**Project Portfolio**

**Entreprise name**

City, Country

**Work streams “XXX”, “YYY”, etc. in the strategic value chain**

Table of Content

[1 Project Outline 4](#_Toc34314332)

[1.1 Company Presentation 4](#_Toc34314333)

[1.2 Objectives of the company in the IPCEI in all technical fields it’s involved 4](#_Toc34314334)

[1.3 R&D Projects Before IPCEI 4](#_Toc34314335)

[1.4 Technology and Challenges – R&D&I Activities within IPCEI in all technical fields it’s involved 4](#_Toc34314336)

[1.4.1 State of the art 4](#_Toc34314337)

[1.4.2 Technical hurdles that prevent improvements in the field 5](#_Toc34314338)

[1.4.3 Objectives and technical challenges in the project 5](#_Toc34314339)

[1.5 First Industrial Deployment (FID) 5](#_Toc34314340)

[1.5.1 Purpose of the FID phase 5](#_Toc34314341)

[1.5.2 Technical challenges in the FID phase 6](#_Toc34314342)

[1.5.3 Transition from the FID phase to the mass production / commercialisation phase 6](#_Toc34314343)

[1.5.4 Revenues in the FID phase 6](#_Toc34314344)

[1.6 Environmental, energy or transport projects 6](#_Toc34314345)

[1.6.1 Project’s contribution to the decarbonisation of the energy sector 6](#_Toc34314346)

[1.6.2 Project’s contribution to the European industry’s innovation and global leadership in the green economy 7](#_Toc34314347)

[1.6.3 Project’s contribution to the rolling out of cleaner, cheaper and healthier forms of private and public transport 7](#_Toc34314348)

[1.6.4 Project’s contribution to creating new jobs in the green economy 7](#_Toc34314349)

[1.6.5 Other contributions to sustainable development 7](#_Toc34314350)

[1.7 Contribution to the hydrogen strategic value chain 8](#_Toc34314351)

[1.7.1 Project’s position in the hydrogen strategic value chain 8](#_Toc34314352)

[1.7.2 Contribution to the industrial value chain in France 8](#_Toc34314353)

[1.7.3 Contribution to the industrial value chain in Europe 8](#_Toc34314354)

[1.8 Intellectual Property Rights 8](#_Toc34314355)

[1.8.1 IP management principles 8](#_Toc34314356)

[1.8.2 IP protection principles 8](#_Toc34314357)

[1.8.3 IP exploitation principles 8](#_Toc34314358)

[1.9 Work Plan 8](#_Toc34314359)

[1.10 Investment 9](#_Toc34314360)

[1.10.1 Tools and Equipment 9](#_Toc34314361)

[1.10.2 Construction of Buildings/Laboratory 9](#_Toc34314362)

[2 Budget 10](#_Toc34314363)

[2.1 Eligible Costs 10](#_Toc34314364)

[2.2 State Aid 10](#_Toc34314365)

[3 Spill-over Effects 11](#_Toc34314366)

[3.1 Spill-over by non-protected results diffusion 11](#_Toc34314367)

[3.2 Spill-over by IP protected results diffusion 11](#_Toc34314368)

[3.3 Spill-over in the FID phase 12](#_Toc34314369)

[4 Other positive effect on the market 14](#_Toc34314370)

[4.1 Impact of the Project on Employment and New Investments in Europe 14](#_Toc34314371)

[4.2 Environmental protection and reduction in energy dependence 14](#_Toc34314372)

[4.3 Coordination problems 14](#_Toc34314373)

[4.3.1 Coordination failures between companies and research organizations 14](#_Toc34314374)

[4.3.2 Coordination failures between European research organizations themselves 16](#_Toc34314375)

[4.3.3 Coordination failures between SMEs and industry leaders 16](#_Toc34314376)

[4.3.4 Coordination failures between European clusters 16](#_Toc34314377)

[4.3.5 Coordination failures of a very large-scale R&D project 17](#_Toc34314378)

[4.3.6 Coordination failures associated with contractual incompleteness 17](#_Toc34314379)

[4.4 Market failure: Imperfect and asymmetric information 19](#_Toc34314380)

[4.4.1 Risks affecting the project 19](#_Toc34314381)

[4.4.2 Difficulty to recruit highly qualified personnel 21](#_Toc34314382)

[4.4.3 Strategic independence of supply 22](#_Toc34314383)

[4.5 Adequacy of the state aid instrument 22](#_Toc34314384)

[4.5.1 Appropriateness among alternative policy instruments 22](#_Toc34314385)

[4.5.2 Appropriateness among different State aid instruments 24](#_Toc34314386)

[5 Incentive effect 25](#_Toc34314387)

[5.1 Absence of similar projects 25](#_Toc34314388)

[5.2 Start date of the project 25](#_Toc34314389)

[5.3 Counterfactual scenario 25](#_Toc34314390)

[5.4 Increase in R&D and FID efforts 26](#_Toc34314391)

[6 Elaboration on Terms of the Funding Gap Questionnaire 27](#_Toc34314392)

[6.1 Main hypothesis of the business plan 27](#_Toc34314393)

[6.2 Necessity of state aid 28](#_Toc34314394)

[6.3 Proportionality of state aid 28](#_Toc34314395)

[6.3.1 Firm’s hurdle rate 30](#_Toc34314396)

[6.3.2 Project’s funding gap 30](#_Toc34314397)

[6.3.3 State aid intensity 30](#_Toc34314398)

[6.3.4 State aid cumulation 31](#_Toc34314399)

[6.3.5 Open selection proceeding 31](#_Toc34314400)

[7 Limitation of distortion of competition and trade 32](#_Toc34314401)

[7.1 Market affected by the state aid 32](#_Toc34314402)

[7.1.1 Definition of the relevant market(s) 32](#_Toc34314403)

[7.1.2 Current Industry Sector 32](#_Toc34314404)

[7.1.3 Market Situation / Share today and after IPCEI 33](#_Toc34314405)

[7.2 No strengthening or creation of market power 33](#_Toc34314406)

[7.3 Limiting distortion of dynamic incentives 34](#_Toc34314407)

[7.4 No maintaining of an inefficient market structure 34](#_Toc34314408)

[7.5 No effect on location activities 34](#_Toc34314409)

[8 Annex to the Portfolio 35](#_Toc34314410)

1. Project Outline
   1. Company Presentation

*Please give a brief description of your company and type of company*

**e2 additional recommendations:**

* Don’t use too many words like “number one”, “leader”, “best in the market”, etc.
* Identify existing markets
* Explain R&D strategy
* Don’t use “we” but explicitly mention the company’s name in the whole document
* Identify customer base and their activities
  1. Objectives of the company in the IPCEI in all technical fields it’s involved

*Please give a brief description of the overall objectives of activities in all technical fields you’re involved, linking objectives between technical fields.*

**e2 additional recommendations:**

* List the objectives of the project, from technical, industrial and commercial points of view
* Put weight on innovative aspects (R&D + FID)
* Or put weight on environmental / energy / transports aspects
* Briefly clarify the market intended to be served by the company after the IPCEI in terms of products, potential customers, applications, geographical coverage
* Briefly mention the key potential suppliers impacted by the project
* Briefly describe the impact of the project in terms of CO2 reduction
* Use a table to summarize the information at the end of the section
  1. R&D Projects Before IPCEI

*Description of the R&D-parts which were necessary for the IPCEI project and that were carried out before start of the project (background).*

**e2 additional recommendations:**

* Indicate in which projects (name, dates, partners, objective, funding) the company was involved before the IPCEI in the same scientific and technological fields as well as its role / contribution / main results
* Use a table to summarize the information at the end of the section
  1. Technology and Challenges – R&D&I Activities within IPCEI in all technical fields it’s involved

*For each WP describe the state of art, the technical hurdles, the objective and the technical challenge to solve de technical hurdles.*

* + 1. State of the art

**e2 additional recommendations:**

* For each WP, describe what is the current state of the art as well as the relevant technical KPIs (not costs-related)
* Use a table to summarize the information at the end of the section
  + 1. Technical hurdles that prevent improvements in the field

**e2 additional recommendations:**

* For each WP, specify what technical obstacles the sector encounters that prevent further improvements in the field (current limits of the state of the art)
* Use a table to summarize the information at the end of the section
  + 1. Objectives and technical challenges in the project

**e2 additional recommendations:**

* For each WP, describe in sufficient detail the objectives / innovations that the company aims at in the IPCEI with the associated technical KPIs (the “what?”)
* For each WP, prove that these objectives / innovations have never been met on the market so far (new to the world)
* For each WP, describe in sufficient detail what activities will be carried out to reach the objectives (the “how?”); they have to bring about fundamental novelty in the light of the state of the art
* Note: Please be very specific in this section, sentences of the form: “(performance indicator) will see a (%) rise/drop by (date)”
* Use a table to summarize the information at the end of the section, for example:

|  |  |  |  |
| --- | --- | --- | --- |
|  | **What?** | **KPI** | **How?** |
| WP1 |  |  |  |
| WP2 |  |  |  |
| …… |  |  |  |
| …… |  |  |  |

* 1. First Industrial Deployment (FID)

*For each WP describe the FID investment and linked Opex insisting on the description of beginning of FID (after R&D phases) and the end of FID (before mass production).*

*Cf. FID definition in Guidelines.*

* + 1. Purpose of the FID phase

**e2 additional recommendations:**

* According to the footnote (1) to the annex of the IPCEI Communication, “First industrial deployment refers to the upscaling of pilot facilities, **or** to the first-in-kind equipment and facilities which cover the steps subsequent to the pilot line including the testing phase” (our emphasis); please make your choice in one of the two possibilities
* Explain in detail what the objectives of the FID phase are (the “what?”), provide the start date and the end date
* Explain in detail what activities will be carried out to reach these objectives (the “how?”)
  + 1. Technical challenges in the FID phase

**e2 additional recommendations:**

* According to letter (g) in the annex of the IPCEI Communication, “the industrial deployment [must] follow on from an R&D&I activity and itself contain a very important R&D&I component which constitutes an integral and necessary element for the successful implementation of the project”; prove that the FID phase has a strong R&D content, i.e. explain and quantify as far as possible the RDI efforts needed to overcome the technical challenges expected during the FID (without a strong R&D content, the FID costs will not be eligible to public funding)
* Use a table to summarize the information at the end of the section, for example:

|  |  |  |  |
| --- | --- | --- | --- |
|  | **What?** | **KPI** | **How?** |
| WP3 |  |  |  |
| WP4 |  |  |  |
| …… |  |  |  |
| …… |  |  |  |

* + 1. Transition from the FID phase to the mass production / commercialisation phase

**e2 additional recommendations:**

* Define which KPIs will be used and the associated values to decide that the FID phase is over and the Mass production / commercialisation starts
* Note: The transition from FID to mass production must be based on technical criteria not market one.
  + 1. Revenues in the FID phase

**e2 additional recommendations:**

* If the company decides to have revenues during the FID phase, provide detailed, convincing explanations why the company consider that the amount of sales during the FID phase should not be viewed as normal sales / commercial activities; explain the nature of these sales during the FID phase: what kind of products will be sold, to whom and for what purposes?
* Note: typically, samples and testing or feedback sales can be reconciled with the concept of FID under the IPCEI Communication; however, important volumes and revenues of sales typically correspond to commercial activities under the IPCEI Communication; the sales shall not be larger that 20% of steady state commercial sales
  1. Environmental, energy or transport projects

**e2 recommendations:**

* Explain how the project contributes to EU objectives such as the Green Deal
  + 1. Project’s contribution to the decarbonisation of the energy sector

**e2 recommendations:**

* Explain and estimate investments in renewable energy sources
* Explain and estimate the contribution to a better link/integration of intermittent energy sources
* Explain and estimate the contribution to the decarbonisation of the gas sector
* Explain and estimate improvement of energy infrastructure and district heating
* Explain and estimate the contribution to energy efficiency
* Explain and estimate the contribution to a secure and affordable EU energy supply
* Explain and estimate the contribution to a fully integrated, interconnected and digitalised EU energy market
* Explain and estimate the contribution to increasing cross-border and regional cooperation to better share clean energy sources
  + 1. Project’s contribution to the European industry’s innovation and global leadership in the green economy

**e2 recommendations:**

* Explain and estimate the creation of new firms, SMEs and start-ups in the green economy
* Explain and estimate investments in research and innovation activities
* Explain and estimate the contribution to the transition to low-carbon technologies and economic diversification based on climate-resilient investments and jobs
* Explain and estimate contribution to setting standards for sustainable growth across global value chains
  + 1. Project’s contribution to the rolling out of cleaner, cheaper and healthier forms of private and public transport

**e2 recommendations:**

* Explain and estimate the project’s contribution to reducing emissions from transport
  + passenger cars
  + commercial vehicle
  + heavy trucks
  + trains
  + ships
  + planes
  + modal shift
* Explain and estimate the project’s contribution to refuelling infrastructures
* Explain and estimate the project’s contribution to improved transportation networks
  + 1. Project’s contribution to creating new jobs in the green economy

**e2 recommendations:**

* Explain and estimate the project’s contribution to creating new jobs in the green economy
  + 1. Other contributions to sustainable development

**e2 recommendations:**

* Explain and estimate the project’s contribution to reducing European industry’s pollution (air, water and soil)
* Explain and estimate the project’s contribution to more circular products
* Explain and estimate the project’s contribution to reducing damage to forests
* Explain and estimate the project’s contribution to reducing damage to oceans
* Explain and estimate the project’s contribution to reducing damage to biodiversity
* Explain and estimate the project’s contribution to reducing water stress
* Explain and estimate the project’s contribution to reducing water stress
* Explain and estimate the project’s contribution to a toxic-free environment (chemicals).
  1. Contribution to the hydrogen strategic value chain
     1. Project’s position in the hydrogen strategic value chain
     2. Contribution to the industrial value chain in France

**e2 additional recommendations:**

* Describe the French partners
* Explain the complementarities / synergies with French partners and their projects
  + 1. Contribution to the industrial value chain in Europe

**e2 additional recommendations:**

* Describe the European partners
* Explain the complementarities / synergies with European partners and their projects
  1. Intellectual Property Rights

*IP management principles*

*IP protections principles*

*IP exploitation principles*

* + 1. IP management principles

**e2 additional recommendations:**

* Briefly describe here the company’s general IP management principles
  + 1. IP protection principles

**e2 additional recommendations:**

* Describe here the IP protection principles that will be followed in the IPCEI
  + 1. IP exploitation principles

**e2 additional recommendations:**

* Describe here the IP exploitation principles that will be followed in the IPCEI; please note that the company will be requested to commit to grant licences on IP protected results from the IPCEI on FRAND conditions if it requires a large State aid amount (see below chapter 3 on Spillovers)
  1. Work Plan

*Please describe your work plan in respect to the described work in the Technical Fields (TF) annex.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **TF no.** | **WP no.** | **R&D / FID** | **Title** | **Person Months (global)** | **Person Months (R&D&I)** |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  | Total PM |  |  |

Table 1: Work Packages (WP) vs. Person Months (PM)

**e2 additional recommendations:**

* Please remember that FID “must allow for the development of a new product or service with high research and innovation content and/or the deployment of a fundamentally innovative production process”; FID costs will be eligible only if FID activities have a strong R&D content
  1. Investment
     1. Tools and Equipment

*Please cluster your investment by technology classification. Please provide also a brief and simple description of 1 or 2 sentences to the table (what is the purpose of the investment?).*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Technology**  **Classification** | **No. of Tools** | **Examples of Tools** | **Investment Cost [EUR]** | **Year\*** | **TF no.** | **WP no.** |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  | Total |  |  |  |  |

\*Investment year

Table 2: Overview of investment in tools and equipment

**e2 additional recommendations:**

* The costs of plug & play equipment (i.e. not modified by R&D activities) are not eligible because they are considered as part of mass production equipment (no R&D content)
* Only the depreciation corresponding to the use of the instruments / equipment for the IPCEI activities will be considered eligible cost (R&D or FID)
  + 1. Construction of Buildings/Laboratory

*Please provide a brief and simple description of 1 or 2 sentences to the table (what kind of building? for what purpose?). Please cluster your investment so that the table does not exceed 1 page.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Technology**  **Classification** | **No. of Tools** | **Examples of Tools** | **Investment Cost [EUR]** | **Year\*** | **TF no.** | **WP no.** |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  | Total |  |  |  |  |

\*Investment year

Table 3: Overview of investment in buildings or laboratories

**e2 additional recommendations:**

* Please explain whether the building would be used only for the IPCEI activities or also for other activities / activities carried out after the period covered by the IPCEI
* Only the depreciation corresponding to the use of the building for the IPCEI activities will be considered eligible cost (R&D or FID)

1. Budget
   1. Eligible Costs

*Eligible costs only cover costs made for the purpose and the time span of the IPCEI:*

*• The following costs should be listed in a disaggregate manner:*

*• Costs for each of the R&D activities*

*• Costs for each of the FID activities*

*• And, within the FID costs, the costs of R&D carried out in the FID phase should be mentioned; this could give an idea of the overall importance of the R&D*

*• The cut-off date of the R&D and FID phases should be provided explicitly by each company (The template Excel contains vertical lines, showing these cut-offs, these should be adapted per company)*

*• Eligible costs cover costs up to the end of the FID phase (even if the FID phase goes beyond the national granting period for some companies)*

*• The end result of this step should be one figure: the total amount of eligible costs at the end of the IPCEI, including the FID phase*

*Note: all costs mentioned in the Excel sheet are considered by the Member States as eligible costs under the IPCEI Communication.*

* 1. State Aid

*Indicate the State aid requirement in nominal terms and discounted terms, as well as the anticipated yearly instalments.*

1. Spill-over Effects

Different dissemination activities, ranging from awareness to exploitation, are proposed by McPhy to ensure the translation of developments and outputs into new findings and market opportunities for third parties (research organisations, companies, Members States, industrial sectors). The objective is to reach the fullest range of potential users and uses among research, social, investment and policy makers. McPhy developed a specific Work Package in the project’s global Work Plan for planning all dissemination actions (WP X).

* 1. Spill-over by non-protected results diffusion

McPhy commits to undertake the following dissemination actions of non-IP protected results from the IPCEI on Hydrogen:

* Share results with the scientific & technological community through conferences / workshops
* Share results with the scientific & technological community through publications
* Share results with the scientific & technological community through the participation to large European research projects (Horizon Europe)
* Share results with the scientific & technological community through R&D collaborations with universities and public research organisations
* Share results with the scientific & technological community through actions in industry associations
* Promote / fund the completion of doctoral work in the field
* Promote / fund the completion of post-doctoral work in the field
* Set up / participate in courses & training
* Set up / participate in apprenticeship programs
* …
  1. Spill-over by IP protected results diffusion

The IPCEI on Hydrogen is about the development of a complete European supply chain for low CO2 hydrogen supply and applications. Each IPCEI partner will develop technological building blocks to develop this European supply chain. Some of them will be IP protected typically through filing patents. McPhy is committed to develop Intellectual Property (IP) such as patents. IP creation will range from process technology, general architecture, software, and hardware development.

Regarding the exploitation of IP-protected results, only a very low number of exclusive IP licenses deriving from the IPCEI on Hydrogen results are expected. Indeed, the patents that will be licensed will be related mainly to generic technological building blocks; therefore, they will not be blocking for the final products or processes because alternative processes and solutions could be implemented. This will actually serve to create further innovation in Europe as wider industry takes the building blocks present and then develop their own products and processes.

In the exceptional case of a request for an exclusive license for commercial exploitation of results from the IPCEI on Hydrogen, the domain and the duration of the exclusivity will be limited. In addition, in case of non-exploitation of the technologies for the application purposes provided for in the license within a reasonable contractual period (in the light of the tests to be carried out), the exclusivity will fall automatically in order not to block the diffusion of new technologies in the involved domain.

Moreover, dissemination policies will be implemented in order to promote and stimulate new approaches regarding the licensing of generic IP building block (avoiding any blocking issues for final product), with a view to serve other application fields through different value chains in order to get wider societal impacts. The IP will be generated with the intent to be as open as possible in order to facilitate the best possible uptake of new technologies from the IPCEI on Hydrogen.

McPhy expects to file X patents on results from the IPCEI on Hydrogen, regarding the following technological building blocks:

* technological building block 1
* technological building block 2
* etc.

McPhy’s IP strategy will also allow for the cross-industrial use of its IP protected results from the IPCEI on Hydrogen. More specifically, McPhy’s commits to grant FRAND licences on its IP-protected results to…

* 1. Spill-over in the FID phase

Within the project timeframe, FID activities in the IPCEI on Hydrogen will lead to significant spill-over effects in downstream and upstream markets, among IPCEI partners but most importantly also beyond them. In general words, downstream and upstream markets parties will benefit in many ways from the FID phase. The IPCEI on Hydrogen will enable them to develop new equipment / instruments, new product applications and designs and to acquire specific skills as well as knowhow, which again can be used in cooperation with third parties (inside and outside the IPCEI).

A key asset of the IPCEI on Hydrogen is to embed many players from all along the hydrogen value chain, either as direct or indirect participant. Additional cooperation programs will bring even more players inside and outside the Members States which fund the IPCEI. This is a strategic advantage that will make easier access to them inside the European Union. McPhy’s strong implantation in France and Italy will attract many actors such as research labs, SMEs, start-ups… in the context of innovation proposals around provision of sustainable energy solutions.

The IPCEI on Hydrogen will provide access to next generation electrolysers, HRS and services as well as to new technologies issued from the FID phase to partners, large companies, SMEs and PROs. This will be very helpful for SMEs and PROs (e.g. as listed in the Chapeau document as direct or indirect partner in all Work streams) which want to develop new applications considering the entire lifecycle of high-performance electrolysers. These partners will benefit of an early access to the latest engineering methods and the most innovative testing equipment. This will empower them to shorten their development time.

Downstream market players (basically, related to mobility and industrial applications of hydrogen) tend to be the main contributors initiating new requirements for electrolysers: new designs, new technologies, new testing equipment, new products. Once the need is known by a potential customer, through market studies or direct market request, a feasibility study is launched. Eventually, a decision is made in order to start R&D&I work. But during the R&D&I phase, the new methods / technologies / testing equipment are not reliable enough. The downstream market is usually not interested to test such innovations at this stage.

Conversely, when entering the FID phase, the innovative methods / technologies / testing equipment have demonstrated their intrinsic value: functionality and reliability and a minimum level of repeatability. Then, some engineering methods / technologies / testing equipment can be translated to downstream markets. Sampling with demonstrators, while sharing the risks between the potential end user and the technology provider, can start and continuously involve R&D&I phase in downstream markets: mock-up conception, measurement and testing campaign, additional specification request, data gathering and processing, several generations of prototyping, reliability at application level, are some examples of typical R&D&I activities of downstream market partners.

The FID activities from the electrolyser / HRS manufacturer and the R&D&I from the downstream markets progress in the same time. This is a decisive phase to assess the new technologies and make the downstream markets ready to use them. A successful final stage is when downstream markets initiate their own FID while using the electrolyser / HRS manufacturer’s innovative technologies.

The FID phase will also generate spill-over effects to other industrial partners such as equipment / instruments manufacturers present all over Europe. Indeed, in order to support the FID phase, some technological progress will be needed from these industries; McPhy will lead the way in automating 20 MW and 100 MW platforms production, as well as developing new XL stack technology. Therefore, the equipment / instruments manufacturers will benefit from their own “Feedback R&D” improving their own equipment, materials and processes. This spill-over will be reinforced since the scope of IPCEI on Hydrogen is very large.

Thus, the benefits of the FID phase are clearly not limited to the company itself but will also spill-over to the project’s partners and further expand to many EU high-tech industries, businesses and research organisations. IPCEI on Hydrogen will create positive spill-over effects on multiple levels of the value chain.

More specifically, McPhy…

In order to inform the European technological and scientific community about this new opportunity, the company commits to communicate through press releases, media tools and during workshops about the inauguration of the new manufacturing facility, as well as to actively approach at least X European SMEs and PROs from non-IPCEI Member States each year to check whether they could be interested.

1. Other positive effect on the market
   1. Impact of the Project on Employment and New Investments in Europe

*Estimation of the quantitative and qualitative impact of your project on direct and indirect employment and training in European economy and society new investments in Europe.*

**e2 additional recommendations:**

* Detail the magnitude of employment that is envisioned
* Include a time-line of employment (how is employment associated with each step in the process?)
* What is the nature of the employment? (Industry/qualifications of potential jobs); explain and estimate the project’s contribution to creating new jobs in the green economy
* Will McPhy be training this extra workforce?
* Discuss also what kind of indirect impact on employment there could be (employment that results from the project but not used attributable to McPhy).
* Are there any downstream projects that could result in additional employment in the future? (either by McPhy or another firm)
  1. Environmental protection and reduction in energy dependence

*Description of the project influence on environment protection and on the reduction of energy dependence.*

**e2 additional recommendations:**

* How much savings of CO2 emissions per year does the project represent?
* Detail the above by including potential reduction in CO2 due to reduction in imports.
* Explain and estimate the project’s contribution to reducing European industry’s pollution (air, water and soil); is there a significant reduction of pollution linked to the equipment that is to be deployed?
* What is the difference in energy-efficiency between current industrial mainstream and this project?
* How will the project change the % of energy in the region that is due to renewables?
* Explain and estimate the project’s contribution to more circular products
  1. Market failures: coordination problems
     1. Coordination failures between companies and research organizations

The very large number of public and private initiatives to define a mainstream trend to develop the next generation Hydrogen creates important coordination problems. Academia and businesses differ greatly in many aspects. The goal of scientists’ activities is the growth of knowledge, while for companies the principal motivation is profits. Each one tends to underestimate or even discard the objective that the other pursues. Reward modes are also orthogonal: an important scientific discovery will contribute to the reputation of the team that makes it, while a significant innovation will enrich the company that develops it. Finally, scientific results acquire their value when they are shared through scientific publications, while businesses’ R&D&I results get their value if they are patented. The reconciliation of the two approaches is possible but often causes misunderstandings and conflicts.

The goals of research organizations and companies are often disconnected. The main reason is due to the time horizon under consideration. While research organizations are often concerned with plausible long-term trajectories, companies are oriented towards projects that can have clear value added in the short term. This causes a large disconnect between the kind of research that is done by research institutions and the kind of research that firms need in order to act. In simpler terms, research organizations are often concerned about possible paths the economy could take, whilst companies are concerned more about which paths are more “effective” in terms of direct economic benefits.

The difficulties that companies and research organizations face when trying to work together are well documented. In particular, these relations are known to be much more complicated in Europe than in the United States. A lack of investment by public and private actors inhibits knowledge transfer by directly limiting the transfer capacity between public research organizations and companies, leading to limited communication and increases in coordination failures. This lower investment could be attributable to a stricter dichotomy in Europe between public and private financing.

In the case of the European Hydrogen strategic value chain, this lack of coordination between research organizations and companies in most Member States is a major systemic failure. Its outcome is a deficit of growth and competitiveness as compared to other parts of the world, particularly Japan and the United States. This is reflected in the loss of momentum of European players in research and innovation capacity, particularly visible in the low impact of their patents worldwide.

In addition, partnerships between research organizations and companies tend to be set up only at a local dimension. They prefer to collaborate when they know each other well and are close, which leads to neglecting other partnership opportunities that could be more productive from the scientific and technological points of view. The lack of cross-frontier public funding leads some public research organizations to focus solely on local companies for partnerships. This means that there could be potential synergies that could be exploited at the more European level in the form of cooperative projects if far-reaching connections were facilitated.

The IPCEI on Hydrogen will promote an intense cooperation between academic partners and industrial partners from numerous different Member States. Market forces alone cannot lead to such cooperation. This major European R&D&I and industrial partnership will significantly intensify scientific and technological exchanges between European players from academia and from players across the industrial value chain. As part of the IPCEI on Hydrogen, the research agendas of academic laboratories and companies will be better aligned, and exchanges will transcend the borders established by local tropisms. Thus, the ambition of R&D&I activities can be of a higher level. The IPCEI on Hydrogen initiative will foster new trans-border collaborations between EU companies. Without the IPCEI on Hydrogen, such collaboration would very likely not have happened.

* + 1. Coordination failures between European research organizations themselves

Most European research organizations suffer from sub-critical size to engage in advanced research in next generation hydrogen. Such research activities require heavy resources in manufacturing equipment and characterization. No European public research laboratories own the full set of equipment included a complete production line to carry out their research activities.

The sub-critical size of European research organizations, particularly compared to the United States, combined with a lack of coordination between them, leads to dispersion and redundancy. Important efforts are made on some research topics without exchange of information, leading to a deteriorated scientific productivity, while other topics are neglected. The setting up of in-depth discussions within each technological field of next generation Hydrogen can enable knowledge production to be more efficient.

The IPCEI on Hydrogen will mobilize and bring together many European research laboratories, thus making it possible to overcome the lack of coordination that characterizes them. As part of the project, the redundancies will be removed, synergies and exchanges will be developed to pursue common R&D&I objectives in the field of advanced materials for Hydrogen and next generation Hydrogen, considered to be strategic for Europe.

* + 1. Coordination failures between SMEs and industry leaders

The IPCEI on Hydrogen will provide SMEs with access to R&D&I activities and innovative infrastructure that they would not have accessed in the absence of the project. Without State aid, McPhy would work with some of these SMEs in a standard "client-supplier" logic, rather than associate them as partners and allow them to anticipate technological breakthroughs. Thus, most of these SMEs simply would not have the ability to work on these highly challenging technological areas.

The State aid encourages many European SMEs to collaborate and invest in R&D&I, by pooling and sharing risks. The project will enable the actors to achieve collectively the critical size that is needed to carry out advanced hydrogen R&D&I activities. European SMEs in the hydrogen sector will coordinate R&D&I activities with much higher levels of ambition and risk.

* + 1. Coordination failures between European clusters

The European hydrogen industrial value chain is limited in size and scope because of the market’s infancy and lack of business / technological opportunities. It is insufficiently coordinated to foster complementarities, synergies, learning curves that are key in order to compete globally. The weakness of cross-frontier public funding for large projects leads each cluster’s actors to carry out their R&D&I activities in a regional logic, e.g. at a level of a city that wants to purchase a dozen hydrogen buses with the associated hydrogen infrastructure. The weakness of cooperation between European clusters leads to redundancies, neglecting synergies and significant complementarities, and finally to significant losses in terms of scientific and technological productivity.

The scientific and technological objectives of the IPCEI on Hydrogen constitute a major scientific, technological and organizational challenge, particularly for the development of new technology platforms and pilot lines. All players across the European industrial value chain must engage in closely coordinated R&D&I and FID activities to achieve this development, reducing redundancies, developing synergies and complementarities.

* + 1. Coordination failures of a very large-scale R&D project

The scope, scale and the high scientific and technological complexity level of the IPCEI on Hydrogen require joint work amongst a very large number of actors, most of them industrial companies and some being public research organizations and university laboratories.

The intensity of collaboration inside IPCEI on Hydrogen is very important, program partners will work in a very strong interdisciplinary sense, which could not be mobilized without the State aid. The results obtained by each partner will impact the other partners' actions. The collaboration must be coordinated in a very close and dynamic way, in order to get the best results from trials and error experiences of R&D&I and FID activities, as well as to reorient all work packages as a result of the progress of each partner, so that the R&D&I and FID program can achieve its objectives. Round trips will be necessary between the different partners to coordinate their work, in order to remove the technological barriers that will be identified. This is a huge task.

State aid to partners of the project IPCEI on Hydrogen deeply strengthens the coordination of the consortium. The disbursement of the public funding will be spread over the lifetime of the project, thus necessitating a very close monitoring by public authorities through progress reports, milestones, etc. All partners know that they must progress together towards the achievement of IPCEI on Hydrogen objectives to get the public funding. Thus, the State aid gives each partner very strong dynamic incentives to overcome the difficulties of such a large-scale and long-lasting project. It makes possible to set up a very large European R&D partnership which constitutes an efficient and responsive mode of organization, able to catalyse synergies between partners and ensure gathering and coordination of the broad spectrum of necessary sector skills for the realization of such an ambitious project. Major European players in the hydrogen field will all work together for the first time in a collaborative approach around a major unifying R&D&I and industrial program, kick-starting the Europan hydrogen market, as well as lowering the technical and economic barriers.

* + 1. Coordination failures associated with contractual incompleteness

The State aid will also limit the coordination difficulties related to the contractual incompleteness of major collaborative R&D&I programs. It is well known that R&D&I contracts are incomplete, that is, they cannot anticipate or take into account all possible situations and all future contingencies. Indeed, R&D&I programs are characterized by high uncertainty: not all results can be determined in advance ("serendipity"), unanticipated scientific and technological hurdles can arise, with a potentially strong impact on the program's calendar or costs, successes or failures can come from where they were not expected, etc.

Contractual incompleteness may encourage opportunistic partners' behaviours, reducing their commitment to the collaborative R&D&I project. In such context, cooperation is rendered very unstable by the alternative opportunities that are offered to the partners. The occurrence of an unforeseen event in the contract can lead to a chain of reactions from the partners, putting at risk the primary purpose of the partnership. Naturally, this risk is all the more important as the number of partners grows and the research is of a high level of complexity, which is very clearly the case for the project IPCEI on Hydrogen.

A very large collaborative R&D&I project like IPCEI on Hydrogen is characterized by a high uncertainty, which means the occurrence of unpredictable events during the project. A partner could invoke the occurrence of an unforeseen contingency in the contract to defend opportunistically his interests. The collaboration contract cannot therefore prevent these behaviours. Sanctions or penalties cannot solve this problem: a sanction can only apply over a behaviour considered as deviant by reference to foreseeable configurations provided for in the contract.

Second, the interests of the partners may diverge over the content of the program, or its objectives, or even its costs, as it progresses. This is common in a very large collaborative R&D&I program like IPCEI on Hydrogen, since project developments are very likely to deviate from the initial plan. Therefore, each of the partners would tend to influence the program in such a way as to favour its interests to the detriment of the common interest of the consortium, while it would be hardly possible to invoke the contract to prevent it (in particular, through penalties provided for in the contract). This may for example involve renegotiating the allocation of costs between the partners, to the detriment of the effectiveness of the project.

Third, it is very difficult, if not impossible, to anticipate and define in an exhaustive way the totality of the results of a very large R&D&I program. Thus, one of the partners might be tempted to appropriate some unanticipated results of the program by claiming that they would result from R&D&I activity outside the program. Here again, applying fines could not address anything, because of the intrinsic uncertainty of the very large collaborative R&D&I programs and the resulting contractual incompleteness.

The examples above, where a partner might be interested in adopting opportunistic behaviour, are not exhaustive. However, they provide an overview of the wide range of opportunities for partners in a very large collaborative R&D&I program like the IPCEI on Hydrogen to derive a profit from the program at the expense of the common interest of the partners. Thus, although collaborative R&D&I contracts are essential for framing partnership relations, they may reveal a limited effectiveness in managing the divergences of interests that do not fail to appear, especially in the context of a program as expensive, long and complex as the IPCEI on Hydrogen. Since it is very difficult to anticipate all situations in which a partner might have an interest in opportunistic behaviour, or even to prove this type of behaviour, it is impossible to provide for an appropriate system of sanctions.

State aid makes it possible to reduce a priori the opportunistic behaviour that may result from contractual incompleteness, and thus facilitates the coordination of IPCEI on Hydrogen partners. Indeed, for each partner, the risk related to the implementation of the program will be shared with the public authorities, limiting its potential financial losses in case of failure. This sharing of risks reduces each partner's incentives to use opportunistically contractual incompleteness to his advantage.

* 1. Market failure: Imperfect and asymmetric information
     1. Risks affecting the project
        1. Technological risk

The European Commission generally recognizes that a greater technicality of a R&D project goes along with a greater probability of failure. R&D and innovation are highly complex and challenging in the hydrogen sector, and therefore they inherently carry a very high level of risk.

In the specific context of the IPCEI on Hydrogen, McPhy will undertake RDI activities in order to explore scientific and technological paths that are very risky. McPhy is focusing on developing automated electrolysis platforms manufacturing, optimising larger electrolysis platforms to be able to serve future market demand, and developing innovative stacks and HRS.

It is well understood that all these very innovative R&D and innovation pathways that will be explored as part of the IPCEI on Hydrogen may not be performing as anticipated. The technologies developed by McPhy are characterized by a very high level of complexity and there is a high risk that the work undertaken in the project will not achieve all the expected results, or not in the anticipated planning. For each technical objective, there are indeed several paths that can be explored in parallel (e.g. alkaline vs. PEM), and the paths chosen within the project may not produce the expected performances.

Furthermore, there is a risk of non-compatibility of the solutions developed in IPCEI on Hydrogen in FID and large-scale industrialization or with the equipment available on the market, for example [please provide an example of difficulties that McPhy may face in the FID stage]. High-performance technology may be difficult to exploit in order to produce operational finished products.

* + - 1. Economic risk

Different learning curves for different competing technologies for hydrogen production will develop as a consequence of market expansion in the coming decade. There is a risk that not only McPhy products be introduced too late on the market but also that the cost of competing technologies decreases quicker than the cost of McPhy’s products, entailing a significant economic risk is attached to the innovative application of hydrogen technologies.

Moreover, hundreds of R&D teams worldwide are investing time in the development of hydrolysers based on PEM technology. Hundreds of millions have been committed to the development of this technology. These company’s regularly report breakthroughs. There is a clear economic risk that hydrolysers based on PEM technology grasp a large share of the market earlier than expected, leaving little room for alkaline-based electrolyers.

* + - 1. Partnership risk

The risk of partnership of a very large R&D and industrial program such as the IPCEI on Hydrogen results from the difficulties to organize the coordination and the synergies between such a large number of actors and centers of competences that are culturally very different, as well as to maintain the cohesion of the partnership in the long run.

The R&D and industrial partnership set up in the IPCEI on Hydrogen involves a very large number of partners coming from various sectors, they also have different sizes and institutional origins. Indeed, the IPCEI on Hydrogen requires academic research laboratories and companies to work together on common scientific and technological objectives. Given the strong interdependence between their activities, it will be very difficult to coordinate their numerous contributions to the project. It is clearly the case regarding the contributions of the numerous public research laboratories, which will work in parallel on multiple tasks of scientific modelling and development of basic technological building block.

* + - 1. Risk associated with major R&D programs

Major R&D and industrial programs such as IPCEI on Hydrogen, which extend over several years and aim at many technological breakthroughs across complementary steps in the value chain, are generally exposed to numerous and significant risks that are not all identified and even less quantified. For example, it is common for nominal objectives not to be achieved; also there may be defects at the interfaces, delays in the availability of the results of a subsystem, failures of partners during the program, technical and functional problems, etc. This is why significant uncertainty often weighs on the fulfillment of the initial schedule, as well as on the forecasted estimation of R&D and industrial expenditures. The two risks are associated to the extent that each year of delay generally induces significant additional costs.

* + - 1. Regulatory risk

European regulations such as the RoHS directive prohibit the use of certain components, and the REACH regulation requires the registration and evaluation of any new chemical used. European regulations introduce regulatory constraints for European manufacturers that have not, or not yet, been imposed to their Asian or American competitors.

These regulations apply in particular to manufacturing processes that use substances banned only in Europe, which may limit the operation of European factories. For the purposes of the IPCEI on Hydrogen, it is important to focus attention to comply with these European regulations, which are often more stringent than those in force in the United States and Asia.

Complying with such regulations may have severe consequences on industrial investments by increasing the costs and slowing down the industrialization process from a competitive point of view. Hydrogen may be exposed to some unique regulatory risks due to its combustibility; this could entail adapting to more stringent safety demands which would require a more expensive investment.

* + - 1. Strategic and organizational risk

Though the core of electrolysis uses water, the process itself does entail the use of some strategic commodities. Nickel and Ruthenium are the two principle commodities which are subject to geopolitical risks.

Nickel represents a relatively lower risk (and it is technically not categorized as a strategic commodity) because it is distributed throughout the world with the largest shares of exports belonging to Indonesia with 20%, Philippines, 15.7% and New Caledonia 14.8%. However there also exists a substantial share of Nickel within the European Union’s geographic zone, in Finland which represents 7.4% of Nickel exports.

Ruthenium is the second commodity which can represent some geopolitical risk, with the main exporters being China, Japan and South Africa. McPhy does not have direct control of this part of the supply chain as it is McPhy’s European suppliers who procure the needed materials. Thus, McPhy is exposed to the risk of not being able to secure the supply of these strategic components of electrolysers, meaning not being able to deliver to its customers.

Finally, McPhy has historically procured compressors from the United States. In the present global context of increasing tensions on international trade, McPhy is exposed to the risk of an increase in trade barriers (such as tariffs) resulting in an unbalanced supply chain.

* + 1. Market failure: Difficulty to recruit highly qualified personnel

At the global level, the hydrogen sector suffers from an important difficulty for the recruitment of highly qualified profiles, a problem that hinders the development and commercialization of innovative technologies. This shortage is a result of mismatches between needed skills and available skills on the labor market. The qualifications proposed by the education system, university formations or training programs lag behind the fast-changing specific highly qualified profiles required in the hydrogen sector. This problem is well documented in numerous studies, reports and research publications.

One key problem is that training programs fail to include several scientific disciplines under one technological field, while companies in the hydrogen sector are demanding profiles with strong interdisciplinary skills.

One of the main objectives of the public support for the IPCEI on Hydrogen is precisely to foster university – industry collaboration and to enhance the attractiveness of the European hydrogen clusters regarding the highly qualified labor market, thus supporting the evolution of academia to train and supply to the market these highly qualified profiles. For that purpose, thanks to public funding, the IPCEI on Hydrogen will implement the following features at a very large European level: a strengthening of partnerships, a better circulation of ideas and people and a better mutual understanding between public research organizations and companies.

The specific technical skills that are needed are numerous, from engineers specializing in electrical equipment, to software specialists who can automate the processes, to station designers and who will ensure optimized equipement. There is also a significant innovative component which must be carefully calibrated theoretically by specialists in electrical product development.

* + 1. Market failure: Difficulty to raise funding on financial market
    2. Strategic independence of supply

Europe is strongly dependent on imports of energy, including natural gas. Hydrogen used for industrial applications is nowadays mainly produced through steam methane reforming, requiring large quantities of natural gas (grey hydrogen). McPhy’s electrolysis innovative technology serves the purpose of increasing the competitiveness of low carbon hydrogen supply compared to grey hydrogen. In case of success and diffusion of this technology Europe-wide, it will result in less dependence on European imports of natural gas.

* 1. Adequacy of the state aid instrument
     1. Appropriateness among alternative policy instruments

There is no other less distortive policy instrument than State aid which would make it possible to achieve the same result for the IPCEI on Hydrogen.

* + - 1. The regulation

Regulation is a standard and widely used public policy instrument. The use of regulation to implement the IPCEI on Hydrogen has little practical consistency. In theory only, Member States could impose to companies in the industry to develop the innovations proposed in the IPCEI on Hydrogen, based on full technical specifications. However, because of the numerous technological uncertainties weighing on the technological building blocks and integrated systems to be developed, such regulation does not seem to be realistic. For example, it is very likely that due to deficient information from the State regarding the evolution of the hydrogen market, regarding the technological state of the art, regarding the strategies of the different actors, etc., the choice to impose the development of such an innovation rather than another would be inefficient.

It is much more efficient to trust the strategies and technological choices of companies to decide on their R&D and industrial projects. This is the option retained in the IPCEI on Hydrogen.

* + - 1. A better funding of public research

The IPCEI on Hydrogen aims at removing technological barriers and demonstrating the technical and economic viability of many industrial innovations in the field of hydrogen. The project must therefore have a strong technological and industrial component, on top of its scientific dimension. To this end, R&D activities must be carried out simultaneously in public research organisations (which will contribute, with their advanced knowledge, to the development of scientific models) and in companies, which have the essential role to ensure the development of new technologies and their industrial and commercial deployment. A very important gap (in terms of time, cost, and risk) separates the concepts studied in PROs from the demonstration of the technico-economic viability of an innovation, carried out in companies.

A better funding of public research would not achieve the same effect as the State aid from France for the IPCEI on Hydrogen, meaning the structuration of a sustainable ecosystem of research and innovation around a very large R&D partnership between many public and private actors from numerous EU Member States.

* + - 1. The research tax credit

In order to succeed, the project IPCEI on Hydrogen must implement a strong collaborative logic between multiple public and private European actors.

A general tax measure in favor of R&D, such as the research tax credit (Crédit Impôt Recherche in French) implemented since 2008 by the French government, may lead French companies to boost their individual R&D efforts. However, it is not oriented towards the deployment of the European collaborative logic of the project that is a necessary condition for its success.

* + - 1. The innovation tax credit

The innovation tax credit is a French tax measure reserved for SMEs to stimulate their innovation activities, such as building a prototype or a pilot installation of a new product. In concrete terms, a SME having incurred innovation expenses of up to € 400,000 will be able to receive a 20 % reduction in the cost of the expenses incurred in favor of the innovation.

The IPCEI on Hydrogen is dependent on the complementary contributions of a very large number of partners: large companies, SMEs and public research organizations, in France but also in several other Member States. All contributors that are not SMEs nor French cannot benefit from the innovation tax credit. Conversely, the IPCEI on Hydrogen cannot start based only on the contributions of French SMEs that would be supported by the innovation tax credit. Therefore, this fiscal measure is not an appropriate policy instruments to promote the large R&D and industrial collaboration envisioned in the IPCEI on Hydrogen.

Moreover, some key partners, including McPhy, will have expenditures far above the 400,000 euros ceiling of the innovation tax credit. This is another reason why this fiscal measure does not constitute an appropriate policy instrument to promote the activities carried out in the IPCEI on Hydrogen.

* + 1. Appropriateness among different State aid instruments

In the context of the IPCEI on Hydrogen, the main market and systemic failures come from spillovers, coordination problems and Europe’s strategic dependence. To address these failures, a grant is the most appropriate State aid instrument.

The market failure or other important systemic failure which the State aids aim to address are neither a problem of access to finance nor a problem of risk sharing. As such, a public soft loan, a State guarantee or a repayable advance are not taken into account.

The grant is intended to compensate for the low profitability of the project for McPhy without State aid, induced notably by the very high level of spillovers (see Chapter 3). McPhy understands that committing to disseminate the results of the project is a requirement for its activities to be eligible to State aid funding in the IPCEI framework. This being said, it remains that such spillovers result in a lack of incentives to invest in the project and this is partly contributing to the negative NPV for the project. It is well known in economic theory that such positive externality has to be corrected by granting a so-called Pigouvian subsidy to the economic agent who is at the origin of the externality. This refers here to McPhy who will carry out R&D and FID activities that will largely benefit to third parties as a result of the company’s commitments to disseminate the project’s results.

The simulation of a repayable advance in the business plan can only have a marginal impact on the project’s profitability: public money is received in the first hand but reimbursed including interests in the nominal scenario of success. Only a direct grant has the potential to have the profitability reach the company’s hurdle rate by filling the funding gap.

The grant also addresses the coordination problems (see Section 4.3), being a cement of the coordination of the partnership. The grant will encourage partners to commit to the project although it is exposed to a high degree of uncertainty and to returns that will materialize only in the long term. Indeed, the payment of the grant, spread over the four years of the project and closely monitored by French public authorities (progress reports, key milestones, decision-making milestones), offers dynamic incentives for the partners (including McPhy) to overcome the difficulties of coordinating the very large research partnership, and to progress together towards the achievement of the project objectives.

The payment of the grant also limits the potential financial losses of the partners in case of project failure, which reduces their incentives to opportunistically use contractual incompleteness to their advantage. Repayable advances have a major drawback in this respect: they provide an additional incentive to opportunistically use contractual incompleteness, since putting the project in a situation of failure from the contractual point of view makes it possible to avoid repayment of the advance (while the project could be a success from the technical and commercial point of view). The grant to McPhy is therefore the appropriate aid instrument to address the coordination problems in IPCEI on Hydrogen.

The IPCEI on Hydrogen is designed to bring together public and private sectors to undertake a very large-scale project that provide significant benefits to the Union and its citizens. It is very clear that the huge coordination challenge rooted in the IPCEI on Hydrogen could not be addressed by providing a public soft loan, a State guarantee or a repayable advance to the IPCEI’s partners. Only a direct grant can adequately address such market or systemic failure.

However, the grant provided by France to McPhy could be backed upon a claw-back mechanism that shall be targeted on the FID activities and related costs / State aid (they are closest to the market). The principles of this claw back mechanism are considered and developed in the Chapeau text of the IPCEI on Hydrogen.

1. Incentive effect
   1. Absence of similar projects

According to McPhy’s and French Authorities’ best knowledge and according to public information, no similar project exists today in Europe.

McPhy’s current technology of 20 MW electrolysis platforms manufactured manually and based on 1 MW stacks represents the state-of-the-art to date. The IPCEI project would take this further, targeting a 100 MW electrolysis platform which is manufactured automatically, remotely controlled and which would use an innovative XL stack technology (5 MW).

* 1. Start date of the project

McPhy has submitted a demand for public funding to the French public authorities on 20/03/2020. The project would start not before 2021. Thus, the incentive effect of the aid cannot be presumed to be null.

* 1. Counterfactual scenario

McPhy did not consider an alternative project nor a clearly defined and sufficiently predictable alternative project in its internal decision-making process (point 29. of IPCEI Communication). Thus, there is no counterfactual scenario.

However, McPhy understand there needs to be a baseline in order to assess the increase in R&D and FID efforts associated with the State aid from France. Therefore, the company’s “business as usual” activities are described below.

Without the IPCEI on Hydrogen and the associated public support, McPhy would continue to seize business opportunities in the 1-20 MW range on the emerging European hydrogen market, and it would manufacture the associated electrolysis platforms based on a conventional stack from its Italian pilot plant, which is based on manual assembly. This plant has a maximum capacity of 300 MW and McPhy could deliver to the market until 2024-2025 based on a maximum European market share target of 15 %. The activities include the production of low CO2 hydrogen, the installation of hydrogen fueling stations and various services such as roll-out of facilities.

Regarding R&D specifically, McPhy would continue to promote small publicly funded projects focusing on specific building blocks in the technology, either on the process or the product side. The company would not have the capacity (human and financial) to carry out a large integrated R&D project that would improve the overall performance of its electrolysis platforms.

* 1. Increase in R&D and FID efforts

The State Aid from France will allow McPhy to conduct more R&D on new processes and new products, to invest in its first production facilities in France and to recruit new personnel in Europe. From a technical point of view, the technology development process is a necessary step to enable a technological move to 100MW automated platforms with an XL stacking technology. In Europe and to assure the delivery of innovative and hence competitive products are clearly defined. These targets can only be reached following the work program outlined in the project proposal. Therefore, no alternative yet effective project can be defined. The direction and pace of innovations on electrolysis systems used by McPhy would not only be in the hands of McPhy but to all future downstream users.

In the IPCEI Hydrogen scenario supported by a public funding in France, the main positive effects of the project would be:..

1. The integrated approach across the value chain

McPhy proposes to develop from the current state of the art electrolysis and integrate this innovation throughout the value chain through the development of hydrogen refuelling stations and associated services throughout the value chain.

A higher capacity for hydrogens solutions will enable players along the value chain invest in more hydrogen related products, the most obvious such investment would be commercial vehicles. However in general, the lack of a cohesive approach to such investments may often lead to incompatibility of products or to inefficient production structures.

This behavior would be radically changed following the innovative integrated approach within McPhy’s project and the collaborations within the IPCEI hydrogen. This approach means that there will be a strong, open and interactive exchange between the electrolysis, refuelling stations and the services that McPhy will provide. McPhy will ensure that there is integration throughout the value chain, up to the point of hydrogen consumption.

This integrated approach can only be successful if all necessary information, knowledge, know-how, datasets and requirements are available. In the typical value chain of electric mobility, the OEM is responsible for his product, knows the customer and behavior and is thereby defining the requirements for the electrolysis and the downstream value chain. His focal point is delivering the energy to the customer, designing the electrolysis platform, enabling such platforms through refuelling stations, and supporting such development through services. This system works only if the OEM has a deep knowledge and the capabilities to link customer behavior to hydrogen platform design requirements and identify their interaction on manufacturing basis. Thus, the contribution of McPhy to the IPCEI hydrogen is a key to the success of this very large integrated European initiative. Furthermore, the willingness of all partners along the value chain to cooperate and also to commonly define targets and share risks is essential. This strong cooperation did not happen in the past and very likely will not happen without the integrated IPCEI hydrogen. This holistic approach will lead to innovative and outstanding solutions that would not be possible without the IPCEI and the associated public support.

2. The essentially improved level of innovation

The integrated IPCEI hydrogen will drastically increase the probability to reach McPhy’s target in terms on innovation. Only by the increase of the competence level enabled by the IPCEI will McPhy be able to take the risk and change its business model towards an own product development of a future highly innovative 100MW automated XL stack system. This would allow McPhy to take the own responsibility to assure that such innovations really arrive on the European Market, taking advantage of the very large collaboration set-up promoted in the IPCEI hydrogen. Ultimately, this would lead to more innovative and better products on the European market as well as the strengthening of the European industry along the hydrogen technology chain.

1. Elaboration on Terms of the Funding Gap Questionnaire
   1. Main hypothesis of the business plan

*Each company should provide all costs and revenues associated with the investment as a whole and the boundaries of investment should be defined from the perspective of the business investor: the calculation should include all (positive and negative) cash-flows for what the investor regards as the investment project, at the time these cash-flows are to be incurred. It is not enough to only submit the eligible costs. For the purpose of calculating the funding gap, what matters are all the costs (eligible or not) associated with the investment project and all the revenues over the entire lifetime including the mass production phase.*

Annex B describes precisely the different assumptions made in the Business Plan and demonstrates that McPhy’s assumptions are reasonable.

Due to technological evolution toward Hydrogen solutions, we expect next generation electrolyzers to be more efficient and make the installed technology obsolete by 2035, as such we will place our business case in the period 2020-2035.

The terminal value was assessed using the net book value of the assets at XXXX.

*Revenues*

* + **Volume:** Volumes starts in YYYY with XXX MW of sales of Air Liquide products. Progressive production ramp-up increases sales from XXX tons in YYYY to XXX MW per year in YYYY. Sales assumed to remain stable from YYYY to YYYY. Considering that the next generation hydrogen solutions will start mass production in YY years from now, new standards for Electrolysis and fueling stations will progressively replace the current paradigm. Therefore Air Liquide has assumed a XXXX MW per year decline of sales volumes from YYYY till YYYY. Therefore, volumes is limited to XXXX MW in YYYY and null in YYYY.
  + **Selling price**: The expected selling price of electricity is assumed to be XXXX in YYYY. This price is based on historic tends as well as potential carbon tax. According to research of the consulting firm, Name we expect the price to be increase/decrease by x% a year from YYYY to YYYY.
  + **Additional revenues from the sale of by-products**: On top of the above-mentioned sale plan (YYYY to YYYY), Air Liquide has assumed, in YYYY during the FID phase, revenues of XXX k€. These revenues come from the sale of service stations which are expected to bring in ¼ of revenue, which will amount to XXXX at selling price XXXX.

**e2 additional recommendations:**

* + Please include a table here, Columns will have years, row 1 will have sales Volumes, row 2 will have sales price, and row 3 will have Sales/Revenue.

*Variable costs*

Variable costs are estimated on current raw materials costs and central scenario for recipients and production costs taking into account the existing experience of processes and future complexity of the products.

*Terminal value*

The funding gap questionnaire has been set in accordance with the expected duration of stations and electrolysis to be employed. So, terminal value is only limited to trade working capital recovery.

*Inflation*

All revenues and costs are not inflated and expressed on 2019 basis, idem WACC is without inflation impact.

*WACC*

Air Liquide is a privately-owned company. Therefore, there is no public WACC calculation. The WACC of Air Liquide has been computed by NNNN. The WACC has been calculated post-tax to be consistent with the funding gap (also calculated post tax). On Date YYYY, NNNN has publicly disclosed its calculation of the WACC on, a competitor of Air Liquide. The competitor WACC has been calculated at XXXX%, therefore very close to Air Liquide’s own WACC calculation (XXXX%).

* 1. Necessity of state aid

*Point 28 of the guidelines*

According to point 28 of the IPCEI Communication, the aid must not subsidize the costs of a project that an undertaking would anyhow incur and must not compensate for the normal business risk of an economic activity.

In order to assess the activities grouped under the IPCEI on Hydrogen, Air Liquide built a business model considering the incremental efforts and the incremental returns.

Air Liquide’s Internal Rate of Return for the IPCEI on Hydrogen is equal to XXXX % without State aid, in a nominal scenario based on conservative and reasonable assumptions. It is almost six points below the company’s WACC (xxxx %). Thus, it is clear that the State aid does not subsidize the costs of a project that Air Liquide would anyhow have carried out.

* 1. Proportionality of state aid
     1. Firm’s hurdle rate

According to point 30 of the IPCEI Communication, in the absence of an alternative project, the Commission will verify that the aid amount does not exceed the minimum necessary for the aided project to be sufficiently profitable, for example by making possible to achieve an IRR corresponding to the firm’s hurdle rate.

Air Liquide’s Internal Rate of Return for the project IPCEI taking into account a XXXX k€ State aid from France would be XXXX %. This happens to be the value of the company’s WACC. Thus, the State aid required would provide the necessary incentive to enable Air Liquide to launch these highly ambitious and long-term R&D and FID activities, by raising the IRR just at the level of the WACC. The State aid does not confer extra profits for the company, it is proportionate.

* + 1. Project’s funding gap

According to point 31 of the IPCEI Communication, the maximum aid level will be determined with regard to the identified funding gap in relation to the eligible costs. The funding gap refers to the difference between the positive and negative cash flows over the lifetime of the investment, discounted to their current value on the basis of an appropriate discount factor reflecting the rate of return necessary for the beneficiary to carry out the project notably in view of the risks involved.

Air Liquide’s funding gap, calculated as the discounted difference between the positive and negative cash flows over the lifetime of the IPCEI on Hydrogen, amounts to -XXXX k€ (with a discount rate of XXXX % equal to the company’s WACC).

The State aid granted to Air Liquide, in the form of a direct grant amounting to XXXX k€ nominal, has a post-tax Net Present Value of XXXX k€. Thus, it is exactly equal to the funding gap; the State aid is proportionate.

* + 1. State aid intensity

The eligible costs to carry out the proposed activities are calculated only to the level necessary for achieving the project objectives. They consist in personnel costs (technicians, engineers and other supports mandatory for the project completion), materials costs and equipment costs the details of which are provided in section 1.8. For equipment, only the part of the cost prorated with the usage in the IPCEI on Hydrogen is considered.

The total amount of eligible R&D and FID costs is XXXX k€.

Thus, the required State aid is limited to XXX % of the eligible costs, which is far below the threshold of 100 % set by the Community guidelines for IPCEI.

* + 1. State aid cumulation

In the light of the beneficiary's declarations and to the knowledge of the French authorities, Air Liquide does not receive any State aid other than that indicated in point 2.2 of this notification to finance its share of work under the IPCEI on Hydrogen.

This State aid may come from the State budget or local authorities as well as from the structural funds.

* + 1. Open selection proceeding

The selection of Air Liquide as a partner for the IPCEI on Hydrogen and as a beneficiary of public support in France was done in the context of an open call for expression on interest launched on 21st January 2020, based on objective criteria which are neither discretionary nor discriminatory. Twenty-nine companies applied, among which Air Liquide was selected. This contributes to reinforcing the proportionate nature of the State aid.

1. Limitation of distortion of competition and trade
   1. Market affected by the state aid
      1. Definition of the relevant market(s)

*Describe the product / service that will be commercialised, the competing solutions, the targeted applications, the market segmentation, the geographical subdivisions of the market.*

Air Liquide is a French industrial company producing 3 types of products. Production of hydrogen through alkaline electrolysis, refueling stations for hydrogen vehicles (two products are available, a commercial and an industrial one) and platform solutions to allow integration between solar energy hydrogen storage.

There are various kinds of products which could be considered as possible substitutes with alkaline electrolysis. The most direct substitutes are electrolysis using proton exchange membrane (PEM), Solid Oxide electrolysis cell (SOEC), this last one is also known as high temperature electrolysis.

In the short run alkaline has the most room for growth as it is the cheapest method of electrolysis. The popular opinion in the industry is that PEM and SOEC would have significantly reduced their costs both due to technology and scaling up such that PEM is estimated to be the efficient technology by 2030.

However Air Liquide’s own research into external expert opinion such as Arcellormittal and Nouryon predict that alkaline technologies will continue to lead because of their lower reliance on organic materials and as such the alkaline electrolyzers have a longer life expectancy. With the one plausible exception being in scenarios where energy is being produced non-stop night and day, such as in a refinery.

Any products that Air Liquide plans to develop?

* + 1. Current Industry Sector

*Description of the market situation (EU and worldwide) in this sector (market share, competitors) and recent trends / evolutions.*

The main method of current hydrogen production is steam methane reforming (SMR). It accounts of 95% of hydrogen production. Its principle input is Natural Gas and Coal, as such, it would be considered as “grey” energy. It is [estimated](https://www.iea.org/reports/the-future-of-hydrogen) that hydrogen usage is 6% of natural gas use and 2% of coal use and is thus responsible for 830 million tonnes of CO2 emissions.

The competition for the renewable production of hydrogen has three competing processes. The competing processes are SOEC, PEM, alkaline. The latter of the three being Air Liquide’s specialty, even though Air Liquide has also undertaken research in PEM. In general Alkaline is currently the most efficient method of producing but numerous market players are positioning themselves to potentially take advantage of predicted lower PEM costs. Specifically Hydrogenics and NEL ASA, have been developing both technologies, with the former putting increasingly higher emphasis on PEM technologies.

The large market players who are competing directly with Air Liquide on alkaline electrolysis are Thyssenkrupp, CMI energy, and Hydrogen Pro, with the latter two having significant parts of their electrolysis imported from China. The PEM players are Siemens, Areva H2gen and ITM Linde. Finally only one major player is currently invested in technology, Siemens.

* + 1. Market Situation / Share today and after IPCEI

*Estimate your market situation / share (EU and worldwide) and your competitors’ market situation / share (EU and worldwide) today and after the project will have been finished in a nominal scenario of success.*

Air Liquide *current market share is small and practically non-existent.* Air Liquide is a small start-up whose only facility is in Italy where it produces What and what volume and market share currently? At this rate Air Liquide’s future market share will not represent an important share.

After the IPCEI, Air Liquide intends to build capacity of X tonnes (build capacity of how many tonnes 40tonnes??. If this capacity is fully utilized, Air Liquide expects to have 15% market share of the electrolysis hydrogen market.

Moreover, according to reports the size of the hydrogen energy market will be of 40MW a year and still set to increase in large quantities, entailing that there will be ample room for growth in the future.

For all the above-mentioned reasons, the French State aid to Air Liquide for the IPCEI on Hydrogen is highly unlikely to deter the company’s competitors’ investments in R&D and FID to develop competing technologies.

* 1. No strengthening or creation of market power

On the selling side of Hydrogen, Air Liquide will have strong Euopean competitors such as Thyssenkrup which will not benefit from Air Liquide competition, indeed there is unlikely to be much effect on market power since Air Liquide envisages only 15% market share. Indeed, a stronger presence for Air Liquide is likely to reduce the market power of existing larger firms.

On the buyer’s side, Air Liquide will have to the solutions to large energy industrial and commercial energy suppliers such as Engie, EDF and Vattenfall. This will mean that there will not be much scope for the supply side to increase its market power.

Air Liquide actual and future market position, the presence of very strong established competitors, the anticipated growth of the market and the strong buying power of its future customers make it reasonable to assume that the State aid from France to the company will not create nor strengthen any market power. As a new entrant, Air Liquide will rather positively affect the competition at a European level by weakening the market concentration and providing an alternative to the currently Asian-dependant European Hydrogen manufacturers.

* 1. Limiting distortion of dynamic incentives

Being a potential new entrant in the hydrogen market, Air Liquide will have to face strong competition from well-established European/Asian/American competitors. The European competitors are already more active and have a significant advance on Air Liquide.

The State aid required by Air Liquide for the IPCEI on Hydrogen amounts to XX M€ per year on average (four year 2010-2024), that is approximately XX M$ per year. It is very small compared to the size of the market (for example, less than XX % of the 2019 sales of the top players who are YYY reported in Table 1 above). Moreover, it will be dedicated to R&D funding for ZZ% approximately and to FID for only 1-ZZ%, which makes it less likely to distort dynamic incentives.

Moreover, according to Hydrogen Europe, the anticipated growth rate is set to be around 5% with the Hydrogen market doubling by 2030 and increasing by eight times by 2050. As a result of this forecasted market growth, there will remain ample opportunities to develop profitable business for Air Liquide’s competitors on the Hydrogen market.

For all the above-mentioned reasons, the French State aid to Air Liquide for the IPCEI on Hydrogen is highly unlikely to deter the company’s competitors’ investments in R&D and FID to develop competing technologies.

* 1. No maintaining of an inefficient market structure

The State aid that is granted to Air Liquide in France for the development and first industrial deployment of innovations in the field of Hydrogen will not adversely impact a market that is not suffering from overcapacity and is not declining. Indeed, the European hydrogen sector is still in its infancy and should experience an important growth in the coming decade, nurtured by strong innovations and competition. Moreover, the installed capacity in Europe is marginal, while the number of new entrants is expected to rise significantly. These features are typical of dynamic and efficient markets.

* 1. No effect on location activities

Air Liquide’s current industrial activities are located in Italy; it is also the case for its R&D and FID activities in the IPCEI on Hydrogen that the location of the project (France and Germany) does not depend on the source public funding. The company did not consider locating its activities related to the IPCEI on Hydrogen outside France, and it did not demand any public funding to another Member State for the same project.

Thus, there is no risk of a subsidy race between Member States that may arise in particular with respect to the choice of Air Liquide’s location for the IPCEI on Hydrogen.

1. Annex to the Portfolio
2. *Funding Gap Questionnaire*
3. *(If necessary) Internal Company Documents substantiating the counterfactual scenario*