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 XXXX 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 XXXX).
* Are there any downstream projects that could result in additional employment in the future? (either by XXXX 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 demand and supply of green hydrogen

The European market for hydrogen is only embryonic, it is not consolidated so far. Hydrogen is not a commodity. There is no obvious commercial way for a hydrogen user to be supplied for a given quantity at a given date and for a given price. Similarly, a hydrogen provider cannot easily find customers on a market for the product it supplies, based on clear price signals.

As explained in the Report of the Strategic Forum for Important Projects of Common European Interest, p.63, “the deployment of this seemingly simple concept [providing a link between renewable and/or low CO2 electricity generation or other low-carbon hydrogen sources and the end-uses of this energy carrier] requires a coordinated action among the stakeholders and implementation at significant scale to tap on economies of scale.” The IPCEI on Hydrogen serves the purposes of enabling this coordination by supporting European-wide projects on both the supply and demand sides and connecting them together. The IPCEI on Hydrogen is a kick-starter of the European hydrogen market.

Moreover, as explained in the same report (p.68), some hydrogen technologies and systems are technologically mature for large scale deployment but are not cost competitive due to a lack of economies of scale. The IPCEI will provide a strong support in coordinating and structuring large scale initiatives, which will accelerate the deployment of massive hydrogen production and utilization beyond RDI. The economies of scale will develop, equipment manufacturers will move down their learning curves. A snowball effect will be triggered: as costs will actually decrease, hydrogen-based solutions will see their competitiveness increase; the demand will follow and further drive the costs down.

* + 1. Coordination failures across national energy policy focused on hydrogen

Each Member States develops its own national energy policy, including the targets set for hydrogen and the actions supported to reach these targets. They are implemented with the purpose to serve the European objectives. However, there is no coordination at the fine-grained level between the different national policies. This results in missed opportunities in terms of project complementarities which could result in better results for the same costs.

The IPCEI on Hydrogen will provide the supporting Member States with a focal point to coordinate their national policies targeted to the promotion of hydrogen. The Member States actually discussed in order to identify some complementarities, some room for collaboration between the companies they support in the IPCEI. This will result in a higher efficiency from the point of view of the tax-payer’s money that will be allocated to the promotion of hydrogen-based solutions for the European economy.

As stated in the Report of the Strategic Forum for Important Projects of Common European Interest, p.69, a coordinated roadmap has been prepared taking into account compatibility, additionality, inter-dependency across Member State, regions and stakeholders.

* + 1. Coordination failures across EU industries

The development of a more extensive Hydrogen value chain has the potential to affect many industries: Refineries, steel manufacturing, glass manufacturing, chemicals, automobile, trucks, buses, ships, trains, etc.These industries have a low incentive to cross collaborate because their demands are often not identical, for instance glass manufacturing can make due with low purity hydrogen, while mobility applications require a much higher degree of purity.

These various industrial sectors do not communicate with one another based on standard market coordination. Thus, their initiatives regarding the promotion of hydrogen could only be scattered and would result in duplicating efforts, low efficiency because of a lack of coordination, etc.

Conversely, the IPCEI on hydrogen provides a strong policy instrument for coordinating their efforts aiming at the promotion of hydrogen. The Report of the Strategic Forum for Important Projects of Common European Interest, p.69, insist on the IPCEI process being an efficient tool to decide on selected technologies, systems, utilization cases and the timeframe for their scale-up across several EU industries.

* + 1. Coordination failures for the deployment of the hydrogen supply chain

Due to the very early stage of the European hydrogen market development, the industrial supply chains are not structured as of today. Since green hydrogen is substitutable with grey hydrogen, there is currently very little incentive to develop the green branch of the hydrogen production process, that is, there exist significant technological development costs, but the revenues could be appropriated from grey hydrogen.

The IPCEI on Hydrogen will pull together in a very large scale project, numerous companies that will work together in order to articulate their technologies, design, products, processes, quality requirement, … in order to develop fully integrated supply chain for different hydrogen-related products and services.

* + 1. Coordination failures for the deployment of the hydrogen infrastructure

Hydrogen infrastructure suffers from a chicken and egg problem. Hydrogen production requires a buyer who will consistently buy before investing in the given capacity; similarly facilities that use Hydrogen, like the refinery presented by total would not be undertaken unless a consistent supply of hydrogen could be guaranteed.

The situation makes the project proposed by XXXX a natural candidate for the IPCEI since it allows public spending to enable the current gridlock and help the markets grow. The IPCEI on Hydrogen will help solve this problem by supporting both the supply side and demand side, solving the coordination problem.

* + 1. Coordination failures for the deployment of the hydrogen framework conditions

Firms involved in the Hydrogen IPCEI will help contribute to development of hydrogen framework conditions. This will allow for the development of both strategies for entering the market and allow for a clearer vision from the regulation point of view.

The IPCEI on Hydrogen, by pulling together a very large number of companies from several Member States, will produce a huge load of results from R&D activities, from FID activities and from the large-scale roll-out of hydrogen-based solutions. All these activities will be strongly coordinated in the IPCEI, meaning that the results of the different partners will have a huge potential to be translated in a comprehensive way into new standards, norms, regulations that are required to enable the European hydrogen vision.

* + 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 own constructions 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 construction projects to create proper interaction between their investments and avoid wasteful redundancies, focusing instead on developing synergies and complementarities.

* + 1. Coordination failures of a very large-scale 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 construction activities, as well as to reorient all work packages as a result of the progress of each partner, so that the construction 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 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 construction program, kick-starting the European 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 construction programs. It is well known that construction contracts are incomplete, that is, they cannot anticipate or take into account all possible situations and all future contingencies, indeed unless all parties that will benefit from the ex-post gains are initially present, it is impossible that investment will be equal to the value added. Indeed, constructions programs are characterized by high fixed costs by few parties 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' behaviors, reducing their commitment to the collaborative construction 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 project is of a high level of complexity, which is very clearly the case for the project IPCEI on Hydrogen.

A very large collaborative construction 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 behaviors. Sanctions or penalties cannot solve this problem: a sanction can only apply over a behavior 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 construction 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 favor 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 construction program. Thus, one of the partners might be tempted to appropriate some unanticipated results of the program by claiming that they would result from construction activity outside the program. Here again, applying fines could not address anything, because of the intrinsic uncertainty of the very large collaborative construction programs and the resulting contractual incompleteness.

The examples above, where a partner might be interested in adopting opportunistic behavior, are not exhaustive. However, they provide an overview of the wide range of opportunities for partners in a very large collaborative 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 projects 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 construction project goes along with a greater probability of failure. Large infrastructure projects 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, XXXX will undertake infrastructure activities in order to explore establish an autonomous supply chain of hydrogen production where a single element of the chain resulting in failure can result in total failure. XXXX is focusing on developing the infrastructure that is necessary for the full the advancement of Hydrogen solutions.

There is a small risk of non-compatibility of the solutions developed in IPCEI on Hydrogen. The infrastructure developed by XXXX will have to bring together various skills on a very large scale, as such; there may be technological incompatibilities between PV and electrolyze infrastructure.

* + - 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 XXXX will develop platforms that will become relatively less important in the coming decades, for instance. The demand for hydrogen infrastructure is projected to increase as such there is very little economic risk associated with the project. Instead, it may be that other technologies can provide energy at lower cost and this would cause the infrastructure.

* + - 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 construction 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 will put to work the results of years of research to create a new cohesive project. Given the strong interdependence between the various activities, it will be very difficult to coordinate their numerous contributions to the project,

The above is in addition to the specific risks associated with the XXXX-Total partnership. This partnership represents an additional risk because if the company was vertically integrated it employee interaction would be more free flowing but since the entities are separate, their dealings must be supervised with contractual obligations.

* + - 1. Risk associated with infrastructure projects

Major construction 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 to some parts of the chain, will create delays in the overall deployment. This is why significant uncertainty often weighs on the fulfillment of the initial schedule, as well as on the forecasted estimation of the construction and operational costs. 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

**e2 additional recommendations:**

* Please list the kind of materials that are used in construction that could be subject to geopolitical risk.
  + 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 equipment. 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). XXXX’s infrastructure investment serves the purpose of increasing the competitiveness of low carbon hydrogen supply compared to grey hydrogen. In case of success and diffusion of this kind of infrastructure 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 fully integrated supply chain 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 construction and industrial projects. This is the option retained in the IPCEI on Hydrogen.

* + - 1. A better funding of public infrastructure

The IPCEI on Hydrogen aims at removing technological barriers and demonstrating the technical and economic viability of many logistic innovations in the field of hydrogen. The essential investments being undertaken today by XXXX are not substitutable with public funding; indeed this investment will use very different skills and will service higher parts of the value chain than ordinary investments. Public investments are not tailored for company use, firms must create their logistic chains independently of public works.

The project must therefore have a strong logistic and industrial component, on top of its scientific dimension. To this end, the activities would be complemented by parallel public investments and company investments on their own facilities for commercial and industrial deployment. There is a very important gap between the kind of activities that the state invests in, which directly benefits citizens, and activities which companies invest in, which only affect the citizen indirectly, such as the through the market process.

A better funding of public infrastructure 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 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.

Though the project has a novel component in its logistical integration, it is, in the technical sense not innovation, and even if it were, it would be too large to be eligible for the tax credit. This on top of the fact that the project would involve numerous companies throughout the EU , which would mean that non-French contributions would not be eligible.

* + 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 XXXX without State aid, induced notably by the very high level of spillovers (see Chapter 3). XXXX 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 XXXX who will carry out large infrastructure spending and will not be able to fully recoup the value added of the project, indeed studies have shown that infrastructure projects are only able to recoup 20% of the value added they contribute.

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 XXX 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 XXXX) 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 XXXX 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 XXX 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.