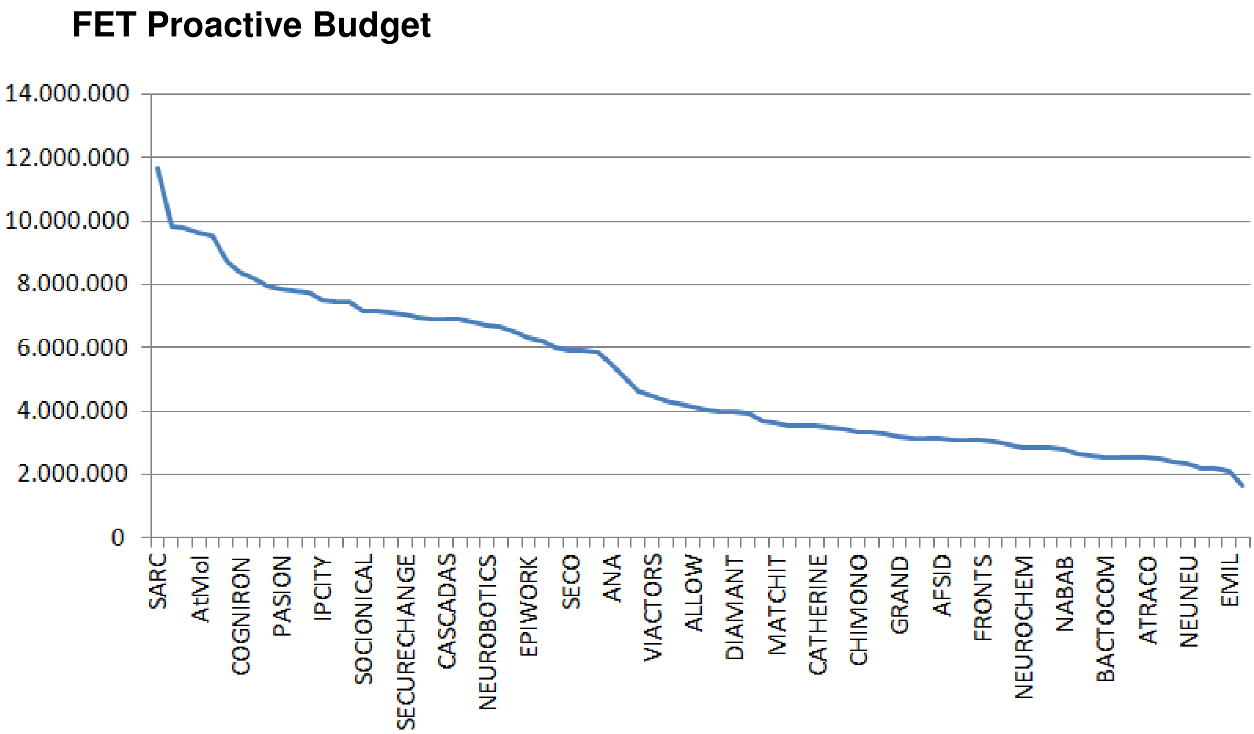



Table 13: Smallest and highest budget and typical project budget: FET Proactive

| FET Proactive | EURO |
|---:|---:|
| smallest budget | 1.631.545 |
| highest budget | 11.681.410 |
| average | 5.022.677 |
| median | 2.777.932 |

Figure 11: Budget distribution of FET Proactive projects in our sample



# 14 Background information: FET in FP6/ FP7

Table 12: FP6 - FET in the IST Programme

| |
|---|
| In FP6, FET was the "IST Programme nursery of novel and emerging scientific ideas". Its mission was to promote research characterized by a long-term nature or involving particularly high risks with a high potential for a significant societal or industrial impact.[13]<br><br>FET was not constrained by the IST Programme priorities but rather aimed to open new possibilities and aimed to set new trends for future research programmes in Information Society Technologies.<br><br>FET goals were addressed in two different schemes in FP6:<br><br>• FET OPEN SCHEME[14]: a 'roots up' approach available to any ideas for long-term visionary research related to IST. It aimed at supporting the widest possible spectrum of research opportunities and to nurture bold ideas that would involve high risks.<br><br>• FET PROACTIVE SCHEME15: a 'top down' approach which sets the agenda for a small number of strategic areas holding particular promise for the future. Actions focused on predefined themes: ACA (Advanced Computing Architectures), BIO-I3 and other NEURO-IT related initiatives; CO (Complex Systems), COMS (Situated and Autonomic Communications), DC (The Disappearing Computer), FP5-UIE (Univeral Information Ecosystems), FP5-TN (Thematic Networks in FP5), GC (Global Computing), NANO (Emerging Nanoelectronics), PR (Presence Research), QIPC (Quantum Information Processing and Communications), RO (Beyond Robotics), |

Table 13: FP7 - FET in the IST Programme

| |
|---|
| In FP7, FET is the" ICT incubator and pathfinder for new ideas and themes for long-term research". Its mission was again to promote high risk research characterized by potential breakthrough with high technological or societal impact.<br><br>• FET-Open aimed in FP7 to serve as a light, topic-agnostic and deadline free research funding scheme to support novel and fragile ideas that challenge current thinking, The scheme stimulated interdisciplinary non-conventional to explore and |

[13] http://CORDIS.europa.eu/ist/fet/home.html

[14] http://CORDIS.europa.eu/ist/fet/int-o.htm

[15] http://CORDIS.europa.eu/ist/fet/int-p.htm

foster new research trends and helping them mature in emerging research communities. [16]

- FET-Proactive aimed to be a pathfinder for the ICT programme by fostering novel approaches, foundational research and supporting initial in selected themes. As a 'top-down approach' it was the counterpart of the 'open' scheme to support emerging societal and industrial needs. [17]

Both kinds of FET projects (Open and Proactive) are complementary and could build on one another.

16 http://CORDIS.europa.eu/fp7/ict/fet-open/home_en.html

17 http://CORDIS.europa.eu/fp7/ict/fet-proactive/home_en.html

# 15 Two time periods: Early projects and more recent projects

For the LDA analysis, which will be done in a later work package, it is important to distinguish between early and more recent projects. The sample includes FP6 projects as well as FP7 projects, all more recent projects ending no later than end of the year 2014. The project sample is divided into two 4-year time slots, 2007-2010 (projects finished some time ago, mostly FP6) and 2011-2014 (projects finished rather recently, mostly FP7).

Table 14: Time slot distribution of our sample

| **Time slot** | **Number of projects** |
|---|---|
| Early projects: (finished between 2007 and 2010) | 100 (45%) |
| More recent projects: (finished between 2011 and 2014) | 124 (55%) |
| **Total** | **224 (100%)** |

# 16 Coverage of topics in FP7 FET projects

Starting with FP7, FET Open and FET Proactive projects have been assigned to one of 12 predefined topical clusters (see table below) by the FET unit. This 12-topics-grid gives a rough overview of the subject the projects have been dealing with. The 12 topics are the point of reference of the following analysis.

Figure 15: FP7-FET - 12 topics[18]


Source: https://ec.europa.eu/digital-single-market/en/fet-projects-portfolio, see also the Future & Emerging Technologies (FET) FP7 Projects Compendium 2007-2013.

It has to be noted that for FP6-projects, such a topical assignment does not exist. In principle, a similar topical assignment could be done using to the different calls of FP6 Proactive initiatives. However, it seems that not all FP6 FET projects were assigned to these headlines. A list of Proactive calls and related projects (FET Proactive as well as

[18] Source: https://ec.europa.eu/digital-single-market/en/fet-projects-portfolio; See also the Future & Emerging Technologies (FET) FP7 Projects Compendium 2007-2013.

FET Open) can be found in the FET Proactive Initiative activity report of 2007.[19] In this report, 73 FET projects of FP6 (37 FET Proactive, 36 FET Open) were grouped under the following headings:

Table 14: Topics covered by FET-projects in FP6 (according to FET Proactive calls)

1. BEYOND ROBOTICS
2. DISAPPEARING COMPUTER
3. COMPLEX SYSTEMS
4. SIMULATION OF COMPLEX SYSTEMS
5. QUANTUM INFORMATION PROCESSING AND COMMUNICATIONS
6. GLOBAL COMPUTING
7. EMERGING NANOELECTRONICS
8. BIO-INSPIRED INTELLIGENT INFORMATION PROCESSING SYSTEMS
9. ADVANCED COMPUTING ARCHITECTURES
10. PRESENCE AND INTERACTION IN MIXED REALITY ENVIRONMENTS
11. SITUATED AND AUTONOMIC COMMUNICATIONS
12. SIMULATION OF COMPLEX SYSTEMS
13. QUANTUM INFORMATION PROCESSING AND COMMUNICATIONS
14. GLOBAL COMPUTING
15. EMERGING NANOELECTRONICS
16. BIO-INSPIRED INTELLIGENT INFORMATION PROCESSING SYSTEMS
17. ADVANCED COMPUTING ARCHITECTURES
18. PRESENCE AND INTERACTION IN MIXED REALITY ENVIRONMENTS
19. SITUATED AND AUTONOMIC COMMUNICATIONS

Source: FET Proactive Initiatives. Activity Report 2007, p. 45-47.

The FET projects listed within these topical headers were started between 2004 and 2007. Obviously the list does not include a larger share of FET-Open projects. Thus, a more detailed analysis of topics of FET-projects in FP6 cannot be provided. However, the list of topics displayed above gives an indication on the spectrum of research subjects covered in FP6 FET-projects.

[19] FET Proactive Initiatives. Activity Report (2007): 6TH FRAMEWORK PROGRAMME, 2002-2006, APPENDIX: IST FET FP6 Projects in Proactive Initiatives and Related Projects, http://cordis.europa.eu/pub/fp7/ict/docs/fet-proactive/press-05_en.pdf.

As mentioned above, a more detailed analysis is possible for FET-projects in FP7. The following analysis takes into account FET-Open and FET-Proactive projects started in FP7 and ending by 2014. To be exact, the number of projects which have a topical assignment is 129. However, in our total project sample we have 131 FP7 projects. The reason for the difference is that 3 projects from FP6 have also been assigned a topic but 5 FP7-projects have not, from reasons we cannot reproduce. Thus, for this topical analysis of FP7-projects we have a slightly smaller sample than in the overall sample.

To give a short overview, what topics are being explored in the different clusters, we present the portfolio-descriptions by the FET unit as it can be found on the Websites of the programme.[20]

Figure 15: S&T topics in the relevant FET clusters as presented by the FET programme


Understanding by building is at the heart of research in Artificial Intelligence (AI) and cognitive systems.

This area explores synergies between cognitive science and the neurosciences, but also the social sciences and humanities to create technologies for intelligent systems. Creativity, context awareness, associative reasoning, learning, adaptation, evolution, emotion and social intelligence are some of the topics addressed.

**For example, projects deal with:**

- Trying to use real bacteria for computing (EVOPROG)
- Trying to use real bacteria for cell-to-cell communication (PLASWIRES)
- Designing computational architectures using the nervous system as a blueprint (SI ELEGANS)

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20 https://ec.europa.eu/digital-single-market/fet-projects-portfolio. Please note that the project examples given in the overview are not necessarily projects of our sample.


The convergence of biology, nanotechnology, neuroscience and information technology is interfacing wet and dry technologies.

This convergence creates tools to better study one or the other, to create hybrids between them or to use inspiration from neuroscience and biology to create better systems (sensors for instance). Neuroprosthetics is an important area of application for this.

**For example, projects deal with:**

- Designing swarm-robotics using insights from cellular level morpho-genesis in plant roots (SWARM-ORGAN).
- Using plants as sensors for pollutants (PLEASED)
- Using real bacteria for parallel computing  (ABACUS)
- Artificial eyes: Developing a silicon retina (SEEBETTER)
- Retina-inspired encoding for advanced vision tasks (RENVISION, VISUALISE)

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When many simple systems start to interact, anything can happen.

In complex systems, even if the local interactions among the various components may be simple, the overall behaviour is difficult and sometimes impossible to predict, and novel properties may emerge. Understanding this kind of complexity is helping to understand many different phenomena, from financial crises, global epidemics, propagation of news, connectivity of the internet, animal behaviour, and even the growth and evolution of cities and companies. Mathematical and computer-based models and simulations, often utilizing various techniques from statistical physics are at the heart of this initiative.

**For example, projects deal with:**

- Exploiting  evolutionary computation principles to build bio-hybrid adaptive systems (ASSISI_bf)

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Computers are everywhere, but is computer science ready for it?

This is the challenge in this area where projects are pushing information theory, algorithmics, signal processing, communication protocols, cryptography and other core areas of computer science to a new level of ambition where the high expectations that others have from it can really be met.

**For example, projects deal with:**

- Speed of adaptation in population genetics and evolutionary computation (SAGE)


Computing architectures

How will we progress to massively parallel systems, possibly using millions of cores?

How to overcome the strict separation between memory and processing functions? How to deal with the changing balance between computing power and data intensity? How will we build computers so complex that component failures are a way of life?

**For example, projects deal with:**

- Heterogeneous Ad-hoc Networks for Distributed, Cooperative, and Adaptive Multimedia Signal Processing (HandiCAMS)


Green Computing & Networking

Energy consumption is one of the biggest hurdles towards achieving green computing and networking.

A growing number of projects are tackling this problem head on.

**For example, projects deal with:**

- Operating ICT basic switches below the Landauer limit (LANDAUER)


Human-Computer Interaction

The screen, the keyboard, the mouse: is that how we will interact with computers forever?

Of course not! In the future computers may speak and understand natural language, engage all our senses (touch, smell, …), understand what we want ('Help me!') from the context, or adapt to our mood. Embedded in our living environment or' disguised' as robots, everyday objects, in our cloths or behind 3D interfaces, we will simply forget about them and enjoy the magic they create for us.

**For example, projects deal with:**

- Making a computers learn to recognise and produce a sound which is being described verbally and non-verbally by gestures (SKAT_VG)


Information & Modeling

Information, knowledge and models are three steps along the way to understanding the weather, the physiology of diseases, or the economy.

As systems become more and more complex we need better tools to capture the information, to extract the knowledge, to construct and to validate the models. Projects in this area look at privacy preserving data collection, data mining, multi-level modelling, high-end simulation, visual analytics, among others.

**For example, projects deal with:**

- Data Science for Simulating the Era of Electric Vehicles (DATA SIM)


Interdisciplinary science and technology collaboration challenges the limits of current research and innovation practices.

FET projects often have to bridge between very different research areas that use very different vocabularies, apply different methodologies, often have a different pace of progress, and have different habits of publication, industry collaboration, and so on. In this sense FET also explores new ways in which collaborative science and innovation can be done.

**For example, projects deal with:**

- Connecting ICT and Art communities: new research avenues, challenges, and expected impact (FET-ART)


Devices that exploit quantum phenomena such as superposition and entanglement of quantum states have the potential to enable radically new technologies.

Several promising directions are now well known, for instance quantum simulation, quantum communication, quantum metrology and sensing, and the quantum computing in a long term. FET projects in FP7 have kept on exploring these new mind-boggling possibilities and have produced some world class fundamental results, while also pushing other topics, like quantum key distribution, metrology and sensing, to the level of more practical use.

**For example, projects deal with:**

- Scalable Superconducting Processors for Entangled Quantum Information Technology (ScaleQIT)
- A Guided Matter-Wave Interferometer on a Atom-Chip (MatterWave)


This area is pushing science and engineering of robots beyond fiction.

Robots inspired by plants, octopus or insects. Swarms of robots with emergent behaviours, evolving and shape-changing robots? These are some of the topics explored in this area.

**For example, projects deal with:**

- Mimicking roots developments in a plant-like artefact (PLANTOID)


Computers are tireless in shuffling ones and zeros around.

Why ones and zeros? And why with currents, transistors and silicon chips as in any computer, laptop, mobile phone or tablet today? These projects show how to compute with, for instance, light, sound, molecules or bacteria. They show how to encode information in different ways, like analog or in electron spins. They question the meaning of computing, and push the limits of what is computable.

**For example, projects deal with:**

- Trying to use cellular processes as a basis for parallel computing (BIOMICS)
- Programming cellular networks and community behaviour with synthetic RNA-based devices (RIBONETS)
- Using mathematical methods to detect cancer in tissues in real-time (Helicoid)

In the topical portfolio-analysis of FP7-projects of our sample, we display the number of projects funded within the topics and the budgetary strength of the respective clusters.

Of the 129 FET Open and FET Proactive FP7 projects in this sub-sample, the most projects were grouped into the “Unconventional Devices” topic (32 projects or 25% of all projects in the sample). Second and third places according to the number of projects are “Quantum & Photonics” (20 projects or 16% of all projects) and “Bio- & Neuro-ICT” (17 projects making a share of 13% of all projects) (see following table).

Table 15: Number of projects in topical clusters

| | Topics in FET | Total No. of projects | FET Open | FET Proac-tive |
|---|---|---|---|---|
| 1 | Unconventional devices | 32 | 22 | 10 |
| 2 | Quantum & Photonics | 20 | 17 | 3 |
| 3 | Bio- & Neuro-ICT | 17 | 8 | 9 |
| 4 | Computer Science | 16 | 12 | 4 |
| 5 | Human-Computer-Interaction | 12 | 8 | 4 |
| 6 | Complexity | 10 | 5 | 5 |
| 7 | Green Computing & Networking | 5 | 2 | 3 |
| 8 | Computing architectures | 5 | 1 | 4 |
| 9 | AI & Cognition | 4 | 1 | 3 |
| 10 | Information & Modeling | 4 | 3 | 1 |
| 11 | Robotics | 3 | 0 | 3 |
| 12 | Practices & Communities | 1 | 1 | 0 |
| | Total | 129 | 80 | 49 |

A similar picture evolves when analyzing the budgetary strength of the topical clusters. Here again, the top-three clusters are “Unconventional Devices” (with a budget of 77,8 Mio Euros or 23 percent of the total budget of this sample), “Bio- & Neuro-ICT” and “AI & Cognition”.

Table 16: Budget of projects in topical clusters

| | Topics in FET | Total budget of cluster in Mio Euro | Average project budget in Mio Euro |
|---|---|---|---|
| 1 | Unconventional devices | 77,8 | 2,4 |
| 2 | Quantum & Photonics | 48,7 | 2,4 |
| 3 | Bio- & Neuro-ICT | 44,9 | 2,6 |
| 4 | Computer Science | 38,0 | 2,4 |
| 5 | Complexity | 33,8 | 3,4 |
| 6 | Human-Computer-Interaction | 26,7 | 2,2 |

| | | | |
|---|---|---|---|
| 7 | Computing architectures | 15,7 | 3,1 |
| 8 | Green Computing & Networking | 10,9 | 2,2 |
| 9 | Robotics | 16,1 | 5,4 |
| 10 | Information & Modeling | 11,1 | 2,8 |
| 11 | AI & Cognition | 9,1 | 2,3 |
| 12 | Practices & Communities | 1,8 | 1,8 |
| | **Total** | **334,6** | **2,75** |

The average project budget ranges between 2 and 3 Mio Euros. Interestingly, in the "Robotics"-cluster, average projects are bigger and amount to 5,4 Mio Euros.

# 17 Publications

The analysis of publications of FET projects is based on publications that are listed in CORDIS and publications of the Web of Science (WoS). To have comparable data for all FET projects, the WoS data are the most important ones. The Web of Science provides publication data of FET projects that have no longer a website or/and have not reported their publications to be part of the CORDIS database. Not all publications of the respective projects might be listed in the WoS but the use of the database makes project output comparable and ensure that potentially important project publications are covered. However, this is only the case if the authors indicate FET funding in the acknowledgements.

We used a variety of approaches to match and identify publications related to FET projects. With different search strategies and combinations of strategies we identified more than 6000 potential FET –related publications. More than 4000 have been determined as being related to the selected FET projects. However, in some cases, authors used a grant number that was not related to their project. In these cases we had to eliminate assigned publications accordingly. In the following section, we list the publications that are traced so far and have been clearly attributed, as part of the detailed information of each project. Altogether we have found 4197 publications attributed to the 224 FET-projects in our sample.

More entries will probably be added in the context of the following work packages. Originally we wanted to include results from more sophisticated methods into this deliverable (like network of authors or disciplinary stretch of the consortium). However, as these methods are applied in later work packages we will document them at later stages in the respective deliverables.