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Drawing funding and financing scenarios for effective implementation of Smart Specialisation Strategies

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Drawing funding and financing scenarios for effective implementation of Smart specialisation strategies

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Abstract

Leveraging greater impact from the array of research and innovation funds in the EU is driving efforts to combine such funds and develop synergies at the policy and strategy levels. However, one of the first challenges for policy makers and stakeholders intervening in the support to R&I is to obtain a full picture of all current and planned funding and financing instruments.

This report uses the Technology Readiness Level (TRL) framework to characterise the different funding that is available. The major bottlenecks in the innovation process that can arise through the lack of appropriate funding are discussed along with the background and the utility and criticisms of the TRL. The use of TRL to characterise and map research and innovation in the EU provides a useful framework. However, there is a need to broaden the scope of TRL to include commercialisation of new products and services and scale-up business capacities. Furthermore, it is limited by its technology focus, while innovation can embrace many aspects beyond the purely technological.

This work has also highlighted many issues that can affect the optimal combination of funds. There is a need for cross-cutting knowledge of the different funds rather than there being ''silo-thinking'' where a person only considers the area in which they directly work and not interrelated areas in other domains. Hand in hand with this is a better understanding of how beneficiaries decided between funding options and the support they may require. This support can include clearer information communicated with regards to the funds and also the financial instruments that are available, such as those implemented by the European Investment bank. Finally, an improved alignment of the rules of participation of the various funds is needed, both between the different funds at the EU level but also with national funding.

Keywords: EU funding, financing instruments, synergies, Research & innovation, TRL, Smart specialisation strategies, Horizon 2020, ESIF.

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Contents

1. Introduction

The smart specialisation framework has not only introduced new ways of thinking about local development and structural change (Foray et al., 2009), but also a new approach to envisage the combination of support dedicated to R&I. The design and the implementation of innovation policies, particularly smart specialisation strategies, should take into consideration various funding and financing options to achieve the ultimate objectives. For the implementation plan to become fully realistic there needs to be links of activities, equipment and infrastructures with their respective funding or financing source. Primary sources for funding to implement Smart specialisation strategies are European Structural Investment Fund (ESIF) then the Horizon 2020 programme but they are not the only ones. Many other public, semi public or private sources should also be taken into consideration to complete the R&I support landscape. Considering other support may provide more opportunities to better address the economic and societal challenges but they can also add some more layers of complexity with new rules mainly for beneficiaries.

This combination of funding and financing sources aimed at creating synergies is a challenge that the European Commission is encouraging and supporting (European Commission, 2014) through the provision of guidelines and various initiatives. In 2014 the Joint Research Centre (JRC) and the Directorate General for Regional and Urban Policy (DG REGIO) of the European Commission to implement a Pilot Project of the European Parliament: the Stairway to Excellence (S2E). S2E is centred on the provision of assistance to EU Member States and regions with the aim of contributing to closing the innovation gap through the creation of synergies between EU funding. The support offered for R&I may be rich and diverse but it is also quite dispersed. It is difficult to obtain a comprehensive overview of the support available to implement research and innovation strategies. This complexity can deter stakeholders and policy makers from envisaging, developing and implementing synergies of funding.

The origin of this document comes first from the need to provide to policymakers a tailored approach to better plan the combination of R&I support instruments using the technological readiness level scale (TRL) to position each funding and financing source. A workshop focusing on EU funding supporting Energy Projects organized by JRC Seville took place on the 13th of June 2017 (see agenda in annex), which was a concrete specific action raising the need to better communicate on the various possibilities for funding and financing. The event gathered representatives of European Commission from JRC, DG RTD, DG REGIO, of European Investment Bank (EIB) and the European Institute of Innovation and Technology (EIT).

The objective of this report is to provide to those in charge of the design and implementation of S3 strategies a methodological approach to navigate a coherent path with regard to the combination of funding and financing instruments.

The document is composed of four main sections beginning by setting the context with the various challenges of combining funding and financing tools. The TRL scale and various other scales are then presented followed by a description of a methodological approach to design a more coherent picture of available public funding and financing to implement R&I strategies. The last section tests the methodological approach with a concrete case on Concentrated Solar Power technology in the Andalusia region of Spain.

2. The challenges of combining funding and financing tools

2.1. R&I support and the implementation of Smart Specialisation Strategies

Smart Specialisation Strategies are now a reality in Europe developed through the involvement of R&I stakeholders together with social partners in an entrepreneurial discovery process (EDP). To complement R&I activities, smart specialisation strategies had to include upstream actions to create favourable conditions for the implementation of R&I activities and downstream actions to help create economic value. As the design of S3 (Foray et al, 2012) is an ex ante conditionality for the allocation of EU European Development funding (ERDF) funding under Thematic objective 1 dedicated to Research and innovation, managing authorities had to provide information on the design of a framework outlining available budgetary resources for research and innovation indicating various sources of finance from EU, national and other sources as appropriate. This criterion is difficult to fulfil because it needs a long term vision (seven years) on the various funding sources necessary to implement the strategy. Priority (or specialisation) areas should represent new and emerging market opportunities while aiming to avoid duplication and fragmentation of efforts. Long-term vision on budgetary planning need also to be adjusted according to the specialisation areas selected, many funding sources are targeting only specific areas, specific territories or specific stakeholders.

Although primarily centred on the use of ERDF resources, the combination of funding is at the core of the implementation of S3. In order to achieve, synergies between various funding sources, the Commission services paved the way for Managing Authorities to set out the national or regional frameworks for investments in research and innovation not only from ESIF, but from all funding sources. All public bodies directly concerned by Horizon 2020 for instance and other EU programmes in the given territories should, therefore, have an in this process[1].

Part of the S3 objective is an effective economic exploitation of research results. This is a necessary step for transforming R&I investments into job creation and economic growth and welfare. It is therefore essential to ensure a stable legal and economic environment for R&I actors as well as continuous and sustainable financing. European funding instruments (e.g. SME instruments, ESIF Financial Instruments) represent major tools for venture capital and entrepreneurial support. Moreover, the prioritisation of investment areas and the effective implementation of S3 can help to provide a more predictable environment for investors and beneficiaries.

Complementing each EU Member State's efforts to support R&I, EU invests for the 2014-2020 period amount to around €130bn to support Research & innovation and related activities. Around €55bn is coming from cohesion policies devoted to research & innovation[2] and around €75bn through the

[1] Enabling synergies between European Structural and Investment Funds, Horizon 2020 and other research, innovation and competitiveness-related Union programmes- Guidance for policy-makers and implementing bodies, European Commission (2014)

[2] ESIF devoted to R&I are included in the 15 following categories of intervention : 002 - Research and innovation processes in large enterprises- 056 Investment in infrastructure in SMEs- 057 Investment in infrastructure capacities and equipment in large enterprises- 058 Research and innovation infrastructures (public)- 059 Research and innovation infrastructures (private incl. science parks)- 060 Research and innovation activities in public research Centre)- 061 - Research and innovation activities in private research centre-062 Technology transfer and university-enterprise cooperation-063 Cluster support and business networks-064 Research and innovation processes in SMEs (including voucher)- 065 Research & innovation

Horizon 2020 programme. Five other programmes are connected to, or impact on, research and innovation activities: COSME, Erasmus+, the Health programme, the Life programme and the Connecting Europe Facility. Furthermore, complementary to the funding instrument providing grants, financing instruments (loans, equity, debt) aim to support SMEs, the building or acquisition of infrastructures or equipment and are playing a more and more important role and should be considered in the multiannual budgetary plan. Such a non-exhaustive list of funding and financing support shows, first the identification of the appropriate funding may be difficult and, second, the link between those instruments in order to create synergies can be challenging when planning the implementation of strategies with a long term perspective. The following sections aim to help stakeholders in regions to get a comprehensive view of the full spectrum of the innovation process showing that some gaps can be associated to the scarcity of available support for research and innovation.

2.2. Bridging the "Valley of Death"

Public intervention to support R&I innovation is justified by the scarcity or sometimes the absence of private funding to create favourable conditions for the introduction of new products or services on the market and the development of companies. There remains considerable theoretical and empirical uncertainty about what causes or hinders innovation. One area of debate relates to the required general conditions of the economic system for innovation to take place in an efficient manner. These general conditions include education, training, the available infrastructure and equipment, and the entrepreneurial spirit. The lack of such conditions constitutes a systemic failure. The market failure rationale is considered as a valid although insufficient justification for policy intervention that therefore needs to be complemented by the arguments put forward by the systemic failure rationale (Bleda and Del Rio, 2013).

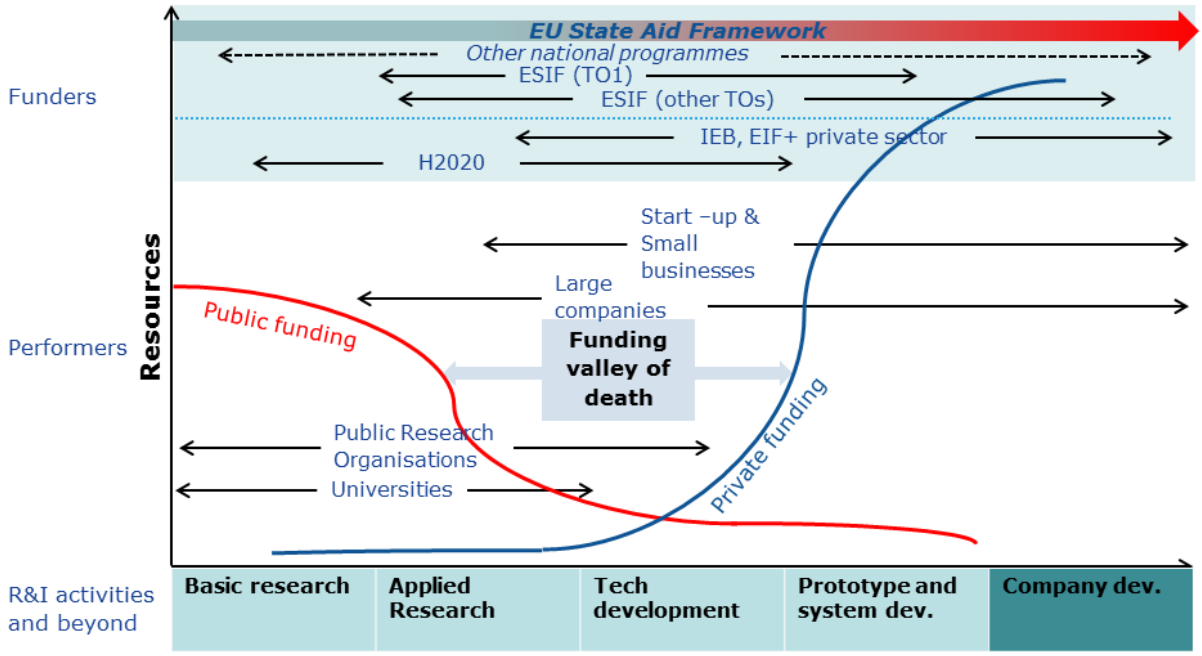
Originally, the concept of the "Valley of Death" described the point where a business, often a technology based business, has a working prototype for a product or service that has not yet been sufficiently developed to earn money through commercial sales. The transition from the research to the deployment phase is a crucial and risky step in the process (Wiesenthal et al, 2011). As many technologies fail to take this step, it is often called the 'Valley of Death'. It frequently manifests itself through a lack of financial resources and expertise between the companies or institutions on the research side of innovation and those on the commercialization side.

The concept of "Valley of Death" refers also to the challenges of bringing the technology focus of public R&I support together with the financial focus of industrial R&I effort. In particular, small companies, that can often pursue radical innovations, experience a lack of financing when bringing their innovations from research to the market phase. During the Death Valley curve, additional financing is usually scarce due to limited availability of public funding and the reluctance of private investors to invest in risky projects. This step in the company development leaves it vulnerable to problems associated with a low cash flow. In many cases, companies need to find support to develop the prototype until it can generate sufficient cash, through sales to customers that would allow it to be self-sufficient and grow. Growing companies should generate jobs and wealth, an objective for any public policies.

processes, Techno transfer in low carbon economy-066 Advanced support services for SMEs and groups of SMEs- 067 SME business development support to entrepreneurship and incubation-073 Support to social enterprises (SMEs)- 101 Cross financing under the ERDF : support to ESF type actions

The "Valley of Death" is sometimes used as an analogy to describe this discontinuity in innovation processes (Figure 1). Providing support to stakeholders that can bridge this valley is identified as a stepping stone, and is therefore high on the agenda of policy programmes, such as Horizon 2020.

Figure 1 General overview of funding and Stakeholders type according to R&I activities and beyond



Recent study on Key Enabling Technologies (KETs) (Butter et al, 2014) suggested that new technologies can easily cross the bridge to the market and that the barriers to transform product prototypes to low-rate mass production are mostly financial. Others who criticised the idea that there was a single 'Valley of Death' tended to argue that the concept encouraged people to think that innovation is linear, which implies that it is only necessary to get through this particular stage when, according to critics of the concept, successful innovation is an interactive process in which commercialisation plans have to be effective at all stages and sometimes simultaneously.

The European Investment Bank (EIB) provides support to firms along all stages of their development in order to help them to bridge various "Valleys of Death". The size of the company to support is considered here and EIB provides tailored support through various types of loans or equities (according to the stage of the company development). Two main types of "Valleys" can then be distinguished according to the size of the company and the level of development of the product:

1. The technological Valley of Death, in which further capital is needed to develop a commercial product and prove its basic market viability. It is about the research, development, and innovation of the product. The stage can be decomposed into two distinct but linked valley of death:
    - The "cash flow Valley of Death" corresponds to the seed stage when the start-up is created. The first Valley of Death as a real company attributed to a lack of early stage risk capital for start-ups. Such a company is a small SME.

- The "feasibility Valley of Death" when innovation's transition from technical and economic feasibility to commercial production is inhibited. There is still a very high technical risk. Company activity is moving from research to pilot plant (idea is feasible).

2. The commercialisation Valley of Death is about the development of a commercial production system, where entrepreneurs seek capital to fund first-of-a-kind commercial-scale projects or manufacturing facilities. It can be called also the "Investment Valley of Death" which still implies high technical risk. A Company needs to move from pilot plant to commercialization.

The concept of Valley of Death in the combination of funding or financing instrument, it is important to highlight that it is not only about technological matter (product and manufacturing), but also a question of organisational and market issues. The approach presented in the next section can help stakeholders to identify challenges at any point in the research and innovation process and beyond. The technological readiness level scale (TRL scale) for instance is increasingly used in public support to R&I to identify activities and objectives. Some other related readiness scales can be also used and can contribute to complete the approach outlined in this report.

3. A more coherent picture of R&I support available to better implement S3

One important role of the public action is to provide stakeholders support unobtainable through other means. Except for the Horizon 2020 programme, centrally managed by the European Commission and offering a coherent picture of funding instruments from 'excellence' research (fundamental research) to demonstration activities and scale-up of innovative companies, we can observe an 'atomization' of support for R&I activities. Numerous R&I support products are available and are not always easy to understand. This complex picture is underlined by the growing importance of financial instruments provided by the European Investment Bank (EIB) (see overview of financial instruments in Annex document). The consequence is that R&I stakeholders are confronted with multiple support mechanisms managed by different bodies and following different rules and constraints. It results, inevitably, in a silo approach which can hamper the ability of the overall ecosystem to deliver optimal results in terms of the creation of knowledge and more importantly economic value.

The objective of this section is to enhance understanding of how to approach funding and financing instruments to support R&I. The general idea is to move from a static picture providing a simple inventory to a more dynamic 'map', starting from building capacities to perform research activities to the introduction of a new products or services on the market and beyond. The use of TRL scale as the core of the map is explored in the remainder of this report.

3.1. The technology readiness level scale: origin, implementation and limitations

- *Origins*

The Technology Readiness Level (TRL) scale originated in the aerospace industry in the USA where it was originally developed by the National Aeronautics and Space Administration (NASA) in the 1970s as a management tool for systems and technology managers to make an assessment of the maturity of new technology (EARTO, 2014; Mankins, 2009a). Synchronising the maturity of technological components is logically required before their incorporation into a specific system or development programme (Mankins, 2009b). A more extensive use of the TRL scale is proposed, which is not only focussed on technological aspects. The scale is now more widely used including in the allocation of funding to identify the type of call activities and specify criteria in topic descriptions. The following table presents the TRL scale used by the European Commission. Each technology project is evaluated against the parameters for each technology level and is then assigned a TRL rating based on the projects progress. There are nine technology readiness levels. TRL 1 is the lowest and TRL 9 is the highest. The boxes 1-3 in this section provided concrete examples of the use of the scale.

Table 1 Technology Readiness Levels: Horizon 2020 – Work Programme 2014-2015 General Annexes

Technology Readiness Level (TRL)	Definition
1	Basic principles observed
2	Technology concept formulated
3	Experimental proof of concept
4	Technology validated in lab
5	Technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
6	Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
7	System prototype demonstration in operational environment
8	System complete and qualified
9	Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

Box 1 The use of TRL scale in Horizon 2020 programme

TRL has become an important management tool that has facilitated communication and common understanding between technology producers and developers, clients and managers. Being aware of this the European Commission has progressively introduced the use of the TRL concept to define topics included under different Framework Programme (FP) calls for proposals, especially for certain instruments related to research and innovation projects in collaboration between research institutions and companies. The TRL metric included in the description of FP topics has enabled a better understanding of the expected impact by potential beneficiaries, as well as FP project evaluators and European Commission project officers. Identifying the type of activities eligible for funding according to the technology maturity expected, the collaborations needed and jointly define project phases and outcomes to adequate fit within the scope of a specific topic has been greatly facilitated by the inclusion of TRL scale for describing call for proposals topics.

The evolution in the introduction of TRL metric has been very clear from the 7th Framework Programme to Horizon 2020. On the former, the Cooperation pillar for Transport and the Fuel Cells and Hydrogen Joint Undertaking (FCH JU) work programmes were the sole including references to the TRL. In the case of Horizon 2020, an important number of work programmes include references to TRL to describe the scope of the activities expected to be funded. In this sense, so far the following work programmes for 2014-2015 and 2016-2017 have included references to TRL metrics: Joint Undertakings, Leadership in Enabling and Industrial Technologies (ICT, Nanotechnologies, Advanced Materials, Biotechnology and Advanced Manufacturing and Processing, Space), Innovation in small and medium-sized enterprises, Smart, green and integrated transport, Secure, clean and efficient energy or Climate action, environment, resource efficiency and raw materials.

Due to the increasing complexity of European funding landscape with broader number of programmes funding different project phases and managed under different European Commission Directorate Generals and agencies, TRL has become an extremely helpful tool to understand the complementarity of existing programmes and a more coherent and targeted support of research and innovation activities.
Source : https://ec.europa.eu/research/participants/portal/desktop/en/home.html

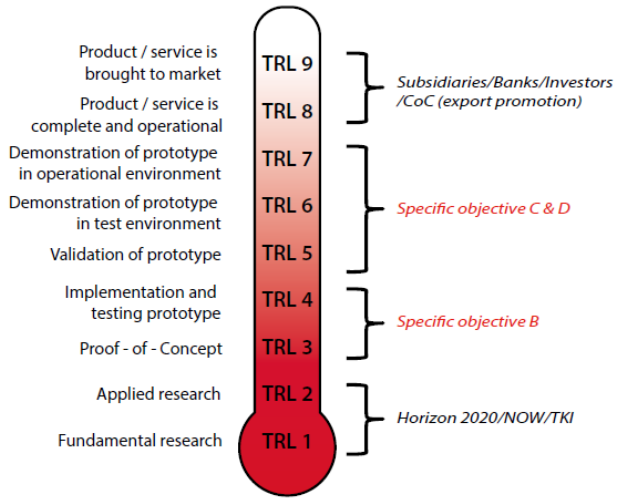
TRL is implicitly based on the linear model of innovation. The underlying assumption of the 'linear model' of innovation is that innovation progresses from basic science to applications and innovations due to applied science and development undertaken in laboratories (Freeman and Soete, 1999; Martin, 2003; Bramwell and Wolfe, 2008), this model has been added to overtime but the basic linearity remains. However, some scholars that argue that while the linear model has limitations it can be a useful analytical tool (Balconi et al., 2010). It can be seen not as a concept that fully describes the complexity of the process of innovation but a concept to study certain aspects of the innovation process. The linearization of the process enables project managers to trace the progress and issues that may arise during a project as, when applied to R&I policies, it provides to policy

makers a useful tool to measure the distance to the creation of economic value and the different support available to reach this important objective.

Box 2 The use of TRL scale in the ERDF operational programme of Northern Netherlands region

The region of Northern Netherlands has included in the definition its Operational Programme OP) for European Regional Development Fund 2014-2020 the Technology Readiness Level scale as a way of prioritising and narrowing down the type of projects that will be funded under ERDF during the referred period. The region has decided that rather than addressing the whole innovation chain, they would like the funds are targeted to later stages of the innovation processes, and TRL3 to TRL7 projects are the ones in which the OP will focus. In a more strategic approach to funds, the region analysed other available funding and identified that other European and national funds are supporting more fundamental research and lower TRL.

In order to provide more clear indications to regional ERDF beneficiaries, the Northern Netherlands OP includes the next figure to explain the stages of the innovation chain targeted by the specific objectives of the programme. In this sense, under objective *B "Fostering knowledge innovation"* and objective *D "Increase the proportion of innovations in the Northern Netherlands specifically designed to reduce CO2 levels"* will be funding projects in TRL5-7 of the innovation chain, whereas under objective C "Promoting innovation and valorisation in the SME sector" projects with TRL3-4"will be targeted.



NOW = Netherlands Organisation for Scientific Research
TKI = Topconsortia voor Kennis en Innovatie / Top consortia for Knowledge and Innovation

Figure 2: Relationship between the TRL scale and Northern Netherlands OP objectives

The use of the TRL scale in the definition of the scope of the programme provides a clear guide to beneficiaries on the type of projects that will be funded by calls and enable them to strategically plan the access to funding and synergies with centrally managed EU programmes.
Source : http://ec.europa.eu/regional_policy/en/atlas/programmes/2014-2020/netherlands/2014nl16rfop001

Consequently, when combining funding, the use of the TRL scale can allow for the better planning of the use of R&I support that may be required and therefore the appropriate funding needs to be focussed at different TRLs. In addition, TRL can be grouped to better represent widely used demarcations, for example: Basic research (TRL1-3), Development (TRL3-5), Demonstration (TRL 6-7), and Early deployment (TRL8-9) (EARTO, 2014). TRL can also be aligned with specific terminologies and scales used by different organisations.

There is an increasing use of the Technology Readiness Level scale in the definition of calls for proposals and funding programmes, as a way of increasing the focus and better targeting the funding sources towards the desired expected impact from funded projects. Some examples are highlighted in Boxes 1-3 in this section, giving a perspective of the range of programmes and R&I initiatives in

which can be potentially be applied, going from EU, national or regional programmes, clustering or triangle of knowledge initiatives.

Box 3 The use of TRL scale in Arctic Development Environments

The region of Lapland in Finland has put in place the so called Artic Development Environments, physical and virtual environments to stimulate the testing and development of products and services, bringing together universities, VET colleges and research centres. These living lab environments have been promoted in the different smart specialisation priority areas selected by the region as a way of supporting a continuous Entrepreneurial Discovery process.

The Artic Development Environments cluster has introduced the TRL scale to measure the cluster's readiness level to introduce new services in the market.

Source: http://luotsi.lappi.fi/arctic-development-environments and http://luotsi.lappi.fi/arctic-smartness-cluster-game

- *Some limitations of the use of TRL scale*

The linear model of innovation is now widely accepted as not fully representative of the innovation process, as it does not show the complete complexity and feedback loops that occur. Such complexity means that a technology or process that is at a high TRL may still have individual technologies or components that require some research at lower TRLs (EARTO, 2014). If the project is financed by only one source of funding then the support for further research developments at low TRLs will not be accommodated unless other funding sources can be obtained.

Despite its utility and comprehensive approach the concept of TRL scale is facing some criticism. In particular this relates directly to the definition of continuity or non-continuity of the innovation chain. The core concept the TRL scale is based on the linearity of innovation, a process going step by step but reality shows that TRL scale does not explicitly take account of the feedback loops that may require further research at lower readiness levels as the scale is focused on a single technology conceptualization. Similarly, the concept of 'Valley of Death' can also be criticised as it implies that innovation is a linear process in which it is only necessary to get through this particular difficult stage whereas successful innovation is an interactive process in which commercialization plans have to be effective in all stages and sometimes simultaneously as it has been highlighted by the S&T committee of the UK parliament (2013)[3].

- *Budget planning for innovation policies*

However, as the objective of this document is to design a comprehensive approach of how to map existing funding source at specific moment of the maturity of a technological area (but not only), rather than a means to describe the entire innovation process, this limitation may not be detrimental to the objectives of the design of a 'funding map'. Furthermore, when designing funding scenarios the potential non-linearity of the process should be taken into account.

For example, a limit is the difficulty in assigning a TRL to capacity building activities, something particularly pertinent when considering funds such as ESIF. Equipment and infrastructure may be funded for different purposes and not linked to one single activity on the TRL scale. There may also be important issues related to deployment that are not captured by TRL.

[3] House of Commons Science and Technology Committee, Bridging the valley of death: improving the commercialization of research, Eighth Report of Session 2012–13

Perhaps a more important limitation is that TRL is focussed on technologies whereas there are innovations that are not technology related and even if they are there are important aspects of the innovation process that are outside the scope of the TRL scale. That is the case for many of the Smart Specialisation priorities chosen by EU Regions and Countries which are not obviously technology related. The example of the tourism area is particularly meaningful because it is not directly technology related even if research activities can be performed on the topic in social sciences and humanities for instance. The definition of technology in the TRL scale should be, in such a case, taken in the broadest sense possible. The steps of building capacities (upstream) and access to the market (downstream) remain still valid even for non-technological areas. For this reason the next section addresses in more detail mechanisms that go beyond TRL and that could be usefully complementary to this concept.

As the linear model could still be useful to analyse subsets of the innovation process that can be linear in nature so TRL can be used for planning and communication purposes and also as a supporting tool for decision making on investments. The purpose of using the TRL scale in the characterisation of funding and financing instruments is not to understand the innovation process or assess the maturity of technologies but how they may fit into a system. It is to help policy makers and, ultimately, research organisations and researchers have a better idea of where the most appropriate support may be.

3.2. Beyond Technology Readiness Level to better define R&I support

The simplicity and widespread use of the TRL scale makes it highly interesting for mapping the existing R&I funding programmes or defining new ones. However, the technological and scientific elements are not the sole or most important drivers of research and innovation policy and therefore funding programme objectives. In this sense, the aim of EU cohesion policy and ESIF is to address disparities and contribute to economic, social and territorial cohesion between EU regions. As such, the S3 priority areas identified through the activation of the entrepreneurial knowledge should be driven by societal challenges defined at the European level (ageing, climate change, etc.). Equally, the European research and innovation framework programme objective is to increase the EU research and innovation excellence, but with the importance place of societal challenges, as a sub-programme in the current H2020, impact is a core element required in funded projects.

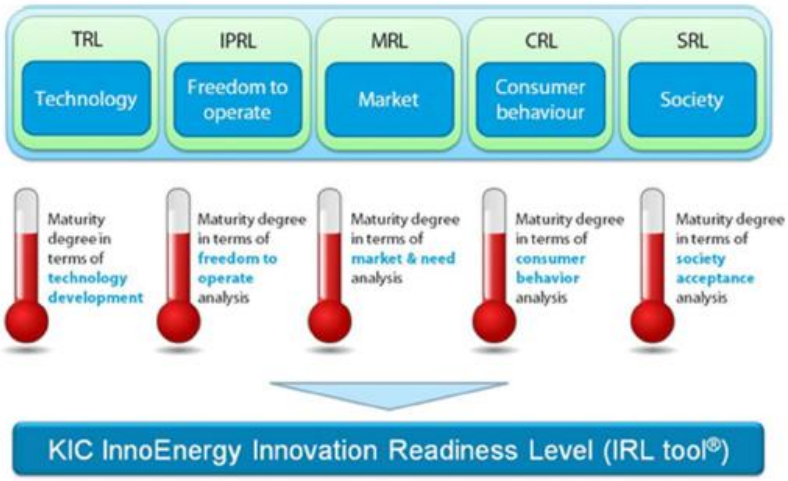
Therefore we observe an increasing interest among scholars and policymakers in understanding the key elements that contribute to strengthening the research and innovation systems. Technology driven policies and programmes are not always able to answer the most pressing contemporary challenges. In this direction, different scholars have conceptually developed other readiness scales that consider other key components of the innovation process and provide a more complete or holistic understanding of innovation as a complex and multi-layered process.

These various scales developed to complement the TRL scale have proved to be relevant and useful in the context of selection of research and innovation projects, addressing specificities of certain sectors or ensuring the relevance and acceptance of scientific innovation by final users. Some of these scales are summarised below and one case is covered in more detail in Box 4. Nevertheless, the complexity and limited knowledge of such scales by innovation actors make them of less interest for the purpose of this work, even if could be part of future work that could be done in this direction in the context of S3.

Box 4 The Innovation readiness level of the EIT KIC Inno-energy

The EIT Knowledge and Innovation Community constitute long-term partnership in the Knowledge Triangle to finalise and commercialise technological innovations that lead to new products and services. Therefore, EIT-KICs are promoting innovate projects that bring technologies and services closer to the market and shorten the time to market period. All KICs use TRL scale in the definition of the expected results and impacts of the projects funded under calls.

Furthermore, KIC Inno-energy has gone a step forward and has developed the Innovation Readiness Level, a tool to evaluate the innovative projects received for funding and determine in a more holistic way the readiness of a service or product to access the market. Innovation Readiness Level is a methodology developed by EIT Inno-energy to assess, the innovation readiness of a technology, product or service along 5 dimensions: technology readiness level, Intellectual property (IP) readiness level, market readiness level, consumer readiness level and society readiness level.



Source: European Institute of Innovation and Technology promoted Knowledge and Innovation Communities (https://eit.europa.eu/activities/innovation-communities) KIC InnoEnergy Innovation Readiness Level (IRL tool®) (https://www.iea.org/media/workshops/2014/egrdmodellingandanalyses/13_Jullien.pdf)

A number of readiness scales targeting different purposes have been designed in the past years showing an increasing necessity to better predict and plan future activities, investments or decisions. What is true at project or programme level for industry decision-makers may also be true for policy makers when planning public investments over a long period of time. It is also important to take account the other scales showing the multiple dimensions when planning a long term strategy.

The following table proposes a non-exhaustive list of scales (objectives, origins and limitations) related to the purpose of this policy brief and potentially relevant to complement or substitute the TRL approach. We can notice the recent emergence of various Innovation Readiness level scales (IRL) which are, *de facto*, sort of customized versions of the TRL scale. At least, 4 IRL scales designed by different have been identified so far, two are detailed in the table (the one from the EIT KIC inno-energy and the other from the *H2020 ProgressTT* project) and the two others are from the UK University of Strathclyde and an innovation consulting company. This recent emergence of modified TRL scales shows two things:

- the increasing need of visibility and decision support tool for decision makers
- and the necessity to adapt the TRL scale approach to be more appropriate for policy making

Table 2 Beyond TRL scale-Some existing scales to be used when planning S3 strategies

	Definition	Limitations
Innovation Readiness Level tool (IRL tool ™) First identified source : Developed by EIT Kic Inno-energy	Composite measure built on various scales TRL, IPRL, MRL, CRL, SRL (see box 4).	Difficult to implement in practice in most innovation projects, being an advanced tool.
Innovation Readiness Level (IRL) First identified source : university of liege in the context of the H2020 project PROGRESSTT	IRL is designed to better shape technologies transfer programme. University of Liege has launched a Prove of concept programme to bring project from IRL 4 (prototype approved in labs.) to IRL5 (prototype approved in real environment). In contrast to the IRL tool developed by the EIT KIC Inno-energy, the intellectual property is considered apart.	The project has reformulated the Steps of TRL scale to better shape with innovation policies and instruments. A case study on assessing IP and technology at the university of Liege shows the relevance of such tool when designing a support measure.
Manufacturing Readiness Level (MRL) First identified source : US Department of Defence http://www.dodmrl.com/	MRL measures the maturity of manufacturing readiness, similar to how technology readiness levels (TRL). It can be used in general industry assessments or for more specific application in assessing capabilities of possible suppliers	Very specific to the manufacturing sector
Technology Readiness Index (TRI) First identified source : Parasurama A., 2000	Measure to assess people's general beliefs about technology. It is comprised of 4 dimensions: optimism, innovativeness, discomfort and insecurity.	Measure mainly used for digital technologies and products
Technology Acceptance model (TAM) First identified source : Davis and Bagozzi, 1989	TAM predicts the people's technology-adopting behaviour at work environments. Developed in the 80s, it assesses the acceptance of IT by asking individuals about their future intentions to use the IT.	Measure focussed on individual 'user' of IT
Societal Readiness Level (SRL) Horizon2020-SWAFS (Science with and for Society) project "NewHoRRIzon" https://newhorrizon.eu/	SRL identifies the level of knowledge about the stakeholder's interests and concerns and to what extent affects the product/service to the society. SRL includes adequate legislation and governance arrangements to mitigate adverse effects; and the existence of mechanisms to ensure involvement of citizens and societal actors in the production and assessment of new knowledge and technologies.	The limitations of the use of TRL considering that technological readiness levels are actually always sociotechnical, i.e. include economic and social (and sometimes political) readiness)
Human Readiness Level (HRL) First identified source : US Naval Postgraduate School (NPS)	HRL Measures the likelihood of usable, fit-for-purpose systems being delivered to the end-users is getting every closer	First developed for military purposes, no other use identified
Societal Readiness Level (SRL) First identified source : Innovation Fund Denmark	SRL assess the level of societal adaptation of, for instance, a particular social project, a technology, a product, a process, an intervention, or an innovation (social or technical) to be integrated into society.	No other use of SRL scale identified
System readiness level (SRL) First identified source : Sauser et al,2002	SRL incorporates the current TRL scale, and introduce the concept of an integration readiness level (IRL) to dynamically calculate a SRL index	Technology oriented and potentially difficult to use for policy purpose
Market readiness level (MRL)(2)	MRL(2) measures the need of a technology in the market from the identification of an unsatisfied need to the full commercialization and scaling	MRL (2) is related to TAM and TRI. MRL(2) should be used ex-ante the implementation of R&I policies. MRL should have been taken into account upstream when S3 specialisation is decided through the entrepreneurial discovery process.
Demand Readiness Level (DRL) First identified source : Paun F., 2011	DRL addresses the Market Pull approach while doing technology transfer and technological innovation	DRL is similar to MRL. DRL and MRL should be considered at broader level than region itself. European and international demand/market should be considered.

4. A more coherent picture of available public funding for R&I

4.1. From the definition of the scope to the building of funding scenarios

The map of existing funding and financing instruments targets first policy makers such as managing authorities but also all organisations and bodies having a role in informing or managing R&I funding. The general overview aims to cover the core research and innovation activities and also the full range of activities upstream and downstream Research and innovation activities, from the building of capacities (eg. infrastructure, equipment, training, and skills development) to all activities contributing to the introduction onto the market of a new product or service and beyond. Activities to be funded or financed can be framed in three blocks: upstream activities, downstream until the market and post market entry. These can be summarized as follows:

- 'Upstream' activities because they generally precede research and innovation activities. Upstream activities cover infrastructures, equipment but also training, skills development, certain types of external consulting or subcontracting.

- 'Downstream' activities support access to the market and the creation of economic value. Such activities can be prototyping, pilot lines, external expertise linked to Technological transfer, IPR, and others.

- Post market entry activities include all types of support to companies' development (growth): enhancement/ modernization of production capacities, expertise for market share growth and others, scaling-up, validation for market replication, including other activities aimed at bringing innovation to investment readiness and maturity for market take-up.

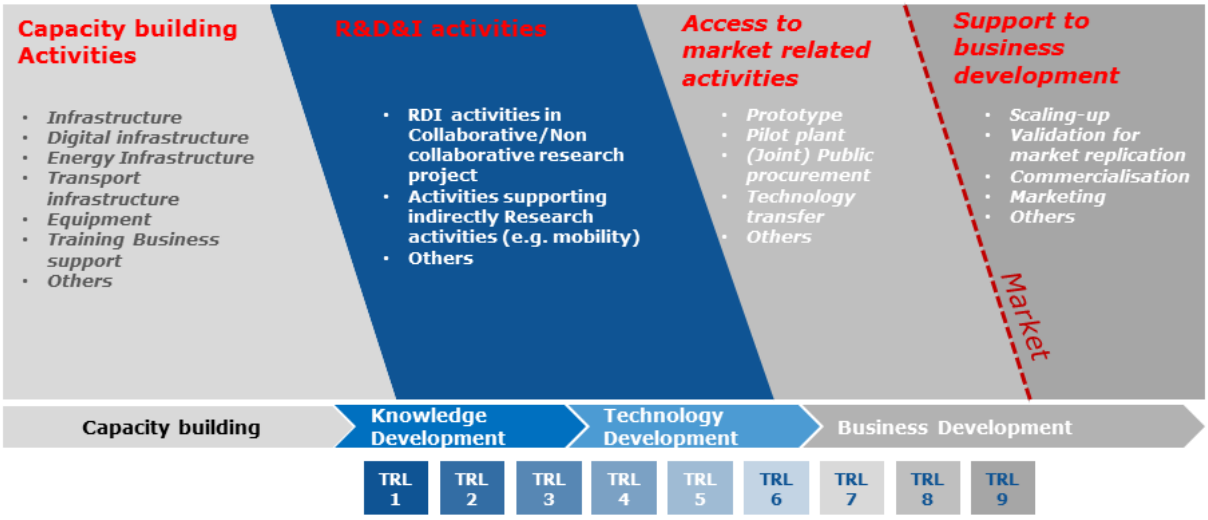
Activities are positioned along the chain from those related to the building of capacities to the ones related to the access to market with the introduction of new products and/or new services and beyond. The TRL scale allows a positioning of funding sources only along a part of the chain. A TRL grade cannot be assigned to upstream activities and activities beyond the introduction to the market of a product or service nevertheless it seems crucial to mention the non-linearity of the innovation process.

- Fundamental research can take place at any point along the chain (on components already introduced onto the market for instance)

- The 'chain' can suggest a timeline which can or cannot be the case. Activities, particularly upstream activities (infrastructures, equipment, and training) can take place in parallel with RDI activities or with support to business development, for instance.

- The technological aspect with the TRL scale is the focus of this work but the scale approach cannot be reduced to only technological aspects. Other type of scales, described in the previous section, can be also taken into account (eg. the Innovation Readiness Level scale, the Market Readiness Level scale).

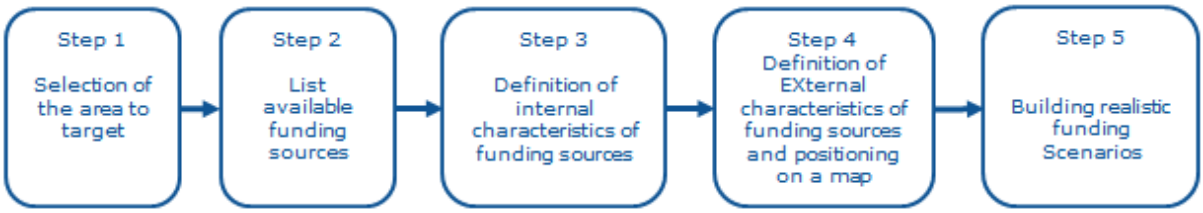
Figure 2 General overview of Research, Development & Innovation chain with upstream and downstream related activities



4.2. Five steps to build a coherent map of funding instruments

We propose a step by step approach to map and then link existing public, private or semi-public funding along a "chain" starting from capacity building to support to the development of a product or service on the market.

Figure 3 Synopsis of the 5 steps approach



The five steps can also be detailed as follows:

1. Choosing the target area in order to be as specific as possible. The definition of the most appropriate level should fulfil some conditions depending on the territorial level of interest. A Smart specialisation priority would be appropriate as it corresponds to a specific geographic area represented by community of regional stakeholders gathered during the Entrepreneurial discovery process (EDP). The appropriate balance between specificity and genericity should be targeted, to identify what is relevant and useful to policy makers and the S3 user community. The thematic selection criteria could be the following:
    a. The funding mapping exercise addresses a specific research community or sector.
    b. The area has specific dedicated funding, if not it may be more appropriate to move to a higher thematic level. The funding can be national or regional depending on the territorial level.

2. Establishing the exhaustive list of available funding and financing sources (instruments) for the selected area/themes and region.

The challenge here is to select only the relevant funding/financing tools related to the chosen thematic and territorial level. The list should include:

a. Generic funding/financing sources (without any thematic focus),
b. Funding/financing sources targeting specific Stakeholder (e.g. SMEs or universities),
c. Funding/financing sources dedicated to the area chosen in step 1.

3. Defining internal characteristics of each source of funding. The information should be, first, at programme level and then at instrument (funding scheme) level if relevant. Characterising funding should allow positioning on a map going from capacity building to the support organisational development. Funding characteristics are divided into two parts: the first part is dedicated to the expenditure items covered by the funding (or the instrument) and the second concerns other basic information about the funding. This internal characteristics should cover the following items:

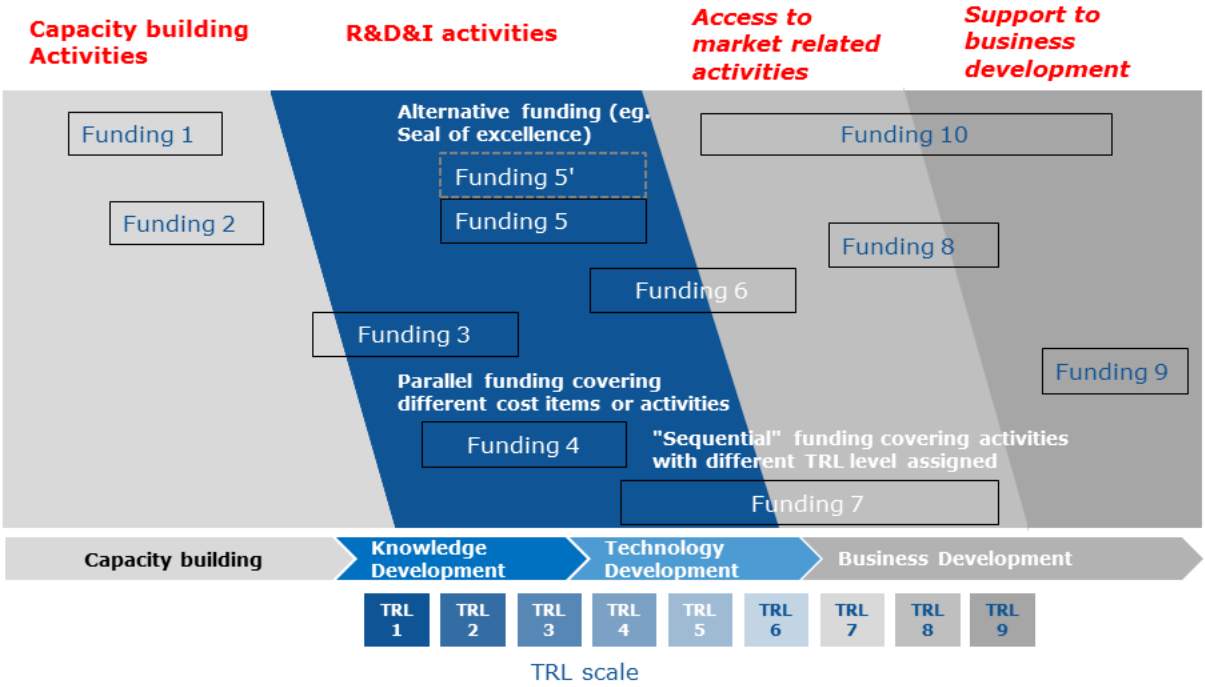
    a. Cost items covered:
        i. Infrastructures (in a broad sense, for multiannual use);
        ii. Personnel costs;
        iii. External support and subcontracting (Ad-hoc experts costs for specific activities, Contractual research, Acquisition of knowledge and patents bought or licensed from outside sources);
        iv. Mobility and Training costs (Fellowship, traineeship, incoming / outgoing mobility);
        v. Meetings, seminars, conferences.
    b. Other basic information:
        i. Institution in charge (EC DG, EIB Etc.);
        ii. Main target (SME, PRO, HES etc.);
        iii. Collaborative project (Yes/No);
        iv. Under R&I State aid framework (Yes/No);
        v. Type of the instrument/program;
        vi. Aid intensity (% of total eligible cost);
        vii. Average Amount per beneficiary provided.

4. Defining external characteristics of funding sources and position sources on a 'map' using the TRL scale when relevant.

    Each funding and financing instrument is positioned according to the type of expenditure covered (e.g. Equipment, personal, support, training) and, when possible, the distance to market using the TRL scale. The qualification of research activities as Fundamental, industrial or experimental does not need to follow a chronological approach, moving sequentially from fundamental and applied research to activities closer to the market. As research and innovation activities do not necessarily follow a linear process, the map should not be interpreted chronologically.

    a. Position on the TRL scale (min to max) when relevant (from 1 to 9);
    b. Project or companies' stages (when relevant).

Figure 4 Step 4: tentative funding map positioning each funding source along the TRL scale

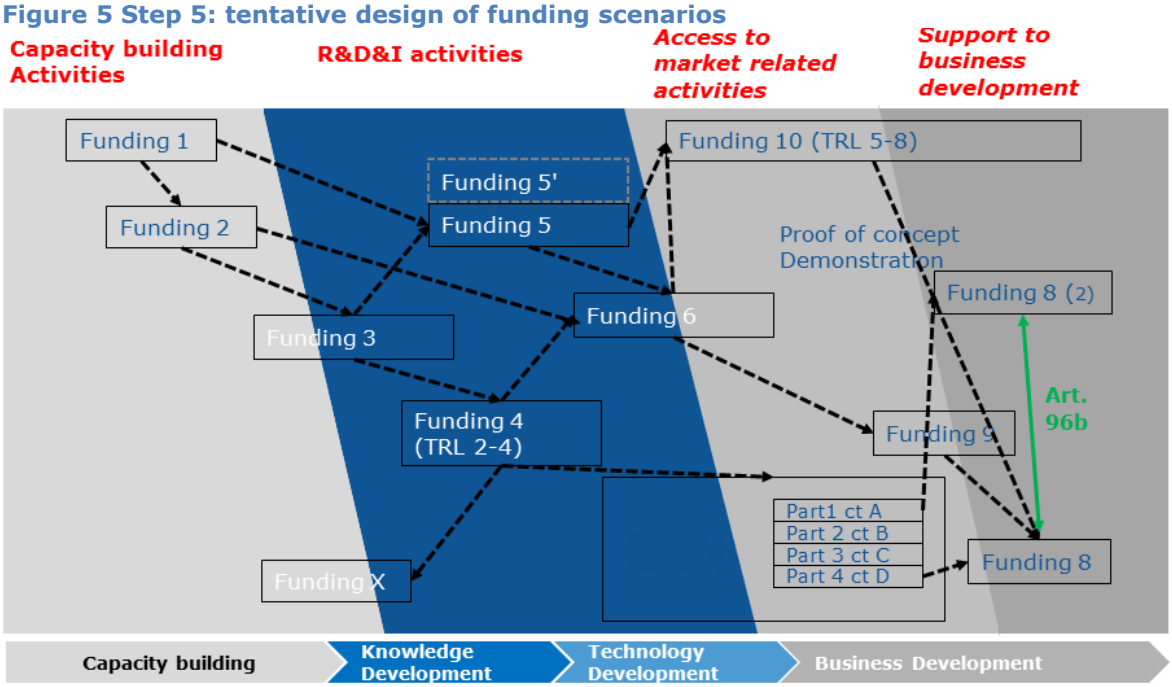


5. Build realistic Funding Scenarios complementing external characteristics with all possible existing funding. This crucial final step provides an answer to the question on the programme or other source of funding to pursue. Funding could be sequential (upstream or downstream), in parallel covering different activities or alternative funding covering same activities. To a larger extent, semi-private or private funding can be considered and be part of the map.

   Those coherence characteristics complete the boundaries of a source of funding. The four types of connection envisaged are the following:
   1. Complementary funding upstream;
   2. Complementary funding downstream;
   3. Complementary funding in parallel ;
   4. Alternative source of funding.

All information gathered in the previous steps allow the positioning of and linking to all funding/financing sources related to specific themes. From this starting point, many different funding scenarios can be elaborated in linking various instruments to each other. The nature of the links between funding/financing instruments is of crucial importance and subject to discussion. It shows the feasibility of the combination between two sources.

Figure 5 Step 5: tentative design of funding scenarios



Box 5 EU Risk sharing financial instruments suited for the Solar FOAK project

By combining existing EU financial support instruments and the use of cooperation mechanisms of the 28/2009/EC Directive, it should be possible to make solar electricity cross-border trade projects marketable. In this respect, and supported by the Solar Smart Specialization Partnership, Extremadura is planning to host a cross-border solar electricity First-Of-A-Kind (FOAK) project in Europe. Such a project would not only demonstrate its financial and regulatory viability but, most important, the associated benefits of the initiative.

Among the existing alternatives, when considering the characteristics and financial needs of solar FOAK project, the following options were identified as the most suitable investment support for a solar FOAK project:

- InnovFin Energy Demo Project (EDP) Facility is an entirely market driven instrument that appears to be the most suitable financial instrument for the Solar FOAK.
- European Funds for Strategic Investment (EFSI) can support energy sector investments that are difficult to finance through the market.
- H2020 programme is applied for innovation actions to support low carbon technologies and services.
- InnovFin for large projects facility delivers direct loans and guarantees from EIB for R&I projects emanating from larger firms; universities and public research organisations; R&I infrastructures (including innovation-enabling infrastructures); public-private partnerships; and special-purpose vehicles or projects (including those promoting FOAK, commercial-scale industrial demonstration projects).
- The European Structural and Investment Funds (ESIF), which represent over half of EU funding jointly managed by the EC and the Member State.

In order to successfully support innovation in the energy sector throughout all phases of the innovation process, existing different tools should be combined. The Solar FOAK project considers the combination of EU financial instruments to support the commercial scale of the project by incentivising and catalysing investment and finance from the private sector in Europe. In so doing, the EC reduces the risk level for other investors facilitating the mobilization of private risk finance in order to leverage EU budget resources. Specific funds have been set up that tackle this critical stage in the innovation process.

Climate Strategy (2017a): Finance for Innovation: Towards the ETS Innovation Fund. Presentation of Peter Sweatman, CEO Climate Strategy as Rapporteur for Industry Stakeholders in Brussels on 12th June 2017.

Source: http://s3platform.jrc.ec.europa.eu/s3-energy-partnerships-solar-energy

5. Case study on Concentrated Solar Power technology in Andalusia region

5.1. The implementation of the five step approach

❖ Step 1: Selection of the area to target

Expected content (justification of the theme addressed and definition of the context)

-Short description of the area/technology selected (maturity, techno/innovation challenges)
-Short description of the sector (Europe position, main stakeholders/key players, more SME or MNE)
-Related Selected specialisation area
-Regions working/investing on the same domain
-Related S3 interregional partnership
-Related EU initiatives such as Joint undertaking, ERA nets, EIT KIC inno energy, Interreg project?

Definition

Concentrated Solar Power (CSP) technologies produce electricity by concentrating the sun's rays to heat a medium (usually a liquid or gas) that is then used in a heat engine process (steam or gas turbine) to drive an electricity generator. CSP uses only the beam component of solar radiation (direct normal irradiance), and so its maximum benefit tends to be restricted to a limited geographical range [European Commission 2013a].

CSP employed 22 000 people worldwide in 2014, 15 000 in the case of Europe [Ferroukhi et al. 2015]. Over the period 2015-2030, solar thermal electricity is expected to create up to 150,000 qualified jobs including engineering, development and financing, manufacturing, construction and operation and maintenance [Estela 2016].

Innovation challenges and justification of the public intervention

CSP can make a significant contribution to the transformation of the European energy system by providing an important share of dispatchable renewable electricity. CSP can facilitate the integration of variable output renewables such as photovoltaic (PV) or wind energy, thereby contributing to the reliability of the transmission grid. The best solar resources for CSP are to be found in Southern Europe, which makes this technology complementary to those renewable energy technologies that find their best resources in other regions of Europe.

The European industry is a global leader in CSP, with European entities involved in most of the projects developed so far worldwide. Yet, in order to maintain this global leadership, the European industry needs to stay ahead with more advanced, competitive technologies. In addition, innovation (i.e. new technologies reaching the market) needs to take place in Europe again, to maintain or regain the confidence in European technologies of international investors and promoters abroad. This is a very distinctive and crucial need of the CSP sector. There is a clear funding gap in Europe to bring new CSP technologies to the market (to move new technologies from demonstration to first-of-a-kind commercial scale plants).

CSP innovation needs, therefore, to be reactivated and for this it is necessary to reduce costs via a combination of technology improvements, volumes deployed (learning curve and economies of

scale) and risk-financing to support innovation projects. In addition, it is necessary to improve other framework conditions for first-of-a-kind demonstration projects and subsequent market deployment, including the ability to supply dispatchable electricity generated by CSP plants from Southern Europe to Central/Northern Europe, thereby facilitating CSP access to new markets.

Potential Synergies with national policies

The potential technology deployment is supported by national policies. Thus, six EU member states have included CSP in their National Renewable Action Plans (NREAPs): Cyprus, France, Greece, Italy, Portugal and Spain. So, despite the current economic environment, technology diffusion is expected in the coming years. [SETIS 2013]

Smart specialisation strategies

Related selected specialisation area (source: Eye@RIS3): Promotion of Renewable Energies[4]

Related interregional partnership (source: S3platform): Solar Energy partnership[5] with Extremadura (ES) and Alentejo (PT), Andalusia, Asturias (ES), South Estonia (EE), Sicily (IT), Slovenia (SI), South Karelia, Vaasa (Ostrobothnia) (FI), GAP Region - TR33 (TR)

Related EU initiatives

- EIT KIC inno energy

❖ Step 2: Listing available funding (Generic and Thematic)

Expected content

- List of Funding/financing sources addressing directly or indirectly the area selected in step 1. Funding and financing tools without a thematic focus (eg. some H2020 instruments, ESIF TO and IEB financing instrument) should not have to be updated. The focus is here on Specific funding and financing instruments targeting the selected area AND the funding and financing sources existing at national and/or regional level AND, if useful, the private financing support.

Various sources of information on funding and financing sources targeting the Energy field are available on the internet. We have the listed the following three, but many others exist:

- C-ENERGY 2020 :Connecting Energy National Contact Points in a pro-active network under Societal Challenge 3 'Secure, clean and efficient energy' in Horizon 2020
- European Alternative Fuels Observatory
- The EU Covenant of Mayors for Climate & Energy

[4] Estrategia de innovación de Andalucía 2020-RIS3 Andalucía(2012)

[5] http://s3platform.jrc.ec.europa.eu/s3-energy-partnerships-solar-energy

Table 3 Main source of funding and financing potentially addressing CSP in Andalusia

id	sources	Brief description
1	Horizon 2020	Covers the entire spectrum of research activities generic and thematic oriented and involving all type of stakeholders. The programme goes from TRL 1 to 8 including upstream activities (e.g. light equipment, training). Funded projects can be mono beneficiary or collaborative. H2020 is out of the State aid framework and centrally managed by EC https://ec.europa.eu/programmes/horizon2020/
2	ESIF TO1 TO2 TO3 TO7	Covers a large spectrum of research activities from TRL4 (applied research) to TRL 9 (the market) including upstream activities (Infrastructures, equipment, training). ESIF are generic (e.g. Support to competitiveness of SMEs) and thematic oriented (TO1 with S3 strategies TO2 digital economy and ICT TO4 low carbon economy). ESIF are under State aid framework
3	COSME	EU programme for the Competitiveness of Enterprises and SMEs, covers activities from TRL6 to 9 and beyond. It aims at (1) Facilitating access to finance (2) Supporting internationalisation and access to markets (3) Creating an environment favourable to competitiveness (4) Encouraging an entrepreneurial culture. COSME funds the Enterprise Europe Network (EEN) helping SMEs find business and technology partners, understand EU legislation and access EU financing.
4	COST	provides Grants for organising conferences, meetings, training schools, short scientific exchanges or other networking activities in a wide range of scientific topics
7	CEF Energy	Financial instruments, by bringing in new classes of investors and mitigating certain risks, help project promoters to access the necessary financing for their projects. Grants to contribute to the construction costs are applied to fill in the gaps in commercial viability of the projects. Activities beyond TRL 9
8	EUREKA - EUROGIA2020	EUROGIA2020 aims to support and promote transnational, low carbon energy technology innovation projects (from TRL 4 to 6). Funding is granted via EUREKA Countries' national programmes (under State aid Framework).
9	Eurostar2	provides grants for international collaborative research and innovation projects that will be rapidly commercialized (from TRL 4 to 6 or 7)(under State aid framework)
11	NER300	NER300 provides Grants to support demonstration (TRL6 and 7) activities in a wide range of CCS technologies (pre-combustion, post-combustion, oxyfuel, and industrial applications) and RES technologies (bioenergy, concentrated solar power, photovoltaics, geothermal, wind, ocean, hydropower, and smart grids).
12	PF4EE (EIB/EC)	The PF4EE Instrument address the limited access to adequate and affordable commercial financing for energy efficiency investments. It provides guarantees as portfolio-based credit risk protection provided by means of cash-collateral (Risk Sharing Facility / "RSF"). Intermediaries in each MS can be found on internet
13	IEF IEB InnovFin	Loans, Guarantees, equities provided by IEB to, in most of the cases , financial intermediaries (See annex2)
15	EEEF - European Energy Efficiency Fund	Targets private public partnership, primarily through the provision of dedicated financing via direct finance and partnering with financial institutions. Investments should contribute significantly towards energy savings and the reduction of greenhouse gas emissions to promote the environmentally friendly use of energy. offers funding for energy efficiency and small scale renewable energy project.
16	EIT - KIC InnoEnergy	The EIT incentivises Innovation Communities to co-finance added-value activities from other resources, supporting their way towards financial sustainability. Other Innovation Community activities not financed by the EIT grant, known as Innovation Community complementary activities, must contribute to the implementation of the strategy of the Innovation Community. Such activities must be linked with added-value activities to increase impact.
17	Progr Estatal de Fomento de la Investig Científica y Técnica de Excelencia	Promotion of talent and its employability, knowledge generation and system strengthening, business leadership in R + D + I, societal challenges oriented R & D.
18	IDAE	The Institute for the Diversification and Saving of Energy (IDAE) carries out promotional and training activities, technical consulting, and development of specific programmes and financing of technical projects which are innovative and replicable. Likewise, the Institute leads active international engagement within the framework of various European Programmes and co-operation with third countries.

❖ Step 3: Definition of internal characteristics of funding sources

Expected content:
Relevant information regarding each funding source is gathered. Part A gathers basic but useful information qualifying each instrument. It is completed by the part B focusing only on cost items (category of expenditure) covered by the instrument. This latter information is particularly important when considering parallel combination of instruments.

A. Basic information about funding source

i. Institution in charge (EC DG, EIB Etc.)
ii. Main target (SME, PRO, HES etc.)
iii. Collaboration criterion (Yes/No)
iv. Regulation framework
v. Under R&I State aid framework (Yes/No)
vi. Type of support (funding or financing)
vii Submission mode (open call/annual calls etc.)
viii. Aid intensity (% of total eligible cost)
ix. Average Amount per beneficiary provided (in EUR)
x. Average duration (in months)
xi. Average Success rate (in %)
xii. Pre-payment (yes/no)

B. Cost items covered

i. Infrastructure (in a broad sense, for multiannual use)
i.1. Construction: buildings, land, roads, laboratories, testing facilities
i.2. "Heavy" equipment: ICT, non ICT (Demonstration prototyping, Pilot line)
i.3. "Light" equipment and material: ICT, non ICT ((Demonstration prototyping, Pilot line)
ii. Personnel costs
ii.1. Researchers, technicians and other supporting staff to the extent employed on the project
ii.2. Personnel committed in the project as coordination and/or management support
iii. External support and subcontracting (Ad-hoc experts costs for specific activities, Contractual research, Acquisition of knowledge and patents bought or licensed from outside sources)
iv. Mobility and Training costs (Fellowship, traineeship, incoming / outgoing mobility)
v. Meetings, seminars, conferences
vi. Renting Facilities
viii. Overhead costs
ix. Operating expenses

A database of the 18 funding or financing instruments aiming to support R&I and also business development in concentrated solar power (CSP) has been created. Illustrations of its contents are provided available in annex 2. This database combines both sources of funding to support generic R&I (i.e. not targeting a particular theme) and other thematic oriented instruments and schemes. As such, much of the information gathered is reusable for other cases targeting other thematic areas.

Table 4 List of selected funding and financing instruments

n°	name	Info source	Grant(G)/Financing instrument (FI)	Thematic Scope	Geographical scope	
1	H2020	Web link	G	generic	EU28+	See Annex x
2	ESIF-ERDF-TO1 research & innovation	Web link	G	Thematic Scope	National-Regional	
3	ESIF-ERDF-TO3 Sme comp	Web link	G	generic	National-Regional	
4	ESIF-ERDF-TO4 low carbon economy	Web link	G	generic	National-Regional	
5	ESIF-ESF	Web link	G	generic	National-Regional	
6	COSME	Web link	G&FI	generic	EU28+	
7	COST	Web link	G	generic	37 COST MS	
8	CEF energy	Web link	G&FI	Thematic Scope	EU28	
9	EUREKA - EUROGIA2020	Web link	G	generic	35 Eureka Country members	
10	Eurostar2	Web link	G	generic	Eurostars participating states (33) & partner countries (3)	
11	LIFE programme	Web link	G	Thematic Scope	EU28 and specified 3rd countries	
12	NER300	Web link	G	Thematic Scope	EU28	
13	PF4EE/LIFE	Web link	FI	Thematic Scope	EU28	

14	IEB InnovFin	Web link	FI	generic	EU28	
15	IEB Innovscience	Web link	FI	generic	EU28	
16	European Energy Efficiency Fund (EEEF)	Web link	G&FI	Thematic Scope	EU28	
17	EIT KIC InnoEnergy)	Web link	G	Thematic Scope	EU	
18	Marguerite Fund	Web link	FI	Thematic Scope	EU	
19	Programa Estatal de Fomento de la Investigación Científica y Técnica de Excelencia	Web link	G	Secure, efficient and clean energy	Spain	
20	IDAE	Web link	G	Efficient energy building, mobility and efficiency in industry	Spain	

❖ Step 4: Defining external characteristics of funding sources and position sources on a 'map'

Expected content
This fourth step should be approached together with the fifth step when envisaging funding scenarios in linking funding sources to find complementarities. Last information items "potential barriers for synergies" should open discussion about the difference between regulations, geographical coverage and other types of bottleneck hampering the creation of synergies
-A database (excel format) of relevant information regarding each funding source concerns the following information items:

C. Positioning funding/financing sources

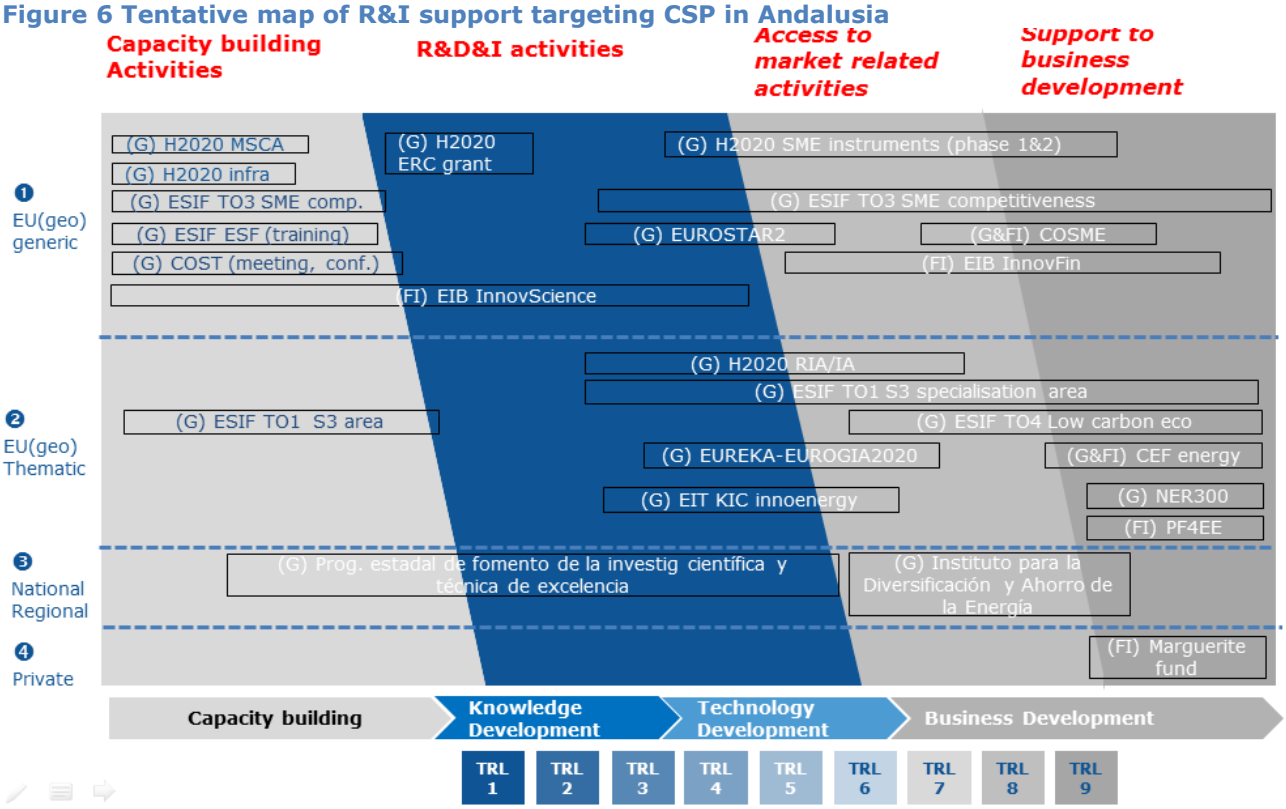
i. Position on the TRL scale (min to max) when relevant (from 1 to 9)
ii. Project stages (when relevant)

From information characterizing R&I support, each funding source can be "mapped " according to four main criteria:

- Their origin: European, National/regional, Private
- Their thematic orientation or not: Distinction is made only for European R&I support
- The type of support: Grant (G) or financing instrument (FI)
- The type of activities supported using the TRL scale when it is relevant. TRL scale does not cover upstream activities (infrastructures, equipment or training) aimed at building capacities to perform R&I activities. This is also the case regarding downstream R&I activities going beyond the introduction of products or service on the market (support to company growth, scale up). The cost items information collected in the previous step are of particular utility when placing funding/financing on the map.

Even if the map aims to be as complete as possible, it is clear that other R&I support sources/instruments could be added.

Figure 6 Tentative map of R&I support targeting CSP in Andalusia



❖ Step 5: Building realistic funding and financing scenarios

Expected content

Together with step 4, this step should open discussions about the feasibility of combination of funding taking into account barriers and bottleneck that hamper the creation of synergies (timing of project calls, low success rate making the acquisition of funding hypothetical).

- Investigating the link between funding. Complementary Sequential funding, complementary parallel funding, alternative funding
- Graph: dynamic funding map from Capacity building to the introduction of new product/service on the market linking source of funding. The feasibility of the link between funding should be commented

Discussion points

C. Complementary characteristics with other sources

i. All Potential Complementary funding upstream
ii. All Potential Complementary funding downstream
iii. Complementary funding in parallel (covering different activities e.g. training, equipment)
iv. Alternative source of funding
v. Potential Barrier to synergies

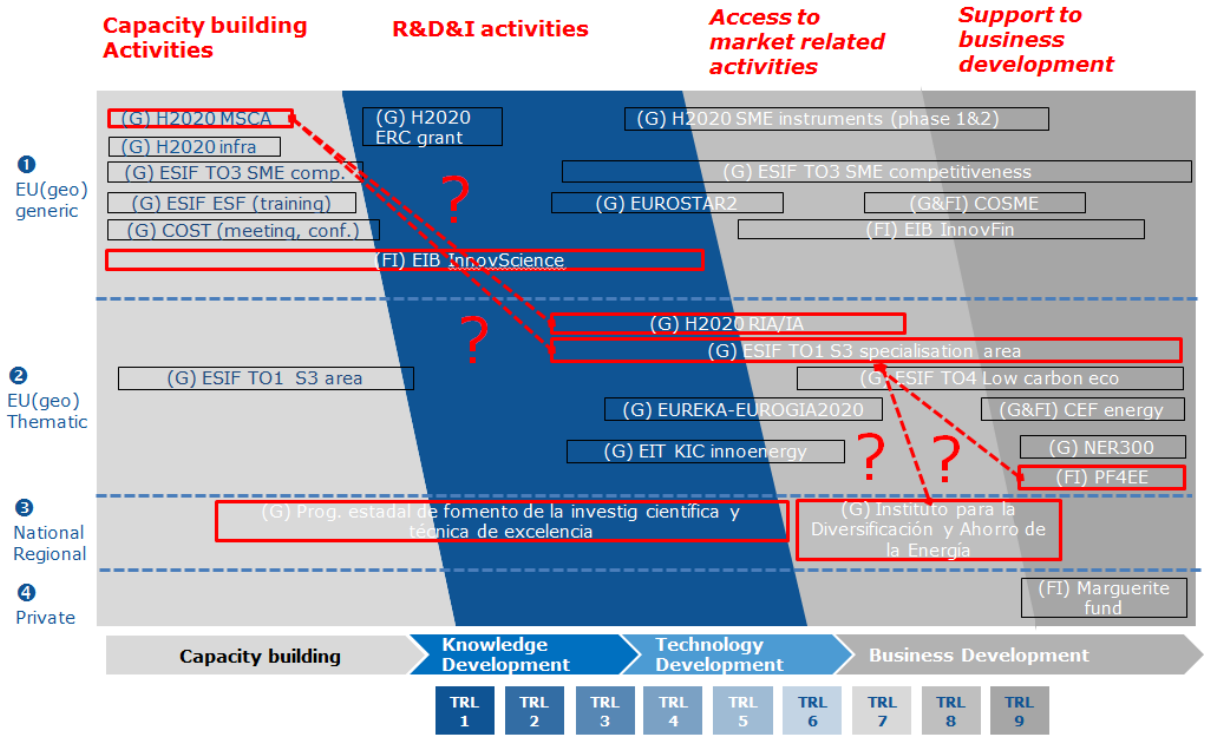
From the information gathered in the four previous steps, scenarios including funding and financing instruments can be elaborated. Scenarios can consider a long term span for the implementation of S3 or/and the economic development of the territory with sequential and parallel combination of several instruments not covering same expenditures items. Alternative funding scenarios can be also envisaged in the planning process due to the possible rejection of funding requests as a sort contingency plan. For instance, the "Seal of Excellence[6]" proposed by Horizon 2020 offers the

[6] The idea of creating a 'Seal of Excellence Certificate' is to award the proposals rated above quality threshold but not funded with a European high-quality label to allow them to see their effort and the value of their proposal recognized. https://ec.europa.eu/research/soe/index.cfm?pg=what

possibility to SME measures proposals and some MSCA mobility actions[7] rejected due to lack of budget to be funded by ESIF.

Figure 7 shows the 'map' with seven funding or financing instruments selected in order to show that not every support mechanism must be activated. The selection of and the bridging between support mechanisms may be subject to comment.

Figure 7 Tentative scenario targeting concentrated solar power technology in Andalusia



5.2. Critical view of scenario building

The case study has focused on the Spanish region of Andalusia. However, the relevance of the results are not limited to this region, as most of the funding programmes and instruments included in the tentative scenario are eligible for all EU regions and beyond. Certain considerations should be taken into account when using the funding scenarios:

1. **Difference of availability of placed-based funding may hamper the transferability of the scenario in other European region**

The availability of ESIF differs widely across EU member states. In the case of member states and regions with high ESIF, the potential complementarity of ESIF funding with other EU instruments is important. In fact in some cases, high amounts of ESIF might even deter participation in competitive EU programmes with lower success rates such Horizon 2020. In the case of regions with low ESIF, in most cases it becomes an incentive to be more active in EU funding programmes. Therefore, the scenario does not show such aspects, neither the success rates of the different funding programmes that greatly influence in beneficiaries decision to choose among them.

[7] The Marie Skłodowska-Curie actions (MSCA) provide grants for all stages of researchers' careers - be they doctoral candidates or highly experienced researchers - and encourage transnational, intersectoral and interdisciplinary mobility. https://ec.europa.eu/programmes/horizon2020/en/h2020-section/marie-sklodowska-curie-actions

2. The scenario versus reality: anticipation of all potential difficulties

The concept of scenario is not only to define the ideal path of the implementation of a chosen Smart Specialisation area in a given territory but also to anticipate all potential difficulties and barriers which come along the chain going from capacity building to the development of a product or service on the market and envisage all available alternatives. Moreover, the lack of international networks, weak expertise in EU project management or skills to draft competitive proposals can generate difficulties when bridging funding or financing sources.

3. Non-linearity of innovation

The scenario should not be read as a linear representation of innovation, in which funding instruments are accessed in successive phases. The scale going from capacity building to the market should not be interpreted as a time scale. Innovation can work by iteration or through backward loops requesting for instance upstream research activities for a product or service already on the market

4. Further considerations

When developing scenarios, there are various aspects that could influence their implementation. Aspects we can control and some others not. A risk assessment would always useful to take into account all additional possible factors. Such additional considerations may be the following:

- H2020 is administratively easier to implement and can give a project more flexibility but is very competitive with less chance of success than other types of funding;
- Some funding schemes such as H2020 do not come under the State Aid Framework whereas others such as ESIF do. This would have to be a consideration when linking different funds to build a scenario and understand how viable it will be;
- The funding rates can vary between different schemes as can the method for calculating the overheads. This can impact on the funding received and will be a consideration for deciding on the most appropriate scenario.

6. Concluding remarks

The response to the societal, environmental and economic challenges faced by Europe is the main driver of EU policies. The implementation of those policies is set in motion through a number of different support instruments comprising different scope, rules and legal frameworks. One of the first challenges for policy makers and stakeholders intervening in the support to R&I is to have a full picture of all existing instruments available now and in the future (funding and financing instruments). When having this picture, the second and more difficult challenge is to, eventually, bridge those instruments, considering the different characteristics and related constraints considering Horizon 2020 and ESIF enter into a different stage of a project given the distinct nature of these two policies. Strategic synergies, in terms of broader policy settings and specific advisory support to beneficiaries, could help tackling bottlenecks and thus foster business involvement into the innovation ecosystem. The general objective in promoting synergies is to move from a combination of funding by opportunity to the creation of synergies by a better planning of implementation of innovation policies.

Beyond the methodological frameworks proposed in this document, the case study on CSP in Andalusia showed us that starting from the simple objective to map the R&I support available for potential beneficiaries may be a difficult exercise. Policy makers from regional or national authorities when planning the implementation of their Smart specialisation strategies face difficulties to envisage and consider the full range of R&I support available and the possible combination.

When developing the methodological approach and the thematic case study some issues and potential recommendations have emerged to contribute facilitation the synergies between funding and financing instruments.

Need for cross-cutting knowledge of existing funding and financing support

Information on R&I support schemes is very often considered separately from each other in what is known as a "silo thinking" approach. Persons in charge of the dissemination of information are too often specialised in one type of funding instrument. A recommendation could be to favour the development of cross cutting knowledge on R&I support instruments and encourage the creation (or the reinforcement) of EU grant offices with the appropriately skilled people, trained in public research organisations and universities complementing the task, for instance, of H2020 National Contact Points.

Develop a better understanding of decision factors for potential beneficiaries

Develop a better understanding on the decision factors of potential beneficiaries according to each type of support and develop appropriate information and support strategies as policy maker. Within a specific domain before envisaging combination of funding/financing instrument, policy maker need to understand the determinant of potential beneficiaries. Are they well informed about all the R&I support available? What are their main constraints (budget, time)? Does the instrument or programme meet their needs and expectations? What are the main barriers and bottlenecks to their combination?

Propose a better alignment for rules of participation

An important disparity of the rules of participation (e.g. eligibility criteria) and the legal framework can be observed. A better alignment of funding rules between EU funding, and also national, programmes could facilitate synergies between funding.

Adaptation of existing TRL scale into a tool suitable for a type of innovation activities

The Technological readiness level scale is considered as a reference and used increasingly by EU programmes (eg. Horizon 2020, some ERDF operational programmes) but the approach appears to be too technological and fits less with none or less technological areas. Other scales designed using the same approach of TRL scale but in including other features to fit better with R&I policy type activities have been designed. For instance, the various versions of the Innovation readiness level (IRL) scale takes into account some new dimensions adding to the TRL scale to improve the tool.

Broaden the scope of TRL scale to Commercialisation of new products and services and scale up Business capacities

It is important to ensure continuity of funding and financing support in terms of both technology requirements and time horizon. European funding should aim at a coherent support between the different levels of technological development and entrepreneurial stages via an effective mix of public policy instruments. The timing is also an important issue with the need of a smooth transition from each programming period to the next one without gaps due to policy design and implementation.

Better communication regarding the financing instruments

The offer of financing instruments needs to be clarified by EIB and the European Commission in order to give a more coherent picture of what can be done in terms of synergies with other types of support. The offer of financing instruments provided directly by the EIB or through financial intermediaries remains difficult to understand from the point of view of potential beneficiaries.

Technology as the main innovation driver

As underlined in the core of this analysis the technology might be one of the components of the innovation project or initiative that a region wants to deploy through their ESIF operational programme. However, there is an increasing focus towards innovation strategies that address specific societal challenges of the region and specific programmes designed towards this end. This makes more difficult to represent funding programmes in the one unique scale of technology. In fact, the new proposal of the European Commission for the future Horizon Europe programme goes in this direction, with more mission-oriented research and innovation.

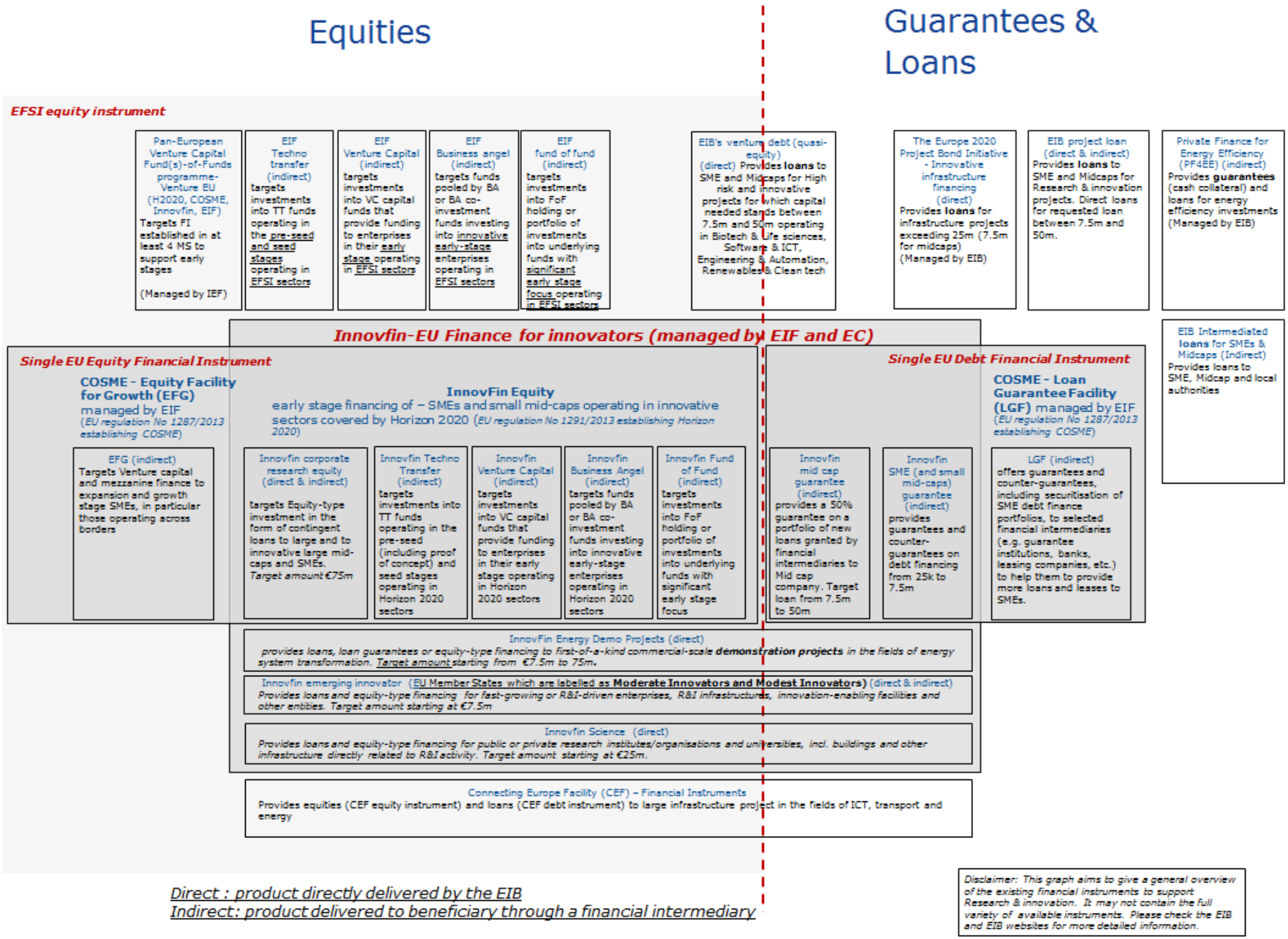
Nevertheless, the TRL scale could be very useful in shaping the regional Operational Programmes, if the funding instruments and topics are designed with the broader societal challenges and mission-oriented focus in mind, the technology being one of the innovation components. In addition, the difficulty of representing the innovation readiness level or more complex readiness levels in a funding scenario has to be taken into account.

Annexes

Annex 1 an overview of financial instruments provided by directly and indirectly by the European Investment bank

Finance Glossary

EIB	European Investment Bank
EIF	European Investment Fund (EIF is a subsidiary of the EIB Group specialised in capital-venture and acts independently and commercially under market conditions
Innovfin - EU Finance for innovators	Co-managed by EIF and the DG R&I of the European commission, Innovfin offers a range of tailored products which provide financing to support research and innovation under Horizon 2020 framework. Innovfin can invest in innovative projects with higher risk with the Horizon 2020 risk sharing funding facility.
Debt	Money borrowed from lenders (e.g. banks) or the capital markets for a variety of corporate or personal purposes (e.g. to cover the financial needs of a project). The borrower pays interest for the use of the money and is obliged to repay the loan within an agreed period.
Loan	A loan is money, property or other material goods that is given to another party in exchange for future repayment of the loan value amount along with interest or other finance charges. A loan may be for a specific, one-time amount or can be available as an open-ended line of credit up to a specified limit or ceiling amount.
Bond	A bond is a fixed income investment in which an investor loans money to an entity (typically corporate or governmental) which borrows the funds for a defined period of time at a variable or fixed interest rate.
Equity	Participation in the capital of a company
Contingent loan	A contingent loan is a loan with a condition that can occur before the deal can close (for instance in case of non-reimbursement of the loan).
Quasi Equity	Quasi-equity is an innovative debt instrument that has some of the characteristics of equity. Quasi-equity is a contingent and participating loan, meaning that its profits are contingent on the success of the company and that it participates in the risk and the potential upside
Guarantee	Portfolio-based credit risk protection provided by means of cash-collateral. The colateral is the asset put in front of the loan. It can be tangible or not. In this case it is a cash collateral. A guarantee covers risks of large and small projects, as well as loan portfolios to make them more attractive to other investors or to provide potential economic and regulatory capital relief
Venture capital	Venture capital is financing that investors provide to start-up companies and small businesses that are believed to have long-term growth potential.
Different type of private companies (linked to the eligibility to financial instruments)	SME - Micro-enterprises (0-9 employees) - Small enterprises (10-49 employees) - Medium-sized enterprises (50-249 employees*) Mid-cap - Small mid-caps (250-499 employees) (in the case of SME guarantee) - Mid-caps (250-3 000 employees*) *EU recommendation 2003/361/EC



Direct : product directly delivered by the EIB
Indirect: product delivered to beneficiary through a financial intermediary

Disclaimer: This graph aims to give a general overview of the existing financial instruments to support Research & innovation. It may not contain the full variety of available instruments. Please check the EIB and EIB websites for more detailed information.

Annex 2 Case study data

Table 5 Basic Information about R&I support dedicated to CSP

					A. Basic information											
n°	name	link	Thematic	Geograph	i.Institution in charge (EC DG, EIB Etc.)	ii. Main target (SME, PRO, HES etc.)	iii. Collaboration criterion (Yes/No)	Iv.Regulation framework	v. Under R&I State aid framework (Yes/No)	vi. Type of support (fnding or financing)	vii.Submission mode	viii. Aid intensity (% of total eligible cost)	ix. Average Amount per beneficiary provided (in EUR)	x. Average duration (in months)	xi.Avg Success rate	xii.Pre-payment
1	H2020	https://ec	generic	EU28+	EC	all	Yes but not all	Regulation	no	Grant	Calls for propo	Up to 100% of	7.5Me - 50 ME	Wide variation	15%	yes
2	ESIF-ERDF-TO1	https://ec	Thematic	National-Regional		all	no		yes	Grant	Calls fro project/open calls					no
3	ESIF-ERDF-TO2 digital	https://ec	Thematic	National-Regional		all	no		yes	Grant	Calls fro project/open calls					no
4	ESIF-ERDF-TO3 Sme comp	https://ec	generic	National-Regional		Sme	no		yes	Grant	Calls fro project/open calls					no
5	ESIF-ERDF-TO4 low carbon	https://ec	generic	National-Regional		all	no		yes	Grant	Calls fro project/open calls					no
6	ESIF-ESF	https://ec	generic	National-Regional		all	no		yes	Grant	Calls fro project/open calls					no
7	COSME	https://ec	generic	EU28+	EC	SME	no	Regulation	no	Grants	Open call		150k			yes
8	COST	http://ww	generic	37 COST M	EC	all	yes	EU Financia	no	Grant	Open call			4 yrs		
9	CEF energy	https://ec	Thematic	EU28	EC/INEA	all	no	Regulation	no	Grant	Calls for propo	50	from 300K to 4	up to 3 yrs		yes
10	EUREKA - EUROGIA2020	http://ww	generic	35 Eureka	National rules	PRC/PRO	yes			Grant	Calls for projects					yes
11	Eurostar2	https://w	generic	Eurostars	EC/EUREKA	R&D performi	yes	REGULATIO	Depends on co	Grant	Call for propos	25%-80% depends on countr		up to 3 yrs	30%	yes
12	LIFE progr.	http://ec.	Thematic	EU28 and	EC	all	Yes - transnati	Regulation	yes	Grant	Calls for propo	up to 60% (with some except		4-5 yrs	4%-34%	yes
13	NER300	https://ec	Thematic	EU28	EC	SME, midcaps,	no		no	Grant	Calls for proposals		avg 52m			yes
14	PF4EE/LIFE	http://ww	Thematic	EU28	EIB/EC	FI and PRC	no		no	Garantee/Loa	Open call					
15	IEB InnovFin	http://ww	generic		EIB/EIF/EC	FI and SME/mi	no		no	Equity/Loans	Open call					
16	IEB Innovscience	http://ww	generic		EIB/EIF/EC	Public and pri	no		no	Loans	Open call					
17	European Energy Efficiency Fund (EEEF)	https://w	Thematic Scope				no				Open call					
18	EIT KIC InnoEnergy)	https://eit	Thematic	EU	EIT/EC		no				Open call					
19	Marguerite Fund	http://ww	Thematic	EU	private		no				Open call					
20	Programa Estatal de Fomento de la Investigación Científica y Técnica de Excelencia	http://ww	Secure, ef	Spain	MINECO	SME, RTO, HES	Yes	ERDF	yes	grant	calls for proje	50-80% depen	48-96			no
21	IDEA	http://ww	Efficient e	Spain	IDAE	Municipalities	No	ERDF / Nati	yes	grant	calls for proje	50-85% depen	30			no

Table 6 Cost items covered by R&I support dedicated to CSP

		B. Cost items covered								
		i. Infrastructure (in a broad sense, for multiannual use)			ii. Personnel costs					
n°	name	i.1. Construction: buildings,land, roads, laboratories, testing facilities	i.2. "Heavy" equipment: ICT, non ICT (Demonstration prototyping, Pilot line)	i.3. "Light" equipment and material: ICT, non ICT ((Demonstration prototyping, Pilot line)	ii.1. Researchers, technicians and other supporting staff to the extent employed on the project	ii.2. Personnel committed in the project as coordination and/or management support	iii. External support and subcontracting (Ad-hoc experts costs for specific activities, Contractual research, Aquisition of knowledge and patents bought or licensed from outside sources)	iv. Mobility and Training costs (Fellowship, traineeship, incoming / outgoing mobility)	v. Meetings, seminars, conferences	vi.overhead
1	H2020		yes	yes	yes	yes	yes	yes	yes	yes
2	ESIF-ERDF-TO1	yes	yes	yes	yes	yes	yes	yes	yes	yes
3	ESIF-ERDF-TO2 digital	yes	yes	yes	yes	yes	yes	yes	yes	yes
4	ESIF-ERDF-TO3 Sme comp	yes	yes	yes	yes	yes	yes	yes	yes	yes
5	ESIF-ERDF-TO4 low carbon	yes	yes	yes		yes	yes		yes	yes
6	ESIF-ESF						yes	yes	yes	yes
7	COSME						yes		yes	
8	COST							yes	yes	
9	CEF energy	yes	yes							
10	EUREKA - EUROGIA2020									
11	Eurostar2				yes	yes	yes	yes	yes	yes
12	LIFE progr.		yes	yes	yes	yes	yes	yes	yes	
13	NER300	yes	yes	yes						
14	PF4EE/LIFE	yes	yes	yes						
15	IEB InnovFin	yes	yes	yes	yes	yes	yes	yes	yes	
16	IEB Innovscience	yes	yes	yes						
17	European Energy Efficiency Fund (EEEF)	yes	yes	yes						
18	EIT KIC InnoEnergy)									
19	Marguerite Fund	yes	yes	yes	yes	yes	yes	yes	yes	
20	Programa Estatal de Fomento de la Investigación Científica y Técnica de Excelencia		yes	yes	yes	yes	yes	yes	yes	yes
21	IDEA	yes					yes			

Annex 3 Agenda of the workshop on EU funding supporting Energy Projects

When: June, 13 (9:30-17:30)

Venue: JRC-Seville: Edificio Expo; Calle Inca Garcilaso 3, Sevilla ; room A41

Size: around 25 persons

Objectives:

Mapping of the European funding landscape for low-carbon energy:

- as regards the budgets of the large horizontal funds dedicated to energy (more concretely energy efficiency, renewables, infrastructure, and also innovation and interregional collaboration in energy), and those of specific funding schemes;

- as regards the specific characteristics of each funding scheme as concerns the type of activity they target, management, co-financing, use of financial instruments, type of funding (competitive call, grants, etc.), eligibility criteria for participation, eligible costs, mono- or multi-beneficiary, funding rate, timing of calls, different success rates for example;

- as regards the possibilities for combination of funds -particularly with ESIF- and the related issues (e.g. due to conflicting rules of the programmes (such as differences in relation to state aid and use and generation of IPR) or operational aspects of each funds (for example double funding of the same cost item).

Expected output:

Besides the improved understanding of the EU funding landscape relevant for supporting energy projects, the workshop's expected output comprises the following:

- a comprehensive mapping of the different EU funding programmes and financing instruments for energy investments that support energy projects, and quantification of the energy-related parts of the budgets;

- an illustration of possible combination of the various instruments for (at least 2) concrete examples (e.g. energy efficiency in buildings; large solar power plant)

Agenda (June 13, 9:30 – 17:30)

9:30 - 10:30	**1) Introduction** • JRC: Motivation and objectives of the workshop • JRC: Investment needs in the energy sector and overview of available funding sources
10:30 - 13:15	**2) Overview of EU funding programmes and financing instruments from an energy viewpoint** Introduction of the different funds managed with a clear focus on energy: energy-related budget, characteristics, type of activity, co-financing rate and conditions, possibilities for synergies with other funds, possibilities of interregional collaboration.
10:30 - 10:50	• Gergana Miladinova (DG REGIO): ESI Funds
10:50 - 11:15	*Coffee break*
11:15 - 12:00	• Isidoro Tapia (EIB): EFSI, Marguerite, other instruments, including technical assistance (ELENA, JASPERS, …)
12:00 - 12:40	• Agustin Escardino Malva (DG RTD): H2020, InnovFin • Ignacio Puente (DG RTD): Financial instruments and state aid
12:40 - 13:10	• Vasco De Janeiro (EIT - European Institute of Innovation and Technology) • Joan-Marc Joval (EIT InnoEnergy) • Mike Cherrett (Climate-KIC)
13:10 - 13:30	Q & A
13:30 - 14:30	*Lunch*
14:30 - 15:30	
14:30 - 15:00	• Zita Csoka (DG ENER): The energy funding landscape (incl. CEF)
15:00 - 15:30	• Filippo Gagliardi (DG CLIMA): NER300/400; LIFE climate
15:30 - 15:45	*Coffee break*
15:45 - 17:00	**3) Combination of available funds** • Robert Pernetta (EIB): Synergies between ESIF and other financing instruments from EIB portfolio • All: Illustration of combining various funds and financing sources for either stylized examples (e.g. energy efficiency in buildings; large solar electricity generation; infrastructure), or making use of actual case studies • All: Issues and barriers for synergies
17:00 - 17:30	**4) Closing session**

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