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Council

Implementing the pro-active management of the EIC pathfinder for breakthrough technologies & innovations

Lessons from the ARPA model & other international practices

Independent
Expert
Report

Research and Innovation

Implementing the pro-active management of the EIC pathfinder for breakthrough technologies & innovations:
Lessons from the ARPA model & other international practices

European Commission
Directorate-General for Research and Innovation
Directorate RTD – Research and Innovation
Unit RTD TF.1 – EIC Governance and Coordination

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Implementing the pro-active management of the EIC pathfinder for breakthrough technologies & innovations

Lessons from the ARPA model & other international practices

November 2020

2020

Directorate-General for Research and Innovation
Enhanced European Innovation Council (EIC) pilot

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If we were building an ARPA-like organisation for breakthrough innovation in Europe, in today's innovation economy, **how should we organise it?**

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FOREWORD

Europe is about to take a big step forward with the establishment of the European Innovation Council (EIC), a new EU programme and an Investment Fund (the EIC Fund), which will champion and scale up breakthrough and disruptive innovations that create new markets, building on the wealth of excellent science in Europe.

During its current pilot phase (2018 – 2020), the EIC has proven its importance in supporting high-risk, high-impact companies and projects and providing critical support to start-ups and SMEs in the European economic recovery. The establishment of the full EIC under Horizon Europe builds on the pilot, and goes much further. Acting as a one-stop shop and operating on an innovator-centric basis, the EIC features simplified and agile funding from advanced research to commercial scale up. It combines grant support with business advisory and support services, equity investment through the new EIC Fund, and new ways of managing funding with the first EIC Programme Managers.

To realise its full potential, the EIC itself will need to be innovative, learning from others, taking risks, and optimising funding and activities to ensure that Europe leads the next wave of innovation and safeguards technological sovereignty.

I very much welcome this report from a group of international experts which proposes guiding principles for the successful implementation of the EIC. Drawing on international experience, the report provides recommendations on the design of key strategic objectives calling for deep-tech and radical thinking (also known as 'challenges') towards which to direct EIC support at the research phase (the EIC Pathfinder), the proactive management of portfolios by EIC Programme Managers and support for the transition from research results to innovation uptake.

I look forward to the beginning of this new chapter for European innovation driven by a new, innovative way of managing public innovation programmes.

MARIYA GABRIEL
Commissioner for Innovation, Research, Culture, Education and Youth

ACKNOWLEDGEMENTS

The report of the expert group on creating the European Innovation Council (EIC) way of proactively managing innovation under the Pathfinder is a product of its members who graciously shared their time and expertise. Special thanks go to Carsten Dreher, Angelos Dennis Keromytis and Cheryl Martin who were extremely generous with their expertise, time and energy as subgroup leads. The expert group is thankful to the EIC staff for their support and input throughout this project. We would especially like to thank Frédérique Péron-Lührs, Keith Sequeira, Nicolas Sabatier, Viorel Peca, Jean-David Malo, Bence Börcsök and Simon Hertig for their continuous support and insights.

While this report is the product of the expert group, the responsibility for any omissions or errors is mine.

My sincere gratitude to all who contributed to producing the report.

LARS FRØLUND
Chair of the expert group

EXECUTIVE SUMMARY

The goal of the European Innovation Council (EIC) is to position Europe firmly at the forefront of the next wave of breakthrough innovations. This goal is enshrined in the new legislation that establishes the EIC (as part of the Horizon Europe 2021–2027 programme), which also sets out the need for the introduction of proactive management of EIC funding including the appointment of programme managers (PMs). The European Commission has set out its intention to create a new executive agency from the beginning of 2021 to implement EIC activities. Drawing on our collective experience of innovation agencies and policies around the world, we have focused our work on the EIC Pathfinder which supports advanced research on new and emerging technologies and the critical role of PMs, where there are strongest parallels with other agencies. The EIC is also unique in combining the Pathfinder with an Accelerator that supports start-up companies and SMEs to bring breakthrough innovations to market and scale up. The Accelerator is not considered in this report, although we recognise that Programme Managers may play an important role here as well.

To achieve its goal, we believe that the EIC should become **a hands-on innovation agency**. This will require a new risk-taking mindset and tailor-made management. Such features can be found in the so-called ARPA model for breakthrough innovation in such organisations as the Defense Advanced Research Projects Agency (DARPA) and the Advanced Research Projects Agency-Energy (ARPA-E). The goal of the EIC should not be to copy the ARPA model, but should instead be to translate the ARPA model into the EIC context by taking into account the Horizon Europe legislation and the current EIC culture. Only in this way can the EIC create its own unique identity in the European landscape for supporting breakthrough innovations – create the **EIC way**. Developing the unique EIC way will be challenging and necessary. It will comprise novel practices of supporting the development of breakthrough technologies and bringing these technologies to the market. **To support breakthrough innovations, the EIC must itself be an organisational breakthrough in Europe**. In our view, the main components for achieving this endeavour are centred on the creation of challenge- and thematic-driven programmes, active portfolio management of funded projects, transition activities that bring new solutions to the market and EIC PMs who bind all of this together into complementary practices.

The recommendations of the expert group are directed mainly to the European Commission and future EIC agency, as well as to Member States and others who have a role in approving and implementing the EIC. However, we also believe that these recommendations will be useful for those Member States that are establishing or reforming innovation agencies at national or subnational level.

The recommendations of the expert group are summarised as follows:

PROGRAMME CREATION

- **Empower and support excellent PMs**
  The EIC should empower excellent PMs to create, assemble and actively manage (i.e. in a hands-on way) portfolios of projects to achieve ambitious goals with high socioeconomic impact. PMs should be provided with the tools to manage projects and programmes to maximise the probability of success for both the technological aspects and the transition elements. This calls for flexibility, delegation, acceptance of risk and the occasional failure, and a mission-driven culture by the EIC. Supervision and accountability should be pursued, such that they do not unnecessarily slow down/have a negative impact on programme execution. To deliver the active management required, the EIC should ensure that each PM has access to the necessary support resources, which could include a dedicated team and/or shared resources. PMs should report directly to the EIC Agency Director.

- **Create programmes in a process that balances the vision of the PM and diverse insights from across Europe**
  The creation of programmes (by which we mean funding for specific challenges) should balance the vision of the PM with the diverse external insights from national initiatives, stakeholders in Europe's innovation ecosystems and research communities.

- **Ensure that programmes articulate a clear strategy beyond the confines of the laboratory**
  Programmes should articulate a clear and ambitious vision, a set of possible novel paths to achieve this vision, a strategy for making a difference beyond the narrow confines of the laboratory, and measurable milestones and deliverables to determine progress and success. Programme and project success or failure will largely be judged based on the meeting (or not) of programme objectives and metrics. Projects and programmes may be terminated for not meeting their goals.

- **Utilise the EIC programme questions**
  Programme design and approval should be done in a deliberate and principled, yet flexible and efficient, manner. We recommend a proposed set of EIC programme questions as a framework for both programme design and approval. These questions, inspired by the Heilmeier questions used by DARPA and ARPA-E, provide a blueprint for thinking about the validity and structure of a research and development problem, anticipating the structure of the programme that will address said problem. Answering the EIC programme questions must not be interpreted as a strict, prescriptive process.

- **Have a nimble programme approval process**
  The authority to approve programmes should be delegated to the EIC Agency Director, with advice provided by the EIC Board and consultation with the EIC Programme

Committee. This will make the programme approval process flexible and agile, given that programmes sometimes have to be developed urgently.

- **Intimately involve the PMs in proposal evaluation and selection**
  PMs should be intimately involved in proposal evaluation and selection to integrate the evaluation criteria of 'portfolio consistency' and depart from the rack-and-stack approach, which may lead to the discounting of the most innovative projects.

ACTIVE PORTFOLIO MANAGEMENT

- **Integrate contracting into active portfolio management**
  The EIC Pathfinder should integrate the negotiation of milestones and deliverables into the contracting process. Negotiations of the milestones should happen in person, ideally at the location of the principal investigator (PI), and include all contracting parties. A dedicated EIC Pathfinder contracting team, working for all programmes, should be created to facilitate efficient contract timing and allow for the integration of the learning outcomes of the Pathfinder journey, such as 'top-up' capability, the reorientation of deliverables, termination, etc.

- **Ensure PMs have direct and active relationships with the projects**
  The PIs should submit quarterly written updates on their progress on technology, transition and budget to the PMs and the EIC agency. The PMs should review progress and milestones on a periodic basis, no less than once per quarter. Ideally, at least one of these meetings per year would be in person. The PMs' engagement with each project should not be a check-box exercise, and PMs should provide guidance to teams to overcome challenges.

- **Accelerate, reorient and/or terminate all projects and programmes according to their ability to achieve the negotiated milestones**
  Active programme management should apply to all projects from the different programmes. Ultimately, if a project cannot meet its performance criteria or those criteria become obsolete, the PM can recommend that it be terminated. It is worth stressing that, unless failure demonstrably occurred by programme management failure, programme or project termination should not reflect badly on the PM or the PI.

- **Allow for top-up funding for programmes**
  EIC Pathfinder implementation should plan for budget reserves to allow budget flexibility to EIC areas of priority and programmes that are increasingly promising. Funds remaining from a terminated project should be made available to other projects within the programme's portfolio and duration.

TRANSITION ACTIVITIES

- **Develop a transition strategy at the programme level**
  The PM should – on the basis of EIC Pathfinder-aligned processes – be in charge of developing, at the programme level, a transition strategy with discrete objectives and measurable milestones during the programme creation phase. These documents should be reviewed and updated at least annually. Systemic gaps identified in the transition strategy, such as regulatory barriers or a lack of appropriate pilot facilities across the EU, should be addressed by the PM and the EIC during the programme to accelerate the transition paths for all projects.

- **Establish a transition plan at the project level and allocate 5–10 % of the total grant to transition activities**
  The goal of the PM with each project should be to focus on the continuity of transition activities that run throughout the project lifetime and on gaining different perspectives on how the market opportunities develop and the team's performance to handle the challenges and opportunities. This integrated view of each project (with both technology development and early commercial transition activities forming integral parts of the project) enables the PM to connect support activities to the objectives and vision of the project. To this end, all projects should establish a transition plan and incorporate milestones related to that plan into their overall project plan at the start of the project. The funding to deliver on the transition plan/milestones should be included as part of the overall project budget plan and we recommend a target allocation of 5–10 % of the total grant. The teams should be eligible to apply for additional funding increments of EUR 50 000 to support extra transition activities as they gain transition momentum during the project time period.

- **Create a tech-to-market team and establish EIC fellowships**
  Ultimately, success in transitioning projects comes down to people and how they work together to anticipate transition, share knowledge and networks, and remove barriers in a timely manner to accelerate projects from laboratory invention to market impact. The EIC should empower the PM to plan and deliver on the transition activities outlined in the previous recommendations. However, owing to both bandwidth and expertise, additional support should also be engaged. We recommend that the EIC agency creates a tech-to-market (T2M) team with limited term assignments to deliver key elements of transition planning such as building programme-level ecosystem engagement plans, managing transition working groups (see below) and working with project teams on their individual transition plans. Finally, we recommend that the EIC creates an EIC fellowship to engage post-graduates to work with both the PM and the T2M team on key transition elements (ranging from techno-economic analyses to supply chain maps to market/customer understanding).

- **Create an innovation ecosystem engagement plan and transition working groups**
  Early and continuous engagement with Europe's innovation ecosystems should be used for benchmarking, gathering early interest from specialised risk capital providers, accessing technical expertise, testing market needs and potential take-up, assessing the possibility of creating a new market and validating projects' impacts. To this end, we recommend that transition working groups be formed at the programme level, made up of committed individuals from different stakeholders in Europe's innovation ecosystems, to give advice on the transition to the market of the programme portfolio and its projects. An innovation ecosystem engagement plan, forming an integral part of the transition strategy, should be developed by the PM and the T2M team to lay the groundwork for ecosystem engagement.

- **Create an EIC deep-tech training programme and a dynamic customer relationship management system**
  The above recommendations on planning and executing transition activities at both the programme and the project levels require robust tools and tailored training. A well-designed, easy-to-use and dynamic customer relationship management (CRM) system should be developed by the EIC that addresses the needs of the PM, PI and EIC. We also recommend that an EIC deep-tech training programme be created to support a new generation of deep-tech entrepreneurs in Europe. The programme should be tailored to the high ambitions of the EIC and thus be based on best practice from Europe and internationally. In addition, an annual EIC emerging technology summit should be held for investors and corporates to highlight Pathfinder projects and portfolios.

SCOPE OF THE WORK

The European Innovation Council (EIC) is being established at the request of EU Heads of State in order to identify, develop and scale up breakthrough innovations. It is currently in a pilot phase and is due to be formally established as part of the new Horizon Europe programme at the start of 2021. The EIC will be implemented primarily through two complementary types of action, namely the EIC Pathfinder for advanced research, for the early stages of technology development, and the EIC Accelerator for innovation and market deployment actions, including the pre-mass commercialisation stages and company growth[1].

These two complementary types of actions will have the following common characteristics.

- They will support high-risk innovations where the risks, whether financial, technological/scientific, market and/or regulatory, cannot be borne by the market alone or yet supported by financial instruments under InvestEU.

- They will mainly focus on high-risk breakthrough and/or deep-tech innovations, while also supporting other forms of innovation, including incremental innovation, that have the potential to create new markets or contribute to resolving global challenges.

- They will be mainly bottom-up, open to innovations from all fields of science and technology and for applications in any sector, while also enabling targeted support for emerging breakthrough, market-creating and/or deep-tech innovations of potential strategic significance in terms of economic and/or social impact. The Commission services will evaluate this potential strategic impact on the basis of recommendations from the independent experts, from the EIC programme managers (PMs) and, where appropriate, from the EIC Advisory Board.

- They will encourage innovations that cut across different scientific and technological (e.g. combining physical and digital) fields and sectors.

- They will be centred on innovators, simplifying procedures and administrative requirements, making use of interviews to help assess applications and ensuring fast decision-making.

- They will be implemented with the aim of significantly enhancing the European innovation ecosystem.

- They will be managed proactively with milestones or other predefined criteria to gauge progress and the possibility to, after a thorough assessment with the possible use of independent experts, reorient, reschedule or terminate the projects, where needed.

[1] Proposal for a Decision of the Council on establishing the specific programme implementing Horizon Europe – the Framework Programme for Research and Innovation – Partial General Approach, section 1, the European Innovation Council (EIC); section 1.1, Areas of intervention.

While maintaining its mainly bottom-up nature, the Pathfinder will importantly also provide for competitive challenges to develop key strategic objectives calling for deep-tech and radical thinking. The general topics for those challenges will be determined in the work programmes[2]. The regrouping of selected projects into thematic- or objective-driven portfolios will allow a critical mass of efforts to be established and new multidisciplinary research communities to be created.

These portfolios of selected projects will be further developed and enhanced, each along a vision developed with their innovators, but also shared with the research and innovation community at large. The Pathfinder's transition activities will be implemented to help researchers and innovators develop the pathway towards commercial development, such as demonstration activities and feasibility studies to assess potential business cases, and support the creation of spin-offs and start-ups. The transition activities may also consist of complementary grants to top up or enlarge the scope of previous and ongoing actions, to bring in new partners, to enable collaboration within the portfolio and to develop its multidisciplinary community.

On the basis of the Horizon Europe legal framework and taking into account the vision and recommendations from the EIC pilot Advisory Board, the expert group was asked to give guidelines and recommendations on developing the EIC way of proactively managing innovation under the Pathfinder by focusing on:

- programme creation, through targeted competitive challenges, and the management structure and process to approve a programme focused on a challenge;
- active portfolio management to enable a novel hands-on way to manage a programme and possibly to accelerate, reorient or terminate projects;
- transition activities that would facilitate the transition of projects and portfolios towards the market from the early stages of the innovation process.

The scope of the expert group does therefore not comprise recommendations on the management of the support provided under the EIC Accelerator.

Against this background, the expert group structured its work into three subgroups focusing on (1) programme creation, (2) active portfolio management and (3) transition activities.

Additionally, based on the Horizon Europe legislation and building on the Horizon 2020 FET Open and FET Proactive instruments, the expert group recommends the following guiding definitions of two types of programmes in the Pathfinder[3].

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[2] Proposal for a Decision of the Council on establishing the specific programme implementing Horizon Europe – the Framework Programme for Research and Innovation – Partial General Approach, section 1, the European Innovation Council (EIC); section 1.1, Areas of intervention; section 1.1.1, The Pathfinder for advanced research.

[3] Proposal for a Regulation of the European Parliament and of the Council establishing Horizon Europe – the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination – Common understanding, CHAPTER V, Blending operations and blended finance; Article 42a, The Pathfinder.

- **Challenge-driven programme.** A programme consisting of portfolio(s) of projects selected on the **basis of a PM-initiated call**. The objective is to identify competitive challenges whose solutions based on deep-tech and radical thinking will have a significant positive socioeconomic impact in the world and whose pursuit creates a research and development (R&D) ecosystem that makes Europe a leader in the corresponding scientific field. The funded projects will be actively managed (active portfolio management) via negotiated milestones with the possibility to accelerate, reorient or terminate projects.

- **Thematic-driven programme.** A programme consisting of **principal investigator (PI)-initiated projects** that, after selection based on an **open call**, are grouped into a portfolio within a well-defined thematic area such as battery technologies. The thematic-driven programme is thus based on a **bottom-up funding instrument** with the objective to support the early development of radically new technologies that have the potential to create a new market and address a societal challenge. Similar to a challenge-driven programme, the funded projects in a thematic-driven programme will be actively managed (active portfolio management) via negotiated milestones with the possibility to accelerate, reorient or terminate projects. Active portfolio management will allow for a project from a portfolio in a thematic-driven programme to join a portfolio in a challenge-driven programme. An important source of ideas for challenge-driven programmes will also be the results stemming from EIC Pathfinder's thematic-driven programmes (see figure 1).

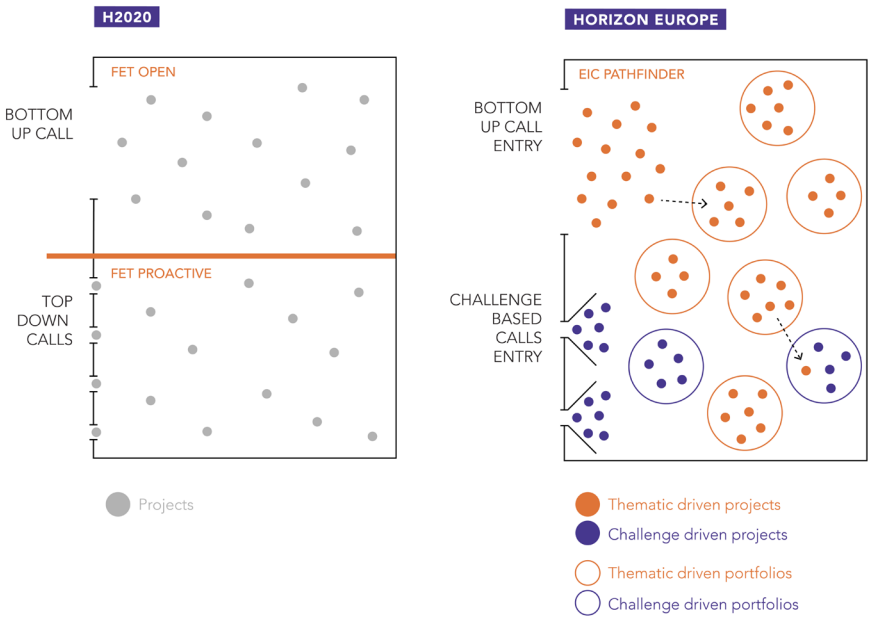

Figure 1. From Horizon 2020 to Horizon Europe: Active Portfolio Management of funded projects

The following are a few important notes for the reader of the report.

- The concept of a 'programme', which is used throughout the report, does not refer to the well-known concept of a 'work programme' in the European Commission vocabulary. Instead, in this report, we are using this term to refer to the different types of programmes that the EIC PMs will manage (challenge- and thematic-driven programmes) in the Pathfinder.

- We underline that a Thematic-driven Programme does not impact the *open nature* of the call and funding instrument. The projects in a thematic-driven programme are grouped into a thematic portfolio *after* the selection based on the open call.

- To avoid ambiguity, we will, throughout the report, indicate when the guidelines and recommendations apply for **both** programme types or for just **one** of the programme types. As a rule of thumb, the guidelines and recommendations for programme creation are pertinent only to challenge-driven programmes, whereas the guidelines and recommendations for active portfolio management and transition activities are pertinent to both programme types.

INTRODUCTION

The greatest invention of the 19th century was the invention of the method of invention.

ALFRED NORTH WHITEHEAD
Science and the Modern World (1925)

The goal of the EIC is to position Europe firmly at the forefront of the next wave of breakthrough innovations. The EIC is a new entity in the European R&D ecosystem, filling a gap in the types of R&D programmes that are created/funded/executed, in the maturity of the expected outcomes (technologies) of said programmes and in the support for bringing those technologies from the laboratory to the market. As such, the EIC is intended to be complementary to existing R&D funding and management initiatives, such as Horizon Europe, national R&D funding agencies, private R&D spending and risk capital.

This support will require the identification of and support for innovators with high-risk, high-impact ideas, and will need Europe to be an internationally attractive location to develop, invest and scale up highly innovative technologies and companies. This calls for **a new risk-taking mindset and tailor-made management** methods. Such features will require specific innovation management approaches and processes to be developed and built upon, including similar endeavours such as the Defense Advanced Research Projects Agency (DARPA) and the Advanced Research Projects Agency-Energy (ARPA-E). These agencies, supporting early-stage breakthrough technologies, have accumulated successes. DARPA, established in 1958, has revolutionised many technologies, leading to the creation of, for example, the internet, the Global Positioning System (GPS), cloud computing and semi-autonomous robots. ARPA-E, established in 2009, has already demonstrated a great deal of early success. With 875 projects funded to date with a total of USD 2.4 billion, ARPA-E project teams have been published in peer-reviewed journals 4 021 times, issued 609 patents, created 86 new companies and attracted more than USD 3.3 billion in follow-on funding from the private sector for 161 projects.

The core features of the ARPA model are as follows[4]: (1) the creation of high-risk programmes focused on delivering solutions to challenges defined in the overlap between a problem statement and emerging technological opportunities, (2) the use of active portfolio management to mitigate risk across a portfolio of high-risk projects, (3) the integration of transition activities within each programme and (4) the empowerment of PMs who bind all of this together into complementary practices.

The focus and task of the expert group is to provide guiding principles and recommendations on the development of the EIC way of proactively supporting breakthrough innovation.

[4] See Azoulay, P., et al., *Funding Breakthrough Research: Promises and challenges of the 'ARPA Model'*, NBER Working Paper Series, Working Paper 24674, 2018, for a comprehensive breakdown of the key features constituting what has come to be termed the 'ARPA model' of innovation. Available at: https://www.nber.org/papers/w24674

Throughout the work of the expert group, the overarching question has therefore been as follows:

> *If we were building an ARPA-like organisation for breakthrough innovation in Europe, in today's innovation economy, how should we organise it?*

The term 'ARPA-like' underlines that the task of the expert group is **not to copy** the ARPA-model, but to translate the ARPA model into the European Commission/EIC context by taking into account the Horizon Europe legislation and the EIC culture. The important part of 'ARPA-like' is therefore not 'ARPA' but '-like'. We appreciate that the Horizon Europe legislation has already adopted key features of the ARPA model (e.g. the use of PMs and active portfolio management) and thus has laid the foundation for developing the EIC way of implementing the ARPA model under the Pathfinder. We will, throughout the report, reference the relevant legal base.

The question posed by the expert group also requires consideration of the impact of 'today's innovation economy'. Today's innovation economy across Europe is highly concentrated in geographical regions characterised by significant agglomeration and exchange of resources, strongly grounded in teams building high-growth, innovation-driven enterprises. These so-called innovation ecosystems are the engine of today's innovation economy and are multistakeholder in nature, with critical roles for government, private corporations, risk capital providers, entrepreneurs and universities. For the EIC Pathfinder, the ability to effectively access the diverse innovation ecosystems across Europe and to further develop nascent ones are therefore essential success factors. In the report, this engagement with Europe's established and emerging **innovation ecosystems** therefore plays an important role – especially for programme creation and transition activities.

Needless to say that developing the EIC way of implementing the ARPA model under the Pathfinder represents for the EIC, and the European Commission in general, a novel practice of supporting the development of breakthrough technologies and bringing these technologies to the market. It underlines not only the EIC's ambition to fund high-risk, high-impact projects, but also the imperative to change from a traditional grant-giving agency (the dominant funding paradigm throughout Europe's innovation agencies) to a hands-on and agile innovation agency. In short, **to support breakthrough innovations, the EIC must itself be an organisational breakthrough in Europe**.

To achieve this, continuous strategic and organisational learning is important in order to make the EIC Pathfinder the most agile instrument for innovation within Horizon Europe. This can be achieved, for example, by having a **strategic intelligence set-up** at the agency level to perform foresight activities to understand the needs of the innovators

in Europe and by having a permanent evaluation activity allowing the EIC to check if it is still on course. This will allow for an **experimental design approach to innovation policy, resulting in the identification of the most suitable tools and instruments**. In short, the EIC Pathfinder should enable itself to continuously experiment and change to achieve its objectives and define the EIC way of proactively supporting innovation.

The transition towards a hands-on innovation agency will be challenging and will likely be characterised by tensions (internally and externally) between advocates of the value of bottom-up and PI-initiated projects and those of challenge-driven PM-initiated calls; between advocates of the priority of open-ended exploration and those of targeted exploitation towards defined outcomes; and between advocates of PI freedom and those of the PM's involvement through active portfolio management. These tensions are all known dilemmas in European innovation management or at least have been known since the end of World War II.

Our recommendation to the EIC is to continuously balance these tensions and make this **balance a core feature of the EIC way**. As Cheryl Martin, a member of the expert group, noted during one of our meetings: 'if there is no tension in the sails, the ship cannot move forward'. We have translated this philosophy into our recommendations. In programme creation, the recommendations balance the tension between the vision of the PM and the diverse external insights from across Europe that define the overlap between a challenge statement and emerging technological opportunities; in active portfolio management, the recommendations balance the empowerment of the PM and having transparent processes ensuring accountability; and, in transition activities, the recommendations balance the process of open exploration and early transition activities (exploitation) towards the market. **It is through this balancing, and not by eliminating these tensions, that the EIC will be successful.**

THE STRUCTURE OF THE REPORT

The report is structured in three main chapters – each written by a subgroup. At the beginning of each chapter, the names of the members of the subgroup and the subgroup lead are shown. Although the chapters are distinct, have their own style and, to some extent, can be read independently, they are intended to take the reader all the way from the creation of a programme to the completion of projects and the possible transition to the next phase, such as the EIC Accelerator (see Figure 2).

Chapter 1, 'Programme creation', focuses on the conception, validation and approval process of challenge-driven programmes and also gives recommendations for the evaluation and selection of projects for the portfolio of a challenge-driven programme. Chapter 2, 'Active portfolio management', focuses on active portfolio management as

a decisive way to increase the probability of success of a portfolio of high-risk projects. Chapter 3, 'Transition activities', focuses on how to substantially improve and accelerate the transition of a project and portfolio towards having socioeconomic impact.

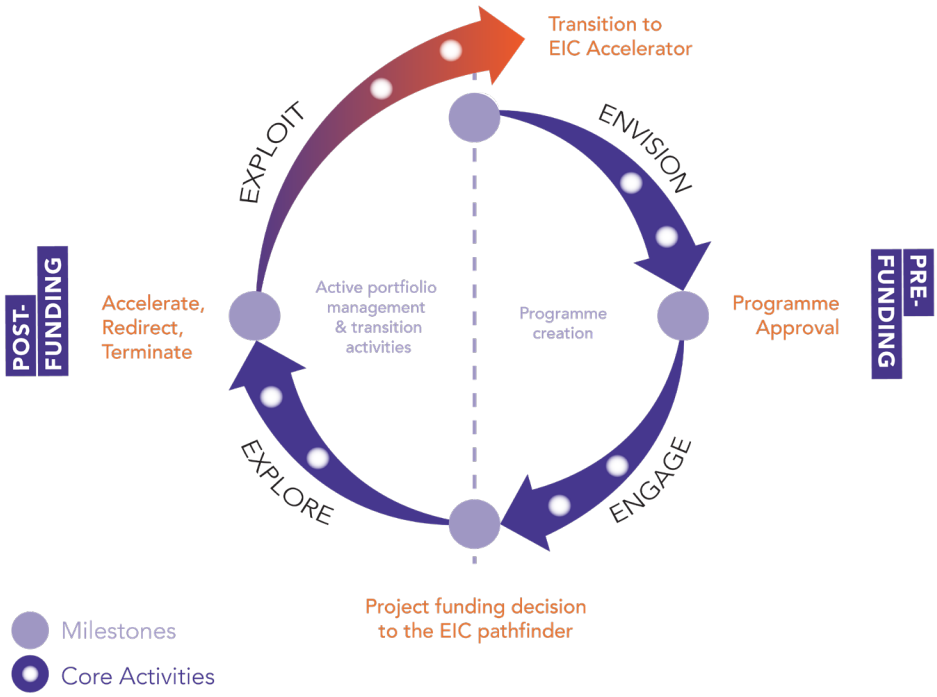

Figure 2. *The work of the expert group*

Recommendations & Guiding Principles

Programme Creation

ANGELOS DENNIS KEROMYTIS *(Subgroup lead)*
JES BROENG
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PROGRAMME CREATION

SUMMARY OF RECOMMENDATIONS

- **Empower and support excellent PMs**
  The EIC should empower excellent PMs to create, assemble and actively manage (i.e. in a hands-on way) portfolios of projects to achieve ambitious goals with high socioeconomic impact. PMs should be provided with the tools to manage projects and programmes to maximise the probability of success for both the technological aspects and the transition elements. This calls for flexibility, delegation, acceptance of risk and the occasional failure, and a mission-driven culture by the EIC. Supervision and accountability should be pursued, such that they do not unnecessarily slow down/have a negative impact on programme execution. To deliver the active management required, the EIC should ensure that each PM has access to the necessary support resources, which could include a dedicated team and/or shared resources. PMs should report directly to the EIC Agency Director.

- **Create programmes in a process that balances the vision of the PM and diverse insights from across Europe**
  The creation of programmes (by which we mean funding for specific challenges) should balance the vision of the PM with the diverse external insights from national initiatives, stakeholders in Europe's innovation ecosystems and research communities.

- **Ensure that programmes articulate a clear strategy beyond the confines of the laboratory**
  Programmes must articulate a clear and ambitious vision, a set of possible novel paths to achieve this vision, a strategy for making a difference beyond the narrow confines of the laboratory, and measurable milestones and deliverables to determine progress and success. Programme and project success or failure will largely be judged based on the meeting (or not) of programme objectives and metrics. Projects and programmes may be terminated for not meeting their goals.

- **Utilise the EIC programme questions**
  Programme design and approval should be done in a deliberate and principled, yet flexible and efficient, manner. We recommend a proposed set of EIC programme questions as a framework for both programme design and approval. These questions, inspired by the Heilmeier questions used by DARPA and ARPA-E, provide a blueprint for thinking about the validity and structure of a research and development problem, anticipating the structure of the programme that will address said problem. Answering the EIC programme questions must not be interpreted as a strict, prescriptive process.

- **Have a nimble programme approval process**
  The authority to approve programmes should be delegated to the EIC Agency Director, with advice provided by the EIC Board and consultation with the EIC Programme Committee. This will make the programme approval process flexible and agile, given that programmes sometimes have to be developed urgently.

- **Intimately involve the PMs in proposal evaluation and selection**
  PMs should be intimately involved in proposal evaluation and selection to integrate the evaluation criteria of 'portfolio consistency' and depart from the rack-and-stack approach, which may lead to the discounting of the most innovative projects.

INTRODUCTION

The purpose of this chapter is to provide recommendations on programme creation for an EIC Pathfinder that seeks to foster disruptive innovation towards advancing the social, economic and scientific status of Europe. **The chapter focuses its attention and recommendations primarily on the challenge-driven programmes of the EIC Pathfinder (i.e. on a portfolio of projects selected on the basis of a PM-initiated call to find a solution to a competitive challenge).** That being said, many of the principles and recommended approaches in this chapter apply to thematic-driven programmes, and we indicate the extent to which this is feasible.

To create high-risk, high-impact technologies that address critical societal challenges, the EIC Pathfinder must focus a critical mass of resources on meeting strategically chosen and ambitious challenges. The design, creation and management of the project portfolios must both be conducted in an accountable fashion and retain flexibility consistent with the overall vision embodied in the challenge; it is in the nature of R&D efforts to encounter both unexpected roadblocks and opportunities, both of which require course correction, often across multiple projects. The greater the challenge and the more high-risk the technological effort, the more active management will be needed to achieve the technological disruption and innovation necessary for solving critical challenges, and the higher the likelihood of creating the right conditions for having an impact (including the transitioning of the outcomes of the effort into practice).

The programme creation subgroup held extensive discussions, both internally and with the EIC/Commission, over a period of almost 4 months. These discussions focused on understanding the goals of the Commission and the legal framework pertaining to the EIC Pathfinder, the relationship of the EIC Pathfinder relative to existing European Commission and Member State R&D efforts, the needs and current R&D landscape in Europe, and the structure/operations of R&D investment organisations elsewhere (primarily in the United States). Based on these discussions, the subgroup agreed upon a set of guiding principles

for the EIC Pathfinder, from which a certain 'way of doing business' flows. This chapter lays out these guiding principles (see the next section) and then offers recommendations on how these should be put into practice based on an analysis of similar (and dissimilar) R&D investment organisations. The most important aspect of this document is the guiding principles, which we wholeheartedly urge the Commission and the EIC to adopt; our recommended programme creation process described herein is intended to be a general guide, rather than a detailed, prescriptive workflow. Even if the recommended programme creation process is adopted in its entirety, we expect the EIC Pathfinder to evolve and mature with experience, continuously adopting new ways and modifying existing ones in a quest for effectiveness and broad impact. The world is continuously changing and technology does so at an even faster tempo; an R&D organisation that does not at least keep pace (both technologically and process-wise) is doomed to fail.

GUIDING PRINCIPLES

- **Ambitious vision**
  The EIC should hire visionary, technologically strong, mission-driven, highly motivated and adaptive PMs to tackle difficult challenges through high-risk/high-reward efforts that have the potential for significant socioeconomic impact. The occasional technological failure (and certain other types of failure) of projects and even programmes is to be expected and used as a learning opportunity; a 'perfect' record suggests that the programmes are not ambitious enough.

  It is worth noting that success/failure is generally non-binary; instead, it is a matter of how many of (and how fully) the initial project/programme goals were met, also keeping in mind any unexpected (unplanned for) positive outcomes, scientific or otherwise. Unacceptable failures typically relate to programme management and administration, to the extent that these were predictable or addressable by the PM. Broadly speaking, even though it is not possible to guarantee a priori that particular projects or programmes will be successful, at the level of the EIC as a whole expectations and planning should be based on assumptions of successful outcomes. Concrete and precise project goals, set early on, prevent confusion in determining success factors and realisation, and enable easy follow-up.

- **PM empowerment**
  The EIC should empower these PMs to pursue, articulate, communicate and execute, through their programmes, ambitious visions that can lead to real impacts across society and the economy, while gaining and retaining the trust of all EU stakeholders (citizenry, Member State governments Governments, technological bases, academia, opinion leaders, European decision-makers and the business/investment world). As an analogy, a PM would be expected to act as a company chief executive officer (CEO)

and chief technology officer (CTO) rolled into one, while oversight is provided by an independent board of directors that periodically reviews decisions or is consulted for major strategic decisions.

While formal authority rests with the EIC Director, facets of PM empowerment include delegation of such authority (by the EIC Director to the PM) and of responsibility, and a culture of flexibility across all aspects of programme creation, source selection and portfolio management; an assumption of leadership by and trust in the PM in these same matters, subject to appropriate oversight; instillation of a sense of 'ownership' (by the PMs) of their programmes, and recognition of accomplishments, as motivating factors; and the development of an esprit de corps that will make PMs proud of their work and the EIC a desirable place to work (which will then attract more top-tier PMs). The degree and details of authority delegation, as it affects the decision-making paths and confirmations of decisions taken by the PM, to be approved by the EIC Director, need to be well specified to place responsibility (PM) and accountability (EIC Director) as accurately as possible.

- **Building trust**
  Trust is built over time through proper communication, clear conflict of interest guidelines and management, openness and inclusivity (while insisting on technological excellence), and accountability, for both the EIC and the PM. At the same time, it is important to balance accountability with the need for speed and flexibility. This balance suggests granting significant autonomy to the PMs to manage their programmes on a day-to-day basis, while conducting periodic programme reviews and independent financial oversight.

- **Flexibility**
  Based on the above, we recommend that PMs be granted significant autonomy while being provided with clear guidelines on the processes that the EIC will use to approve new programmes, conduct source selection and review existing portfolios. The goal of these guidelines should be to ensure compliance with EU laws and regulations while providing maximal flexibility to the PMs. A support structure that enables PMs to achieve their vision while easing the task of oversight should be put in place, with a mission-oriented mindset instilled into all members.

- **Constant reflection and improvement**
  Finally, the EIC should constantly challenge itself to improve all of its processes, including how programmes are created, approved, contracted, managed, etc. The EIC must become an organisation that can quickly learn from failures (and successes) at all levels of its operation and through continuous engagement with the EU Member States. If the EIC looks and operates the same in 10 years' time, it is likely that it will have become a stagnant organisation that cannot meet its goals.

KEY ELEMENTS OF A CHALLENGE-DRIVEN PROGRAMME

Within the strategic objectives of the EIC Pathfinder, the goal of challenge-driven programmes is to identify competitive challenges whose solution based on deep-tech and radical thinking will have significant positive societal/economic impacts and whose pursuit creates an R&D ecosystem that makes the European Union a leader in the corresponding scientific field.

The challenge-driven programmes should articulate a technological vision for how these challenges may be addressed, identifying promising technological directions that typically go beyond what individual projects may be able to achieve, while leaving room for unanticipated, surprising approaches. These programmes should also identify, motivate and assemble the right group of participants into a strong portfolio of projects; provide them with sufficient resources and technological direction (including measurable milestones to gauge progress/success) to achieve the individual projects' and the overall portfolio's goals; and set the proper conditions for both achieving technological goals and translating successes into practice.

Balancing all of these tasks is a complex endeavour that requires creativity and 'taste' in picking challenges (and setting discrete goals and milestones) that are important yet tractable. For example, 'a cure for cancer' is a laudable goal, but is **too vague and too broad a statement** to constitute the challenge of a programme. Instead (to provide a concrete example), a challenge within this space could be 'developing techniques for automatically reading the vast medical literature to extract identified pathways, assembling these pieces into more complete causal models, and reasoning over these models to produce explanations'.

With that in mind, the necessary elements for a challenge-driven programme are as follows.

1. A PM who is the 'soul' of the effort, and mandated to manage the tactical and strategic direction of their portfolio in any way they see fit, subject to transparent but non-invasive oversight (no 'micromanagement').

2. A supporting team (a mix of shared and dedicated personnel and services) that helps the PM assemble and manage the portfolio.

3. A clear and thorough, yet nimble, documented programme approval process. The formal documentation should include a brief internal programme approval document, the EIC Pathfinder programme questions document, the presentation slides used by the PM during the approval process and the budget plan/justification.

4. Equally clear portfolio selection and periodic evaluation criteria, established and justified during the approval process, documented and (as much as possible) published as part of the proposal call process.

5. The provision of sufficient resources to the PM and the programme to achieve their stated goals, as established during the programme creation and validation and approval phase.

6. A proposal call announcement (and corresponding process) that describes the challenge-driven programme and its goals, the technological direction, the desired milestones and (as much as possible) quantitative metrics for judging progress/success, the requirements for proposals submitted in response to the proposal call, and the process and criteria that will be used to select proposals for award. While the call will typically have a specific due date, it may be left open for proposals to be submitted at a later time (e.g. a 'continuous call') via a thematic-driven programme.

7. A collection of projects (a portfolio) selected according to the aforementioned criteria that together seek to address the challenge of the programme.

THE ROLE OF PMS

PMs should play a central role in the creation of challenge-driven programmes. They are responsible for conceiving, articulating and developing the programme and shepherding it through the approval process. Although they may draw their inspiration from any source (within or outside the EIC, from their own experience, etc.), PMs are the ones that will 'breathe life' into the programme. In the early stages of programme creation, PMs should determine (and later convince the EIC and stakeholders of the fact) that the programme and the discrete challenge it focuses on is feasible and that there exists a reasonable path to transition. PMs may draw on their own expertise, input and advice from other parts of the European Commission and third parties, open literature and any other source they deem necessary and relevant. PMs are responsible for defining milestones and metrics for measuring progress and determining success, and defending their choices during the approval process. In collaboration with EIC management, PMs must determine the appropriate level of resources (primarily funding) that need to be committed to the programme to achieve sufficient mass. They are the single point of contact for all matters pertaining to the programme, but are expected to delegate specific matters to their supporting team.

PMs will also play a key role in communicating the programme to the world outside the EIC, seeking to both encourage broad participation in the call for proposals and defend its importance to all stakeholders. PMs will play a leading role in assembling the project portfolio that will address the challenge of the programme by driving the proposal review and project selection process, such that the resulting portfolio is as aligned with the PM's vision as possible. PMs will recommend and defend a proposed portfolio to EIC management for final approval. PMs will then work with the contracting team to ensure that negotiations do not cause undue deviation from the programme goals. After project selection, the PM will actively manage the portfolio; further discussion on that phase will be provided by a different subgroup (see Chapter

2, 'Active portfolio management'). Relevant national contact points in all Member States will regularly be informed about the plans and their execution. To avoid participation discrepancy, road shows and other awareness-raising actions will be organised to publicise the forming of a programme and to collect information in all Member States.

In summary, a PM is expected to act as a programme CEO, driving all aspects of the process and being the single point of contact for all matters relating to the programme, its challenge and the portfolio. The PM will be assisted by a support team that takes direction from them.

PROGRAMME CONCEPTION – A BOTTOM-UP AND TOP-DOWN APPROACH

The conception of a challenge-driven programme requires a unique combination of creativity and technological background (with a certain degree of iconoclasm in the mix), placing the practice somewhere between art and science. With that in mind, certain practices and concepts appear to contribute to the generation of good challenge-driven programmes.

In a programme concept, the challenge statement and the opportunities provided by new technologies have to overlap. This overlap is something that the PM is expected to identify, and represents one key component of the creative process. As with all creative processes, programme conception is also inspired by a **diversity of bottom-up inputs from across Europe**. Programme conception is therefore a collaborative effort between the PM and the different inputs from, for example, research communities in Member States and national initiatives[5]. For the EIC, this suggests that a PM should seek continuous and meaningful exposure to both the scientific literature (to identify both problems and opportunities) and practitioners (to identify problems). PMs should be encouraged and provided the resources to travel, attend conferences and hold workshops or meetings with any individuals or organisations in the Member States and beyond that they believe could inform programme conception. Other sources of inputs are desk research, consultation procedures, input from other Horizon Europe pillars and calls to stakeholders and science communities.

Desk research could look for foresight and technology assessment studies addressing problems, threats, themes or other issues that have to be solved. Following science debates in specialised conferences and other academic discourses can be supported by online research or publication and patent analysis.

Consultations can take place in various formats as well. Open stakeholder consultation may identify pressing issues and problems, which have to be addressed by science and research. Scientific conferences could be evaluated on the opportunities they provide for solving societal or economic problems, by keeping abreast of the latest scientific/technological developments and offering a venue for informal but high-bandwidth interactions with leading researchers and

[5] See Fuchs, E., 'Rethinking the role of the state in technology development: DARPA and the case for embedded network governance', Research Policy, Vol. 39, 2010, pp. 1133–1147. On a similar note, but more focussed on the decentralized role of Programme Managers in relation to management in the public sector see Piore, M. (2009) "Sociology, Street-Level Bureaucracy, and the Management of the Public Sector". Available here: https://economics.mit.edu/files/4288.

practitioners. Here, approaches such as hackathons or other IT-based consultations could be extremely helpful to mobilise communities across Europe.

The PM must be dedicated to the inclusivity of all Member States in terms of discussions with stakeholders and preliminary technological discussions with the relevant players in the field, and the PM should strive to take this inclusive approach at all times.

Another potential channel involves inputs from other pillars of the Horizon Europe framework programme. The Horizon Europe missions will identify a lot of challenges that have to be solved by additional scientific and technological research. The activities of the knowledge innovation communities of the EIT, especially after they have run out or stopped, need to be followed up, exploiting the opportunities and the precise challenge description that these knowledge innovation communities provide. In terms of the scientific and technological opportunities, results from European Research Council grants may contribute to problems identified somewhere else.

An important source of ideas for challenge-driven programmes will also be the EIC Pathfinder's thematic-driven programmes. The continuous open call for projects with promising ideas for breakthrough technologies will give the PM/EIC a unique insight into Europe's technological capacity, which can then be overlapped with a challenge statement.

It is thus important to understand that, although the programme creation process and the resulting challenge-driven programme is driven by the PM, it should not be understood as a top-down process. **The programme is the result of a process that balances the vision and inspiration of the PM (top-down) with diverse external insights from and engagement with Europe's innovation ecosystems (bottom-up); these collectively create the programme at the overlap between a challenge statement and emerging technological opportunities.** One of the key features of this EIC way of implementing programme creation under the Pathfinder (see Figure 3) is therefore that it goes beyond traditional views of funding instruments being either top-down or bottom-up.

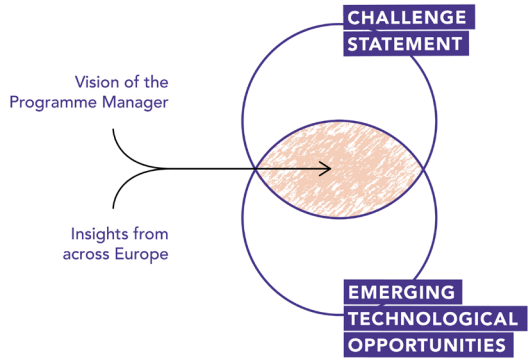

Figure 3. Programme creation balances the vision of the PM and insights from across Europe

PROGRAMME VALIDATION

Because of the significant investment and concentration of attention and effort into the EIC Pathfinder challenge-driven programmes, it is important that the process through which the corresponding programmes are developed and selected is rigorous, repeatable and equally applicable across different technological domains. The rationale for selecting a specific programme should naturally combine a description of the programme's scientific and socioeconomic significance and relevance to the European Union and the EIC Pathfinder; the expected technological pathway(s) to address the discrete challenge of the programme, including the type of research and development that will be needed; the expected nature of successful results of the effort and how they will be transitioned into practice; the ways (metrics, milestones, etc.) through which progress will be measured and success will be determined; the time period needed to accomplish the technological goals; and the level of investment necessary to bring together all of the necessary components. This narrative will form not only the basis of the deliberation within the EIC on the selection of programmes to pursue, but also the core of the programme announcement, the criteria for proposal review and selection, the blueprint for managing the portfolios throughout the execution of the effort, the goals for the transition into practice, and the way all of the above will be communicated to the various stakeholders.

Inspired by the famous Heilmeier Catechism[6], we recommend a set of guiding questions (which we have called the EIC programme questions) for PMs to answer as part of the validation/justification of their proposed programme. As we discuss below, PMs are expected to create a document that addresses these questions as part of the programme approval process (note that answers to several of these questions are generally intended to be broad, with only occasional in-depth examinations of key points). It is also important to mention that the questions have been tailored to create the EIC way by focusing on questions that make sure the programme relates to EU/EIC priorities and considers scenarios for transition activities[7].

The EIC programme questions

- What are you trying to do and who cares if you are successful?
- How is it done today and what is new in your approach?
- What is the state of the art in R&D? What research areas and communities (academic, private sector, etc.) could contribute towards the programme goals?
- What will be the impact of the programme? How will the programme contribute to solving EU and EIC key priorities (such as climate change), in measurable terms?
- What are the scenarios for transition activities and the barriers to commercialisation that must be overcome?

[6] See: https://en.wikipedia.org/wiki/George_H._Heilmeier

[7] The EIC programme questions may also play an important role in the recruitment process of EIC PMs. A possible PM candidate could, for example, be given the task of presenting their vision for a programme using the EIC programme questions during the interviews.

- What are the key risks and how can they be mitigated?
- How much will it cost?
- How long will it take?
- What are the discrete and measurable goals of the programme, and what are the milestones to check its success?
- What is the preferred programme design to achieve the goals (e.g. collaborative versus competitive)?

PROGRAMME DESIGN

The design of a challenge-driven programme fleshes out the initial programme concept, expanding on the EIC programme questions to define the structure and composition of the desired portfolio. There are many moving parts to a complex programme, and their interactions can have significant ramifications for the research direction, the system integration, the transition efforts, the ability to react to unexpected circumstances (fortuitous or otherwise) and, ultimately, the success or failure of the programme.

There exists no prescriptive blueprint for how to design a programme once it has been conceived. Over the long term, the EIC Pathfinder and the PMs will establish patterns and anti-patterns of programme design based on experience. Although such patterns cannot be easily codified, best practices can be relayed to new PMs in a variety of means, both formally (e.g. through a programme completion report) and informally (e.g. through discussions among the PMs). Until such a practice is established, we encourage the EIC and PMs to reflect on key design elements of challenge-driven programmes.

A non-exhaustive list of questions/concerns that may be considered at this stage, listed in no particular order, include the following.

1. Is the programme outcome a single system/technology or a set of distinct components that do not need to be integrated? In the latter case, why should they not be pursued as different programmes?

2. Should the programme be structured as collaborative or competitive?

3. What should interim metrics/milestones/deliverables be including as natural go/no-go points for the programme and for individual projects?

4. How will transition success or impacts be measured, during and beyond the lifetime of the programme? How will the EIC know whether a particular technology transitioned or was successful in the market?

5. What are the key evaluation criteria for proposals? Are there specific technological or other topics that proposals should (or must) address in depth? These will need to be clearly communicated through the announcement and any other public communications (e.g. the 'Proposers Day' event – see below).

6. Are there distinct technological subproblems that each require significant and specialised expertise? This may suggest the need for multiple separate technological areas within the programme, each with its own metrics and milestones. Alternatively, the PM may opt for large teams that can holistically address each of these subproblems.

7. As regards point 6, in either case, a certain degree of redundancy is probably desirable, for technological and programmatic risk management reasons. How many distinct technological approaches are necessary? The minimal degree of redundancy is two, but higher may be merited for particularly thorny challenges or when it is desirable to explore and develop multiple technologies. From a programmatic risk management perspective, it is desirable to avoid having the programme beholden to the success (or whims) of a single project or organisation. Active portfolio management cannot be effectively practised when it is impossible to redirect or terminate a non-performing project (see also Chapter 2, 'Active portfolio management'). Redundancy also introduces a degree of competition within the programme, which acts as additional motivation and inspiration if managed correctly by the PM.

8. The multiple technological areas approach allows for smaller teams, which increases the number of organisations that may respond, and allows for niche-but-relevant expertise to be brought into the programme without forcing awkward teaming. However, to the extent that the outputs from the different areas need to be integrated, a specific entity must act as a designated integrator[8]. This may be a designated entity funded by the programme only for integration purposes, a project that is also pursuing R&D tasks or an external partner. In the case of a double-duty project (i.e. one acting as integrator and innovator), the PM must anticipate and avoid conflict of interest issues (e.g. the integrator favouring its own technological approach). It is not uncommon for integrators to be prohibited from also being funded for a regular R&D project. On the other hand, it is sometimes possible to design a programme such that there exists a 'natural' integrator, or it is possible to define interfaces among the different technological areas that minimise the need for additional scaffolding. While desirable, opportunities to adopt either of these structures tend to be rare in practice.

9. Integrators (of any type) often represent single points of programmatic risk, because multiple parallel integration efforts are not typically desirable (as they would cause conflicting requirements and increase administrative work for regular R&D projects). Furthermore, as a programme gets closer to a successful conclusion, the integrator

[8] Integrators are responsible for collating the technological outputs of innovators (i.e. the various R&D projects in the programme) into one coherent, demonstrable system. Integrators are typically treated as another project in the programme, from a contracting point of view. Their evaluation criteria, milestones and deliverables are specific to system integration, rather than related to the development of novel technologies. Not all programmes require integration/integrators.

becomes increasingly important, acting as the natural point of interaction with external partners and the 'face' of the programme. Effectively managing integrators throughout the lifetime of the programme is a very important task for the PM. One key consideration is to avoid 'technology lockup' by the integrator (i.e. allowing the integrator to become the only entity that can transition technology developed by the programme, by virtue of being the only entity with a complete system). Examples of risk-mitigation strategies include frequent demonstrations and 'code dumps' to the EIC or open-sourcing (i.e. making freely available) the integrated system. The differing requirements and peculiarities of any particular technological domain place the burden of devising, refining and executing appropriate mitigation strategies squarely on the PM.

10. Because integrators (of any type) generally require significant access into the work of the R&D funded projects, questions about intellectual property must be addressed early on. This may involve non-disclosure agreements or other types of agreements, which often take time to negotiate. A programme announcement may specify the relevant terms or leave it to the proposers to address as part of their proposals. The more specific the guidance offered at programme call time, the higher the likelihood of timely resolution.

11. The large-team approach effectively pushes the burden of integrator management from the PM to the individual projects. For certain areas of technology or specific desired outcomes, large-team efforts are a natural approach. Because teaming is done as part of proposal submission by the proposers, it is a good idea for the PM to offer opportunities for potential team members to discover each other (e.g. through 'Proposers Day' events, workshops, teaming websites and teleconferences, or other mechanisms). Not all organisations find appealing the idea of teaming as part of a project, because they typically cede control of their effort to the project lead and because of intellectual property concerns. In some cases, relevant organisations may decide not to participate in a programme (i.e. not submit a proposal) because of these concerns, which is undesirable from a programme perspective. Furthermore, the large-team approach almost always results in a much more rigid programme than the multiple technological areas approach, because the research efforts are tailored to the specific integration vision and technological approach of their teams, significantly reducing (practically eliminating) opportunistic mix-and-match.

12. How will periodic and final evaluation be done? Options include organic evaluation (i.e. by the R&D organisations) or by an independent evaluator. It is also possible to do both: organic evaluation replicated or verified by an independent evaluator.

13. Is the independent evaluator an external (unfunded) partner (typically an entity that may be a transition partner) or will it be an entity funded by the programme? In the latter case, how will the evaluator's performance be judged?

14. Are programme-funded evaluators allowed to participate in the R&D component of the programme and, if so, how will conflict of interest be avoided?

15. Will evaluation be done at the individual project level, the integrated system level, both or in some other way?

16. How often will evaluation be done, keeping in mind the disruption that large or frequent evaluation events bring to R&D. In the extreme case, a programme may devolve to 'keeping the evaluator happy'.

17. What are the repercussions of a 'failed' evaluation at the integrated system level? (The repercussions for individual projects are more straightforward.)

18. If potential transition partners have been identified, how will they engage with the programme? Options include attendance at some of the programmatic events and assumption of some role in the programme (R&D, integration, evaluation, advising, etc.). The earlier and more closely such partners engage with the programme, the higher the likelihood of a successful transition.

19. What are the optics of developing the specific technologies/addressing the particular challenge? Are there sensitivities that must be addressed, avoided or managed?

20. What kind of contract vehicles are appropriate for the anticipated projects and performing organisations, given the goals of the programme and the technological paths pursued?

While it is not necessary to explicitly answer each question in the way it is posed, PMs should consider these issues and design their programmes (and write the calls) so that they are as clear as possible as to how they expect the programme to be pursued (and why). Budget realities must also be kept in mind when designing the programme structure.

ANTICIPATING TRANSITION

The transition towards the market should be anticipated during the programme creation phase and reflected in the programme design. How do we translate the imperative to consider market entry, exploitation, scalability, etc., at the very first stage? Here we would argue that the pitch of the PM to secure the programme should include some feedback from the market, expressions of interest by investors or industrial companies and intentions from laboratories to be involved if the programme is selected (i.e. bring the stakeholders on board early).

This is anticipated by three EIC programme questions.

1. What are you trying to do and who cares if you are successful?

2. What will be the impact of the programme? How will the programme contribute to solving EU and EIC key priorities (such as climate change), in measurable terms?

3. What are the scenarios for transition activities and the barriers to commercialisation that must be overcome?

More detailed discussion and guidance are provided in Chapter 3, 'Transition activities'. Transition planning during the programme creation phase should also take into consideration the current and expected status of any intellectual property used and produced by the programme.

The PM has to set up a clear view of transition activities from the beginning of programme creation. First, to achieve this goal, the PM must identify all of the ecosystems that have an interest in the programme. Once the PM achieves a clear understanding of ecosystems, they need to set up an expression of needs (workshop, meeting, etc.). In this work, the PM may have the support of external or internal teams that provide market analysis or arrange a workshop to highlight the expression of needs.

The PM then needs to establish the outcome of the programme, not only in terms of technology, but also to identify all of the barriers (standardisation, scalability, etc.) that the programme has to pass through to find solutions for market needs. The PM can anticipate scenarios for transition, namely either technology transfer for portfolios that are more oriented towards technology outcomes or start-up creations for new products and services. This means that the PM must determine whether the programme will mostly have technological (three to six technological readiness levels) outcomes (the expression of needs to identify a lack of technology) or products and solutions outcomes (the expression of needs to identify use cases and possible markets).

The role of the PM is once again critical. The PM must develop a global and transversal approach in order to break the silos and bridge gaps between several ecosystems; this requires significant knowledge of industry needs, strategy and market evolutions.

THE ROLE OF PORTFOLIO MANAGEMENT

Although portfolio management is covered in more detail in the next chapter, it is worth briefly describing how it interacts with the creation of programmes.

The most obvious way in which the two areas interact is via the metrics, milestones and deliverables articulated as part of the programme, since these form the basis for evaluating the progress and success of the overall portfolio and of individual projects.

A more subtle interaction happens through the design of the programme, namely whether it is divided into technological areas that pursue subproblems or whether every project is independently trying to solve the same problem (albeit with different approaches). Complex programmes typically require portfolios with groups of projects pursuing complementary goals. For both technological and programmatic risk management, each technological area would need more than one project. PMs should keep in mind that each technological area (and therefore each individual project) should be on a path to producing technologies that are useful on their own (i.e. even if every other project in the programme fails to achieve its goals). Extending this further, good programme design would anticipate the areas in which there is higher risk and either increase the degree of redundancy and technological diversity or provide a flexible integration framework.

Integration itself, the extent and nature of which is generally defined as part of the programme design, affects portfolio management, most obviously through the decision to conduct organic integration or through a designated integrator as mentioned above. Another option is to run two or more 'mini programmes', each with its own integrator, or even its own integration strategy, in a team-of-teams approach.

A programme may address several complementary 'pieces' that must come together to provide solutions. This, along with the inevitable budget constraints, suggests that the portfolio should be diverse and complementary, so as to explore the most promising solutions to address a problem or question tied to a market need. The PM has to consider all of these pieces. However, it is not uncommon for PMs to identify the following during programme execution:

- new problems or barriers that must be addressed for transition activities to be successful;
- a more promising technology or new breakthroughs in academic research that can contribute to the programme;
- a need for integration between several technologies or cooperation between projects or even programmes.

It is unreasonable to expect PMs to anticipate all of the aspects of the programme during programme creation (which may not be knowable at that time). To ensure agility and efficiency, improvements or 'add-ons' may be undertaken throughout programme execution. Some of those add-ons may require new financial investment (e.g. a new subcall) and others can be addressed by redirecting existing resources and research/integration efforts.

For a new subcall, the EIC should institute a process that addresses at least the following questions.

- How can the EIC allow the PM to launch a new subcall during programme execution in order to address gaps? The goal of the new subcall is generally to cover gaps or pursue targeted opportunities, without introducing drastic modifications to the programme goals and strategy.

- What should the approval process be? This process needs to be quick so it can be responsive and effective, in order to avoid delays that can compromise programme planning and goals. We recommend that the approval process involve only the PM and the EIC Director. The PM can provide the EIC Director with a short document explaining the reasons for this new subcall and all the information required to make a decision (technological, planning, milestones, budget, etc.). This process should take less than a month and it should be possible to launch the subcall within 3 months.

- What budget percentage should be set aside by the EIC Director to cover subcalls? We recommend a target of 10 %.

PROGRAMME APPROVAL PROCESS

While PMs will work with EIC staff and the EIC Director to shape the challenge-driven programme during its conception and design phase, it is important that a formal internal approval process be instituted. The approval process should not be lengthy or too onerous, keeping in mind the inherent risk and uncertainty of research endeavours, but it should be as comprehensive as possible. The rest of this section offers a recommendation for an approval process, starting from the final decision point and working backwards.

The primary purposes of such an approval process are to:

- provide a concrete, definitive and time-bound mechanism that the PM can work through to achieve a go/no-go decision for a challenge-driven programme (i.e. become adopted as a Commission decision);

- offer an opportunity for a holistic and comprehensive review of and final modifications to the programme prior to its launch, based on the EIC programme questions and any other criteria deemed to be important by the EIC Director;

- document the programme and memorialise the decision process;

- prepare and refine the initial messaging of the programme for external stakeholders.

We recommend that the authority to approve challenge-driven programmes be delegated to the EIC Director, with advice from the EIC Advisory Board and in consultation with the EIC Programme Committee. This will make the programme approval process flexible and agile, given that programmes sometimes have to be developed urgently. The EIC Director may create an advisory council that reviews proposed programmes and provides an independent perspective. Because programmes are expected to fit within broader strategic goals pursued by the EIC, the membership of this council should have a degree of continuity, possibly augmenting it temporarily with deep expertise specific to a particular programme. Several options exist, including using EIC staff of appropriate seniority or other EIC PMs, having an external oversight/advisory board with a fixed term, or using a mix of the two. When external members are brought in, attention must be paid to preserving the confidentiality of the deliberations and managing potential conflict of interest concerns. When relying on other PMs (either as official members of the council or as guests/observants/experts), attention should be paid to not creating a negatively competitive environment within the EIC.

Regardless of the composition of the council, it is worth repeating that the authority for programme approval lies with the EIC Director. When there is reasonable doubt and difference of opinion, deference should be given to the PM.

With the above in mind, the end point of the approval process should be a 30-minute presentation to the EIC Director and the council, followed by a question-and-answer period. The EIC programme questions can be used as the general theme for the presentation, although it is not necessary (and it is probably undesirable) to explicitly answer every question and to answer at the same depth for each programme; instead, emphasis should be placed on those questions that are most pertinent to the particular programme. This presentation will also form the basis for the initial messaging (announcement) of the programme to external stakeholders (the general public, the research community, etc.), allowing for a preview and for fine-tuning of how the programme will be communicated. Therefore, the presentation must not simply and explicitly answer the EIC programme questions in a 'dry' manner, but should weave a narrative that is informative and motivational while also addressing key aspects of these questions. A good rule of thumb is that such a presentation should be between 10 and 15 slides, avoiding 'wall of text' slides, overly complex graphics and gratuitous animations.

At the end of the presentation or shortly (i.e. 1–2 days) after, the EIC Director should make a decision to approve the programme or not. The goal should be to avoid protracted processes, so the majority of the decisions are expected to be approval (and so the pursuit of the programme) or denial (and altogether abandoning of the concept). In limited cases, the PM may be asked to do some additional 'homework', typically in answering an important but not critical question. In those cases, the programme may be considered conditionally approved, subject to satisfactory completion of the homework. This outcome must be viewed as a mechanism not for instituting significant changes to the programme design, but instead for fine-tuning certain aspects of it. A second formal presentation to the EIC Director and the

council is not necessary in these cases. The EIC Director may simply meet with the PM or discuss it over email or in any other way that the EIC Director feels is appropriate and fully satisfies the homework assignment.

In conjunction with and prior to the presentation, the PM should provide for review a programme approval document, namely a short document that describes the key elements of the programme.

- Programme goal: in high-level simple language, what is the programme trying to achieve? (One or two paragraphs.)
- Impact: what happens if this programme is not pursued and what are the expected benefits if it is successful? (One or two paragraphs.)
- Technological approach: what kinds of technology/research will be pursued, what is the programme structure (e.g. technological areas, phasing), what are the anticipated risks and mitigation strategies, and what is the level of effort expected? Brief justifications should be provided for each of these. (One to two pages.)
- Funding profile and high-level management process (e.g. planned PI meetings, formal evaluations). (Typically a spreadsheet-like table and one or two paragraphs of prose.)
- Technological and management milestones: metrics and targets, evaluation milestones, go/no-go criteria. (One or two paragraphs.)
- Transition strategy. (Two or three paragraphs.)
- Partnership strategy: what other efforts are ongoing in Europe (and elsewhere) that could prove synergistic? Particular emphasis should be paid to the Directorate-General for Research and Innovation and efforts of other Directorates-General, as well as Member States' programmes. (One page.)
- Any other required or programme-specific elements (e.g. human subjects research protocol, privacy impact).

In addition, the PM must provide a document that contains prose directly answering the EIC programme questions. This document may be as long as needed or as dictated by the EIC Director, but in general should not be longer than one page per question.

The programme approval document (which should be no more than 5–10 pages long) and the EIC programme questions document, in conjunction with the presentation, constitute the formal inputs into the final decision point, in addition to the programme/decision-making

documentation. Based on these, the PM may then work with EIC staff to prepare the official programme announcement and any other necessary public material.

Prior to the final approval presentation, the EIC Director and the PM may hold informal 'vector check' meetings to discuss the current status of the programme's development and review drafts of the documents and presentation. The frequency, length and structure of such meetings are left to the EIC Director and the PM. The goal is to avoid surprises for either the EIC Director or the PM and to offer an opportunity for the EIC Director to influence the shape of the programme. However, the EIC Director should not use these meetings to micromanage programme development; instead, the goal is simply to course-correct the process.

The decision to formally pursue programme development and reaching the approval point described here is based on an initial presentation of the concept by the EIC Director and/or the PM at an EIC Advisory Board meeting and consultation with the EIC Programme Committee. The presentation is expected to contain a subset of the material, answering some of the EIC programme questions in broad terms. The goal of the presentation is to identify and avoid development of programme ideas that the EIC/European Commission does not wish to pursue (e.g. because they do not fit within the broad strategic framework) and to offer initial feedback (e.g. identifying the most critical questions that the PM should focus on during programme development).

The decision to present the initial programme concept to the EIC Advisory Board and the EIC Programme Committee is made by the EIC Director, in consultation with the PM. The process may be initiated by either the EIC Director or the PM, and is likely to follow the initial programme conception (the 'aha!' moment) and potentially an initial analysis by the PM along the lines of the EIC programme questions. This part of the process need not be formal or formalised, but may rely on PM initiative, ad hoc interactions between the EIC Director and the PMs (e.g. brainstorming sessions, strategy meetings) or any other approach. For an overview of the approval process, see Figure 4.

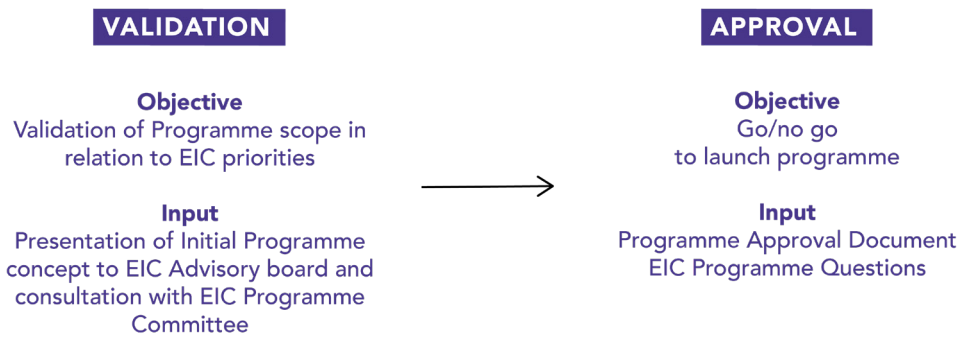

Figure 4. *The programme approval process*

PROGRAMME ANNOUNCEMENT

Programmes will be announced as all project calls are on the European Commission website and through other traditional mechanisms. In addition, PMs should consider holding a 'Proposers Day' event to explain the programme and answer questions by prospective proposers. It is critical that the PM clearly conveys the goals of the programme and what critical questions or issues the strong proposals are expected to address. For an overview of the programme creation, see figure 5.

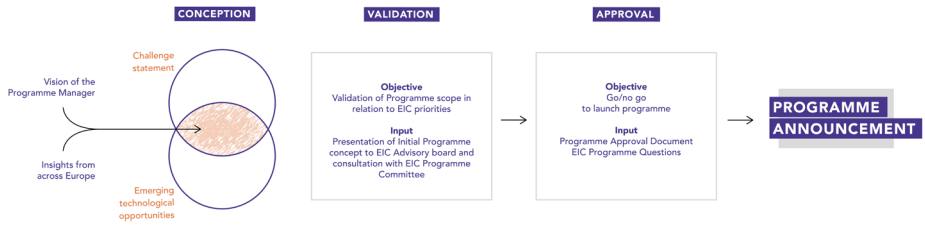

Figure 5. *The full programme creation process*

It is entirely appropriate (indeed, desirable) for PMs and their staff to reach out to the various relevant individuals and organisations they have consulted with (and those they have not) or that they are aware of, to ensure that they know of the programme and the event – of course without offering any inappropriate advantage, such as privileged information.

Proposers Day events may have a physical meeting component, but should generally allow for virtual attendance to accommodate the broadest possible audience. A common practice is to use a subset/adaptation of the slides used for the programme approval presentation as the basis for explaining the programme to the public.

A second important purpose of these events is to allow prospective proposers to identify teaming opportunities. This may be done by providing a teaming portal (website), by allowing interested parties to give brief presentations or through any other means deemed appropriate.

We reiterate that relevant national contact points in all Member States should regularly be informed about the plan for new programmes and their execution. To avoid participation discrepancy, road shows and other awareness-raising actions will be organised to publicise the forming of a programme and to collect information, in all Member States.

PROPOSAL EVALUATION AND SELECTION

The Horizon Europe legislation allows the PM to be part of the Evaluation Committee, and the evaluation criteria for **portfolio consistency** allow the approach to depart from an initial ranking[9] (i.e. to depart from the traditional 'rack-and-stack' approach), which may lead to discounting the most innovative projects due to consensus driven decision-making[10]. We therefore see it as a key role of the PM to integrate this **portfolio perspective** in the evaluation and selection process, which should be regarded as essential to the development of the EIC as a hand-on innovation agency and thus an important part of the EIC way.

At a high level, we recommend that the Evaluation Committee analyses the submitted proposals using the criteria described in the programme announcement (which were agreed during the programme approval process) and constructs a ranking for all submitted proposals looking at both the merits of the individual proposed efforts and the overall portfolio needs. The PM, who has been part of the Evaluation Committee, then constructs a recommendation for the programme's portfolio looking at both the ranking of the individual proposed efforts and the overall portfolio needs.

The EIC Director approves, disapproves or makes changes to these recommendations from the PM. Changes or disapprovals should be made only when significant problems with the evaluation process are discovered. Generally, as long as PMs can articulate good reasons for a particular recommendation, we recommend deference should be paid to their choices. This allows for an evaluation and selection process that includes the criteria for **portfolio consistency** and a dual process that combines the traditional review process by external experts and the portfolio perspective of the PM. The result is an evaluation and selection process that allows the EIC Pathfinder in its challenge-based component to move away from the 'rack-and-stack' approach that is contrary to the main objective of the EIC: to fund the next wave of breakthrough innovations.

The criteria used to evaluate proposals may vary among programmes, but in general they are expected to include the impact proposed results, the quality and the accuracy of the information and data provided, excellence in innovation potential, impact and quality, and the efficiency of the implementation. For the evaluation of portfolio consistency, the following aspects may be considered.

- How a project aligns with programme objectives, milestones and go/no-go criteria as defined in the programme announcement but also as these emerge from the submitted proposals.

- How a project complements or overlaps with other proposed efforts, also in the context of technological and programmatic risk management.

[9] See Article 26 of the Common Understanding of the European Parliament and the Council on Horizon Europe.
[10] See, for example, Goldstein, A.P., and Kearney, M., Uncertainty and Individual Discretion in Allocating Research Funds, 2017. Available at: https://www.gwern.net/docs/statistics/peerreview/2017-goldstein.pdf

- The specific nature of the deliverables and their fit with desired programme outputs or integration efforts.

- Excellence in innovation potential: does the proposed activity greatly help move the output of research towards the initial steps of a process leading to a commercial or social innovation? The proposal should include plans for an analysis of whether the project's expected outcomes are innovative or distinctive compared with existing solutions.

- Does the proposal provide a suitable outline of how the commercialisation or the generation of the above-mentioned benefits will be achieved? The proposal should include:

  - plans to assess and validate the effectiveness of the project's outcomes;
  - plans to clarify the intellectual property position and strategy or knowledge transfer strategy;
  - plans for setting up contacts with industry partners, societal or cultural organisations, policymakers or any other potential 'end users' of the projects' results.

- Does the proposal provide a reasonable and acceptable plan of activities against clearly identified objectives and for establishing the feasibility of the project? This should include:

  - a sound project management plan, including appropriate risk and contingency planning;
  - demonstration that the activities will be conducted by persons well qualified for the purpose;
  - justification that the resources described in the proposal are appropriate for the implementation of the project.

The EIC should not lower standards owing to a lack of suitable candidates at a given time: if no proposals meet the desired criteria, then selections may not be made.

The maximum time period from programme approval to the first project being funded should be 3 months. If the programme is set with enough care and due diligence, this time could be even shorter.

CONTINUOUS PROGRAMME COMMUNICATION TO STAKEHOLDERS

Assuming it is a clear requirement for the PM to have outreach/contacts to be able to mobilise several European ecosystems when applying the programme, this section is about activating these contacts and taking the programme to the next level (i.e. beyond the existing, secured networks when announced). This takes effort from the PM and the EIC communications team. The following three ways to communicate the

programme (progress, results and newsworthy outcomes) to stakeholders must be planned and put into action.

1. Announcements should be as broad as possible, also supported by targeted messaging to involve a wide group of supporters for the programme. Press relations and influencers (e.g. academia) should not be underestimated. The people contacted should be provided with fact sheets, arguments, contacts to follow up with, etc.

2. Dedicated relations should be created with investors, corporates, national partners and similar PMs internationally.

3. The existing communications should be built on. The PM and EIC teams should engage with their contacts and networks on the specifics of the programme to generate interest, collect and address questions/expressions of interest, and build a community of followers that can be activated.

This requires a dedicated public relations strategy planned for the long term, as the very same communities mobilised at the time of the challenge announcement will be key relays and potential supporters when the programme has results to announce or must change its approach.

PROGRAMME DOCUMENTATION

All reporting material (presentations, technological reports, etc.) generated throughout the programme's execution must be retained and made accessible throughout the EIC, taking care to protect sensitive/proprietary information. In addition, proposal reviews and the recommendations made by the PM to the EIC Director must also be retained for posterity. The programme announcement and contracts should make this clear.

Any significant changes to the programme (e.g. metrics, milestones, other key performance indicators) must be approved by the EIC Director and reflected in a modification to the programme approval document.

At the end of the programme, a programme completion report compiled by the PM provides an analysis of the conduct and outcome of the effort, and any lessons learned. The programme completion report is an important mechanism for capturing knowledge and making it available to future PMs.

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In the next chapter, we consider the active portfolio management that begins in the contracting process.

Recommendations & Guiding Principles

Active Portfolio Management

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ACTIVE PORTFOLIO MANAGEMENT

SUMMARY OF RECOMMENDATIONS

- **Integrate contracting into active portfolio management**
  The EIC Pathfinder should integrate the negotiation of milestones and deliverables into the contracting process. Negotiations of the milestones should happen in person, ideally at the PI's location, and include all contracting parties. A dedicated EIC Pathfinder contracting team, working for all programmes, should be created to facilitate efficient contract timing and allow for the integration of the learning outcomes of the Pathfinder journey, such as 'top-up' capability, the reorientation of deliverables, termination, etc.

- **Ensure PMs have direct and active relationships with the projects**
  The PIs should submit quarterly written updates on their progress on technology, transition and budget to the PMs and the EIC agency. The PMs should review progress and milestones on a periodic basis, no less than once per quarter. Ideally, at least one of these meetings per year would be in person. The PMs' engagement with each project should not be a check-box exercise and PMs should provide guidance to teams to overcome challenges.

- **Accelerate, reorient and/or terminate all projects and programmes according to their ability to achieve the negotiated milestones**
  Active programme management should apply to all projects from the different programmes. Ultimately, if a project cannot meet its performance criteria or those criteria become obsolete, the PM can recommend that it be terminated. It is worth stressing that, unless failure demonstrably occurred by programme management failure, programme or project termination should not reflect badly on the PM or the PI.

- **Allow for top-up funding for programmes**
  EIC Pathfinder implementation should plan for budget reserves to allow budget flexibility to EIC areas of priority and programmes that are increasingly promising. Funds remaining from a terminated project should be made available to other projects within the programme's portfolio and duration.

INTRODUCTION

Technological development and the transition of results towards the market is an endeavour filled with uncertainty. For the EIC Pathfinder, which funds the projects, this

uncertainty is a risk. Active portfolio management is a valuable practice undertaken in public funding to mitigate risk across a portfolio of funded high-risk projects. Said more positively, active portfolio management is a decisive way to increase the probability of success of a portfolio of high-risk projects – a way for the EIC Pathfinder to balance the potential impact of funded projects and the inherent technological and market risk[11]. Active portfolio management represents, for the EIC Pathfinder, a novel practice that underlines not only the ambition to fund high-risk projects, but also the imperative to change from a grant-giving agency (the dominant paradigm throughout Europe) to a hands-on innovation agency for all funded projects. **Active portfolio management will be applied to both challenge-driven programmes and thematic-driven programmes[12]. The guidelines and recommendations in this chapter thus apply to both programme types.**

We distinguish between active portfolio management at three levels:

1. at the agency level, on various programmes and EIC priorities;
2. at the programme level, on the portfolio of projects within a programme;
3. at the project level, on the individual projects and their management.

GUIDING PRINCIPLES

- **Develop the EIC way of active portfolio management under the Pathfinder**
  Active portfolio management will be a new practice to the EIC and is likely to be one of the key features that internal and external stakeholders will pay attention to and even challenge. It is therefore important that the PM and the EIC as a whole quickly adapt and incorporate active portfolio management into their everyday practices. That requires space and time for learning from the interactions between the PIs and PMs and from the successes and failures, with the ultimate goal of developing the EIC way of implementing active portfolio management under the Pathfinder.

- **Freedom and flexibility**
  The EIC must empower PMs to execute active portfolio management that includes negotiation of deliverables and milestones, project budget allocations and ongoing project guidance and management, including reorientation and possible termination of projects.

- **Transparency and governance**
  Although the PM should be empowered, formal authority rests with the EIC Director who will ensure transparency around decisions to maintain the trust of all EU stakeholders.

[11] On the value of Active Portfolio Management in public funding of high-risk projects see Goldstein and Kearney "Know when to fold'em: An empirical description of risk management in public research funding" in Research Policy vol 49. No 1, 2020.
[12] Proposal for a Decision of the Council on establishing the specific programme implementing Horizon Europe – the Framework Programme for Research and Innovation – Partial General Approach, section 1, the European Innovation Council (EIC); section 1.1, Areas of intervention.

ACTIVE PORTFOLIO MANAGEMENT

In the end, it is the outcome of a project that matters. If a project is unable to achieve the expected outcome, it has to change its course, reallocate the resources or be terminated. This is in contrast to historic government grant-giving in the European Commission and in most EU Member States, whereby, once a project is awarded a grant, it is executed essentially with little discussion about direction or the metrics on which it must deliver.

The task of active portfolio management is therefore to enable a project to transition towards a goal/achievement rather than 'just staying alive'. To start with, such projects need to have a defined vision and measurable milestones/deliverables (i.e. content to be delivered within a certain budget and a certain time). These deliverables will then guide the management of the project.

In the following sections, we give recommendations about (1) the negotiation of milestones in contracting, (2) the ongoing active portfolio management throughout the execution of the project and the different levels (project, programme and agency) and (3) the possible termination of projects and programmes.

CONTRACTING CONSIDERATIONS – NEGOTIATING MILESTONES AND FINALISING BUDGETS

Once a project is selected, active portfolio management actually begins with contracting. The negotiation of the milestones is a key element whereby the PM ensures that the project is focused on the delivery of established outcomes. Regardless of the role of an individual project within a portfolio, or the process through which each project was selected (i.e. challenge-driven or thematic-driven programmes), the same management principles will apply.

Contracting will be done as it is in all EU project calls. After approval, the grant agreement is signed by the two parties (the European Commission and the lead partner). Contracting time should be kept to a minimum – current EIC standards seem applicable and are under 2 months. In general, we recommend a dedicated EIC team, working for all programmes, dealing with all contracts. Contracts' durations will vary based on the needs of individual challenges, but typical durations for projects by other agencies/organisations with similar profiles (e.g. DARPA) are 3–5 years (with the majority at 4 years), and a minimum of 2 years.

Negotiation time is important to both sides and should be kept to the minimum possible. To the extent that the programme announcement can specify the information needed to accelerate contract negotiations and can specify that this be included in the submitted proposals, the PM should work with the contracting officer to facilitate this. Negotiation should confirm and clarify aspects of the proposal, rather than seek altogether new information.

Negotiation of deliverables and milestones should take place in person with representatives of all parties, the PM and a tech-to-market (T2M) team member (see Chapter 3, 'Transition activities'). This in-person meeting is an essential foundation for future success, as the meeting attendees will discuss in detail the deliverables and milestones and agree up front on exactly what they are. Milestones should be discrete and measurable and not aspirational. Language such as 'will try to' or 'the ambition is to', which is often seen, is not appropriate for a milestone. This is the only way that later assessment of progress can be made.

At this point in negotiations, the EIC should allow the PM the flexibility to adjust (up or down) the budget assigned to various activities. It should also be noted that the milestones should include both technological and transition-related deliverables (see Chapter 3, 'Transition activities', for more details and examples of these).

ACTIVE PORTFOLIO MANAGEMENT – PROJECT LEVEL

Once a project is fully negotiated and the contract has been signed, the project work can begin. Progress is judged by the value that the project adds to the overall portfolio – in the case of an EIC challenge-driven programme, it is judged by how it meets the distinct and measurable objectives, but also the 'fit' of the solution that is being developed and its broader contribution to science and technology (in Europe and worldwide).

The PIs should submit quarterly written updates on their progress to the PM and the projects officers (POs). The PM will interact as needed with the POs assigned to the projects of her/his portfolio. The PMs should review progress and milestones on a periodic basis, no less than once per quarter. Ideally, at least one of these meetings per year is in person. Being present in the laboratories and facilities of PIs allows for better rapport and also for an understanding to be gained of the true capabilities and capacity of the team. This also enables PMs to have the opportunity to talk to other faculty members, researchers and students and highlight the work of the EIC Pathfinder.

PMs' engagement with each project should not be a check-box exercise. The PMs should be actively working with the PI to understand and help remove issues/gaps. PMs should also be looking out for new discoveries and how they may affect the overall programme. Often, the issues that were not anticipated were the most important. In addition, the T2M team will also provide support to project teams to help them make progress.

After receiving the progress reports, the PMs should rate each project once per quarter using a stoplight chart on the following three parameters: technological progress versus milestones, spend versus budget, and transition versus milestones. This stoplighting, when viewed sequentially across quarters, can help identify whether projects are making progress over time or if a particular area that was going well is starting to slide.

Importantly, deviations from these performance criteria do not automatically mean that a project is not performing; for example, such deviations could occur because there has been a change in the technological direction, but this will still lead to a desirable outcome (e.g. addressing the challenge goals), even though a direction has been taken that is not amenable to the initially anticipated metrics and milestones. In that case, the PM should review the situation and, if a significant change in the metrics and milestones is necessary, the PM can initiate modification of these performance criteria and the project timetable, in coordination with the project's PI. Significant changes that have a programme-wide impact should be documented in the programme approval document (see Chapter 1, 'Programme creation') and approved by the EIC Director.

Note that circumstances external to the project itself could render it obsolete (e.g. new scientific findings or changes in the technological direction for the portfolio due to transition, integration or other reasons). It is part of the PM's responsibilities to anticipate, identify and correct such situations. Again, retasking, rescoping and termination are part of (but not the only) possible actions that the PM can take. The PM needs to balance the tension between hopeful and hopeless when trying to assess a project's possible progress.

Ultimately, if a project cannot meet its performance criteria or if those criteria become obsolete, the PM can recommend that it be terminated (see 'Programme and project termination' section below). The funds remaining from a terminated project should be made available to other projects within the programme's portfolio.

A project may also be making better-than-anticipated progress, or may discover new (additional) promising technological directions that had not been anticipated at the project's start. In such cases, the PMs should be able to reallocate funds within a portfolio, by either shifting funds between projects or tapping into budget reserves to 'top up' projects. The EIC should consider and plan for such budget reserves (which become a powerful management tool for the PM), either at the programme level or at the agency level. In the former case, PMs may be encouraged to set aside a portion of their budget in reserve; in the latter, the EIC Director may do the same and allocate it as circumstances warrant (in response to PM requests and justification). It is also possible to hold reserves at both levels.

The grant contracts should be flexible and allow for the changes noted in this section. In addition, the contracts should ensure that, if the challenge of a challenge-driven programme changes substantially, a project can be reoriented or even terminated. Finally, it is important that the intellectual property rights and knowledge of failed activities gained are secured and can be used by other activities or projects within the programme.

ACTIVE PORTFOLIO MANAGEMENT – PROGRAMME AND AGENCY LEVEL

Within the programmes, all of the projects have to be coordinated and, in the case of challenge-driven programmes, put into the right time frame to achieve the final outcomes. Therefore, PMs have to utilise their programme approval document for challenge-driven programmes as a guide. In addition, PMs for both challenge-driven and thematic-driven programmes should utilise the transition strategy document (see Chapter 3, 'Transition activities') to organise their programme management actions. Both documents should be periodically reviewed by the PM on the basis of the progress made by the individual projects and other programmes. The budget for the programme should also be reviewed on at least an annual basis.

Facilitating interactions between PMs in adjacent programme areas where the learning outcomes from one programme can be helpful to another can also lead to programme and project adjustments. While each PM is focused on their programme, there is benefit in sharing insights between PMs. This responsibility lies with the EIC Director, who should host regular meetings of PMs in specific areas (pandemics, energy, etc.) at which PMs can share their objectives, new ideas, challenges and/or questions. This could be a monthly check-in where PMs give an overview of their programme or pitch a new programme (see Chapter 1, 'Programme creation', on the informal 'vector checks' between the EIC Director and the PMs). Importantly, such meetings may also be where PMs identify and informally discuss projects that could be moved between programmes, such as moving a project from a thematic-driven programme to a challenge-driven programme, or prospective future PMs.

Each programme should have an annual meeting attended by all project PIs and invited guests, including the transition working group (see Chapter 3, 'Transition activities') and other essential stakeholders. These meetings often have presentations (updates of projects, information transfers between invited guests and posters of new projects that were related to this programme area) in addition to one-on-one meetings of each team with the PM to provide an update on progress. Experience from ARPA-E shows that these gatherings are very effective and efficient at getting industry feedback/buy-in, but also in transferring knowledge between programmes. PMs from related programme areas and project officers from other pillars of Horizon Europe should be invited to attend and should perhaps provide a brief status update on their programme. The business and acceleration services of the EIC could co-organise this.

To enable the EIC Director in her/his oversight role, it is important that the tracking of progress and allocating of resources across all programmes happen at the agency level. As previously mentioned, each quarter, the PMs and their teams will submit 'stoplight charts' for each project in their programme portfolio showing the programme's status as

regards milestones, budget and timing. These are then compared with the prior quarter's data in the report so that trends for an individual project and an overall programme can be seen. The agency leadership team meets and reviews the chart and flags questions.

As mentioned in the project level section, the EIC Director should hold funds aside to allow PMs to pitch for 'top-ups'. This can be done in an ad hoc way when a PM recommends additional funding for a project or by having all of the PMs pitch at fixed times to allow the EIC Director to strategically listen to all ideas and allocate additional funds where they would be best used.

PROGRAMME AND PROJECT TERMINATION

Programmes and individual projects may be terminated at any time at the authority of the EIC Director and based on the recommendation of the PM. Such actions are not meant to be taken lightly or exercised frequently, and should be a last resort. Termination may be due to technological or management failures (e.g. an inability to meet metrics and milestones) or because external factors have rendered the continuation of a programme or project irrelevant. It is worth stressing that, unless failure demonstrably occurred by programme management failure, programme or project termination should not reflect badly on the PM or the PI.

Examples of reasons for termination include the following.

- Technological developments by one funded project may obviate the need to pursue a direction by another project.
- Technological or market developments outside the programme (e.g. industry) may address the goals of the programme, rendering it obsolete or unnecessary.
- Impossibility results (from within the programme or by external entities) may suggest that certain goals are unachievable.
- New scientific or other findings may suggest that there are significantly better technological approaches to addressing the challenge, which were neither anticipated by the programme creation nor reflected in the portfolio (i.e. by any of the projects in the programme).

Contracting should be done such that maximal flexibility is retained by the EIC with respect to project and programme termination. However, the disruption to the project teams and the research ecosystem constructed should be taken into consideration; the EIC and the PMs should strive to minimise damage done and ill will induced by such terminations

by demonstrating flexibility (e.g. aligning them with natural and predictable waypoints such as the end of academic semesters/terms or providing a small level of funding for PhD students and postdocs to finish their degree) and managing expectations throughout programme execution (i.e. terminations should not come as a surprise and instead projects should be given as many opportunities to self-correct/recover as possible).

If a PM recommends a termination, the EIC Director should be able to submit a 'non-compliance' letter to the project asking for mitigation plans that, if not met, would lead to termination. Such procedures ensure that the formal authority rests with the EIC Director.

In any case, as the EIC and the PMs must seek to build upon the experience of all programmes, including those terminated, insiders' views pertaining to the latter should be collected with care and organised for transfer to other PMs. Key information regarding the circumstances, warning signals, paths taken to address the situation, time spent closing a programme, etc., can be important data for other programmes. Constructive reviews to discuss terminated programmes could help objectivise the situation, involving several PMs and the EIC. Importantly, the PM should be asked to comment on contacts and partnerships (status at exit) so that important connections in the ecosystem and goodwill towards the initiative as a whole are retained for future use in any other project or programme.

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In the next chapter, we consider the transition activities with a focus on how PMs should be empowered to develop and accelerate a project's pathway to commercial development.

Recommendations & Guiding Principles

Transition Activities

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TRANSITION ACTIVITIES

SUMMARY OF RECOMMENDATIONS

- **Develop a transition strategy at the programme level**
  The PM should – on the basis of EIC Pathfinder-aligned processes – be in charge of developing, at the programme level, a transition strategy with discrete objectives and measurable milestones during the programme creation phase. These documents should be reviewed and updated at least annually. Systemic gaps identified in the transition strategy, such as regulatory barriers or a lack of appropriate pilot facilities across the EU, should be addressed by the PM and the EIC during the programme to accelerate the transition paths for all projects.

- **Establish a transition plan at the project level and allocate 5–10 % of the total grant to transition activities**
  The goal of the PM with each project should be to focus on the continuity of transition activities that run throughout the project lifetime and on gaining different perspectives on how the market opportunities develop and the team's performance to handle the challenges and opportunities. This integrated view of each project (with both technology development and early commercial transition activities forming integral parts of the project) enables the PM to connect support activities to the objectives and vision of the project. To this end, all projects should establish a transition plan and incorporate milestones related to that plan into their overall project plan at the start of the project. The funding to deliver on the transition plan/milestones should be included as part of the overall project budget plan and we recommend a target allocation of 5–10 % of the total grant. The teams should be eligible to apply for additional funding increments of EUR 50 000 to support extra transition activities as they gain transition momentum during the project time period.

- **Create a T2M team and establish EIC fellowships**
  Ultimately, success in transitioning projects comes down to people and how they work together to anticipate transition, share knowledge and networks, and remove barriers in a timely manner to accelerate projects from laboratory invention to market impact. The EIC should empower the PM to plan and deliver on the transition activities outlined in the previous recommendations. However, owing to both bandwidth and expertise, additional support should also be engaged. We recommend that the EIC agency creates a T2M team with limited term assignments to deliver key elements of transition planning such as building programme-level ecosystem engagement plans, managing transition working groups (see below) and working with project teams on their individual transition plans. Finally, we recommend that the EIC creates an EIC

fellowship to engage post-graduates to work with both the PM and the T2M team on key transition elements (ranging from techno-economic analyses to supply chain maps to market/customer understanding).

- **Create an innovation ecosystem engagement plan and transition working groups**
  Early and continuous engagement with Europe's innovation ecosystems should be used for benchmarking, gathering early interest from specialised risk capital providers, accessing technical expertise, testing market needs and potential take-up, assessing the possibility of creating a new market and validating projects' impacts. To this end, we recommend that transition working groups be formed at the programme level, made up of committed individuals from different stakeholders in Europe's innovation ecosystems, to give advice on the transition to the market of the programme portfolio and its projects. An innovation ecosystem engagement plan, forming an integral part of the transition strategy, should be developed by the PM and the T2M team to lay the groundwork for ecosystem engagement.

- **Create an EIC deep-tech training programme and a dynamic customer relationship management system**
  The above recommendations on planning and executing transition activities at both the programme and the project levels require robust tools and tailored training. A well-designed, easy-to-use and dynamic CRM system should be developed by the EIC that addresses the needs of the PM, PI and EIC. We also recommend that an EIC deep-tech training programme be created to support a new generation of deep-tech entrepreneurs in Europe. The programme should be tailored to the high ambitions of the EIC and thus be based on best practice from Europe and internationally. In addition, an annual EIC emerging technology summit should be held for investors and corporates to highlight Pathfinder projects and portfolios.

INTRODUCTION

The transition activities subgroup has been tasked with providing recommendations on how the PM could be empowered to develop and accelerate the pathway to commercial development, notably by connecting with investor communities, large corporations, other suitable European Commission calls and public procurement in Europe's innovation ecosystems from the early stages of the innovation process. The subgroup has also provided advice on new tools and training that would facilitate the transition of the projects with a focus on the team/company (technology protection strategies, modes of transition, types of agreements, development time and cost, etc.) and the market (preparation/creation of the market prior to the arrival of the product or service, competition, end-user needs, etc.). The group has considered recommendations for projects that are a part of challenge-driven programmes and thematic-driven programmes.

This document provides recommendations and guiding principles on transition activities for the EIC Pathfinder, which seeks to foster disruptive innovation towards advancing the social, economic and scientific status of Europe. We urge the EIC to remain a learning organisation and expand on these ideas based on experience within the EIC Pathfinder.

GUIDING PRINCIPLES

Successful, impactful innovation is, ultimately, the result of making big bets on high-risk/high-impact approaches and then successfully addressing **risk reduction** (real and perceived) across a number of areas, including technology risk, product risk, market/regulatory risks, supply chain risk and organisational risk. This effort is not one-sided, namely whereby the PI simply acts independently and develops a fully formed innovation alone. Instead, this is an **iterative** learning process with feedback and further development, pivots and combinations of new ideas in a continuous engagement with key stakeholders in Europe's innovation ecosystems. **Leveraging** a portfolio of projects and planning for transition from an early stage facilitates engagement of the ecosystem even when stakeholders may not yet truly believe in the vision or the individual projects. Then, as people and results and ideas continue to collide, unexpected results happen, learning and trust develop and the 'impossible' becomes not only 'plausible' but ultimately 'inevitable'. Consequently, the guiding principles for transition activities in the EIC Pathfinder can be summarised as follows.

- **Risk reduction from the beginning**
  The failure of projects to enter the market is often the result of transition activities and planning getting done too late and in a pro forma manner. Transition activities and planning must be an essential part of the project from the beginning.

- **Impact by leveraging at the programme level**
  By taking responsibility for transition activities at the programme level (e.g. regulatory barriers that exist for a group of technologies to enter the market), more projects are able to transition and make a difference in the world.

- **Continuously learn and engage the innovation ecosystems**
  Transition towards the market is not a linear process, but a process of iterative learning and continuously engaging key stakeholders and relevant expertise in Europe's innovation ecosystems to gather early interest from risk capital providers, access technological expertise, and test market needs and potential take-up.

TRANSITION ACTIVITIES AT THE PROGRAMME LEVEL

The transition of an idea into a practice with a real impact in the world is generally a low-yield process. There are many reasons for this beyond the lack of technological progress. Often, the technology is not a complete solution in and of itself and needs system-level integration, but this is not taken into account early enough to make simple changes to the design and testing (see also Chapter 1, 'Programme creation', on how this has an impact on programme design). In other cases, the impact of regulations is not fully understood and incorporated into plans and timelines. Even more often, the cost modelling for the technology does not take into account all of the relevant parameters, including requirements to scale. In addition, project teams often lack appropriate awareness of market parameters affecting their product acceptance and also the connections to gain that insight. Every one of these challenges could be addressed with timely and effective transition planning.

When considering how to substantially improve the yield and accelerate the time to gain impact, it is essential to evaluate where and how the greatest leverage can be generated. The usual approach to innovation has been one innovator, one project at a time, but this approach does not provide much leverage at all. Given the EIC's ambition to tackle challenges such as climate change, it is essential to plan and execute both project- and programme-level transitions. Transition activities at the project level aim to address the market and needs corresponding to one or several 'pieces' of the value chain, while transition activities at the programme level aim to address the whole value chain. Addressing systemic challenges such as regulations and specifications in a timely manner at the programme level can allow individual project teams to move faster.

Transition activities must address the needs of projects in both types of programmes (challenge-driven and thematic-driven) and must also support the different possible exits from the Pathfinder. 'Transition activities' cover a wide range, starting, in the case of PM-inspired challenge-driven programmes, from the creation of the vision of the outcome being targeted. For both challenge-driven and thematic-driven programmes, transition activities involve high-level scoping and engaging the right people in Europe's innovation ecosystems to assist the innovators and projects in the portfolio, as well as designing and implementing the tools and training needed over time by each project team to understand the requirements and take action to move their ideas towards impactful solutions and/or products.

The purpose of transition activities within the context of the EIC Pathfinder is primarily to transition a technology to a position from which it could mature further. This can be done through transitioning a team, a company (only if a functional management team has been created), a share in a company, intellectual property rights, a product, a knowledge set or a skill in a joint research collaboration programme with a specific company.

Thus, different transition routes are available, for example the following.

- A company can be created in the end phase of the EIC Pathfinder and apply for the Accelerator/venture capitalist/other joint venture financing or is acquired by an existing company in the field, with the purpose of further developing the technology.
- The intellectual property rights that are a result of the EIC Pathfinder are licensed or sold to a company with prior experience in the field.
- A partner company from the Pathfinder programme (or a different one) licenses or buys in the intellectual property rights and continues with the commercialisation process.

It is also possible, however, that after analysis of the project data and commercial options, a team may conclude that there is no transition path forward at this time and the best option is to share the knowledge via papers, patents and/or presentations, as appropriate.

TRANSITION STRATEGY

Programme-level transition activities require the PM, with the support of the EIC team, to look beyond any legacy boundaries between networks, both within and outside governments, to embrace a holistic look at the problem they wish to solve and identify and engage those who need to be involved in the ultimate solution, right through to scale and deployment. This is challenging task and can take significant thought and work, but if it can be achieved the outcomes should be significant. Widening the responsibility of the EIC to embrace a focus on transition activities at the programme level should enable more projects to transition and, ultimately, make a difference in the world.

For a challenge-driven programme, a successful transition requires the development of an overall vision (requirements, outcomes, etc.), beyond just the science, and includes where, how and why that invention will make an impact. Three of the EIC programme questions (detailed within Chapter 1, 'Programme creation') speak directly to transition activities: (1) What are you trying to do and who cares if you are successful? (2) What will be the impact of the programme? How will the programme contribute to solving EU and EIC key priorities (such as climate change), in measurable terms? (3) What are the scenarios for transition activities and the barriers to commercialisation that must be overcome? For a thematic-driven programme, the projects brought together in a portfolio will not only be at different stages of development and at technological readiness levels (like in a challenge-driven programme), but also probably have a smaller overlap of networks and market needs to address than in challenge-driven programmes. That being said, the approach to transition activities at the programme level is appropriate for both types of programmes.

The PM will deliver **for both types of programmes** an overarching high-level transition strategy stemming from an observed market need/pain point, including potential markets, technological valorisation, funding and/or regulatory barriers/challenges. Key for success is highlighting **system-level** challenges and opportunities for leveraged changes that will accelerate market adoption.

The transition strategy must include an understanding of the state of the art within products used in the market today at the level of 'value', answering the following questions: What is the current cost/performance in the marketplace? Why is that the case? What would it take for the market to adopt a different approach? What does 'better' look like and why would the market consider it 'better'? The strategy process should also include an expression of needs from companies, sectors, etc. To 'build' this expression of needs, officers from the business acceleration services and specialised consultants or teams can support the PM (see the section 'People and Organisation' and our recommendation to create a Technology-2-Market team). The outcome can be new technologies or new products/services, but it has to provide a solution for the 'needs'. The PM can also provide specific use cases in order to foster direct applications coming from the programme and foster integration to progress from technologies to products/services.

The PM also has to anticipate possible transition scenarios regarding a programme's outcome, such as technological transfer to industrial partners, start-up creation, etc. The transition strategy is regularly updated during the programme with internal (especially coming from active portfolio management) or external inputs. Note that these transition plans may even entail highlighting that specific infrastructure – such as a new network of demonstration facilities, a new type of accelerator or other support environment networks – should exist across parts of the EU or that a regulatory barrier should be tackled at the European Commission level.

Using a regulatory barrier as an example, in many technology areas there are quite specific regulations defining operations of the sector. In some cases, the solutions envisaged by the PM in a challenge-driven portfolio may contrast with the way the regulations are currently worded – for example, many standards for biofuels are written to cover plant-derived solutions. If a new solution such as microbes might be used to generate the fuel, then some of these standards may need to be modified to allow the new ideas to be adopted. This type of regulatory challenge should be taken up at a higher level than each individual project and could involve the EIC helping to assemble a consortium of PIs with regulators and other industry groups to discuss and resolve new wording well before any specific project matures to need market entry. Actions such as these could save years in the development of new solutions. Outcome-based regulations are usually most flexible, as they allow new solutions to develop in the future.

A commitment from innovation ecosystems is also essential and the PM will seek a buy-in from these communities. As part of the transition strategy, each programme should also establish an **innovation ecosystem engagement plan** (see the 'Innovation ecosystem recommendations' below). Therefore, industrial networks (which can be, for example, potential customers of new products and services and venture capital (funding for start-ups)) have to be strongly involved in the development of the initial transition strategy. To this end, we recommend setting up a specific group (with representatives of these ecosystems) that can provide advice to the PM regarding transition activities at the programme level (see the section on 'Engaging Europe's innovation ecosystems' below for a discussion of transition working groups).

One of the barriers for cooperation between project teams and even among members of a single project team relates to intellectual property. Despite the contract terms on intellectual property in an EU contract, often teams have not agreed on their intellectual property plan at the start of a project, namely before anyone has invented anything, and then there are delays and disagreements about how this should be managed. For the Pathfinder, we recommend that the PM sets up some principles or guidelines for intellectual property and management at the programme level (e.g. time-limited free cross-licensing between the projects). The principles should be suggested by the PM, but discussed with and accepted by all projects related to the programme before the actual start of the programme. These guidelines of course have to be in line with and support single project valorisation schemes, but must also allow cooperation between projects. For an overview of programme-level transition activities, see Figure 6.

***Figure 6**. Transition activities under the Pathfinder at the programme level.*

TRANSITION TOOLS

Well-designed tools are essential to allow a PM to efficiently and effectively monitor and guide their portfolio of projects for successful transition. **The foundation for this should be a robust CRM system that organises and leverages information within and across programmes and projects.** To benefit transition, the CRM system should contain not only basic details for each project but also commercially relevant

data such as on the development stage (technological readiness level can be a proxy for early projects), transition milestones and a short summary appropriate for ecosystem sharing. The system should be set up to facilitate project management, to enable project comparisons across most input fields, and to categorise the individual projects by subject and their potential impact on the relevant markets[13].

It is crucial that the Pathfinder CRM system has the capability to act as a reporting tool that makes automated exports of data in different formats to make the production of the necessary marketing documents more dynamic and to allow for updates throughout the progress of the project/programme. An example of an output would be a simple 'one pager' report for each programme summarising the objective, the impact and the transition plan and listing all of the projects/teams engaged. In addition, the same CRM system should be able to produce a market-focused 'one pager' report for each project summarising the objective, approach, team, potential impact on the relevant market and transition assistance/partners needed, etc., with contact information of the PI(s).

Another important tool for PMs is being able to access to databases and elements of the CRM system to connect projects to (1) investor communities, (2) large corporations and (3) public procurement. Ideally, much of this information would be accessed from existing databases (commercial or government) to ensure that information remains current. Some potentially relevant sources would be sector-related companies, namely a dynamic, vetted list of registered venture capitalist and angel companies in Europe (and possibly in the United States), and the Enterprise Europe Network expert database.

PROGRAMME TRANSITION RECOMMENDATIONS

- Each programme should have a **transition strategy** developed by the PM at the beginning of the programme and reviewed at least annually. Key for success is highlighting system-level challenges and opportunities for leveraged changes that will accelerate market adoption.

- The EIC should create a **robust CRM system** that organises and leverages information within and across programmes and projects.

TRANSITION ACTIVITIES AT THE PROJECT LEVEL

It is often the problem that projects end up planning for transition activities too late in the project phase (typically in the final 3 to 6 months) or simply keep driving research activities even though the project should begin testing for industrial use cases. Even for promising projects, there are too many examples of the PI and the project team turning

[13] The CRM should be linked with the idea of creating an EIC Marketplace for IP.

their attention towards the next funding opportunity when the project is nearing its end. The problem with this approach is deeper in the sense that it also deprives the PI of the insights that come from the early transition activities, including market intelligence, external resources for team development and to explore the market opportunities, first customer insights, testing of market hypotheses, etc.

Perhaps in an overly critical tone, the failures of many past EU projects to enter the market are the result of transition activities planning being done too late and in a pro forma manner. Single (long) documents to cater for the project owner at a certain given time gives a 'snapshot', but this contrasts with continuous transition activities that run throughout the project lifetime, giving the PM a 'movie' perspective of the project, of how the market opportunities develop and of how the team handles the challenges and opportunities. It is critical that the PM has the ability to have this integrated view of the project, with both technology development and commercialisation progress forming integral, dynamic parts of the project. This view enables the PM to connect support activities with a 'purpose', namely the ultimate impact on the world.

A key element at the project level is that transition activities planning starts from the onset of the project and there is a governance structure to support continuous and efficient efforts for the transition. The project journey must be a collaborative and multitasking path overviewed by a PM and owned by the PI. The journey starts from the first meeting between the PM and the PI (before approval of the project into the programme) and ends when the project achieving the ultimate objectives agreed with the PM. Note that, in some cases, these objectives may be identical to those agreed at the start of the project. However, in other cases, the objectives may change as learning outcomes about both technology and market are explored and more fully understood.

TRANSITION PLANNING AND EXECUTION

Transition planning is an ongoing and iterative process that actually begins when a project is selected to be part of the Pathfinder. When a project is first selected to be part of a challenge-driven programme, or once it is selected for a thematic-driven programme, the project team should, with help from market knowledgeable resources, create a **preliminary transition plan**. This initial plan should be informed by the scope of what the project was selected to do and how it fits into the overall programme, where appropriate. This transition plan should have a draft timeline and milestones and should be refined as the project moves forwards. Regular reviews of the initial transition plan should continue throughout the lifetime of the project, cover any key milestones and include updates on programme supporters/ stakeholders engaged[14].

[14] On the simultaneous pursuit of discovery and invention, see, for example, Goldstein, A.P., and Venkatesh, N., 'Simultaneous Pursuit of Discovery and Invention in the US Department of Energy', Research Policy, Vol. 47. No 8, 2018.

This work will be new and unfamiliar for many teams so substantial support should expect to be provided. For an overview of transition activities at the project level, see Figure 7.

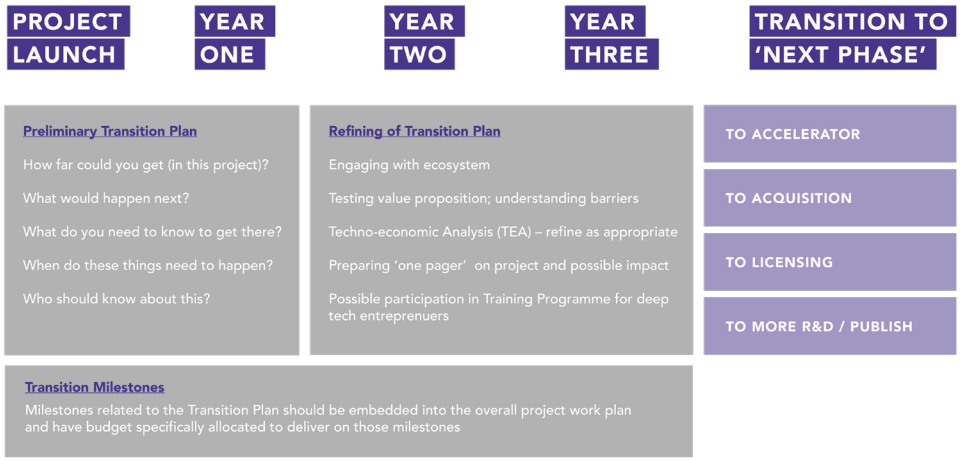

Figure 7. *Transition activities under the Pathfinder at the project level*

PRELIMINARY TRANSITION PLAN FORMATION

For many Pathfinder projects the project team will be in the very earliest phase of the project, which of course should be taken into account. To drive focus on the final transitioning of the project even at this early stage, the team should at this point ask themselves questions such as the following and capture this in the plan document along with appropriate milestones.

- How far can we get in this project?
- What would happen next?
- What do we need to know to get there, for example value chain analysis, techno-economic analysis or an intellectual property plan?
- When do these things need to happen?
- Who should know about this?

As the maturity of the project progresses, the transition plan should intensify and be refined. This is supplemented by identifying an engaging ecosystem, testing the value proposition and understanding possible barriers, refining the techno-economic analysis, enhancing the intellectual property strategy and preparing a

'one pager' on the project and its possible impact. All of the above activities are basically to push the PI and the team to think about the following questions: What happens at the end of this grant? What do I do now to make sure this technology will come to market?

Depending on how far a project will progress in the Pathfinder, the transition activities will intensify, such as through identifying trusted advisors, increased ecosystem engagement or potentially obtaining letters of intent from commercial partners. Really advanced Pathfinder projects that have targeted company formation for transition may begin to engage external advisors with the aim being to incorporate a company or plan for licensing to outsiders.

To drive thoughtfulness and action on transition, appropriate milestones should be established in the team's project plan from the beginning of the project (see the example in Table 1). While these milestones should be tailored to each project, there are certain important areas that should be given thought and for which appropriate milestones should be set: intellectual property, commercialisation readiness, manufacturing and scalability, next stage funding and team development. These milestones will be set up and approved by the PM and reviewed as part of normal project reviews. There are many resources to guide teams in asking appropriate questions to set up their transition milestones. One resource is the milestones template[15] put together by ARPA-E.

Transition activities, as an essential component of project success, should not be neglected when planning overall budgets for a project. It is essential to empower each PI by means of the established milestones and funding from the original grant to allow them to deliver on their transition activities. For example, ARPA-E's authorising legislation[16] requires that 5 % of the federal grant funding be used for technology transition and outreach activities. **We recommend that, initially, 5–10 % of the total project funds be specifically allocated to transition activities and that this be detailed in the budget documentation.** In addition, to provide flexibility for teams that identify additional ways of accelerating transition during the project, **we recommend that teams be able to access increments of up to EUR 50 000 when approved by the PM**. The EIC funding will then be quite progressive in that there will be core elements within the grant (the 5–10 %), but it will also allow for teams that gain momentum with market transition to access supplemental support. Guidelines about how to apply for the additional funding and what it can be used for should be determined. Over time, the EIC Pathfinder should capture data on uses of transition funding by teams and update the guidance based on the learning outcomes.

[15] Available on ARPA-E's website: https://arpa-e.energy.gov/technologies/tech-to-market/milestones
[16] See ARPA-E's web page on authorisation: https://arpa-e.energy.gov/about/authorization

MILESTONE	TIMING	RESPONSIBILITY
Initial transition plan and milestones completed and approved by the PM	Month 2	PI
Primary responsibility assigned for coordinating and completing T2M activities	Month 3	PI
Plan for securing intellectual property presented to the PM (background intellectual property, intellectual property agreement with partners, etc.)	Month 3	PI
Market knowledge compiled and presented to the PM	Month 6	Team member responsible for T2M activities
Preliminary cost model developed	Month 12	PI (may be delegated)
Initial product hypotheses presented to the PM	Month 18	PI and team
Product hypotheses tested through direct conversations with ecosystem (companies, funders, regulators)	Month 21	Team member responsible for T2M activities
Cost-performance model presented to the PM (which will be refined as new technological data become available)	Month 27	PI
Apply to the Accelerator and identify additional EU funding sources for commercialisation	Month 30	PI
Incorporate NewCo	Month 33	NewCo CEO
End of Pathfinder grant	Month 36	PI
Enter the Accelerator	Month 37+	NewCo CEO

Notes: A project team has just received its Pathfinder grant. After working through their initial transition plan, the team members believe that they can develop their technology to the point that they could launch a company and enter the Accelerator. The team sits down in the second month of the grant to put together the major milestones that must be met during the 3-year (36-month) contract term to reach this goal. The team starts this work by 'thinking from the end' and asking 'what do we have to do to be ready at the end of the grant?'. The first milestone the team sets is 'acceptance to the Accelerator'. The PI, the PM and the team member responsible for T2M activities then work backwards from there to draft the milestones in this table, which will continue to be refined and modified as the team learns from the undertaking of its transition activities.

TOOLS AND TRAINING FOR PIS/PROJECT TEAMS

All of the resources available for project teams should be viewed as part of a toolbox. The team should understand when certain tools, templates, training and activities are useful in their project evolution and potential transition pathway and use them accordingly. The T2M team (see the 'People and organisation' section below) can provide specific guidance at the programme level, including development of techno-economic analyses. In addition, existing resources available to the EIC such as the European Commission's business acceleration services[17] can be tapped to provide the project teams with the commercial information and coaching required to deliver specific transition milestones.

Modelling the cost and performance of a particular solution is a critical exercise for everyone interested in developing impactful technologies. This type of analysis not only forces a team to understand the key cost elements of the technology (bill of material) and the manufacturing requirements, but also brings in competitive elements such as the state of the art and its trajectory. Doing this type of analysis provides teams with the insights needed to ensure that they attack the right problem, keep track of competitive developments, and understand system costs and sensitivities. A techno-economic analysis usually begins as a simple cost model and rough market understanding and is refined and developed over time as both the technology and the market understanding progress. Part of the work of the PM and the T2M team will be to develop the parameters for programme-level techno-economic analyses and work with individual teams to modify them for their use.

Tools

Well-designed tools and templates are essential to allow a PI and the project team to efficiently and effectively monitor and guide their portfolio of projects for successful transition. The CRM system discussed for PMs/programmes should allow project PIs to input and update key information on each project, making it easy for transition partners to understand the project. In addition, the reporting part of this same system would make it easy for PIs to generate simple one-page reports to share progress with potential partners.

One of the more helpful elements that the EIC can provide for project teams to facilitate their successful transition are easy-to-use templates for essential activities. Some of the templates that should be available and used at early stages of the project, namely before a transition pathway is identified, include (1) a preliminary transition plan template, guiding project teams on how to think about transition and how it can then be tailored by individual teams; (2) techno-economic analysis models, as, often, a high-level model can provide a solid starting point that leverages system-level knowledge and assumptions – part of the work of the PM and the T2M team will be to develop the parameters for programme-level techno-economic analyses and then work with individual teams to modify for their use; (3) a basic legal support tool for creating a simple but case-specific

[17] See the Executive Agency for Small and Medium-sized Enterprises's web page on business acceleration services: https://ec.europa.eu/easme/en/tags/business-acceleration-services

contract (a joint research agreement, sponsor agreement, development collaboration, etc.); and (4) a set of simple contracts/agreements to work with companies. In addition, there should be templates available for use at later stages of a project, namely when a transition pathway is identified, including those for licensing (a negotiation plan and draft term sheet) and for the creation of a spinout (a template for setting up a memorandum of understanding, examples and tools for how to set the cap table, an elevator pitch template, guidelines for how to conduct an advisory board meeting, etc.).

ARPA-E has done extensive work developing templates and guidelines for transitions[18]. Templates designed specifically for use by the Pathfinder project teams will be developed later this year. To save valuable time during the early stages of technology development, it is useful to have a set of simple agreements to work with companies. A discussion of some of the challenges faced in negotiations, along with two simple templates that can be useful for reaching more rapid agreement between a start-up and larger company, can be found online[19].

Training – creating a generation of deep-tech entrepreneurs

For the EIC to be successful, it must take responsibility for creating a new generation of academic deep-tech entrepreneurs in Europe. In short, the EIC must take responsibility for not only developing technologies in a hands-on way, but also developing the human talent, the academic entrepreneurs, that can bring the technologies to the market. We therefore recommend the creation of an EIC deep-tech training programme as a part of the transition activities targeted at the specific challenges of bringing deep tech to the market.

To this end, we recommend that the EIC take stock of the current best practices in Europe and internationally and, against this background, develop content for the EIC deep-tech training programme. The ambition of the programme should be to become the gold standard in training academic deep-tech entrepreneurs in Europe.

Key design elements of the training programme

- The 'core curriculum' of the programme should be developed together with leading European and international universities, corporations and risk capital companies and should focus on the key challenges of deep-tech entrepreneurs.
- The programme should be scalable and embedded in Europe's innovation ecosystems.
- The programme should be flexible, extending over time to allow the participants (such as the PI) to undertake peer learning and build personal, intimate networks.
- The programme should focus not only on the hard competencies (intellectual property rights strategies, financing sources in different growth phases, governance, customer discovery, etc.), but also on so-called soft competencies, such as developing life skills as an entrepreneur and leadership styles.

[18] Available on ARPA-E's website: https://arpa-e.energy.gov/technologies/tech-to-market/planning
[19] Available at https://www.activate.org/sipa

Project transition recommendations

- Projects should **develop initial transition plans** at the very beginning of the project (instead of in the final 3–6 months of the project period).

- Each team's project plan should contain appropriate **milestones** that are consistent with their transition plan; these milestones should be approved and evaluated during project reviews by the PM in the same way that the technological milestones are. A member of the T2M team should provide guidance to the PI in appropriate early transition planning and should aid in the sharing of tools/training appropriate for each team.

- **Of the total project funds, 5–10 % should be allocated to transition activities.** In addition, projects should have **access to increments of up to EUR 50 000 when approved by the PM** to accelerate transition during the duration of the project.

- To support a new generation of academic deep-tech entrepreneurs in Europe, an **EIC deep-tech training programme** should be created.

Engaging Europe's innovation ecosystems

For the EIC Pathfinder, the ability to effectively access and use the diverse innovation ecosystems across Europe is an essential element of transition activities at both the programme level and the project level. Engagement with the ecosystems should be used for a variety of transition elements including benchmarking, gathering early interest from specialised risk capital providers, accessing technological expertise, accessing research infrastructure, testing market needs and potential take-up, and validating projects' impacts. In short, there should be engagement with the key stakeholders of innovation ecosystems, namely private corporations, risk capital providers, universities, entrepreneurs and government.

Transition working groups

One of the most critical skills for the PM is the ability to engage with stakeholders across technology, business and government networks and speak about the programme in a way that allows each to understand the vision. It can also be important for the PM to engage with stakeholders beyond traditional regional/national ecosystems, and perhaps even have an international track record. However, since PMs will be engaged for only a few years, relationships with key stakeholder groups/ecosystems must be maintained in some other way. The existing EIC staff are viewed as the ones maintaining these relationships, but this should be tested to ensure that these are maintained over time.

However, establishing and engaging with stakeholders in the ecosystems is difficult and can be the reason for failures in moving technologies to market.

Thoughtful and early engagement is essential to avoid situations in which, when key stakeholders (such as risk capital providers) are needed, it feels too long since they have heard from the PM, about her/his programme(s) and/or about the latest developments at EIC.

In addition, in many cases, the PM will need to forge a new set of connections to support the specific programme objectives and desired outcomes. The PM will essentially be creating a tailored group of committed individuals from key stakeholders from several ecosystems owing to the fragmented nature of Europe's ecosystems. In doing so, the PM should recognise that the programme objectives may correspond to only a small number of any of the given innovation ecosystem interests and tailor his/her engagement accordingly. Care also needs to be taken by a PM to recognise that silos develop over time within networks and that efforts need to be made to break through those barriers. All in all, to facilitate the transition towards the market, the PM will often have to act as a broker between different stakeholders in different ecosystems across Europe and thus play a significant role in defragmenting Europe's innovation ecosystems.

Moving from initial ecosystem engagement to transition success requires both planning and a focus on building trust and relationships. For this, the PM should first establish an **innovation ecosystem engagement plan for their programme(s)**, which will be an integral part of the transition strategy. Establishing this plan should involve asking questions about how the proposed solution would get to scale and what is necessary (at a high level) to get there. This will entail listing key ecosystems to support the next phases of scale (accelerators, pilot facilities, investors, etc.) and capturing the supply/value chains that would ultimately need to be engaged and how they would interact. The analysis would also include looking at each of these versus their current state and assessing whether there are gaps (fragmentations) or whether some participants will need to engage with each other in different ways. The output of the analysis would be an engagement plan that identifies which, how and when certain ecosystem members should be engaged and sets out a first draft of an approach to this. This plan will be refined over time.

Having the analysis and the plan, however, is only the first step. The PM and the programme itself require structured and consistent feedback from ecosystem stakeholders. This can be achieved through the formation of transition working groups at the programme level, made up of committed individuals from different stakeholders in Europe's innovation ecosystems, which will give advice on the transition to the market of the programme and its projects. This should be seen as a targeted measure at the programme level to close fragmentation in Europe's innovation ecosystem and underline the interaction between the EIC and the Member States.

Depending on the programme, a series of engagements with the transition working group should be planned with the aim of sharing results from a group of projects, as many are in the early stages and very risky. As time goes on, the PM can plan for more focused interactions with individual projects and the transition working group. Transparency will be essential to mobilise and generate goodwill and interest for the programmes; it is important to go beyond just reporting and ensure that ecosystems are proactively being engaged. A focus on sharing stories, data and results – the good as well as the failures – is essential. One essential point is that it is really important to work to change the language of 'failures', focusing on new learning opportunities and highlighting these alongside the successes.

Coordination of transition activities with national and/or regional activities

The acceleration of ideas into a practice with a real impact will be facilitated by leverage of national or regional activities. Well-facilitated coordination can provide a number of benefits including (1) market intelligence/a good grasp of the European state of the art, information about complementary initiatives and successes in the making, good practices, lessons learnt, etc.; (2) building trust among authorities; (3) reaching out to the parts of Europe that are less involved in EU programmes; (4) building the pan-European community for innovation around more projects; and (5) access to more resources – laboratories, people and partners.

The expert group suggests that the benefits of cooperation are large enough to justify a set of activities organised by the EIC to stimulate this cooperation in an organised fashion and taking a multiannual view. Some suggestions include ensuring the onboarding programme for the PM, including a tour of relevant national and regional sites, meetings with peers who she/he does not work with (yet) and using appropriate programme committees to enable EIC PMs to engage with national partners around specific requests, feedback, discussions around appropriate top-down topics and important challenges.

Events/activities

Essential to successful transition is the engagement of the relevant networks with Pathfinder PMs and project teams. While much can be done with digital efforts (websites, one-page summaries, etc.), ensuring that connections are made through existing or specialised events is critical. The Enterprise Europe Network rolling plan and calendar can be useful for PMs to guide their project teams. The calendar can provide transparent information on events and data available throughout Europe to ensure that the PIs are aware of the full spectrum of opportunities that the EU offers.

In addition, we recommend creating an annual **EIC emerging technology summit** for investors and/or corporates to highlight Pathfinder programmes and projects and allow them to meet representatives of the funded projects organised by the EIC. This event would allow the EIC to highlight not only the projects but also the philosophy, approach and traction of the approach of the Pathfinder.

Innovation ecosystem recommendations

- The PM should establish an **innovation ecosystem engagement plan for their programme(s)**, which will be an integral part of the transition strategy.

- **Transition working groups should be established** at the programme level and be composed of committed individuals from different stakeholders in Europe's innovation ecosystems to give advice on the transition to the market of the portfolio and its projects.

- An annual **EIC emerging technology summit** should be set up.

METRICS FOR TRANSITION ACTIVITIES – MEASURE WHAT MATTERS

Ultimately, the success of any programme or project and of the EIC's efforts overall will be measured by their impact on the world. However, intermediate metrics are necessary to assess progress towards that ultimate goal. If we think about the path to market as a series of handoffs through which projects and portfolios progress to a point where a new evaluation of potential is conducted and investment is made, then we can use two measures of 'handoffs' in the short to medium term. One of these is the 'handoffs' themselves, namely the success in moving to the next stage of development of projects within a programme. The other is how much funding is associated with moving to these 'follow-on' stages.

Over time, tracking a defined group of measures across the projects and portfolios will be helpful in tracking success, learning and improving upon the processes and practices at the launch of the Pathfinder. It will also be helpful in prioritising EIC-level efforts (i.e. training, engagement with innovation ecosystems, etc.). To begin, however, **metrics should be kept simple and allow for adoption as the Pathfinder evolves**. It is important to measure only what really matters and avoid including measures with little meaning just to be able to 'tick them off' a list.

Further work needs to be done to make recommendations on appropriate measures that may be considered over time. This work will have to take into account that some measures will not be available during the time of a specific grant and the ability to have this information reported to the EIC over time once projects have left the Pathfinder will need to be assessed.

Metrics recommendations

Because projects will have different paths to impact, the measurements used should be **handoff metrics**.

- **Handoffs to the next phase of development:** this metric should include the number and percentage of projects transitioned to the Accelerator, new companies formed, licences issued and intellectual property sold to the industry.

- **Follow-on funding**: this metric should include the funding (in euros) from (1) non-government sources (venture capitalists, corporations, etc.) and (2) government sources (the Accelerator of the EIC, other accelerators, government programmes, etc.).

PEOPLE AND ORGANISATION

As already touched upon in Chapter 1, 'Programme creation', a key element of the PM's role is monitoring the ongoing state of the art for both technology and market adoption. As technology adoption/cost curves change over time, what is considered the 'state of the art' also changes. It is essential that PMs have a good feel for where adjacent or competing technologies and solutions, especially at the system level, are moving, so they are sure that the projects they are sponsoring remain relevant.

The T2M team

While the PM is truly the driver of the programme and needs to ensure that there is a plan for transition, the expertise to do this (with a strong value focus) needs to be ensured. Our recommendation is the formation of a **T2M team** that is internal to the EIC that can bring in expertise on the market to inform programme creation and also have the networks to engage the ecosystem and set up engagement plans. These team members would work closely with the PMs. The T2M team can also coordinate strategic intelligence, comprising foresight and roadmap supervision across all of the EIC.

For the T2M team members, ideally each person has a 3-year contract, with the turnover of team members happening not all at once but gradually, so that the team has internal knowledge and external new eyes all of the time. The EIC could hire one or two people each quarter to stagger terms and overlap people better. Ideally, each person on the T2M team would come from a different market/industry segment so that their knowledge could be leveraged across programmes.

In addition, since PMs and these T2M team members would be temporary government employees, it is best practice to discuss with them, from the beginning, how they want to develop in these roles and actively assess how this can be achieved (e.g. training in public speaking or learning more about venture investing).

EIC fellows

To supplement the skills and experience of the PMs and T2M team, the EIC should **establish EIC fellowships**, which will bring into the agency early-career professionals

on 1- or 2-year assignments to help seed innovative ideas and explore new concepts. The fellows should hold an advanced degree with an academic, corporate or entrepreneurial background and will work on programme creation, modelling for technological or transition activities, or even outreach. The fellows will have their own networks, ideas and enthusiasm, which can inspire the learning environment necessary for the EIC to continue to stay at the cutting edge of innovation. These fellowships will bring additional new insights into the Pathfinder community and, ultimately, develop a network of young highly talented researchers, which will encourage entrepreneurship and applications to the EIC Pathfinder. Over time, the EIC fellows will also form a possible recruitment base for new PMs. The idea for these fellowships is modelled upon the successful ARPA-E fellows programme[20].

People and organisation recommendations

- Ensure that PMs have **competency in and passion about the transition of technologies** to having real impact and have excellent communication skills to allow them to engage programme-relevant networks.

- **Form a T2M team** within the EIC composed of people with commercial expertise and credibility across the multiple sectors needed to address sectors of importance to the EIC.

- Establish **EIC fellowships**.

[20] See the ARPA-E website: https://arpa-e.energy.gov/about/team-directory/fellows

EXPERT GROUP MEMBERS

CHAIR: LARS FRØLUND

Research Director, Massachusetts Institute of Technology (MIT) Innovation Initiative; and visiting scholar, MIT Sloan School of Management

Lars Frølund is the Research Director of MIT Innovation Initiative and a visiting scholar at the MIT Sloan School of Management. His research focuses on the success factors for university–industry partnerships, innovation ecosystems and mission-driven research and innovation agencies such as DARPA. He is the co-editor of the book Strategic Industry–University Partnerships and a co-author of the article 'Developing successful strategic partnerships with universities' published in Sloan Management Review. He is on the board of the Danish Innovation Fund and was a Fulbright Scholar at MIT in 2016/17.

JES BROENG

Entrepreneur and professor, Technical University of Denmark (DTU)

Jes Broeng is a serial high-tech entrepreneur, photonics scientist and professor at DTU. He has a PhD and an MSc from DTU and is the author or co-author of more than 200 publications (including in Science), one textbook and 18 patents (h-index = 44, +10 000 citations). Jes Broeng's research interests include business and leadership areas of entrepreneurship, innovation and technology transfer, and scientific areas of optics, photonics and communications. He has extensive expe-rience in applied research, early high-tech business development, intellectual property rights and licensing, and high-tech sales (the United States, Europe and Asia). Jes Broeng is a co-founder of five start-ups – Crystal Fibre (now NKT Pho-tonics), Norlase, Bifrost Communications, Aqubiq and OSAA Innovation – and he has pioneered a new model for successful university spinouts. He is also a mentor to multiple start-ups and a member of the prestigious Nordic Mentor Network for Entrepreneurship (NOME).

JULIEN CHIARONI

Director, French Innovation Council

Julien Chiaroni has been appointed Director of the Great Challenges (Directeur des Grands Défis) at the French Innovation Council. He was previously Director of Strategy and Programmes at List, the institute for digital and artificial intelligence technologies. He implemented the institute's strategy for artificial intelligence and set up partnerships between research and industry, in particular with regard to the theme of trust in artificial intelligence and its implementation in embedded systems. Before this, he held operational positions at both the scientific level and the management level. From 2008 to 2010, he coordinated the nanoscience and nanotechnology programme at the National Research Agency.

CARSTEN DREHER

Professor, Freie Universität Berlin

Since 2009, Carsten Dreher has been Professor of Innovation Management at Freie Universität Berlin. From 2009 to 2012, he was Director of the Center for Cluster Development at Freie Universität Berlin. Earlier, from 2006 to 2009, Carsten was Professor of Innovation Research and Innovation Management at the University of Flensburg and Syddansk Universitet, Denmark.

EXPERT GROUP MEMBERS *cont.*

FRANZ-WERNER HAAS

CEO, CureVac

Franz-Werner Haas, LLD, LLM, joined CureVac in June 2012. In August 2020, he was appointed as CEO. Prior to his role as CEO, he held the positions of Acting CEO and Chief Operating Officer (COO). In his position as COO, he was responsible for human resources, intellectual property, legal and operations. Before joining CureVac, he was Vice President of Operations and Chief Compliance Officer of SYGNIS Pharma AG, where he was responsible for the execution of mergers and acquisitions and capital market transactions.

Dr Haas started his professional career as an assistant to the management of a privately held holding company, before assuming several management positions in the life science industry, including as Vice President and General Counsel of LION bioscience and General Counsel of Sirona Dental Systems. He studied law at the University of Saarbruecken (Germany), Catholic University of Leuven (Belgium) and the University of Edinburgh (United Kingdom) (LLM).

ANGELOS DENNIS KEROMYTIS

Professor, Georgia Institute of Technology

Angelos Dennis Keromytis is the John H. Weitnauer Technology Transition Endowed Chair Professor and Georgia Research Alliance Eminent Scholar with the School of Electrical and Computer Engineering at Georgia Institute of Technology. He is a Fellow of both the Institute of Electrical and Electronics Engineers (IEEE) and the Association for Computing Machinery (ACM). From July 2013 to July 2014, he was on leave with the National Science Foundation (NSF), where he served as Program Director for the Secure and Trustworthy Cyberspace Program (SaTC). From July 2014 to December 2018, he was on leave with DARPA, where he served as Program Manager with the Information Innovation Oce (I2O). Prior to Georgia Institute of Technology, he was an Associate Professor with Tenure at the Department of Computer Science of Columbia University and Director of the Network Security Laboratory, where he had conducted research into computer and network security since 2001 (when he received his PhD from the University of Pennsylvania). He has over 250 peer-reviewed publications in technical conferences and journals, and has co-authored two books; he is the named co-inventor of 58 issued US patents; he has served as a member in over 100 programme committees and has chaired several conferences in the field; he has co-founded four security start-ups; and has served in a number of advisory workshops for the Department of Defense, the National Science Foundation and various US agencies.

CHERYL MARTIN

Innovation consultant and Founder of Harwich Partners

Cheryl Martin earned her PhD in organic chemistry from MIT. She worked for 20 years with the Rohm and Haas Company, initially as a senior scientist and eventually serving as Corporate Vice President in 2007. She then joined Kleiner, Perkins, Caufield & Byers as an Executive-in-Residence during which time she was also the Acting CEO for Renmatix, a company that converts biomass into cellulosic sugars.

Martin joined the US Department of Energy (DOE) initiative ARPA-E as Deputy Director for Commercialization under the then Director Arun Majumdar. After Majumdar resigned from the DOE, Martin was named Acting Director in his place.

FIONA MURRAY

Associate Dean and professor, MIT

Fiona Murray is the Associate Dean of Innovation at MIT Sloan School of Management, the William Porter (1967) Professor of Entrepreneurship and an associate of the National Bureau of Economic Research. She is also the co-director of MIT's Innovation Initiative. She serves on the British Prime Minister's Council on Science and Technology and was made Commander of the British Empire (CBE) for her services to innovation and entrepreneurship in the United Kingdom. She is an international expert on the transformation of investments in scientific and technical innovation into innovation-based entrepreneurship that drives jobs, wealth creation and regional prosperity. She is particularly interested in new organisational arrangements for the effective commercialisation of science, including public–private partnerships and patient capital/venture philanthropy. In her recent scholarship and writing, Murray has emphasised the ways in which women and under-represented minorities are engaged in the innovation ecosystem, and the ways in which different approaches to evaluating early-stage ideas can overcome the unconscious bias that she has documented in entrepreneurial funding.

EXPERT GROUP MEMBERS *cont.*

MARIE-ELISABETH RUSLING

Independent consultant

Marie-Elisabeth Rusling creates high-impact programmes for businesses to engage with EU decision-makers. She provides consultancy services to businesses and organisations to design and adapt their strategies of influence in the EU sphere. With over 20 years spent in Brussels working in the field of EU affairs and de-fending business, she has extensive contacts in place, in-depth knowledge of the workings of the institutions and the different stakeholders, and a strong track rec-ord in accompanying businesses in their corporate and public affairs.

ŠPELA STRES

Head of the Innovation and Technology Transfer Center, Slovenia

Špela Stres is the Head of the Innovation and Technology Transfer Center for the Jozef Stefan Institute and an invited lecturer at the University of Ljubljana. She used to work as an elementary particle physicist, collaborating internationally with DESY Hamburg and CERN Geneve. Currently, she holds a rank of Research Counselor. She is active in the field of business development and designing the financial support environment for innovation. She was instrumental in setting up 15 spin-out companies in the past ten years. She is a member of the 10-Member Group of the United Nations New York. She is a coordinator of the Enterprise Europe Network. She is a delegate to the CERN KT Forum and KT Forum on Medical Applications. Formerly, she served as Vice President and Board member of ASTP. She served as member of FET Advisory Group and member of the SWAFS Advisory Group for the European Commission. She served as a Board Member of CERN Technology Transfer Network. She holds a PhD in Physics from the University of Ljubljana, a Master's degree of law in the field of intellectual property from the University of Turin, an executive MBA from Cotrugli Business School, and has passed the patent attorney exam.

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The goal of the European Innovation Council (EIC), enshrined in the Horizon Europe 2021–2027 programme, is to position Europe firmly at the forefront of the next wave of breakthrough innovation. This sets out the need for the introduction of proactive management of EIC funding and programme managers (PMs). Drawing on our collective experience of the ARPA model and of innovation policies around the world, we have focused our work on the EIC Pathfinder which supports advanced research on new and emerging technologies and the critical role of PMs. The EIC Accelerator is not considered in this report.

To achieve its goal, we believe that the EIC should become a hands-on innovation agency. In our view, to create the EIC way in the European landscape for supporting breakthrough innovation, the main components are centred on the creation of challenge- and thematic-driven programmes, active portfolio management of funded projects, transition activities that bring new solutions to the market and EIC PMs who bind all of this together into complementary practices.

Research and Innovation policy

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