

EIB CoE pipeline project
INNOFEIT Centre of Excellence Road-Map

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Note and disclaimer

This roadmap has been prepared for the European Investment Bank (EIB) as part of the TA2017156 R0 EDI: Road-Map for a Regional Centre of Excellence in the Western Balkans

It has been prepared by the consultant Lisa Cowey in close cooperation with INNOFEIT.

“The author takes full responsibility for the contents of this report. The opinions expressed do not necessarily reflect the view of the Promoter(s) or the European Investment Bank”.

Acronyms

AEC	Agency for Electronic Communications
DSP	Digital Signal Processing
FEEIT	Faculty of Electrical Engineering and Information Technologies ().
FITD	Fund for Innovations and Technology Development
ISAB	Industry and Scientific Advisory Board
MASIT	Macedonian Chamber of ICT
NRT	Near Real Time
MSME	Micro, Small and Medium-size Enterprises
RT	Real Time
TRL	Technology Readiness Level
UKIM	Ss. Cyril and Methodius University in Skopje

0. Introduction

This Road Map is the result of a previous Feasibility Study for a Regional Centre of Excellence in the Western Balkans, which mapped regional institutions and created a short list of four candidates, based on pre-agreed criteria.

In the Inception phase of this action, the four short-listed institutions were all visited for assessment and a refined benchmarking methodology was developed to capture the strengths and weaknesses of each candidate institution, allowing for a final assessment, rating and ranking. Based on this ranking, only INNOFEIT received an overall “excellent/good” rating and was therefore selected for full development of the present Road Map.

Other institutions may be revisited in the future and if meeting the same criteria could be considered for future Road Map development.

Following is a re-statement of the Objectives, Purpose and expected Result of this action.

Objectives

Specific objective: The specific objective of this Assignment is to determine the feasibility of the establishment of a Centre of Excellence with relevance on a regional level in the Western Balkans by:

- assessing the feasibility of a regional CoE, in the Western Balkan and EU context, with regards to the capacity of regional science and its competitiveness, taking into consideration similar activities in other countries with comparable research systems;
- assessing opportunities of Centres of Excellence to generate new talents in science and technology;
- exposing areas of weakness in the current research context - including the training of young researchers - and exploring options for invigorating and improving research capacity;
- identifying likely international partners (i.e. leading research institutes, universities or companies located in the EU) in different areas of cooperation;
- identifying areas of the private sector in the Western Balkans with the potential to partner with research institutions;
- assessing the funding needs of such a programme.

Purpose

The purpose of this TA operation is to inform about which models of funding for CoEs would be the most effective for the present level of development of research and innovation and provide highest potential for short-term growth and impact on the economy. It will provide a basis for policy instruments enhancing investment in R&D, given the low figures for Gross Expenditure on R&D (GERD) currently prevailing in the region.

Result

The Result of the assignment will be a clear picture of the innovation potential of 4 pre-selected institutions to develop into a Centre of Excellence, as well as an individual Road Map for those with highest potential, indicating how the status could be achieved over the next 4 year period.

1. Executive Summary

Background to the CoE

The INNOFEIT Centre for Technology Transfer and Innovation was established in 2017 as a legal entity by the Faculty of Electrical Engineering and Information Technologies (FEEIT) at the Ss. Cyril and Methodius University in Skopje (UKIM). The Centre opened in refurbished premises in April 2018.

The central objective of the Centre is to tackle brain drain from the country and in particular the loss of young and talented scientists and researchers. The Centre proposes to address this issue by supporting the development of a knowledge economy based on innovation and specifically by undertaking activities that will increase tangible knowledge transfer from academia to business at national, regional and international levels.

The Centre proposes to focus on the area of **applied research for ICT services in emerging tele-infrastructures** under 4 main interdisciplinary pillars

- Expert Systems Exploiting Data Science
- DSP Advances for RT And NRT Applications
- Software-Defined Networking And Virtualization
- Renewable Energy Sources And Energy Efficiency

The Centre is able to demonstrate a high level of research productivity and human capacity in these areas as well as a track record in developing and transferring technology to domestic, regional and international companies using a diversity of methods (joint collaborations, licensing and sale and spinoff companies).

The nascent Centre has demonstrated an ability to secure funding from multiple sources for its development including private funding in to renovation of facilities from commercial firms wanting a long term and formal partnership with the Centre. The Faculty has also demonstrated a track record in securing grants for R&D&I that have generated downstream revenues from sale of technology and donor funds for research. The Faculty is well aligned with national strategy, making it a likely recipient of national funds including national IPA. It is also well embedded in to the local innovation ecosystem, although this is still at an early stage of development, including close proximity to a new incubator on the University site as an active member of a number of national and international scientific and business networks.

In order to make a step-change from using undergraduate and domestic research effort on projects the faculty now wishes to secure more substantial investment in to the INNOFEIT Centre. This would enable them to employ more senior researchers and to attract back members of the research Diaspora to work with companies on projects linked to the 4 pillars listed above. A phased approach to development has been explored. This is outlined below.

Phased development

➤ Phase 0: Set-up/ administrative phase (ongoing)

- This phase will establish all the necessary rules and procedures for the centre to operate on a fully international basis e.g. in terms of recruiting and remunerating researchers and charging over-heads for commercial use of facilities and establish an Industrial and Scientific Advisory Board.
- **Technical Assistance in this phase would accelerate the production of the Rule Book and Guidelines.** TA has also been requested to produce a more detailed Business Plan.

- **Phase 1: Initiation phase** spanning 12 months from adopting the Rule book and securing significant external funding
 - During this phase the Centre will identify the research projects that are not currently possible with limited faculty funds e.g. moving from a predominate use of undergraduate students on research projects to employing PhD, Post doctoral researchers and more experienced researchers with a focus on bringing talented researchers back to Macedonia and building international excellence under the four research pillars.
 - The centre will commence the process of recruiting the more experienced research staff to join the projects, using the regulations and guidelines developed in the setup/administrative phase. Other key support staff involved will include the legal and accounting support.
- **Phase 2: Implementation phase**, spanning 24 months from initiation ending
 - This phase will focus on continuously implementing and ramping up R&D actions with a focus on reaching full capacity of the Centre and working increasingly with regional and international companies alongside domestic SMEs.
- **A further scale-up phase** is envisaged after 36+ months. However, this would be triggered by the existing centre reaching full operating capacity. Further space for expansion would necessitate significant capital investment in to a new building and associated equipment. This phase has not been covered by this present roadmap.

Activities, outputs and KPIs

INNOFEIT intends to focus R&D activities on ‘partners’ who have signed a MoU with the Centre and who will commit to a minimum annual investment of 10K in to one or more research projects. These projects will be carried out by PhD students and/ or more experienced researchers including senior researchers from the Diaspora. Each project should result in a clear increase in TRL for a particular technology designed to yield a commercial product or service. There should also be an associated increase in revenue from individual or joint sales of technology as well as a base to launch more spinoff companies in which the Centre can take an equity stake and benefit from sales revenue. The Centre has already signed agreements with a number of domestic, regional and international companies including Neotel (Telecom operator in Macedonia), Iskratel (a Slovenian company with a subsidiary in Macedonia), RadeKoncar TEP (the leading power company in Macedonia with historical ties to Koncar from Croatia) and Inform.mk (recently formed with American capital). Other companies who have had research collaborations with the Faculty in the past might be involved again are Retell Ltd, England, Deutsche Telekom Germany, and Innovation Sprint Sprl, Belgium.

To generate ideas for research projects and interest from new partners the Centre will hold at least 2 focused meetings per year (increasingly termed ‘Hackathons’) to bring together companies and the research base. Personnel of the centre will also travel abroad to conferences or seek out meetings with identified potential partners. Identifying topics and potential partners will also be supported by the Industry and Scientific Advisory Board. By Year 3 the Centre plans to have established an operational ICT platform for regional/international partner outreach and will seek to sign a new partner every 6 months via a MoU and to thus secure a new revenue stream.

To help fund up-stream R&D&I activities the Centre will apply for funding from the national Innovation Fund. This source has previously enabled the faculty to individually and jointly develop technology that has been licensed to external users or formed the nucleus for spinout companies. Although there are limited options on the equity stake that the Centre can take in such a company, they are able to receive royalties from sale of licensing products/services. The Faculty has established a track record in using the Innovation Fund to develop and commercialise technology with commercial returns and the fund allows for patenting costs to help protect competitive advantage and support licensing to international companies. Other non-national funding sources e.g. EU H2020 are also being targeted to pursue this business model.

The proposed KPIs linked to these activities are listed in Table 1.

Cost and revenue

Cost and revenues for the Centre over 3 years are show in Table 4 and Table 5 respectively**Error! Reference source not found.** Revenue includes national grants for R&D&I based on past performance but do not include larger grant/ donor funding.

The deficit between costs and revenues for the Centre in the first 3 years of operation is shown below and detailed in Table 2.

	Y1	Y2	Y3	Total
Deficit (KEURO)	438.60	545.40	656.60	1656.60

FEEIT has identified a number of potential sources of financing to fill this gap. These are shown in Table 3 and include:

- National IPA
- EU grants (H2020)
- NATO
- Other bilateral funding e.g. Swiss and Norwegian governments

The Centre intends to seek funding continuously from these sources, but securing a major grant from a large donor would permit the Centre to ramp up R&D&I operations quickly and focus on securing longer term sustainability from industrial partnerships.

Support from the EIB to help the Centre secure access to funding would be very beneficial.

2. Objectives and focus of CoE activities

The overall objective of the INNOFEIT Centre of Excellence (CoE) is to improve, enhance and stimulate knowledge transfer from academia to existing and new innovative Micro, Small and Medium-size Enterprises (MSMEs) to provide excellent knowledge in ICT and REEE and to valorise research results through a collaborative platform between scientists, students and entrepreneurs with the aim to bridge the gap between academia and industry and enhance the growth potential of a regional eco-system of existing and new innovative, knowledge intensive and high-tech SMEs.

The specific objectives of INNOFEIT are to:

- address the present brain-drain of skilled and educated personnel due to the limited opportunities for “desirable” jobs,
- increase the level of cooperation with industry,
- support young scientists and entrepreneurs and, finally,
- aid Macedonian and wider regional economical growth.

To achieve these objectives INNOFEIT CoE will focus on three main sets of activities:

Knowledge transfer services supporting

- Pitching for academic/research ideas, projects and start-ups and match-making them with interested industrial parties,
- Providing expert knowledge in ICT and REEE in assessing the feasibility and viability of ideas and projects at an international excellent level and
- Providing expert knowledge in management, finance and administration to coach researchers, idea owners, inventors and entrepreneurs in building feasible business plans for start-ups and spin-offs;

Creation of a Collaborative Platform by

- Providing a regional matchmaking platform for ideas, projects, start-ups and investors through organization of INNOFEIT dissemination events
- Participation of national, local and regional stakeholders, such as state agencies, chambers of commerce, cities, regional governmental bodies at INNOFEIT dissemination events and
- Participation of knowledge intensive companies who are in need of new solutions and technologies and can provide their internally (own) developed technology platforms.

Valorisation of research results through

- Identification of needs for new innovative ICT services in existing and emerging industries,
- Identification and quantification of potentials for development of projects in REEE and
- Identification of needs for research in bringing MSMEs and researchers together in scouting meetings on the basis of identified new innovative ICT services at the INNOFEIT dissemination events.

The document that follows provides background on the project and a roadmap and budget for implementation of the CoE over a 3 year period.

3. Introduction and Background

Legal status and organisation

INNOFEIT was established as a centre for technology transfer and innovation by the Ss. Cyril and Methodius University in Skopje (UKIM) at the end of 2017. It is solely operated by the Faculty of Electrical Engineering and Information Technologies (FEEIT). As such, all FEEIT employees are eligible to cooperate/work within INNOFEIT but the Centre intends to operate selectively by engaging with the best scientists in various departments. All interested parties are treated as partners/collaborators of the centre and contracted accordingly.

The managing director of INNOFEIT is the **Vice-Dean for Finances and Cooperation with Industry** at FEEIT. It is planned that there will be an **industry and scientific advisory board (ISAB)**, formed from representatives from selected companies, who have been confirmed as partners/collaborators and 3 representatives from FEEIT. The IASB will ensure that operational and project activities are carried out according to plan and will meet annually. INNOFEIT will use both outsourced and its own administrative staff.

INNOFEIT's operating will be regulated by a specific rulebook for covering its operational activities. This Rulebook will provide clear guidelines for all interested parties and will support the long-term sustainability of INNOFEIT.

Research and Sector focus

INNOFEIT will adopt a multidisciplinary aspect and will focus its activities on **applied research for ICT services in emerging tele-infrastructure**s. This broad area will require a closer integration of different FEEIT departments and will be further organised under 4 separate pillars, (Figure 1). The umbrella topic and its pillars stem from an in-depth assessment of the entire FEEIT portfolio undertaken in 2017.

Figure 1: INNOFEIT research focus

ICT SERVICES FOR EMERGING TELEINFRASTRUCTURES	
Pillar 1	EXPERT SYSTEMS EXPLOITING DATA SCIENCE
Pillar 2	DSP ADVANCES FOR RT AND NRT APPLICATIONS
Pillar 3	SOFTWARE-DEFINED NETWORKING AND VIRTUALIZATION
Pillar 4	RENEWABLE ENERGY SOURCES AND ENERGY EFFICIENCY

The choice of the umbrella topic as well as the pillars was based on global technical trends, FEEIT's extensive international cooperation and the vision for topics of high industrial interest in the near future. Furthermore, these topics correlate with local needs and can provide solutions needed in Macedonian society, thus stimulating local economical growth and development.

These pillars map on to a number of commercial sectors where the Faculty has already demonstrated success in transferring technology. These are outlined in the section below.

Sector Focus and Technology Transfer

1. Smart metering + data analysis (expert system end-to-end)

- a. System for monitoring the quality of electrical energy – currently spun-off in the company DTK SmartTech, <http://www.dtksmarttech.com.mk/content/about-us>, signed contract with EVN Macedonia (national power distributor) for usage of SmartTech solutions
- b. SmartWine system for monitoring vineyards using distributed wireless sensor network – protected by local patent, currently commercialized and being sold worldwide by Deutsche Telekom, https://www.telekom.mk/smartwine_delovni.nsp
- c. System for monitoring patients' vitals and ambiental parameters – a collaborative effort within the FP7 funded eWALL project, currently commercialized by Innovation Sprint Sprl, Belgium

2. Real-time signal processing

- a. System for real-time 3D terrain mapping using drones – currently spun-off in the company Vision Dynamix, <http://www.visiondynamix.com>
- b. System for real-time detection of broadcasted TV commercials – developed for a local company (Media & Advertising) protected by local patent
- c. Text-Independent Speaker Identification – research project on speech technologies for Retell Ltd, England

3. Renewable Energy and Energy Efficiency (REEE)

- a. Establishment of a database for wind energy potential in Macedonia – an extensive study for 3 years (2013-2016) of the wind potential in the entire country, conclusions were adopted by ELEM (national power plants) to establish a wind park in the south of the country
- b. A 20kV PhotoVoltaic (PV) for INNOFEIT’s premises is being installed as a donation from the state refinery OKTA. The PV will be used to show self-sustainability of the INNOFEIT building showcasing novel technologies and will be open for researchers to test different algorithms they develop in the corresponding field.

Personnel and expertise

FEEIT currently has 36 Full Professors, 9 Associate professors, 19 Assistant professors, 7 Teaching and research assistants and 6 Junior teaching and research assistants. The number of assistant professors has experienced a growth of ~60% in the last 5 years. This group is aged between 30 and 35 and represents the strength for future R&D as most of them are young and motivated to contribute. The number of full professors (40+ years) grew 20% in the last 5 years, which is also encouraging, as this group will bring new experience and connections. The percentage of employees in each of the four pillars is well balanced as demonstrated below:

Pillar 1	Pillar 2	Pillar 3	Pillar 4
30%	20%	20%	30%

The group has strong international connections including joint supervision of PhDs and the research activities of FEEIT personnel in international projects by far exceed all other similar WB universities/faculties/institutes.

Facilities and resources

FEEIT possesses state-of-the-art laboratories for optical communications, wireless and mobile networks, electromagnetic compatibility, calibration of instruments, electrical measurements and DSP. The existing equipment is worth over of 2M Euros and will be available to INNOFEIT for all activities.

As a Faculty, FEEIT is considered as an independent body and thus performs many measurements on a regular basis in the country. No other independent institution in Macedonia has the equipment and the human resources to provide such services. For example, all telecom operators in Macedonia using optical links are required by law to perform link measurements by an independent laboratory and the FEEIT laboratory for optical communications is regularly undertaking this work at a national level. The laboratory for wireless and mobile networks has the most advanced equipment in the country and the national Agency for Electronic Communications frequently requires that some measurements are performed using this equipment. The laboratory for electromagnetic compatibility is constantly performing measurements of non-ionizing emissions in the country as an independent body, mostly through contracts from governmental institutions. The laboratory for calibration of instruments is a nationally accredited laboratory and operates on a contract basis with industry and government. The laboratory for electrical measurements performs measurements on groundings, isolations etc. on a contract basis for various entities. This demonstrates that there is an

existing and strong base of contract research to build from and good potential for further regional expansion.

FEEIT is an authorized NI LabView Academy with the software being used in several courses for teaching as well as research. FEEIT is also a partner in online certification for other academies e.g. Juniper Networks Academy, Allied Telesyn Academy and Palo Alto Academy, and selected FEEIT personnel are certified as instructors.

Policy alignment and legislative framework

INNOFEIT's goals align strongly with the main two national strategies tackling economic/industry sector¹ and innovation & research². In the area of industrial policy, INNOFEIT fits into the core of the strategy vision, i.e. development of capabilities for applied research and industrial production of sustainable, organic and specialized high technological products and services for the needs of the international market, with its own design, highly trained work force, modern managerial approach, and use of research and development. With regard to the innovation strategy, INNOFEIT addresses measure D.2: Increase knowledge flows and interactions between research institutions and business, specifically (iii) Technological parks and (iv) Technology Transfer Offices (pages: 40-41).

According to the Governmental policy for economic development in the period 2018-2020, special emphasis will be put on the support of entrepreneurship and innovations within Micro, Small and Medium-size Enterprises (MSMEs). There will be many measures targeting MSMEs, business angels, technology parks and EC co-financing. Furthermore, the new Law for financing of MSMEs is expected to provide 50M Euros for the Macedonian economy³. Given the strong policy alignment INNOFEIT expects to be able to secure funding for most of its planned activities from these measures.

Planned activities are also aligned with existing national instruments supporting innovation. The state Fund for Innovations and Technology Development – FITD⁴ was established with the purpose to encourage and support innovation activities in MSMEs. The rationale behind its establishment was to achieve more dynamic technological development based on knowledge transfer, development research and innovations. There are several instruments available through this fund such as co-financed grants for start-ups and spin-offs, co-financed grants and conditional loans for commercialization of innovations, co-financed grants for technology transfer etc. Therefore, represent as significant source of long-term innovation support to the companies who will wish to work with INNOFEIT. For example, there are currently two start-up companies at FEEIT that have used a total of 3 grants from FITD, each with a value of 30.000 Euros for 1 year.

The Ministry for Education and Science⁵ also supports R&D activities by financing bilateral projects with other countries (participating institutions are from Macedonia and another country that has signed a contract with the Ministry) and by financing R&D projects. However, the amount of funds awarded for these projects is very low. For instance, bilateral projects only cover travel expenses, whereas the R&D projects are in the range of ~5.000 Euros per year, but calls and awards for the R&D projects are very rare.

The law for starting a company in Macedonia is not strict and easily allows researchers to start their own company. According to the Law for Innovations, a Faculty/Research Institution that is public can have equity in such company up to 20%. However, there is no specific incentive in the Law for MSMEs for start-ups/spin-offs to motivate researchers to establish companies. This is something that can only be addressed at state level.

¹ <http://www.konkurentnost.mk/StrateskiDokumenti/IndustriskaPolitikaNaRepublikaMakedonija2009-2020.pdf>

² http://www.konkurentnost.mk/StrateskiDokumenti/Strategija%20za%20inovacii_final_oktomvri2012.pdf

³ http://www.vicepremier-ekonomija.gov.mk/sites/default/files/Nact_tekst_naZakon_za_finansiska_poddrska_na_investigacii.pdf

⁴ <http://www.fitr.mk/?lang=en>

⁵ www.mon.gov.mk

Position in the local and wider innovation ecosystem

FEEIT is actively involved in several business associations/clusters including the Macedonian Chamber of ICT (MASIT⁶), the Macedonian National Committee in CIGRE⁷, different working groups in the Agency for Electronic Communications (AEC) and several state ministries. These involvements are crucial for networking and establishing contacts with national industry.

Researchers from FEEIT have worked on R&D projects with various domestic, regional and fully international companies; these include Neotel DOO, Retell LTD and IMEC Belgium. INNOFEIT already has research cooperation contracts in place to start work with a number of companies once the premises are finished and opened; these partners include Iskratel Slovenia, Neotel, Alfa Inzenering, RadeKoncar TEP and OKTA refinery. There are ongoing negotiations for collaboration with ITCrowd, INformand High-Tech Corporation.

There are various national initiatives for local incubators, the latest being the CEED Hub Skopje⁸. This incubator has recently opened premises at the technical campus close to the building housing FEEIT. Additionally, there is a governmental initiative to open a state Technology Park in 2018 and an international initiative by the Macedonia2025 group⁹.

⁶ <http://masit.org.mk>

⁷ <https://mako-cigre.mk>

⁸ <https://ceedhub.mk>

⁹ <http://www.macedonia2025.com>

4. Road Map and Phased Planning

Present Status and ongoing activities

INNOFEIT is already established as a legal entity by the Faculty of Electrical Engineering and Information Technologies (FEEIT), Ss. Cyril and Methodius University in Skopje (UKIM), Macedonia. It is owned by the university, solely operated by the faculty and has already initiated contract research with companies that have local and regional/international presence. As such, it already operates as a research hub in the region providing excellence in the areas of ICT and REEE (with proven publications/project records) and backed by high regional visibility.

The new INNOFEIT building was officially opened on the 14th April 2018 by the Dean of FEEIT, the Rector of UKIM and the Minister for Education and Science (see photos below). It is located in a completely renovated part of a FEEIT building with state-of-the-art facilities available for use by interested stakeholders. The renovation cost ~130K Euros. This money was covered with funds from the Ministry for Education and Science (~30%), the University itself (~20%), the national company for power transmission (~40%) and several companies with regional and international presence such as Neotel (Telecom operator in Macedonia), Iskratel (a Slovenian company with a subsidiary in Macedonia), RadeKoncar TEP (the leading power company in Macedonia with historical ties to Koncar from Croatia) etc. All these named companies are now confirmed official partners for the Centre. They will form the industrial side of the ISAB and will be using the facilities and engaging in collaborative and contract research with faculty researchers and students.

Alongside this recent significant expansion of facilities the Macedonian company Inform.mk, (formed with American capital) initiated a joint collaboration through INNOFEIT in the beginning of 2018. This resulted in the design and development of a commercial pollution-monitoring sensor containing extensive academic know-how. The sensor is currently being sold to customers including municipalities, schools, public institutions, private companies etc. and generating royalties for FEEIT.

These results clearly demonstrate that INNOFEIT, having attracted 50% industry funding for its installation, is already recognized by regional companies for its services and its excellence and has the potential to develop and transfer technology, generating commercial revenues for the Centre.

INNOFEIT already has plans for activities that it will be able to implement independently if it is unable to secure more significant external funding for expansion:

- The Centre will launch a student innovative project competition guided by a local IT company and funded by a French bank before summer 2018. This should result in student ideas being developed for practical and relevant industrial purposes.
- INNOFEIT will also cooperate with a regionally present IT company (Macedonia and Slovenia) to provide a summer school and training for students in the fields of disruptive IT technologies in summer 2018.
- Parallel to these activities, INNOFEIT has already initiated contract research with the partner companies named above.

These activities represent the base line for INNOFEIT operations. They will be reliant on existing researchers and equipment for collaborations with enterprises and will draw strongly on undergraduates and small project based R&D activities for Proof of Concept and Prototyping actions. They will also define the base-line for outputs and results. Any significant 'step-change' in activities will require a significant further investment of funding.

INNOFEIT Centre of Excellence Road-Map

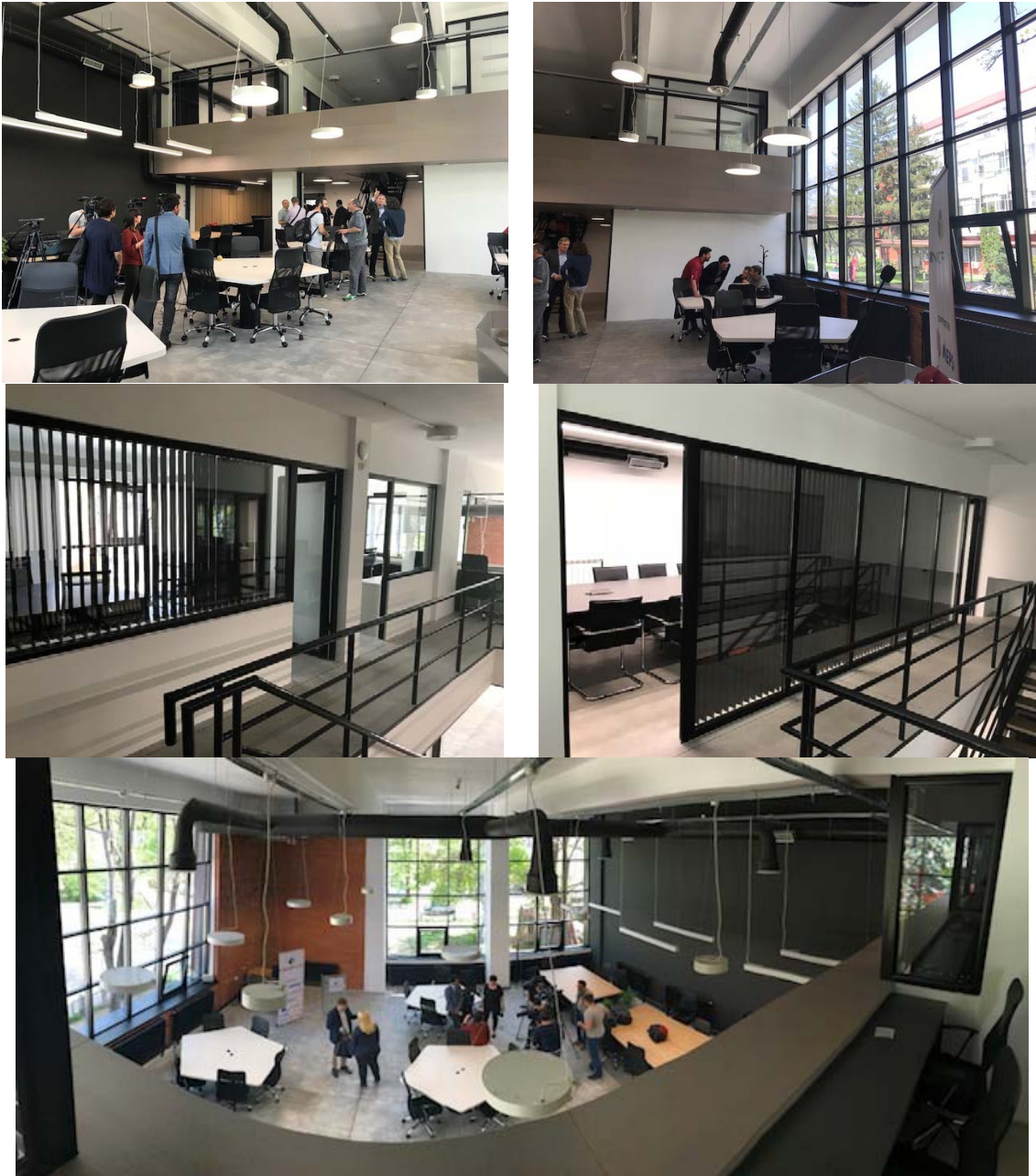


Figure 2 Opening of the new INNOFEIT Building in April 2018

A phased development approach for further development of the centre is now foreseen in two distinct phases with a 'Phase 0' action needed to enable the following 2 phases to take place. A 3 year time-line: is covered from the end of Phase 0

➤ **Phase 0: Set-up/ administrative phase**

- This phase will establish all the necessary rules and procedures for the centre to operate on a fully international basis e.g. in terms of recruiting and remunerating researchers and charging over-heads for commercial use of facilities and establish the Advisory Body.
- KPIs and mile-stones linked to this phase are purely administrative.
- The only cost associated with this phase is Technical Assistance to accelerate the production of the Rule Book and Guidelines.

➤ **Phase 1: Initiation phase** spanning 12 months from adopting the Rule book and securing significant external funding

- During this phase the Centre will identify the research projects that are not currently possible with limited faculty funds e.g. moving from a predominate use of undergraduate students on research projects to employing PhD, Post doctoral researchers and more experienced researchers with a focus on bringing talented researchers back to Macedonia and building international excellence under the four research pillars.
- The centre will commence the process of recruiting the more experienced research staff to join the projects, using the regulations and guidelines developed in the setup/ administrative phase. Other key support staff involved will include the legal and accounting support.
- KPIs in this phase are largely linked to Human Resource (HR) and number of projects and value of early contracts secured.

➤ **Phase 2: Implementation phase**, spanning 24 months from initiation ending

- This phase will focus on continuously implementing and ramping up R&D actions with a focus on reaching full capacity of the Centre and working increasingly with regional and international companies alongside domestic SMEs.
- KPIs in this phase will include phase 2 indicators as well as revenue generation and R&D outputs (papers, patents, products and services, spinoffs and royalties).

If the base of operations were kept constant then the budget for the implementation phase would set the base line for annual cost/ revenue for the Centre.

- **A further scale-up phase** is envisaged after 36+ months. However, this would be initiated by the existing centre reaching full operating capacity. Further space for expansion would necessitate investment in to a new building and associated equipment. This phase has not been covered by this present roadmap.

These 3 main phases clearly map the path of INNOFEIT's growth from a local technology transfer and innovation centre to an international and recognizable CoE. A 36 month timeline and budget is now detailed below with the budget starting from the end of the Phase 0 set-up / administration phase.

Phase 0: Set-up/ Administrative phase

Two main tasks are envisaged for the set-up /administrative phase. The first is the establishment of an industrial and scientific advisory group who will help steer and develop the Centre. The second is the drafting of a suitable set of rules and guidelines for implementing the Centre's activities.

1. Formation of the Industry and Scientific Advisory Board (ISAB)

An advisory board will be formed from industry representatives from the companies who have formalised their relationship with the Centre and 3 scientific representatives from FEEIT. Industrial membership will be drawn from firms who have invested in to the infrastructure and/or who have agreed to a long term research relationship with the Centre. These have been named above.

The IASB will ensure the operational and project activities are according to plan and will meet annually.

The IASB will also be used to help the Centre to generate ideas for new technology based research projects that have industrial relevance and commercial potential.

The selection and operation of the IASB will be regulated by the Centre Guidelines and Rule-book (see below)

2. Preparation of Guidelines and Rulebook for the Centre

INNOFEIT has commenced the preparation of a specific Rulebook and associated Guidelines to regulate its operational activities and enable it to operate as a fully international organisation e.g. by embracing international norms for recruitment and collaboration. This rulebook will also define forms of cooperation, confidentiality, IPR issues, co-ownership and profit sharing from IPR generated through collaborations, general services offered by INNOFEIT etc. The Rulebook will provide clear rule of engagement for all interested parties and will support the long-term sustainability of INNOFEIT.

Specifically, the Guidelines and Rulebook will cover:

- 1 Setting up the Industrial and Scientific Advisory Board;
- 2 Development of guidelines for operation of the Centre, assuring a fair and transparent engagement for all stakeholders;
- 3 Establishment of a clear procedure for recruitment and remuneration of appropriate high quality research personnel (PhD students, post-docs, senior researchers) assuring regional/international competitiveness among potential candidates, thus increasing the centre's visibility,
- 4 Regulating the necessary IPR and other legal frameworks within the Macedonian legal system to address issues of ownership, commercialisation rights and benefit sharing from research results developed by partners using the faculties of the Centre and revenues coming from spinoff companies where the Centre will not be permitted to hold an equity stake but can take a royalty from sales of products/ services.

The existing management of INNOFEIT has already commenced drafting the Guidelines and Rulebook. The Faculty legal department is able to develop the necessary procedures and to check that they do not violate any existing legal procedures. However, ***this document could be accelerated if Technical Assistance could be made available to the Centre.*** 10K EURO has been placed in the budget for Technical Assistance during set-up.

Relevant milestones for the administrative set-up phase are:

- Milestone 1 – Clear and unambiguous **Rulebook** to cover the operational activities of the centre
- Milestone 2 – Fully established **Industrial and Scientific Advisory Board** to steer the future development of the centre

Initiation phase (M1-M12)

The initiation phase focuses strongly on recruitment of key personnel and researchers to implement and grow R&D&I activities and building on relationships that are already established by the Centre.

The core administrative staff of the centre will comprise the Managing Director and 3 Counsellors. The MD will work full time while the Counsellors will be at 50% FTE. These core staff will be responsible for the recruitment of further personnel. Training for these staff to help them develop the specific skills needed to implement the Centre is planned for each year. Necessary skills include business plans creation and go-to-market strategy creation.

The Centre also proposes to recruit key staff with the skills to supply the necessary legal and accounting skills to deal with commercial contracts (2 FTE). Funding for legal and accounting skills has been based on present internal rates at UKIM.

In parallel, the Centre will define the first significant collaborations/ contract research projects with industry and to advertise and recruit the first batch of key researchers. Target levels of recruitment over the first 12 months are:

- 8 new PhD students (2 for every research pillar)
- 4 early stage researchers (1 for every research pillar)
- 2 experienced researchers (to supervise and lead the Research activities)
- 2 members of the research Diaspora who will be invited to return to Macedonia and help lead the research work
- 2 visiting professors who will come for short periods to teach/ contribute to research

To help the Centre to define the research projects and attract new staff a number of activities are planned. These include

- Participation by the core staff in regional events (up to 8 per year)
- Organization of annual events for students/ companies to help define new projects (2/ year)

Finally, during the initiation phase the Centre will start to purchase small equipment and the IT needed for the new personnel and for the Research Labs and projects.

In order to ramp up activities quite quickly the Centre will need to focus on existing cooperation and to begin investigating potential recruitment during the Phase 0.

Relevant milestones for the initiation phase are:

- Milestone 3 – recruitment of the administrative individuals outlined above
- Milestone 4 – Organization of at least 2 regional gathering events with participation of academia/industry representatives from all WB countries
- Milestone 5 – Signing of at least 4 new MoUs with companies that operate on an international level in the fields of interest
- Milestone 6 – new research personnel commencing work on agreed projects in the Centre.

KPIs for this period will focus more on inputs than outputs e.g. the number of researchers recruited and number and value of contracts signed. It is not anticipated that significant R&D output indicators will emerge in the first 12 months of operation although based on ongoing R&D&I and marketing activity the Centre does anticipate signing at least two new industrial partners (value 20K EURO), launching 2 spinoff companies and securing 10K of royalties from technology commercialisation.

Proposed KPIs for Year 1

HR	Target
PhD students	2/ research pillar
Early stage researchers	1/ research pillar
Experienced researchers (domestic)	2
Experienced researchers(Diaspora)	2
Visiting professors	2
Contact Generation	
Number of regional events	2
R&D Contracts/ Activity	
New MoUs	4
Number of commercial contracts	2
R&D&I outputs	
Total Value of commercial contracts	20K EURO
Royalties from joint products developed with companies	10K EURO
Spinouts started	2

Implementation and scale up phase (M12-M36)

The implementation phase builds on the work of the first 12 months of full operation and targets increased regional and international visibility of INNOFEIT. It will focus on establishing closer academic/industrial links with more regional and international partners and increasing the number and value of collaborative research projects and research contracts. It should also see a clear increase in the number of prototypes and products/ services emerging from R&D activity and revenue being generated from spinoffs or royalties from technology licensing.

Over these two years the Centre will increase their scientific visibility as well as international cooperation of incubated spinoff companies. It will also seek to increase of the management capacity for projects addressing socio-economic needs.

By the end of year 3 the Centre aims to be operating at full capacity, with certified recognition for international CoE and a clear need for further capital investment to enable expansion.

Along with the activities outlined above for M1-12 the Centre will also implement the following activities:

- Increase of the scientific visibility of the centre by promoting its research and its start-ups on an international level through a number of diverse public outreach methods including participation at international conferences and fairs;
- Development of a regional/international partner database for easier match-making of all interested stakeholders within the centre;
- Increase of the international cooperation of the centre and its start-ups by leading consortiums targeting regional and international initiatives in the area of ICT and REEE;
- Increase of the management capacity for projects addressing socio-economic needs, thus providing visibility and social responsibility.

Relevant milestones for the implementation and scale-up phase are:

- Milestone 5 – Establishment of an operational ICT platform for regional/international partner outreach
- Milestone 6 – Establishment of at least 2 consortiums with regional/international partners led by INNOFEIT that will apply for international grants and will cover a regional initiative of interest (e.g. digital single market in the WB region)
- Milestone 7–Developing a commercial product of regional/international interest from a start-up in the centre (e.g. smart metering solution for agriculture)

KPIs for the implementation period have a stronger focus on R&D&I outputs with a target of a further 2 spinouts launched each year based on projects funded by the innovation fund and revenue generation from one of the spinouts being collected by Year 3 as well as revenue from direct licensing of technology developed jointly with industrial partners. Other KPIs include the increased collaborations with international/ regional partnership through consortium formation.

The full set of KPIS for all three years are shown in the table below.

Table 1 Proposed KPIs Years 1, 2 and 3

	Y1	Y2	Y3
Human Resource	Targets		
PhD students	2/ research pillar	2/ research pillar	2/ research pillar
Early stage researchers	1/ research pillar	1/ research pillar	1/ research pillar
Experienced researchers (domestic)	2	2	2
Experienced researchers (Diaspora)	2	2	2
Visiting professors	2	2	2
Contact Generation			
No.of regional events	2	2	2
New MoUs	4	6	8
R&D Contracts/ Activity			
No.commercial contracts	2	4	6
Total Value of commercial contracts	20K EURO	40K	60K
No.of research consortiums led by INNOFEIT with regional/international partners to seek international grants and targeting initiatives of regional interest			2
R&D&I outputs			
Royalties from joint products developed with companies	10K EURO	20K EURO	30K EURO
Spinouts started	2	2	2
Revenue from spinouts			10 K EURO
Patents		3	3

5. Budget

Description of main costs and revenues

INNOFEIT has recently completed a major refurbishment of a faculty building to enable the Centre to be located in suitable premises. No major building works are anticipated for the next 3 years. Further significant work would be contingent on the Centre out-growing the present building and would necessitate construction of a new facility.

An over-view of costs for the three years of operation are listed in Table 4 and shown visually in Figure 3; further detail is provided in the accompanying spreadsheet. Major costs are associated with personal (researchers and administrative staff salaries) followed by equipment and maintenance of facilities. Significant costs are also associated with ‘networking’. These are directly linked to development of partnerships with the private sector and international research Centres (e.g. organization of national ‘hackathons’, conferences and workshops to generate ideas and partners for R&D&I projects and or travel grants for national scientists to attend international conferences and workshops abroad). These are followed by the indirect costs associated with maintaining the CoE office (electricity, water, heating and office supplies). Additional costs are associated with visiting researchers, ICT and capacity building (TA and training),

Figure 3 CoE Costs and Income

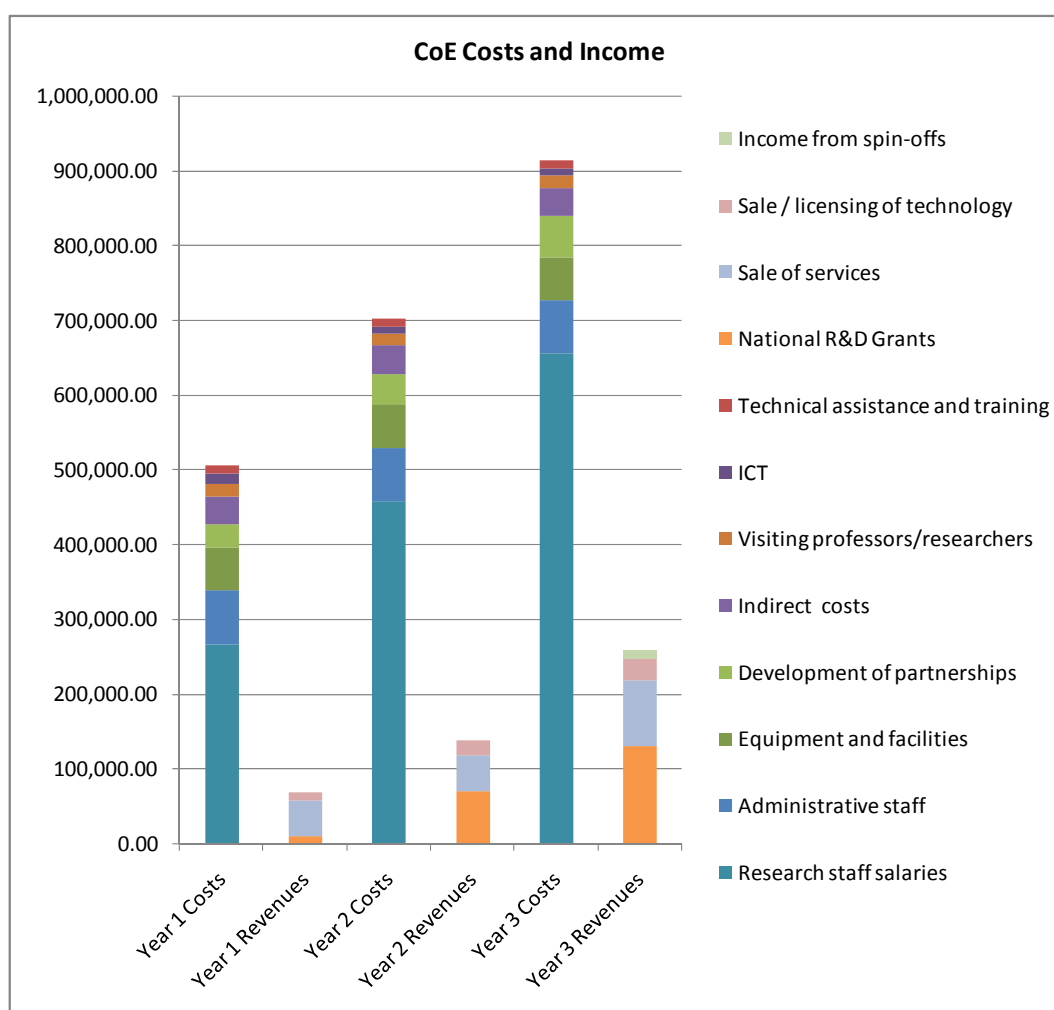


Table 4 shows the anticipated sources of income for the project. These include national grants for R&D from the Ministry for Science as well as grants for innovation from the FITD.

Grants from the FITD rise strongly across the three years and these reflect finance that can be secured for a company to carry our R&D&I with the Centre to develop a new prototype, product or service. This income stream is expected to result in technology that can be protected (patented) and sold/licensed to a company to generate royalties or where the company and the Centre will have a share of rights to exploitation. FITD grants are also expected to drive spinout formation and subsequent royalties from sales from year 3.

Sale of services includes training and consultancy for local/regional entities in the fields of ICT and REEE as well as Contract Research with companies who have formalised a relationship with the Centre. Contract research revenues are set as a minimum of 10K EURO per partnership per year and are anticipated to grow at a rate of one new long term partnership every 6 months. Contract research will also generate future revenue from joint rights to exploitation.

6. Funding shortfall and self-sustainability

The deficit between costs and revenues for the Centre in the first 3 years of operation is shown below.

Table 2 Deficit between Costs and Revenues

	Y1	Y2	Y3	Total
Costs (KEURO)	506.60	703.40	914.60	2124.60
Revenues (KEURO)	68.00	158.00	258.00	484.00
Deficit (costs minus sales) KEURO	438.60	545.40	656.60	1656.60

INNOFEIT has identified a number of potential sources of financing to full this gap. These include:

- Grant for R&D (Ministry and Innovation Fund)
- National IPA
- EU grants (H2020)
- NATO
- Other bilateral funding e.g. Swiss and Norwegian governments

These sources are show in Table 3 Potential sources of Grant Funding. The Centre has made some estimate of its ability to secure such funding. These numbers are based on 5 years of previous experience which lends some confidence to their credibility.

National budget - grants from the Fund for Innovations and Technology Development

The state Fund for Innovations and Technology Development – FITD was established with the purpose to encourage and support innovation activities in MSMEs. There are several instruments available through this fund such as co-financed grants for start-ups and spin-offs, co-financed grants and conditional loans for commercialization of innovations, co-financed grants for technology transfer etc.

Track record in securing funding from this source is good - as of April 2018 there are two start-up companies at FEEIT that have secured a total of 3 grants from FITD, each with a value of 30.000 Euros for 1 year.

National budget - grants from the Ministry of Education and Science

The Ministry for Education and Science also supports R&D activities by financing bilateral projects with other countries and by financing R&D projects. However, the amount of funds awarded for these projects is very low. For instance, bilateral projects only cover travel expenses, whereas the R&D projects are in the range of ~5.000 Euros per year, but calls and awards are very rare.

FITD and the national research budget both have the potential to play an important role in **up-stream innovation funding** to create stronger **down-stream revenue** for the Centre by through sale/ licensing of technology. It seems probable that national grants will continue for the foreseeable future but as noted above, they are not reliable and frequent. The Innovation Fund is less secure having been set up relatively recently; future programs are not known and similar funds in other neighbouring countries (Croatia and Serbia) have been strongly reliant on securing repeatable allocations of money from IPA or structural funds.

Other potential sources of funding

National IPA

The Centre is preparing an application for national IPA. The strategic alignment between the Centre and national strategy suggests that they may be in a good position to secure some of this budget.

EU grants

Based on 5 years of experience the Centre feels it may be realistic to attract 2 grants per year. The size of grant application is likely to be of order 100K Euros each

NATO grants

Based on 5 years of experience the Centre feels it may be realistic to attract 1 grant per year with approximate value of 100K Euros

Bilateral funding

Funding from the Swiss/ Norwegian governments may offer the opportunity to attract at least 2 grants per year with approximate value of 150K Euros each

Funding will be sought continuously from these sources but securing a major grant from a large donor would permit the Centre to ramp up R&D&I operations quickly and focus on securing longer term sustainability from industrial partnerships.

Support from the EIB to help the Centre secure significant money would be very beneficial.

7. Need for Technical Assistance and Institution building

As outlined above, straightforward TA has been requested to develop the Guidelines and Rulebook for the Centre. This would put in place the milestone needed to commence recruitment of international researchers, legitimatise transfer of technology in to faculty spinoffs through licensing or sale and to engage more strongly with international companies with fully clear and transparent rules of engagement. The Centre has also expressed a need for a stronger 'Business Plan' to guide their operations. This would need to be linked to securing funding so that the plan could reflect anticipated revenue.

The Centre has also expressed a need for more capacity building of key staff in the area of Technology Transfer. Support has been sought from the ongoing EU4TECH WB project. Training workshops and a mentor will be made available from this project to the Centre in 2018.

15K EURO has been placed in the budget for simple TA during Phase 0 for the Rule Book and Guidelines. The exact amount should be discussed further with EIB.

In order to realize the full potential of the embryonic center as a regional and ultimately international center there is a need to secure long term and stable funding. This should ideally come from non-national sources in order to ensure that it works to unlock regional and international potential. Too strong a focus on national funding, including national IPA may impose a national focus

on activities which could curtail expansion of technology transfer activities with regional/international enterprises.

The funding needs to be stable and of sufficient duration to enable the institution to be built and an institutional memory to be developed. This increases the likelihood of sustainability and reduces the risk that individuals who have built their own skill set will then move on after 6-12 months taking it with them. Centers of Excellence (CoE) in EU countries typically have a minimum funding horizon of 3 years (Slovakia and Luxembourg) and more typically 5+5 years (extension being based on performance) e.g. Denmark and Norway. German Centers of Competence (CoC) are historically somewhat shorter (2-3 years) with a very clear focus on self-sustainability that reflects the strength of the national economy and enterprise demand for new 'close to market' technology. Regional examples are fewer but the Bio ICT Centre of Excellence in Montenegro provides a very good example. Funded in 2014 for 3 years using EU funds and based strongly on the good practice of the countries mentioned above, the action has focused on building up a strong institution for the country that has clear regional potential and international reach. Early ex-post evaluations suggest the CoE has met 3 year KPIs and further funding will now be made available.

The funding needs to enable an excellent institution to be established that can meet the R&D needs of SMEs. CoCs and CoEs in EU MS work with a very high proportion of SMEs. They do this by providing a viable alternative to the internal R&D centre model favored by large companies. This will necessitate modern, competitive facilities that will attract international caliber staff, as well as the ability to remunerate them at an international level. Flexibility of contracting will be important so that international staff can come for both long and short periods to contribute and transfer knowledge and skills. The ultimate objective should be to return excellent Macedonia researchers to the Center and to keep them on a permanent basis, and to act as a magnet for international and regional talent.

To ensure that the centre is focused on transferring technology to the business sector and reduce the risk that the action simply results in stronger academic research, it will be critical to support bringing both groups together to jointly design and implement collaborative actions, as was previously described. A diversity of activities and events are needed to ensure that the reach is truly international and not simply local e.g. participation in international business fairs and conferences as well as organization of local and regional 'hackathons'. The regional and international enterprise focused activities are reflected in associated KPIs and milestones.

Finally, the centre needs to be able to operate semi-autonomously and not to be reliant on administrative support from the parent organization. Significant reliance on the University introduces a risk that the center could be weakened if support was not forthcoming.

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INNOFEIT Centre of Excellence Road-Map

Table 3 Potential sources of Grant Funding

Sources of revenue	Year 1				Year 2				Year 3			
	Unit	# of units Y1	Unit rate (in EUR)	Revenue (in EUR)	Unit	# of units Y2	Unit rate (in EUR)	Revenue (in EUR)	Unit	# of units Y3	Unit rate (in EUR)	Revenue (in EUR)
A. Grants/ donations (e.g. National budget, National IPA, EU actions, donor, private sector donations)												
National budget - grants from the Ministry of Education and Science	0	2	5,000	10,000	0	2	5,000	10,000	0	2	5,000	10,000
National budget - grants from the Fund for Innovations and Technology Development				0		2	30,000	60,000		4	30,000	120,000
Subtotal A Grants				10,000				70,000				130,000

INNOFEIT Centre of Excellence Road-Map

Table 4 Anticipated project costs

Activity		Year 1	Year 2	Year 3	TOTAL (EUR)
	Phase 0	Initiation	Implementation	Implementation	
Technical Assistance for a Rule book and Guidelines for Operation	15 K				10K
Purchase and maintenance of modern laboratory and pilot plant equipment and facilities		58,000.00	58,000.00	58,000.00	174,000.00
Purchase of modern information and communication technologies		14,600.00	9,600.00	9,600.00	33,800.00
Research staff for CoE - Salaries for full-time or FTE (part time) employed researchers, doctoral students and post-doctoral students at the CoE to conduct relevant research.		266,800.00	458,000.00	655,600.00	1,380,400.00
Costs for visiting professors/researchers from outside the country to conduct research in the CoE and possibly teach - invite at least 2 per year for a period of 2 months		16,000.00	16,000.00	16,000.00	48,000.00
Administrative staff for CoE - salaries for managers, technicians and administrators (gross salaries including social security charges and other related costs, administrative staff)		72,000.00	72,000.00	72,000.00	216,000.00
Technical assistance and training to the management and staff of the new CoE to strengthen strategic areas (particularly project management, monitoring and evaluation, understanding and securing intellectual property rights, technology transfer activities and entrepreneurship promotion)		11,000.00	11,000.00	11,000.00	33,000.00
Development of partnerships with private sector and international research centers (e.g. organization of hackathons, conferences and workshops in the country or travel grants for national scientists to attend international conferences and workshops)		50,200.00	60,800.00	74,400.00	185,400.00
Indirect eligible costs (e.g. car rental, office supplies, miscellaneous utilities, maintenance and spare parts, consumables, local transport and communication)		18,000.00	18,000.00	18,000.00	54,000.00
TA	15.000				
Total Over 3 years (excluding any contingency reserve)		506,600.00	703,400.00	914,600.00	2,124,600.00

Table 5 Anticipated project revenues

Sources of revenue	Y1	Y2	Y3	Total
A. National grants for R&D and innovation	10,000	70,000	130,000	210,000
B. Sale of services (training, consulting, contract research)	48,000	68,000	88,000	204,000
C. Sale / licensing of technology	10,000	20,000	30,000	60,000
D. Income from spin-offs	0	0	10,000	10,000
Total	68,000	158,000	258,000	484,000

INNOFEIT Centre of Excellence Road-Map

Figure 4 Lean Canvas Regional Center for Technology Transfer and Innovations in the area of ICT Services for Emerging Tele-infrastructures- INNOFEIT

<p>Problem</p> <ul style="list-style-type: none"> Brain-drain of skilled and educated personnel due to limited opportunities for “desirable” jobs Low level of cooperation between industry and academia + very rare project calls for cooperation industry/academia funded by the Government Slow economic development <p>Existing Alternatives</p> <ul style="list-style-type: none"> Outsourcing “at home” Isolated efforts for industry/academia cooperation based on personal relations (no organized institutional cooperation) Innovative start-ups and spin-offs by “enthusiasts” (very low number) with low influence on the economy 	<p>Solution</p> <ul style="list-style-type: none"> Competitive environment for work and personal upgrade of students/graduates Innovation consultancy based on participation in international projects working on cutting-edge topics Providing cost-effective R&D for the industry gathering researchers, students and companies under one roof (no need for dedicated R&D departments in companies) Links with research diaspora Established contracts with regional companies (Iskratel, Koncar) <p>Key Metrics</p> <ul style="list-style-type: none"> Number of Centre employees Number of recruited researchers Number/value of research contracts Number of established start-ups Number of patents / IPR agreements for royalties Number of Macedonian researchers that will come back from abroad to work in Macedonia 	<p>Unique value proposition</p> <p>The best scientists, researchers and students in the fields of ICT and REEE at regional level, with multidisciplinary practical experience and vision for future trends, at disposal for cooperation</p> <p>High Level Concept</p> <ul style="list-style-type: none"> Innovation-driven economy Facilitation of the digital convergence New jobs creation based on innovations 	<p>Unfair advantage</p> <ul style="list-style-type: none"> Experience in international research projects participation and successful international innovations Insight into propulsive areas/key enabling technologies for future research and investment Novel undergraduate curriculum accredited in autumn 2017 and harmonized with the German ASIIN Accredited laboratory for calibration of instruments (ISO 17025) Accredited inspection body (ISO 17020) ISO 9001 implemented <p>Channels</p> <ul style="list-style-type: none"> Social media + web-site University and Government support Dissemination events Contacts with chambers of commerce Direct marketing 	<p>Customer Segments</p> <ul style="list-style-type: none"> Companies offering services for the general public (telecoms, energy providers etc.) -> INNOFEIT offers expansion of service/product portfolio Companies manufacturing products -> INNOFEIT optimizes the production process thus adding value to the products <p>Early Adopters</p> <ul style="list-style-type: none"> Companies offering and companies in need of expert systems based on smart metering solutions
<p>Cost Structure</p> <ul style="list-style-type: none"> Salaries and wages Equipment / consumables + maintenance Property fees Office supplies Training, conferences, workshops, networking Awards competitions 		<p>Revenue streams</p> <ul style="list-style-type: none"> Government backup through different R&D&I programs Sponsored research/grants Corporate membership fee/ contract research / feasibility studies Royalties from future salesor licensing of products developed at INNOFEIT Training / life-long learning 		