

PROJECT FINAL REPORT

Grant Agreement number: 290591

Project acronym: PI

Project title: The Piezo Institute – European expertise centre for multifunctional and integrated piezoelectric devices

Funding Scheme: Coordination and Support Action

Period covered: from 1st March 2012 to 28th February 2015

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4.1 Final publishable summary report

Executive Summary

The Piezo Institute (PI) is Europe's centre of expertise within the field of piezoelectric multifunctional materials, their technologies and devices. The Piezo Institute's aim is to exploit its know-how to improve the competitiveness of European industry through the provision of best practice and expertise within the field of piezoelectric, multifunctional materials and devices. This will be delivered through growth of its membership, delivery of industrial training and conferences, business brokerage and outreach activities. This has been realised through a series of connected work packages containing preparatory activities falling into one of 7 categories:

- Materials – creation of institute legal, education and operational materials
- Surveys – gathering information from the community.
- Shaping – defining the shape of Institute activities.
- Protocols – establishing methods of operation.
- Engagement – development of tools with which to encourage bilateral engagement.
- Planning – evaluation of the on-going activities and proposition of future plans.
- Financial viability – assessing the effectiveness of each income generating stream.

A sizable list of potential member organisations has been created. Through visits, phone calls and on-line surveys the opinions of these organisations have been sought to define a sector research roadmap and help shape the Institute. Through this activity the membership package and underlying services have been defined and rolled out. Corporate, SME/academia, individual and associate membership grades have been created. The institute now has over 500 associate members and 20-30 industrial members.

A series of training modules have been developed including a two-day event for industry entitled: "Introduction to piezo materials and devices" and a series of half day industry events covering key aspects of piezoelectric devices and materials. These are now being converted for on-line training to allow distance learning. In addition a number of one-off training events have been delivered to industrial audiences.

Through industry focussed interviews and questionnaires the PI has identified a demand for PhD students to undertake some or all of their training within industrial organisations. To facilitate this opportunity a student exchange/placement facility has been established on the PI website whereby members can advertise opportunities for students to spend time in their facilities. Student details and job opportunities can also be placed within the system. Three doctoral students are currently engaged in industry-academia partnerships.

Best practice for attracting industrial delegates to the Piezo XXXX series of conferences has been established. Similarly a tool kit for engaging with industry at international conferences has been established and is used to attract new members to the Institute.

Rigorous business protocols have been established to manage the brokerage service offered by the institute. Piezo Institute non-disclosure agreement, standard terms and conditions, and collaboration agreement have been established for undertaking such services.

To ensure long term sustainability of this activity the financial viability each activity stream was monitored to provide an overview of the financial health of the institute. In 2015 the Institute is expected to make a net surplus close to €4,000.

www.piezoinstitute.com

Project context and objectives

Project context and objectives,

The Piezo Institute (PI) is Europe's centre of expertise within the field of piezoelectric multifunctional materials, their technologies and devices. The Piezo Institute's aim is to exploit its know-how to improve the competitiveness of European industry by supporting this transformation process to a knowledge-based, resource-conscious economy through provision of best practice and expertise within the field of piezoelectric, multifunctional materials and devices.

In this project the institute is proposing the expansion of its current activities with the aim of increasing the Piezo Institute's financial viability in the short and long-term. These Supporting Activities will be implemented with a focus on industries through the following objectives:

- Increased industry membership
- Development of industrial training packages
- Increase industrial participation in Piezo conference
- Develop technology & business brokerage opportunities and service
- Develop a membership coordination strategy
- Develop dissemination & industry outreach capability
- Establish technology Transfer & operational protocols

Increased industry membership

Engagement of industries through visits will be performed in order to gather data on their specific needs (R&D, training, technology transfer and other services). Industries that have been identified as potential long-term partners will be approached to become members, which will give them substantial advantages such as reduced cost for all activities and access to documents & events organised by PI.

Development of industrial training packages

The training for industry will be increased through the development of new short courses and focused workshops. Industrial secondment will also be incorporated through establishment of exchange agreements for post-graduate students and industry personnel.

Increase industrial participation in Piezo conference

The industry participation at the Piezo Institute's bi-annual professional conferences "Electroceramics for end-users" will be developed with the aim of increasing both the industrial registrations, and number of stands at the associated professional exhibition. Industrial training courses will be organised as satellite activities of the more classical oral and poster presentations. Special sessions will be organised where industry participants and exhibitors will present their products and services.

Develop technology & business brokerage opportunities and service

The capability to perform research and development will be reinforced by the development of an industrial research road map to meet the needs of industry. The Piezo Institute team will identify and contact European SMEs and larger industries, and based on an analysis of outcomes will develop a

road map for piezo-technology within the sector. The Piezo Institute will also enhance its business brokerage service, with new tools. The brokering service will expertly link the customer to the extensive network of solution providers from within the Institute and will pull in additional expertise where necessary.

Develop a membership coordination strategy

We will develop a new membership strategy aimed at doubling the membership of academic members in the next three years, and also double the industrial membership. Industries will be identified through visits.

Develop dissemination & industry outreach capability

The existing PI website and dissemination package will be improved to attract more industrial partners by adding specific content relevant to industry. This will include, as a part of membership, access to a database of completed and on-going projects, technical reports, our Industrial Research Road Map as well as major facilities and associated expertise. In particular, this website will be redesigned to specifically address companies' needs. The capabilities of the PI will be highlighted and the procedures to work with industry will be put on-line.

Establish technology Transfer & operational protocols

The PI will promote technology transfer and knowledge implementation and give access to the necessary technical services such as characterisation of novel materials, powders and inks for new processing methods, properties and micro-characterisation of materials, structures and systems and the evaluation of performance and sustainability life cycle analysis – particularly important in new (Pb-free) materials development.

It should be noted that all work relating to income generation will be conducted outside of the CSA project. The effectiveness of the CSA work will be evaluated via the Financial Viability of the PI.

Principal results achieved

The aim and objectives of the programme have been realised through a series of connected work packages and tasks that interrelate as shown in figure 1. Within each work package a series of preparatory activities were undertaken with each task falling into one of 7 categories designed to prepare the Institute for income generating activities conducted outside of the CSA:

- Materials – creation of Institute legal, education and operational materials
- Surveys – gathering of information from the community via face to face, telephone and on-line questioning.
- Shaping – defining the shape of Institute activities based on community feedback and operational observations
- Protocols – establishing methods of working to ensure prompt processing of the Institute’s business activities.
- Engagement – development of tools with which to engage with the community and for the community to engage with the Institute
- Planning – Evaluation of the on-going activities and proposition of short, mid and long term plans.
- Financial viability – assessing the effectiveness of each income generating stream to ensure a financial margin was generated.


| | WP1 Management | WP2 R&D | WP3 Training | WP4 Brokerage | WP5 Membership | |
|------------|-----------------------|--|---|-------------------------------|------------------------------------|---------------------------------------|
| Materials | | | Training materials (3.1) | Legal documents (4.1) | List of potential members (5.1) | |
| Surveys | |  | | | | Visits to company & analysis (5.2) |
| Shaping | | Research road map (2.1) | ID & define needs and establish services (3.2) | ID & define services (4.2) | Define membership package (5.3) | |
| Protocols | | R&D protocols (2.2) | Industrial conference participation (3.3) | Brokerage protocols (4.1) | | |
| Engagement | | | Toolkit for engagement at conferences (3.4) | | Communication toolkit (5.4) | |
| Planning | Action plans (1.3) | | | | | |
| Financial | FV check | FV check | FV check | FV check | FV check | |

Figure 1 – interrelation of connected workpackages and tasks

1.1. General & administrative management

The Piezo Institute is an independent legal entity with a board of directors which includes a President, Vice President and Treasurer as officials. The Piezo Institute is a named beneficiary of the project but is not the Coordinator. The Coordinator works with the PI board of directors and officials to ensure that the Institute is developed as a self-sustaining independent organisation.

1.2 Financial management

The CSA finances have been managed as per standard practices.

1.3 Action Plans

Action plans based on the evaluation of the Piezo Institute's performance and funding landscape were produced and updated on an annual basis. The latest action plan produced represents the Institute's long term strategic vision for operation beyond the CSA funding period.

1.4 Monitoring of PI Financial Viability increase

The financial performance of the Piezo Institute has been monitored on an annual basis. Reflecting the Institute's business plan the financial performance of the Institute in each of the strategic areas outlined in table 1 has been monitored and used to determine the overall financial viability of the institute. For the Piezo Institute to demonstrate financial viability it is essential that the net contribution remains positive. The initial business plan assumed a relatively high level of personal interaction delivered via 1 full time equivalent staff member, delivering membership, communications and brokerage, supported with associated office infrastructure. Following multiple interactions with potential industrial partners it became clear that income from R&D brokerage was likely to be unforthcoming due to the preferred operating methods of the clients which could not be influenced by the Institute.

Table 1 – 2015 strategic income streams and fixed operational costs illustrating income and outgoings

| | Income | Outgoing | Net |
|--------------------|------------------|------------------|-------------------|
| Membership | € 36,000 | € 0 | € 36,000 |
| Conferences | € 40,000 | € 36,000 | € 4,000 |
| Training | € 30,000 | € 27,000 | € 10,000 |
| Brokerage | € 120,000 | € 108,000 | € 12,000 |
| Dissemination | € 0 | € 0 | € 0 |
| | <u>€ 226,000</u> | <u>€ 164,000</u> | <u>€ 62,000</u> |
| Fixed costs | | | |
| 1 FTE staff | | € 45,000 | € 45,000 |
| Office | | € 8,000 | € 8,000 |
| Website | | € 3,000 | € 3,000 |
| Legal & audit | | € 6,000 | € 6,000 |
| | | <u>€ 62,000</u> | <u>€ 62,000</u> |
| TOTAL | | | <u>€ 0</u> |

Table 2 – Reviewed (2015) strategic income streams and fixed operational costs illustrating income and outgoings

| | Income | Outgoing | Net |
|--------------------|-----------------|-----------------|-----------------------|
| Membership | € 7,000 | € 0 | € 7,000 |
| Conferences | € 40,000 | € 36,000 | € 4,000 |
| Training | € 0 | € 0 | € 0 |
| Brokerage | € 0 | € 0 | € 0 |
| Dissemination | € 2,000 | € 0 | € 2,000 |
| | <u>€ 49,000</u> | <u>€ 36,000</u> | <u>€ 13,000</u> |
| Fixed costs | | | |
| 1 FTE staff | | € 0 | € 0 |
| Office | | € 0 | € 0 |
| Website | | € 3,000 | € 3,000 |
| Legal & audit | | € 6,000 | € 6,000 |
| | | <u>€ 9,000</u> | <u>€ 9,000</u> |
| TOTAL | | | <u>€ 4,000</u> |

2.1 Industrial road map

The Institute’s industrial roadmap was created through direct communication with a selection of industrial companies. A questionnaire was developed by the Piezo Institute based on the 2010 Research Roadmap prepared by the MIND NoE, PI members own business experience and outputs from the PI business plan development activity. Each partner contacted industry (small and large) known to use piezoelectric materials in their products and using a questionnaire obtained information on their perspective of the field of piezoelectric materials and devices. These results were analysed and an up to date roadmap produced in 2013. An update was produced in 2014 based on continued interaction with relevant industrial organisations. Work continues to grow the roadmap and integrate the findings with on-going membership growth.

The road map has identified the following key materials, technologies and development areas that are of core interest and importance to the community:

- Materials – High temperature, lead-free, & polymers
- Structuring techniques – Films, multilayer, microsystems
- Techniques – Modelling, electrical and mechanical characterisation

High temperature and lead free materials represent areas of relative growth in importance between 2013 and 2014.

2.2 Preparation for R&D with industry

Protocols and model agreements (standard terms and conditions, non-disclosure agreements and collaboration agreements) have been produced in preparation for working with industry. Alongside these documents an industry protocol document has been established that defines the standard operating procedure to be followed when dealing with industrial enquiries. Additional ‘industrial guides’ have been created for the industrial members to facilitate networking within the institute.

A series of documents were created to allow for industrial engagement with the PI. These documents were based on outputs from discussions with industry and the development of the PI business plan.

Following detailed discussions with potential industrial collaborators, as well as individual members' existing collaborative partners, it became evident that industry does not consider it appropriate to undertake confidential R&D with the PI directly due to the difficulty in ensuring confidentiality even with a non-disclosure agreement (NDA) in place. This is mainly due to the need of the PI to subcontract the actual research to member organisations. While the PI's NDA includes its member organisations, it was felt by industry that multi-way NDAs were impractical in everyday business operations. Based on such discussions with industry the PI has defined a range of alternative ways in which it can work with industry on R&D related activities and where the supporting legal documents are required.

- Initial contact discussions – *PI NDA can be used if NDA required by industry*
- R&D dissemination services – *PI standard terms and conditions*
- PI as member of an EU R&D consortium – *EU contract takes precedence*

To facilitate the engagement with industry the database of competencies, equipment and R&D capabilities of the member organisations has been updated with information from new members. The top-level details of this remain accessible by non-members so that external organisations can see the types of capability that are accessible through membership.

2.3 Reporting on increase in FV of PI due to R&D activities conducted outside of the CSA

Financial viability of the institute with respect to R&D activities was reviewed on an annual basis. The PI has been included as a partner or subcontractor on a number of EU and national grants with a view that it would either undertake an aspect of R&D work or R&D dissemination. 2014 saw the first successful grants start and the PI receiving income from R&D dissemination activities as part of successful national programmes.

3.1 Developing training material for industrial short courses and workshops

A series of training modules have been developed. During the first year the PI developed a two-day training course for industry entitled: "Introduction to piezo materials and devices". Subsequently the PI developed a series of half-day courses aimed at industrial training. Reflecting the move to digital delivery the Institute has started to convert these courses to online training modules that industry can purchase. Users are able to complete the training courses online from their place of employment reducing the need to travel to the various venues.

Half day training courses available to industry:

- Manufacture and processing of piezo materials
- Characterisation of piezo materials
- Specialist application of piezo materials
- Piezo MEMS: design, fabrication and characterisation
- Processing and structural characterization of lead-based and lead-free piezoelectric ceramics
- Environmental issues and lead-free materials

In addition to the on-going training modules developed the Institute has also organised a number of special events including a Masters short course (EMRP METCO, Piezo Institute collaboration) on

high temperature properties of piezoelectrics was delivered in January 2015 in Maribor, Slovenia. It was attended by nearly 50 people, with 35% from industry, including major European companies Meggitt, Bosch and EPCOS and included industry speakers covering commercial developments in high temperature piezoelectric materials. A industry focused conference entitled “Piezoelectric Micro and Nano Structures and their Applications” was held on September 25-26th 2014 in Blois, France. The topics covered were piezoelectric MEMS and NEMS, devices (sensors, actuators, energy harvesters and ultrasonic transducers) and piezo-semiconductor nanomaterials modelling, synthesis and characterization. More than 60 researchers, from industry (Xaar, ESAOTE, ST Microelectronics and VERMON SA) and academia attended with 14 invited talks.

3.2 Investigation of needs for integration of industry in education programmes (including scientist exchanges from industry to academia)

Through industry focussed interviews and questionnaires the PI has assessed the demand for integration of industry in educational programmes. Results from the analysis of industrial needs indicate that there is an interest in seeing the PI provide opportunities for industrial engagement in educational programmes, however the different forms of engagement are not all viewed equally. The lowest level of interests was seen in supporting MSc level students placed at universities, while the highest level of interest was seen in having PhD students residing in companies. These preferences show a clear alignment with direct benefit that a company may receive through support of that student. To facilitate this opportunity a student exchange/placement facility has been established on the PI website whereby members can advertise opportunities for students to spend time in their facilities. Student members based at University PI member organisations are then able to access this information and apply for the relevant post. Student members are also able to place their details on the exchange site where they can be searched by interested partner organisations. The Placements/Student exchange portal is also capable of advertising vacancies for graduate jobs so that students coming to the end of their studies and employers may benefit from access to this focussed market.

Through this activity a number of collaborative activities have been realised including:

- A study programme for Bologna Masters level at the Jozef Stefan International Post-Graduate School (Slovenia) focusing on piezoelectric actuator, including materials synthesis, processing, dielectric measurements and finite element modeling was conducted in the study year 2013/14.
- A joint PhD studentship with the University of Tours (France) and the Jozef Stefan International Post-Graduate School (Slovenia) is active.
- A joint EngD PhD studentship with the University of Surrey (UK) and NPL (UK) is active with the student based at NPL.

3.3 Exploring mechanisms to extend industry participation in PIEZO20XX conference

Piezo 2013 was the first of the PiezoXXX series of conferences to have a specific target of increasing industrial participation. Ways of increasing participation during the preparatory phase as well as the structure of the conference itself were examined and a best-practice established based on the feedback received. This best-practice was then used for Piezo2015 to ensure a high level of industrial participation.

Best-practice for industrial engagement at conferences

- Identify and nominate a single point of contact on the conference committee to be in charge of the industrial liaison.
- Use focused/personalised mailing to industrial organisations;
- Send personal focused communication to previous industry participants;
- Structure conference such that attendees can visit the industrial exhibitors' booths throughout the conference. Organisation of breaks to be held within the exhibition centre is seen as especially valuable;
- Organise a special session for exhibitor presentations on the first day of the conference;
- Have a clear offering on the sponsorship package;
- Have attractive rates for exhibition booths, including attendance at conference for 1-2 people per exhibitor.
- Ensure venue has easy access from major international airports, roads and public transport.
- Inclusion of industry relevant focussed half day training events.

The Piezo 2013 conference ran in March 2013 in Les Arcs and was well attended with 77 delegates (~25 from industry). Piezo 2015 ran in February 2015 in Slovenia and was attended by over 90 delegates. Piezo 2017 is planned for February 2017 in Scotland.

3.4 Developing industrial engagement tools for international conferences

A tool kit has been developed for industrial engagement at international conferences. Common media can be accessed from the media team and used in members' presentations. Such material is commonly used in 5-10 international conference presentations per year. Engagement at such conferences can be split into three value-based groupings depending on the piezo-focus and potential for membership growth:

- High impact – i.e. sponsorship of event, logo on official media, PI material in welcome pack, stand at event
- Mid impact – PI focussed presentation, inclusion of PI showcase slide in member's keynote/invited presentation
- Low impact – Inclusion of PI showcase slide in member's presentation.

3.5. Reporting on increase in FV of PI due to Training & exchange activities conducted outside of the CSA

Financial viability of the institute with respect to training activities was reviewed on an annual basis.

- **Training and workshop income:** No income has been generated from these courses yet
- **Conference income:** Significant income has been generated through the Piezo 20XX conferences and associated industrial attendance and tutorials. Both Piezo 2013 and 2015 have generated an operational profit for the institute in the region of €4,000.
- **Exchange income:** No direct income could be realised through exchange of staff, however indirect income is possible due membership fees payable where the placement/job portal is seen as a valuable membership offering.

4.1 Business protocols for technology transfer contracts and IPR

Business protocols have been established to manage the brokerage service offered by the institute. These protocols define how the client relationship should be managed to ensure prompt and professional service. IPR in the initial stages is managed by a PI NDA where appropriate.

Piezo Institute non-disclosure agreement, standard terms and conditions have been established,

- Non-disclosure agreements - one way and multiple way
- Standard terms and conditions for purchasing services from PI
- Model collaboration agreement

4.2 Preparation for Industrial service brokerage.

Through the on-going industrial discussions a series of non R&D related services have been defined based on the industry acceptable terms of reference.

- On-line brokerage service, connecting member organisations in peer-to-peer communities. *Included in corporate membership package.*
- On-line job database
- On-line capability search
- On-line knowledge repository
- Enquiries via info@piezoinstitute.com

4.3. Reporting on increase in FV of PI due to Technology transfer & services to industry activities conducted outside of the CSA

Financial viability of the institute with respect to technology transfer activities was reviewed on an annual basis. Income has been generated as a consequence of dissemination services offered by the Institute.

5.1 Identification of target industries to visit

An initial list of potential industrial partner organisations was created based on Members' personal connections, past attendees at Piezo conferences and contacts made at international conferences. This list was used as the basis for the first round of industrial engagement. The list has continued to be updated through direct enquiries received by the institute, additional contacts at conferences, new registrations at Piezo conferences and web based searches.

5.2 Visits to industry

Industrial users of piezoelectric materials and devices have been contacted through in-person visits and phone interviews. Through these interviews an analysis of industry needs has been performed. Feedback from visits and industrial questionnaires has been used to identify potential offerings and membership fees that would be acceptable to the community. These formed the basis of the PI membership package. Phase 2 visits and interviews were conducted where the target group was increased in size and further information elucidated.

Two clear points of concern emerged from the perspective of the material producers: reliability/lifetime/reproducibility and film deposition and processing. Developments in lead free materials were considered important, but not a high priority with many companies adopting a wait-and-see approach due to the opinion that such materials had not yet demonstrated sufficient performance relative to existing lead-free materials and with the uncertainty around long term performance and

manufacturing issues further affecting their uptake. The results generated from the company visits clearly show an alignment with those obtained from the broader web-based study conducted in 2013, with the analysis revealing that the top three topics of interest are structuring/processing, materials and techniques for characterisation.

It is clear to see from the analysis of visits performed and engagement with industry that those items valued most highly are also those that are more difficult to extract value from but which can readily be incorporated as a high value membership offering. Conversely the less valued items tend to be high cost items for the institute to deliver and are desired by a smaller market which makes the investment of significant resources undesirable in the long term for financial viability. The institute has identified a number of routes by which the investment can be minimised.

Highly valued offerings

- **Networking opportunities** (48%) – can be provided through conferences and workshops as well as through the Institute’s searchable database.
- **Brokerage service** (48%) – can be provided through Institute’s searchable database or direct enquiries at info@piezoinstitute.com

Less valued offerings

- **Advice and expertise** (16%) – searchable database allows for effective partnering in conjunction with events such as conferences, and workshops.
- **Education and training** (14%) – provision of online training modules reduced the staff resource required to deliver the material and allows delivery without geographic boundaries,
- **Research and development** (10%) – searchable database allows for effective partnering in conjunction with events such as conferences, and workshops.
- **Standards** (4%) – provision of standards via an online searchable repository minimised staff input and provides an effective dissemination route.

5.3 Development of academic and industrial membership

Based on feedback from questionnaires and industrial visits beneficial services and membership package has been developed. Based on feedback from the community, the most popular reasons for becoming a member are for consortium building, access to experts in the field and access to equipment. At the same time “free membership” was seen as the most popular fee level, with respondents also willing to spend up to €500 on membership. Fees above €1000 were not seen as viable. Based on this feedback the Institute developed zero-barrier entry option (free membership) with a higher membership grade (400/750 Euro – SME&academic/industry) offering added benefits in terms of dissemination and market contact. A €100 individual membership grade has also been established for specialist groups such as sole traders or micro-organisations. Clear definitions of benefits for each grade of membership have been articulated and are shown on the Institute’s website.

The zero-barrier entry option (free membership) has seen significant growth in membership since the formation of the Institute with over 500 members now being registered. Transferring these members to paid-for membership continues to be a high priority for the PI through promotion of the benefits of paid for membership.

As a way to encourage take up of membership attendees at the Piezo series of conferences receive a basic level (individual) membership with a view that they will gain a personal experience of membership and will be more likely to sign-up in following years.

5.4. Development of Industry communications tools

The website is the main communication tool and has been refreshed on a number of occasions to offer greater content and user engagement. The tools available include bespoke membership area, paid for advertising, job posting, news updates, automated mail out, automatic media feed, as well as members editing facility.

5.5. Reporting on increase in FV of PI due to membership growth activities conducted outside of the CSA

Financial viability of the institute with respect to membership was reviewed on an annual basis. Membership income for 2015 is 200% higher than that for 2014 and at a level that is able to sustain the Institute's current activities in its own right.

The expected final results and their potential impact and use (including the socio-economic impact and the wider societal implications of the project so far),

The PI CSA project's aim was to improve the competitiveness of European Industry in the area of piezoelectric materials and devices. The Piezo Institute is now in a financially stable position from which to move forward and strengthen this activity. The Institute has as its designated officials a President, Vice President and Treasurer. In addition there are a number of directors to provide strategic oversight.

The Piezo Institute's role is to improve the flow of information and knowledge, skilled people, and expertise through a range of strategic activities. It is through these activities that impact will be demonstrated. Such impact will be manifested both as direct economic benefits but also through the societal benefits of a more highly skilled workforce and the future, more effective, development of a range of piezo-related devices that will themselves lead to enhancements in the quality of life.

- **Consortium building.** Mechanisms are in place for Piezo Institute members to search a dedicated database to find expert capabilities and directly build consortia for large scale projects. The Institute has put in place clear protocols for managing the flow of information, external enquiries and members' enquiries. These protocols allow relevant member's capabilities to be collected and searched by other members. Members are then able to interact directly to rapidly expedite the formation of relevant consortia.
In parallel the Institute's conferences, workshops and training events provide a further route for members interact and build a variety of consortia.
Such consortia building will result in the establishment of stronger and more robust consortia that will provide a greater long-term impact in terms of research outputs and subsequent economic performance of European companies.
- **Continuing professional development.** The Institute has developed a suite of tools to facilitate the growth of skills of employees of Europe's organisations. These can be delivered via the Institute's on-line courses as well 'live' workshops held in conjunction with international conferences.

The benefits of a more highly skilled workforce are manifold ranging from greater economic impact through to societal impacts relating to higher quality of life.

- **Practitioner resources.** Through the provision of on-line training and knowledge base resources, practitioners are able to develop their skills and access information relevant to their industrial roles. Impacts will be seen through faster solving of problems and the associated market competitiveness that can be realised through faster responses to an technological challenges that may arise.
- **Recruitment pathways.** The Institute provides a directed recruitment database that is able to link piezo-specific job opportunities. With its members including academics, student, researchers and employees the Institute's recruitment portal provides the most effective route for recruitment within the field of piezoelectric materials and devices. Faster recruitment of staff already trained in the area of piezoelectrics provides a direct long term economic advantage as inappropriate recruitment is known to have a significant impact related not only to the direct recruitment cost, but also the lost productivity through having to train and develop new employees.
- **Training pathways.** The institute is able to facilitate training at postgraduate degree level through access to its academic members working in collaboration with industry. Here the academic and industrial member work in collaboration by providing routes to postgraduate qualifications where the students can spend a significant portion of their study working in industry.
- **Dissemination pathways.** With direct access to a dedicated piezo-related community the Piezo Institute is able to act as a highly effective dissemination route for research active companies and institutes. This provides a highly effective route for technology transfer and dissemination of the latest developments in the field of piezoelectric materials and devices.

The address of the project public website

www.piezoinstitute.com

- President 2015 Guy
- Vice president 2015 Markys Cain
- Treasurer 2015 Guylaine Poulin-Vittrant

4.2 Use and dissemination of foreground

A plan for use and dissemination of foreground (including socio-economic impact and target groups for the results of the research) shall be established at the end of the project. It should, where appropriate, be an update of the initial plan in Annex I for use and dissemination of foreground and be consistent with the report on societal implications on the use and dissemination of foreground (section 4.3 – H).

The plan should consist of:

- Section A

This section should describe the dissemination measures, including any scientific publications relating to foreground. **Its content will be made available in the public domain** thus demonstrating the added-value and positive impact of the project on the European Union.

- Section B

This section should specify the exploitable foreground and provide the plans for exploitation. All these data can be public or confidential; the report must clearly mark non-publishable (confidential) parts that will be treated as such by the Commission. Information under Section B that is not marked as confidential **will be made available in the public domain** thus demonstrating the added-value and positive impact of the project on the European Union.

Section A (public)

This section includes two templates

- Template A1: List of all scientific (peer reviewed) publications relating to the foreground of the project.
- Template A2: List of all dissemination activities (publications, conferences, workshops, web sites/applications, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters).

These tables are cumulative, which means that they should always show all publications and activities from the beginning until after the end of the project. Updates are possible at any time.

There is no R&D funded within this project, hence no scientific publications originated from this work.

| TEMPLATE A1: LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES | | | | | | | | | | |
|---|-------|-------------|---------------------------------------|---------------------------|-----------|----------------------|---------------------|----------------|---|--|
| NO. | Title | Main author | Title of the periodical or the series | Number, date or frequency | Publisher | Place of publication | Year of publication | Relevant pages | Permanent identifiers ¹ (if available) | Is/Will open access ² provided to this publication? |
| 1 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | | | | | | | |

¹ A permanent identifier should be a persistent link to the published version full text if open access or abstract if article is pay per view) or to the final manuscript accepted for publication (link to article in repository).

² Open Access is defined as free of charge access for anyone via Internet. Please answer "yes" if the open access to the publication is already established and also if the embargo period for open access is not yet over but you intend to establish open access afterwards.

TEMPLATE A2: LIST OF DISSEMINATION ACTIVITIES

| NO. | Type of activities ³ | Main leader | Title | Date/Period | Place | Type of audience ⁴ | Size of audience | Countries addressed |
|-----|---------------------------------|-------------|--|-------------|-------------------|-------------------------------|------------------|---------------------|
| 1 | Website | NPL | www.piezoinstitute.com | On-going | web | all | large | All |
| 2 | Conference | JSI | Piezo2015 | Jan 2015 | Maribor, Slovenia | Academic & industry | 80-100 | All |
| 3 | Conference | NPL | Dielectrics2015 | Apr 2015 | London, UK | Academic & industry | 50-70 | All |
| 4 | Conference | UTFR | Piezoelectric micro and nano structures and their applications | Sept 2014 | Blois, France | Academic & industry | 50-70 | All |
| | Conference | NPL | Ferroelectric UK 2015 | July 2015 | London, UK | Academic & industry | 80-100 | All |

³ A drop down list allows choosing the dissemination activity: publications, conferences, workshops, web, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters, Other.

⁴ A drop down list allows choosing the type of public: Scientific Community (higher education, Research), Industry, Civil Society, Policy makers, Medias, Other ('multiple choices' is possible).

**Section B (Confidential⁵ or public: confidential information to be marked clearly)
Part B1**

The applications for patents, trademarks, registered designs, etc. shall be listed according to the template B1 provided hereafter.

The list should, specify at least one unique identifier e.g. European Patent application reference. For patent applications, only if applicable, contributions to standards should be specified. This table is cumulative, which means that it should always show all applications from the beginning until after the end of the project.

There is no R&D funded within this project, hence no scientific IP originated from this work.

| TEMPLATE B1: LIST OF APPLICATIONS FOR PATENTS, TRADEMARKS, REGISTERED DESIGNS, ETC. | | | | | |
|--|------------------------------|----------------------------------|--|---------------------------------|---------------------------------------|
| Type of IP Rights ⁶ : | Confidential Click on YES/NO | Foreseen embargo date dd/mm/yyyy | Application reference(s) (e.g. EP123456) | Subject or title of application | Applicant (s) (as on the application) |
| N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | | |

⁵ Note to be confused with the "EU CONFIDENTIAL" classification for some security research projects.

⁶ A drop down list allows choosing the type of IP rights: Patents, Trademarks, Registered designs, Utility models, Others.

Part B2

Please complete the table hereafter:

There is no R&D funded within this project, hence no exploitable material from this work.

| Type of Exploitable Foreground ⁷ | Description of exploitable foreground | Confidential Click on YES/NO | Foreseen embargo date dd/mm/yyyy | Exploitable product(s) or measure(s) | Sector(s) of application ⁸ | Timetable, commercial or any other use | Patents or other IPR exploitation (licences) | Owner & Other Beneficiary(s) involved |
|---|---------------------------------------|------------------------------|----------------------------------|--------------------------------------|---------------------------------------|--|--|---------------------------------------|
| N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | | | | | |

¹⁹ A drop down list allows choosing the type of foreground: General advancement of knowledge, Commercial exploitation of R&D results, Exploitation of R&D results via standards, exploitation of results through EU policies, exploitation of results through (social) innovation.

⁸ A drop down list allows choosing the type sector (NACE nomenclature) : http://ec.europa.eu/competition/mergers/cases/index/nace_all.html

4.3 Report on societal implications

Replies to the following questions will assist the Commission to obtain statistics and indicators on societal and socio-economic issues addressed by projects. The questions are arranged in a number of key themes. As well as producing certain statistics, the replies will also help identify those projects that have shown a real engagement with wider societal issues, and thereby identify interesting approaches to these issues and best practices. The replies for individual projects will not be made public.

A General Information *(completed automatically when Grant Agreement number is entered).*

| | |
|---------------------------------------|--|
| Grant Agreement Number: | 290591 |
| Title of Project: | The PiezoInstitute – European Expertise centre for multifunctional And integrated piezoelectric devices |
| Name and Title of Coordinator: | Professor Robert Dorey |

B Ethics

| | |
|---|------------|
| 1. Did your project undergo an Ethics Review (and/or Screening)? <ul style="list-style-type: none"> If Yes: have you described the progress of compliance with the relevant Ethics Review/Screening Requirements in the frame of the periodic/final project reports? <p>Special Reminder: the progress of compliance with the Ethics Review/Screening Requirements should be described in the Period/Final Project Reports under the Section 3.2.2 'Work Progress and Achievements'</p> | No |
| 2. Please indicate whether your project involved any of the following issues (tick box) : | YES |
| RESEARCH ON HUMANS | |
| • Did the project involve children? | No |
| • Did the project involve patients? | No |
| • Did the project involve persons not able to give consent? | No |
| • Did the project involve adult healthy volunteers? | No |
| • Did the project involve Human genetic material? | No |
| • Did the project involve Human biological samples? | No |
| • Did the project involve Human data collection? | No |
| RESEARCH ON HUMAN EMBRYO/FOETUS | |
| • Did the project involve Human Embryos? | No |
| • Did the project involve Human Foetal Tissue / Cells? | No |
| • Did the project involve Human Embryonic Stem Cells (hESCs)? | No |
| • Did the project on human Embryonic Stem Cells involve cells in culture? | No |
| • Did the project on human Embryonic Stem Cells involve the derivation of cells from Embryos? | No |
| PRIVACY | |
| • Did the project involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)? | No |
| • Did the project involve tracking the location or observation of people? | No |
| RESEARCH ON ANIMALS | |
| • Did the project involve research on animals? | No |
| • Were those animals transgenic small laboratory animals? | No |
| • Were those animals transgenic farm animals? | No |

| | |
|---|----|
| • Were those animals cloned farm animals? | No |
| • Were those animals non-human primates? | No |
| RESEARCH INVOLVING DEVELOPING COUNTRIES | |
| • Did the project involve the use of local resources (genetic, animal, plant etc)? | No |
| • Was the project of benefit to local community (capacity building, access to healthcare, education etc)? | No |
| DUAL USE | |
| • Research having direct military use | No |
| • Research having the potential for terrorist abuse | No |

C Workforce Statistics

3. Workforce statistics for the project: Please indicate in the table below the number of people who worked on the project (on a headcount basis).

| Type of Position | Number of Women | Number of Men |
|--|-----------------|---------------|
| Scientific Coordinator | 0 | 1 |
| Work package leaders | | |
| Experienced researchers (i.e. PhD holders) | | |
| PhD Students | 0 | 0 |
| Other | | |

| | |
|---|--|
| 4. How many additional researchers (in companies and universities) were recruited specifically for this project? | |
| Of which, indicate the number of men: | |

| D Gender Aspects | | | | | |
|---|---|-------------------------|---|-------------------|--|
| 5. Did you carry out specific Gender Equality Actions under the project? | <input type="radio"/> <input checked="" type="radio"/> | Yes No | | | |
| 6. Which of the following actions did you carry out and how effective were they? | | | | | |
| <input type="checkbox"/> Design and implement an equal opportunity policy <input type="checkbox"/> Set targets to achieve a gender balance in the workforce <input type="checkbox"/> Organise conferences and workshops on gender <input type="checkbox"/> Actions to improve work-life balance <input type="radio"/> Other: <input style="width: 150px;" type="text"/> | <table style="margin-left: auto; margin-right: auto;"> <tr> <td style="text-align: center;">Not at all effective</td> <td style="text-align: center;"> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> </td> <td style="text-align: center;">Very effective</td> </tr> </table> | Not at all effective | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> | Very effective | |
| Not at all effective | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> | Very effective | | | |
| 7. Was there a gender dimension associated with the research content – i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed? | | | | | |
| <input type="radio"/> Yes- please specify <input style="width: 150px;" type="text"/> <input checked="" type="radio"/> No | | | | | |
| E Synergies with Science Education | | | | | |
| 8. Did your project involve working with students and/or school pupils (e.g. open days, participation in science festivals and events, prizes/competitions or joint projects)? | | | | | |
| <input checked="" type="radio"/> Yes- please specify <input style="width: 150px;" type="text"/> students attended training events and conferences <input type="radio"/> No | | | | | |
| 9. Did the project generate any science education material (e.g. kits, websites, explanatory booklets, DVDs)? | | | | | |
| <input checked="" type="radio"/> Yes- please specify <input style="width: 150px;" type="text"/> training material/lectures/conferences <input type="radio"/> No | | | | | |
| F Interdisciplinarity | | | | | |
| 10. Which disciplines (see list below) are involved in your project? | | | | | |
| <input checked="" type="radio"/> Main discipline ⁹ : <input type="radio"/> Associated discipline ⁹ : <input style="width: 100px;" type="text"/> <input type="radio"/> Associated discipline ⁹ : <input style="width: 100px;" type="text"/> | | | | | |
| G Engaging with Civil society and policy makers | | | | | |
| 11a Did your project engage with societal actors beyond the research community? (if 'No', go to Question 14) | <input type="radio"/> <input checked="" type="radio"/> | Yes No | | | |
| 11b If yes, did you engage with citizens (citizens' panels / juries) or organised civil society (NGOs, patients' groups etc.)? | | | | | |
| <input type="radio"/> No <input type="radio"/> Yes- in determining what research should be performed <input type="radio"/> Yes - in implementing the research | | | | | |

⁹ Insert number from list below (Frascati Manual).

| | | |
|---|--|--|
| 13c If Yes, at which level? <input type="radio"/> Local / regional levels <input type="radio"/> National level <input type="radio"/> European level <input checked="" type="radio"/> International level | | |
| H Use and dissemination | | |
| 14. How many Articles were published/accepted for publication in peer-reviewed journals? | | 0 |
| To how many of these is open access¹⁰ provided? | | 0 |
| How many of these are published in open access journals? | | 0 |
| How many of these are published in open repositories? | | 0 |
| To how many of these is open access not provided? | | 0 |
| Please check all applicable reasons for not providing open access: | | |
| <input type="checkbox"/> publisher's licensing agreement would not permit publishing in a repository <input type="checkbox"/> no suitable repository available <input type="checkbox"/> no suitable open access journal available <input type="checkbox"/> no funds available to publish in an open access journal <input type="checkbox"/> lack of time and resources <input type="checkbox"/> lack of information on open access <input type="checkbox"/> other ¹¹ : | | |
| 15. How many new patent applications ('priority filings') have been made? <i>("Technologically unique": multiple applications for the same invention in different jurisdictions should be counted as just one application of grant).</i> | | 0 |
| 16. Indicate how many of the following Intellectual Property Rights were applied for (give number in each box). | Trademark | 0 |
| | Registered design | 0 |
| | Other | 0 |
| 17. How many spin-off companies were created / are planned as a direct result of the project? | | 1 |
| <i>Indicate the approximate number of additional jobs in these companies:</i> | | 0 |
| 18. Please indicate whether your project has a potential impact on employment, in comparison with the situation before your project: | | |
| <input type="checkbox"/> Increase in employment, or <input checked="" type="checkbox"/> Safeguard employment, or <input type="checkbox"/> Decrease in employment, <input type="checkbox"/> Difficult to estimate / not possible to quantify | <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> | In small & medium-sized enterprises In large companies None of the above / not relevant to the project |

¹⁰ Open Access is defined as free of charge access for anyone via Internet.

¹¹ For instance: classification for security project.

- 2.2 **Electrical engineering, electronics [electrical engineering, electronics, communication engineering and systems, computer engineering (hardware only) and other allied subjects]**
- 2.3 **Other engineering sciences (such as chemical, aeronautical and space, mechanical, metallurgical and materials engineering, and their specialised subdivisions; forest products; applied sciences such as geodesy, industrial chemistry, etc.; the science and technology of food production; specialised technologies of interdisciplinary fields, e.g. systems analysis, metallurgy, mining, textile technology and other applied subjects)**

3. MEDICAL SCIENCES

- 3.1 Basic medicine (anatomy, cytology, physiology, genetics, pharmacy, pharmacology, toxicology, immunology and immunohaematology, clinical chemistry, clinical microbiology, pathology)
- 3.2 Clinical medicine (anaesthesiology, paediatrics, obstetrics and gynaecology, internal medicine, surgery, dentistry, neurology, psychiatry, radiology, therapeutics, otorhinolaryngology, ophthalmology)
- 3.3 Health sciences (public health services, social medicine, hygiene, nursing, epidemiology)

4. AGRICULTURAL SCIENCES

- 4.1 Agriculture, forestry, fisheries and allied sciences (agronomy, animal husbandry, fisheries, forestry, horticulture, other allied subjects)
- 4.2 Veterinary medicine

5. SOCIAL SCIENCES

- 5.1 Psychology
- 5.2 Economics
- 5.3 Educational sciences (education and training and other allied subjects)
- 5.4 Other social sciences [anthropology (social and cultural) and ethnology, demography, geography (human, economic and social), town and country planning, management, law, linguistics, political sciences, sociology, organisation and methods, miscellaneous social sciences and interdisciplinary, methodological and historical SIT activities relating to subjects in this group. Physical anthropology, physical geography and psychophysiology should normally be classified with the natural sciences].

6. HUMANITIES

- 6.1 History (history, prehistory and history, together with auxiliary historical disciplines such as archaeology, numismatics, palaeography, genealogy, etc.)
- 6.2 Languages and literature (ancient and modern)
- 6.3 Other humanities [philosophy (including the history of science and technology) arts, history of art, art criticism, painting, sculpture, musicology, dramatic art excluding artistic "research" of any kind, religion, theology, other fields and subjects pertaining to the humanities, methodological, historical and other SIT activities relating to the subjects in this group]