The financing large scale research, development and innovation initiatives across Europe

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Abstract: Funded by the European Commission through Horizon 2020, Topic NMP-37-2014—'Practical experience and facilitating combined funding for large-scale RDI initiatives', EU-Great! (web page: http://eu-great.com) project is an investigative study that will identify the best practices, approaches and policy framework to boost the financing of large-scale research, development and innovation initiatives across Europe. The EU-Great! will focus on investigating the best approaches adopted and the barriers encountered by stakeholders when combining funds from different public and private sources, specifically to translate successful fundamental research results and lab-scale prototypes into industrial demonstrators, production pilot lines, first market replications and commercialized products and services. Through interaction and dialogue with industry, researchers, investors, and governmental stakeholders the consortium will identify, analyze and validate the best practices adopted by consortia when forming and managing large-scale RDI initiatives. The EU-Great! consortium will also make recommendations to policy-makers for improving the administrative and policy framework of public-private funding instruments for combining funding, in order to stimulate greater investment and creation of more large-scale RDI initiatives in Europe. The purpose of the article is the description of the results of the EU--Great! project regarding definition and characteristics of large-scale research initiatives as well as issues on combined funding.

Key words: large-scale research initiative, financing of large-scale research, combined funding

1. Introduction

Funded by the European Commission through Horizon 2020, Topic NMP-37-2014—'Practical experience and facilitating combined funding for large-scale RDI initiatives', EU--Great! (web page: http://eu-great.com) project is an investigative study that will identify the best practices, approaches and policy framework to boost the financing of large-scale research, development and innovation initiatives across Europe. The project started on the 1st January 2015 and has been running for a period of two years.

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Today, Europe faces the challenge of translating lab-scale research outcomes into useful and commercialized products and services in order to boost industrial competitiveness, economic growth and job creation. This in turn demands a boost in finance, strategically targeted at Research, Development and Innovation (RDI) initiatives that successfully bridge the 'valley of death' that separates basic concepts (science) from commercial products (market).

Stakeholders of large-scale RDI initiatives often face the challenges of applying for and combining funding from different public and private sources including European Structural and Investment Funds (ESIF), Horizon 2020 and national, regional and private investment programmes in order to build and manage a portfolio of synergetic projects. Such initiatives often need to utilize or result in the creation of new open access research facilities, innovation value chains and shared knowledge.

The EU-Great! focuses on investigating the best approaches adopted and the barriers encountered by stakeholders when combining funds from different public and private sources, specifically to translate successful fundamental research results and lab-scale prototypes into industrial demonstrators, production pilot lines, first market replications and commercialized products and services.

Industrial stakeholders of such initiatives face the task and challenge of raising investment and administrating multiple projects that have different financial rules, audit requirements, legal frameworks and state-aid implications along with the risks and uncertainties that come with commercializing any new and disruptive technology. Governmental stakeholders, at the same time, deal with the demanding tasks of stimulating innovation, often at a regional level, providing co-finance, monitoring initiatives, running audit checks and the need to demonstrate impact to citizens in terms of economic growth, environmental sustainability, improved public services and job creation.

The EU-Great! consortium comprises of TECNALIA R&I, CEA, TNO, VTT, High-Value Manufacturing Catapult, INESC TEC, Plastiques, NANO*futures*, ArcelorMittal, CDTI and Wrocław University of Technology. Through interaction and dialogue with industry, researchers, investors, and governmental stakeholders the consortium will identify, analyze and validate the best practices adopted by consortia when forming and managing large-scale RDI initiatives. The EU-Great! consortium will also make recommendations to policy-makers for improving the administrative and policy framework of public-private funding instruments for combining funding, in order to stimulate greater investment and creation of more large-scale RDI initiatives in Europe.

The purpose of the article is the description of the results of the EU-Great! project regarding definition and characteristics of large-scale research initiatives as well as issues on combined funding.

2. Rationale

Research, Development and Innovation (RDI) are seen as main drivers to tackle the different socio-economic challenges encountered by modern societies and this belief has been also crucial in the definition of the Horizon 2020 (H2020) EU R&D programme. However, RDI activities are not straightforward in all cases and some important economic sectors, such as

manufacturing, very often require RDI activities that take long periods of maturation (lead time), cause uncertainties about successful final results and/ or require expensive infrastructures, thus having to go through what has been called the 'valley of death' before turning into successful results in the form of new products or processes. In order to take into account the long term needs of the society, public support to European industrial RDI activities is needed.

The term 'research and development infrastructure' has been used to refer to facilities, resources and related services used by the scientific and innovation communities to conduct top-level research and experimentation in their respective fields, ranging from social sciences to astronomy, genomics, nanotechnologies, etc. Examples include singular large-scale research installations, collections, special habitats, libraries, databases, biological archives, clean rooms, integrated small research installations, high-capacity/ high speed communication networks, highly distributed capacity and capability computing facilities, data infrastructure, research vessels, satellite and aircraft observation facilities, coastal observatories, telescopes, synchrotrons and accelerators, networks of computing facilities, as well as infrastructural centres of competence which provide a service for the wider research community based on an assembly of techniques and know-how. The current project is not ignoring these domains and their knowledge with respect to funding and overall management; however, it is going to focus on innovation initiatives and thus later stages in the development process, closer to production or manufacturing, namely, higher Technology Readiness Levels (TRLs). In that sense, it is more concerned with industry and applications than with basic science and scientific infrastructures.

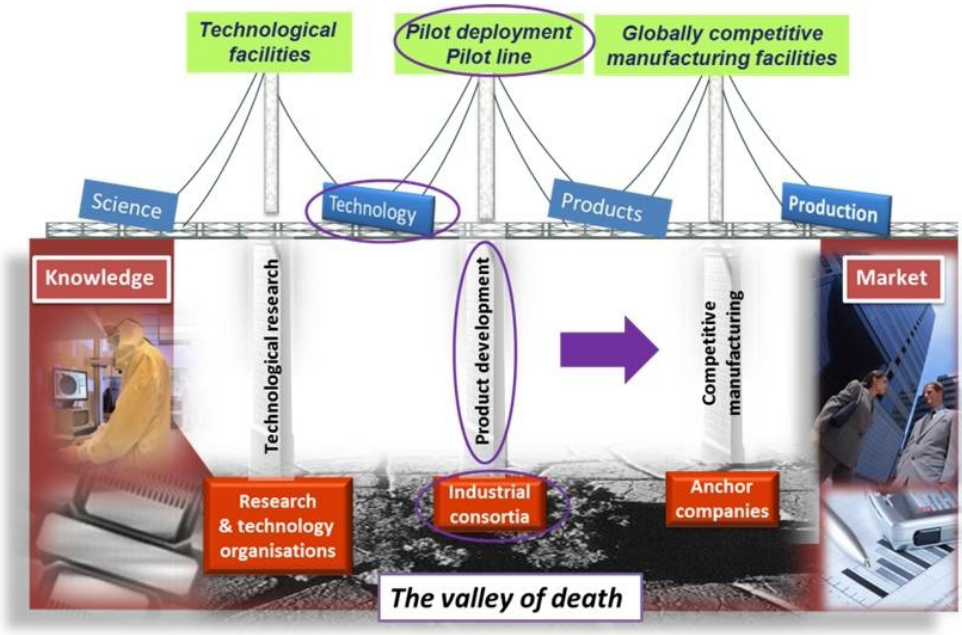

Figure 1. The three-pillar 'valley of death'

S o u r c e: KETs High Level Group Final Report, 2015.

In the case of *key enabling technologies* (KETs), a group of six technologies that are expected to be at the core of many new products, and thus, become a source of growth in the coming years and decades, one of the main concerns stated by the group of experts in the High Level Expert Group—HLG (KETs High Level Group activity report, 2015) for their successful development and later production in the EU is the 'cost of the infrastructures required to go from early research to almost-final prototypes', as it will be further explained later (also see Figure 1). For this reason it is key, in particular with the aim to bridge this part of the 'valley of death' due to expensive infrastructures, to design strategies and prepare guidelines to allow for these new manufacturing capacities that will often need a combination of funding instruments, including the EU, national and regional funding, making use of structural and regional funds, as well as private financing. By doing so, more companies are expected to take advantage of those facilities and reduce their aversion to participate in RDI activities.

The KET HLG underlines the need for efficient combination of funding as a key factor for investments into large-scale pilot lines as a crucial step towards commercial exploitation of new developments. New public programmes are being developed and implemented in connection with the next EU multi-annual financial framework including Horizon 2020 and regional and structural funds. While the responsible authorities are committed to make the instruments compatible, industrial stakeholders including SMEs need to understand what this means, how best to use this for their project, and how to combine public support with private financing as needed. They need to satisfy the different requirements in relation to project quality, cooperation arrangements, reporting, risks and other aspects, while also smart specialization strategies, competition and state aid rules as well as industrial decision structures need to be respected.

The rationale for EU-Great! stems from the observation that more funding is needed and public and private sectors must join forces to increase the number of large-scale RDI initiatives (LSIs) in Europe, in order to ultimately boost the commercialization of new technologies, products and services able to strengthen the competitive-edge of the European Industry (bridging the so-called valley of death).

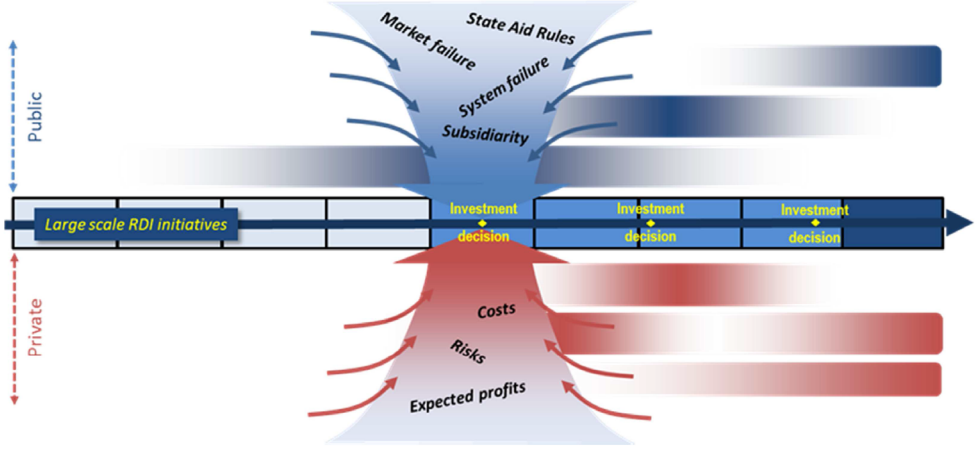

Figure 2. Key elements to analyze large-scale RDI initiatives

Source: EU-Great! Consortium.

As shown in Figure 2, LSIs are the result of complex processes that often require stakeholders to secure and combine funds from multiple channels including public sources at European, national and regional levels as well as private origins like angel funding, venture capital, banks and company equity.

The concept of *Large-scale RDI* relates to high-TRL (demonstrators), which have been difficult to finance in the past and for which the solutions proposed by the European Commission (financial engineering, mixing funding from heterogeneous sources) are still theoretical and difficult to implement.

3. Definition of a large-scale RDI initiative

RDI initiatives have not been created equal: objectives, circumstances, sectors, technologies, consortia, etc. may vary extensively from case to case and, thus, finding a definition fit for all cases may be close to impossible. For this reason, the following definition tries to be the first and stable approach to start working under a common understanding (following the EU-Great! consortium):

> Large-scale RDI initiatives (LSI) are industry and application driven, long-term, broad (open) access, multi-stakeholder partnerships strategically targeting large-scale research, development and innovation activities using a combination of different funds aiming at accelerating the commercialization of technology, boosting competitiveness of companies and renewing industrial ecosystems towards sustainable economic growth and well--being of society.

On the one hand, this definition is open enough to include many different patterns or instances and, besides, it also includes key concepts that are especially important. First, being industry and application driven, LSIs have to be useful for production with a clear market--oriented perspective. Secondly, the facilities have to be open; they may not be free and/ or privately owned, but should be accessible to third parties. Third, the concept of multi-stakeholder is important, thus being beneficial to more than one institution or company. And finally, the objective is to cover big initiatives that by nature request a combination of different funding sources.

One RDI initiative is not the same as the other, especially from the perspective of funding needs. A good example is the difference between the following two examples. First, is a large scale RDI initiative to develop a pilot line for mass manufacturing of power electronic systems. Investments are high, but the organization is usually an innovation ecosystem dominated by a large multinational. A second example is a multi-user technological infrastructure that facilitates testing and validation of different new products in a high-tech manufacturing environment. Different companies and even research organizations can use this high-tech environment and available expertise to take the first step in scale-up to commercial production. These large scale RDI-infrastructures have different business models, different possible investors and different investment decisions to make. The research methodology is, that during the project, at least 100 RDI initiatives will be identified and characterized, a survey

undertaken and some 20 in depth cased studies conducted. The selection will be based on a theoretical framework to ensure good coverage and assessment.

4. Characteristics of large-scale RDI initiatives

In close connection with the above definition, the following elements are decisive to understand any of those initiatives:

1) Multiple number of industrial parties involved in the adoption of the outcomes.
2) Can be led by a single industrial company who is orchestrating a large supply chain; or it can be led by a number of industrial parties who are collaborating to share risks at a sector or cross-sector level.
3) Combines research, development and innovation activities that include significant technological and commercial risk.
4) Runs over several years and contains a significant degree of uncertainty of outcome and might fail.
5) Requires combination of funding from different public and private finance sources.
6) Is holistic taking into consideration environmental and societal issues, and is often leading a paradigm change and/ or giving rise to a new industrial sector.
7) May require new research and innovation infrastructure and buildings as well as harnessing existing facilities.
8) Often requires use of open access facilities and may lead to multiple spin-off technologies, products and applications.
9) May require the need to develop initial market entry products for actual industrial trials.
10) Often forms part of a national and/ or regional economic development strategy; could be initiated by industry or government.

Besides the elements above, other complementing issues to ponder in the cases to be analyzed to gain practical knowledge are the following:

- Who initiates a large-scale RDI initiative? How is the decision made?
- Uncertainty at the early-stages of a large-scale RDI initiative as to its technological and commercial feasibility.
- Different views, positions and interests between industrial stakeholders, RTOs and public authorities in selecting large-scale RDI initiatives for co-funding via public money.
- Administrating the funding requirements of multiple funding sources.
- Funding requirements can stretch years after the completion of projects financed by certain funding sources. This risk continues because the co-funding public authorities and/ or the European Commission as stakeholders cannot fully check subsequent projects' developments during delivery or upon their completion. As a result the risk is transferred to the Large-Scale RDI initiative and one or more partners from the initiative then run the financial risk of a potential claw back of money.

Table 1 summarizes the elements that can help define, from a practical point of view, large scale RDI initiatives.

Table 1. Characteristics of large-scale RDI initiatives

a) Minimum requirements
Involving one or multiple KETs
Involving multiple number of industrial partners
Aimed at commercial exploitation of technologies and/ or accelerating the market up-take of technology breakthrough
Involving both private and public funding
Duration more than one year
b) Possible characteristics
Involves physical infrastructure (e.g. pilot line)
Led by single industrial company
Led by network of industrial companies
Involving variety of stakeholders (universities, RTOs, public policy, etc.)
Open access
Responses to societal/ environmental challenges (e.g. resource efficiency, climate change, etc.)
Is aligned with national/ regional economic development strategy
Has potential for ecosystem renewal/ paradigm change/ new industry creation

S o u r c e: EU-Great! Consortium.

5. Combined funding

Many industrial investments into research, technological development and innovation in Europe, in particular with the aim to bridge the 'valley of death' and prepare new manufacturing capacities, often need a combination of not only public funding instruments (including the EU, national and regional levels) but also private financing. About this latter, banks are the financial organizations traditionally supporting innovation and industrial activities. But also institutions like angel funds, venture capitalists, regional investment organizations, equity based funding as well as new equity, debt and risk sharing instruments in Horizon 2020 and the Risk-Sharing Finance Facility offered by the European Investment Bank (EIB) can be seen as important investment sources. However, the recent crisis of 2008 has altered this landscape. Banks are more reluctant to provide loans and American Venture Capital funds are looking at Europe for investment opportunities. Public/ private partnerships are considered important and the European Investment Bank is enhancing its participation in innovation. As policy, the economy and our society shift towards industrialization of research, these private funding mechanisms are more and more seen as highly dynamic.

6. Funding instruments

Recalling what was said for the definition of large scale RDI, the objective is to cover initiatives that require 'combined' funding, which should be understood as a tantamount for ambitious, complex initiatives. By *combined funding* it is meant, most importantly, bringing together public and private funds, but also opportunities to mix various public or various private funding mechanisms. Analogously, the concept of public funding allows for sources at multiple levels such as: the EU (EC, EIB, etc.), national programmes and even regional and municipal measures.

The simplification of funding programmes at a European level has resulted in more harmonized instruments, specifically: Horizon 2020, COSME and the European Structural and Investment Funds (ESIF). This, combined with the possibility to use different public funding sources within a programme, project or group of projects (combined funding), aims to enhance the synergies between those funding instruments and others defined at national, regional levels and even private funds for ambitious industrial projects.

At the EU level, funding programmes adopt different objectives and Figure 3 by the EC, shows the different types.

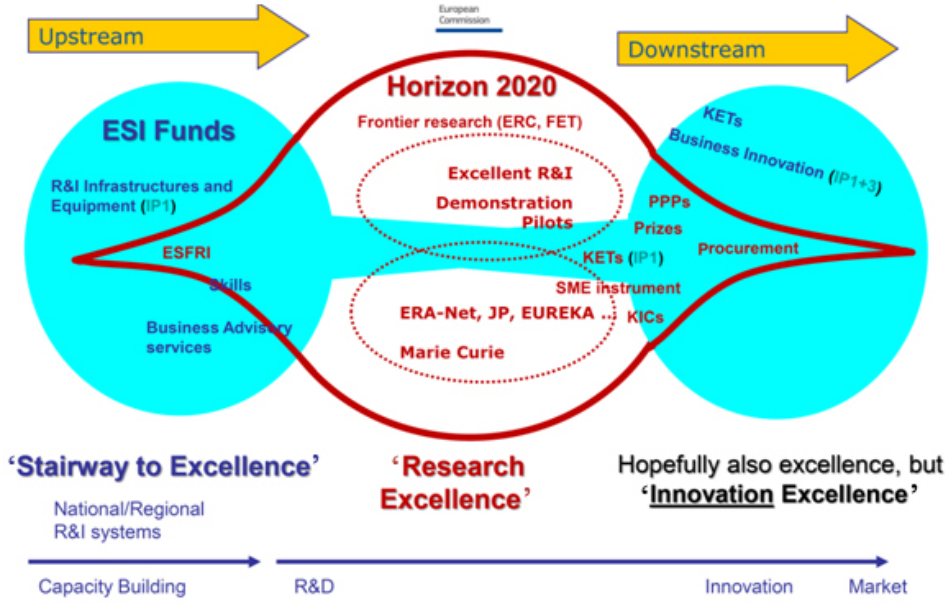

Figure 3: RDI-oriented EU funding programmes

Source: European Commission, Enabling synergies between European Structural and Investment Funds, 2014.

There is certainly some complementarity in the different funding programmes (Towards Smart Everywhere. Fostering Innovation through combining funding sources from Horizon 2020 and Structural Funds, 2015) as shown in Table 2. Whilst H2020 and ESIF are administrated differently, they both include a provision for funding research, development and in-

novation activities. Complementing the other 'open' programmes COSME, EU programme for the Competitiveness of Enterprises and SMEs, aims at improving access to finance and markets, supporting entrepreneurs, and improving conditions for competitiveness.

COSME, H2020 and ESIF are funding instruments part of the European strategy for smart, sustainable and inclusive growth. The High Level Expert Group on KETs recommended, among other actions, to implement effective solutions for combined funding mechanisms if KETs industrial deployment is to be accomplished. They encouraged that funding instruments (H2020, ESIF, COSME…) should provide a workable solution allowing to cumulate different funding sources aligned with the industrial competitive and timeframe constraints.

The determination to exploit synergies between ESIF and H2020 and other EU-related programmes is backed by the European Parliament and Council, and is accompanied by the 'Guide on how to enable synergies between Europe and Structural and Investment Funds, Horizon2020 and other research, innovation and competitiveness-related Union programmes' (Commission Staff Working Document circulated during the meeting of the EARTO Structural Funds Experts Working Group, 2015). The guide contained commitments for further action by the European Commission services to facilitate synergies such as: the update of the guide, supporting potential beneficiaries beyond public authorities, helping them to identify the most suitable EU funding or support sources (Guidance for policy-makers and implementing bodies: Enabling synergies between European Structural and Investment Funds, Horizon2020 and other research, innovation and competitiveness-related Union programmes).

Table 2. Characteristics of large-scale RDI initiatives

☐ **H2020—Top-down approach: Funding coming from European Level** • Apply for funding at EU-level. • Consortia include complex Pan EU networks of competent centres.
☐ **ESIF—Bottom-up approach: Funding coming from own region** • Concrete objective: Get regions to dedicate investments to Information and Communication Technologies (ICT), innovation… in order to foster the emergence of clusters through smart specialization. • Apply for funding in each region and with the relevant authority. • Prerequisite: There must be a hook in the operational plan of the region in terms of a high keyword.

Source: European Commission web, 2015.

7. Conclusions

Defining large-scale RDI initiatives implies taking into account issues such as: technologies, TRLs, openness, ownership, funding, use, networks and risk to name some of the most relevant. This complexity makes it difficult to grasp a unique (and simple) definition that may cover all those issues to the required extent.

Logically, such initiatives require significant investment and commitment in order to establish new state-of-the-art research infrastructure and/ or business incubation facilities and they are accessible to the investing partners and open to third parties. Those projects go

through a board lifecycle where the risks and uncertainty faced by stakeholders during the early-stages are very high and then, towards the later demonstration, scale-up and industrial adoption stages, the risk starts to reduce. LSIs also tend to be ambitious holistically addressing sector level, societal and environmental challenges. Large-scale RDI initiatives require stakeholders to use and secure funding from different public and private sources in order to share risks and to fund different components of the initiative using and combing finance from appropriate instruments.

Large-scale RDI initiatives, by their very nature, usually adopt some ingredients of open innovation approaches as participating partners collaborate to share know-how, intellectual property or capabilities. While most operate in an open access mode, especially whenever funding comes from public sources, it is true that large-scale RDI initiatives also operate under some other modes: accessed only by all the investing partners that form the consortium and who need to manage their interests; accessed by the investing partners (designers of the initiative), who can enable other parties use the facilities as a means to reduce overall risk and costs.

In general, these LSIs can combine existing and new research and innovation facilities and may also need different types of infrastructures: some will be research-focused, with partners later developing industrial demonstrators and production pilot lines. During the early stage, it is more likely that facilities can be operated on an open access basis, whilst in the later stages when production pilot lines are developed, it may by found that these facilities are more specific and dedicated to the partners commercializing their products. Innovation also involves stages beyond the production pilot line, for initial trials and adoption.

In summary, a large RDI could be seen as an initiative where one or several elements mentioned above are extended in terms of capacity, geographical coverage and integration of Science and Technology (S&T) fields (including integration of KETs). Clearly it is not a 'unique purpose' infrastructure, as it should rather be conceived as a 'testing bench', including a clear 'virtual capacity' (services provided electronically). Ideally, these large initiatives should cover a wider TRL perspective by incorporating stakeholders all long the value chain.

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Finansowanie inicjatyw w zakresie badań, rozwoju i innowacji o dużej skali w Europie

Abstrakt: Celem finansowanego przez Komisję Europejską w ramach programu Horyzont 2020 projektu o akronimie EU-Great! jest przeprowadzenie badań, które pozwolą wskazać najlepsze praktyki, podejścia oraz ramy polityczne w celu zwiększenia finansowania inicjatyw w zakresie badań, rozwoju i innowacji o dużej skali w Europie. Projekt UE-Great! skupia się na badaniu najlepszych przyjętych rozwiązań i barier napotykanych przez zainteresowane strony w przypadku łączenia środków finansowych z różnych źródeł publicznych i prywatnych, szczególnie w celu przekształcenia wyników badań podstawowych oraz prototypów laboratoryjnych na demonstracje przemysłowe, pilotażowe linie produkcyjne, pierwsze edycje rynkowe oraz skomercjalizowane produkty i usługi. Dzięki interakcji i dialogowi z przemysłem, naukowcami, inwestorami i podmiotami rządowymi konsorcjum dokona identyfikacji, analizy i zatwierdzenia najlepszych praktyk przyjętych przez konsorcja podczas tworzenia i zarządzania innowacyjnymi inicjatywami badawczymi o dużej skali. Konsorcjum projektu EU-Great! wystosuje również zalecenia dla decydentów politycznych na rzecz poprawy ram administracyjnych i politycznych publiczno-prywatnych instrumentów finansowych do łączenia funduszy, w celu stymulowania większych inwestycji oraz tworzenia większej liczby innowacyjnych inicjatyw badawczo-rozwojowych o dużej skali w Europie. Celem niniejszego artykułu jest przedstawienie wyników projektu UE-Great! dotyczących definicji i charakterystyki inicjatyw badawczych o dużej skali oraz problematyki dotyczącej łączonego finansowania.

Słowa kluczowe: inicjatywa badawcza o dużej skali, finansowanie badań o dużej skali, łączone finansowanie