TECHNICAL GUIDE CALL[1]

"TECHNOLOGICAL PROGRAM FOR THE USE AND ADOPTION OF HYDROGEN IN THE CHILEAN INDUSTRY"

TECHNOLOGICAL CAPABILITIES DIVISION

CORFO

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To all intents and purposes, the original Spanish version of this form is the only valid document, and the English version is just a reference to ease the understanding of the Technical Guide for non-Spanish speakers.

[1] *This Technical Guide purpose is to orient the applicants in the formulation of their application to this call, providing context and relevant information in order to be used in the development of the proposal.*

1. GENERAL BACKGROUND[2]

The recent special report of the Intergovernmental Panel on Climate Change (IPCC) outlines the impacts of global warming of 1.5°C, recognizing the importance of reducing global GHG emissions by 45 to 50 percent no later than 2030 in order to prevent the planet's temperature from rising above 1.5 Celsius degrees (IPCC, 2018a). If no drastic changes are made, the effects on the climate that are already affecting the planet will be faster, far-reaching, and unprecedented in their impact on physical and natural human systems (EDTTCC, 2021). According to the Inter-American Development Bank (IDB, 2019), one of the most exposed regions to the effects of climate change is Latin American, representing significant risks to the population and basic services.

If the development and transfer of technology is properly directed, it can act as a catalyst and be a fundamental instrument to accelerate the transition to a low-carbon society by mitigating and capturing GHG emissions and/or reducing the associated risks of climate change impacts through the adaptation process of societies and their different agents. This was reaffirmed in the Paris Agreement, where nearly 140 developing countries - which represent 95% of the countries generating low GHG1 emissions - adopted the technology as one of the cornerstones of their NDC (Nationally determined contribution) (UNFCCC, 2016).

Chile's level of economic progress requires far-reaching changes in technology to have a sustainable develop and build a better country, reducing GHG emissions and reducing climate vulnerability. Considering the best accumulated evidence on climate change, Chile´s challenge of moving towards a new model of integral and sustainable development implies that knowledge and technology should be at the centre of new practices which surpass the unsustainable practices used in the past and, based on this experience, the conditions should be generated for a rapid adoption and implementation of actions that allow their projection into the future. We must change the productive matrix and establish one that responds to desirable development objectives for the country, with industrial and innovation methodologies that consider the current challenges of facing the climate crisis.

By means of its National Hydrogen Strategy, Chile has committed to reduce its greenhouse gas emissions to mitigate the effects of climate change and achieve sustainable development as it was established in Chile's Nationally Determined Contribution (NDC)[3] and under the judicial framework to face the challenges caused by climate change established by the Framework Law on Climate Change[4]. Through the different sources of clean energies and inputs present in Chile, it is expected to promote the decarbonization of the country´s activities, diversify the national energy matrix and generate new local development industries. It is possible for Chile, as a country, to achieve the transition from an extraction-based industry to one that produces and uses renewable, zero-emission and low-cost fuels and supplies. Furthermore, our country offers the necessary conditions to generate a competitive hydrogen industry to satisfy the local market and export, which can have a great impact on our country´s image, adding value to the products created in Chile, reducing the carbon footprint of transport and offering our renewable energy sources to whoever needs them.

[2] It is developed from internal analysis, based on the Government Programme 2022 – 2025, https://www.minciencia.gob.cl/legacy-files/estrategia_de_transferencia_tecnologica_para_el_cambio_climatico_1.pdf , entre otros documentos de diagnóstico.

[3] https://www.bcn.cl/leychile/navegar?idNorma=1177286

[4] https://www.bcn.cl/leychile/navegar?idNorma=1177286

This way the country has the opportunity to generate spaces for innovation, strength growth and local employment, as well as to create new companies with local and global impact[5].

The Government Programme of President Boric[6] establishes as an objective the addition of value to hydrogen in a decentralized manner, for national industries usage and subsequent export, in order to turn the country into producers and exporters of hydrogen at competitive prices, though, among other axes, the early involvement of citizens in relation to hydrogen projects and a Fair Transition agenda facing the regulatory, environmental and social challenges for the construction and operation of hydrogen plants.

As part of Corfo' s Strategic Objectives for the period 2022-2026, it was determined that the institution will contribute to the task of a new model of sustainable productive development, leading to a new way of creating and distributing wealth, promoting a productive transformation which, based on the knowledge and talent of the people, takes over the major social and productive challenges of the country and ensures greater sustainability and equity. **The guiding challenges are fair decarbonisation; adaptation to the climate crisis and its socio-environmental consequences; and productive diversification, this call "Technological Programmes for the use and adoption of hydrogen in industry" is aiming to contribute mainly to the first two of these challenges.**

Regarding the "Fair Decarbonization" challenge, it seeks to promote the fair energy transition process in the productive sector to achieve carbon neutrality goals by 2050 developing a local industry by means of the adoption of clean technologies which contribute to the mitigation and adaptation to climate change; **Likewise, it is expected to contribute to the development of a competitive H2 Green industry with the progress of local components, diversifying our productive fabric** with a territorial focus and giving continuity to a State Strategy.

In terms of the challenge **"TECHNOLOGICAL PROGRAM FOR THE USE AND ADOPTION OF HYDROGEN IN THE CHILEAN INDUSTRY",** the aim is to promote the development of technology transfer to production processes for the mitigation and adaptation to the climate crisis and its socio-environmental consequences and impacts on socio-cultural environments, contributing to a fair socio-ecological transition and promoting the productive transformation of the country.

In order to advance in these challenges, CORFO, within the scope of its mission and objective, has a financing instrument called "Technological Programs" whose focus is to increase the rate of technological innovation in products and processes of companies in specific productive and/or economic sectors, by means of an inter-institutional associative dynamic, the collaboration between companies and other entities, and a portfolio of technological development projects that make possible to reduce and/or close the gaps detected, improving the productivity of the sector and contributing to its diversification and/or sophistication.

[5] https://energia.gob.cl/h2/Estrategia-nacional-de-hidrogeno-
[6] https://s3.amazonaws.com/cdn.boricpresidente.cl/web/programa/Plan+de+gobierno+AD+2022-2026+(2).pdf

Although, it is a generic instrument, it can be used to solve technological challenges in any sector or transversal platform, its scope, objectives, and expected results and impact must be adjusted according to the technological challenges specified in this Technical Guide which accompanies the Technical and General Guidelines of the programme.

In this scenario, entities are invited to apply to the call "Technological Programs for the use and adoption of hydrogen in the industry" to accelerate the adaptation of different industries, by focusing on the development and incorporation of technologies that allow the adoption of hydrogen as part of the productive matrix. This would contribute, among other things, to forging a more competitive sector at a global level, which must be in harmony with civil society and local development´s welfare.

2. MAIN TECHNOLOGICAL GAPS AND/OR CHALLENGES TO ADDRESS

The proposals applied to this instrument must focus on one of the following challenges and/or gaps:

2.1 Energy transformation (transition) to hydrogen in local industries with high CO2 emissions. Since 2020, Chile has annually generated more than 8.4 million tons of carbon dioxide per year due to the use of fossil fuels[7]. In order to mitigate this type of emissions it is necessary to use technologies that must address, at least one of the following aspects:

a) Decarbonization, understood as the elimination of the use of fossil fuels and productive matrices that impact the competitiveness of the sector and its sustainable growth in the long term.
b) Low development/adaptation of industrial processes and applications that use hydrogen as fuel or energy vector.

2.2. Hydrogen applications as a chemical supply in the production of manufactured products in local industries, to promote massive demand in technological production processes and metals refining, in the production of fertilizers for agriculture and in mining supplies among others, using hydrogen or its compounds as feedstock.

Whichever gap is addressed, the developments must be embedded in an industry value chain linked to the proposal that ensures the use of the technologies during the execution of the technology programme, therefore, it must be planned, among other factors, how, who and the price the hydrogen will be supplied to the program.

In addition, the estimated use of hydrogen (tonne/year) resulting from the developments during the implementation of the programme in the participating companies shall be declared, as well as the potential usage in the sector to which the technology would be transferred,

[7] Power and heat generation and combustion plants for industrial manufacturing and fuel production. Source: Muntean, M., Guizzardi, D., Schaaf, E., Crippa, M., Solazzo, E., Olivier, J.G.J., Vignati, E. Fossil CO2 emissions of all world countries (https://edgar.jrc.ec.europa.eu/booklet/Fossil_CO2_emissions_of_all_world_countries_booklet_2020report.pdf)

3. SCOPES

a) In accordance with the provisions of the last paragraph of section 4.1 of the guidelines, legal entities constituted in Chile, under private law, whether for profit or not-for-profit, may apply as beneficiaries.
b) Focus their developments on the energy sector (associated to productive sectors) or chemical products.
c) Proposals must address the productive chain associated with the developments and/or adaptations, so that these are integrated into the productive chain of the companies in the sub-sector associated with the proposal before the end of the programme.
d) There must be considered, the technological developments that can be implemented in a period no greater than 3 years, in order to achieve and ensure scaling and commercialisation (TRL 8/9) within a maximum period of 5 years. Therefore, the maturity of the technology's development included in the portfolio submitted may not be less than a TRL 5.
e) The proposal should be associative and governed such that those who have the right to commercialise its result do not have a structure that could obstruct either commercialisation or access to other investment funds that are necessary for scaling up and commercialisation.
f) The different proposed work lines shall generate explicit synergies, both within the portfolio of projects submitted, and with other initiatives in the region, the country and the world.
g) The proposal must specify whether the companies and other participants of the programme (universities, technology centres, etc.) are applying for any other public funds, justifying the additionality of the proposal and ensuring that there is no other project with public and private funding that has the same objectives or expected results.
h) The programme should coordinate with current entities, ministries or ministerial offices that are related to the hydrogen industry development, as required by the results to achieve the productive impact.
i) The Programme shall manage and measure the economic, social, and environmental impact generated by its developments (products and services).
j) Technological adaptations and/or developments must respond to real necessities of the national industry, using and strengthening mainly local capabilities.
k) Additionally, it shall take into consideration public studies such as: National Hydrogen Strategy and other public policy documents, as well as the diversity of public information associated with technology gaps and/or challenges to be addressed[8]

[8] Referential compilation of analysis and strategies associated with the gaps of the call (in progress)

4. OBJECTIVES

The general objective of this call is to promote the use and adoption of Hydrogen in industries operating in the national territory, in order to promote technological developments and/or adaptations aimed to a new development model that is based on sustainable and equitable productive transformation.

In terms of specific objectives, the following is expected:

a) Developing technological solutions that incorporate the use and adoption of hydrogen, in national industrial processes and applications.
b) Proving technical and economic viability of the proposed solutions through the development of industrial trials and prototypes, as well as tests in real conditions that provide the necessary empirical background and comply with all the safety protocols for their later packaging and commercial scaling.
c) Promoting and accelerating the transformation of companies' operating models towards sustainable models that use hydrogen in their production processes. c) Promoting and accelerating the transformation of companies' operating models towards sustainable models that use hydrogen in their production processes.
d) Generating and strengthening alliances between industry actors, nationally and internationally, establishing their contribution to the project portfolio and/or to the expected results of the proposal.

5. EXPECTED RESULTS AND INDICATORS

5.1. Consider at least the following results:

a) Technological developments in pre-commercial or commercial stages focused on the adaptation and/or development of technological solutions including procedures to comply with safety standards and testing protocols and certification of results, making the proposed developments viable.
b) Testing of the developed technologies under real operation conditions for at least three months, with proven performance in the industrial environment to which the solution is targeted, together with a subsequent analysis of the effects on the eventual existing system or on the productive chain.
c) Massify the hydrogen uses and adoption demand in the national industry, establishing the initial state, challenge and/or gap to be addressed, defining a final objective and intermediate objectives.
d) Connection between companies in the sector targeted in the proposal, as well as suppliers of productive technological developments and others.
e) Transfer and business model operating for the different technological developments, which enable their implementation in the sector targeted in the proposal.
f) Contribution to the competitiveness of the sector and life quality of the territories, based on the technological developments and associated value chains.
g) Negative impacts avoided by the technological development and positive impacts achieved thanks to it.

h) Effective and efficient technological transfers from international alliances.
i) Technological solutions provided by regional and national associates.

5.2. Consider at least the following indicators:

a) Number of developments in TRL 8/9
b) Percentage (%) of investment in hydrogen infrastructure.
c) Quantity of new ventures with capabilities in zero emission technologies that contribute to increase the number of companies addressing the objective of the call as a spill over effect.
d) Estimated use of hydrogen (ton/year), as a result of the developments, during the execution of the programme by the participating companies.
e) Potential hydrogen usage (tonne/year) in the sector to which the technology will be transferred once the programme is completed.

6. PROPOSAL REQUIREMENTS

In the work plan structure, the submitted proposals must consider at least the following work lines associated to the projects in the portfolio:

6.1 Based on the main needs and technological solutions provided by the deployment of technological systems to address the production challenges of hydrogen use and adoption in industry, it shall:

1. Provide a diagnosis of the opportunities associated to the challenges of hydrogen use and adoption in companies of the targeted sector, estimating the impact of the deployment of the proposed technological programme to address these challenges from a productive point of view.
2. Provide a detailed description of the proposed technological solutions, including the parameters and critical factors for their performance, under the regulations and standards of the industry where they will be applied. The purpose of the above is to facilitate the later commercialisation of the technological solutions developed as part of the programme.
3. Provide the current technological strategies and models of the following aspects: (1) the management of productive systems associated with the use and/or adoption of hydrogen, (2) the suppliers and/or manufacturers of parts or components (OEMs) and, (3) the technical and methodological trends associated with the validation of the development of products and/or technological packages directly related to the guidelines of this Technical Guide.
4. Establish a baseline of the initial situation of each project of the portfolio in accordance with the detected needs of the companies, in order to know the contribution of each project in the defined production lines, and to the reduction or elimination of the gaps identified in this Technical Guide.
5. Identification of regional, national, and international technological associates, establishing their validation and viability of their technological solutions to solve the challenges of the companies linked to the selected sector.

6.2 Portfolio of projects that will address the gaps and/or challenges of Technologies[9] for the Use and Adoption of Hydrogen in the Industry, hereinafter "TUAHI".

1. Define and establish the strategies and action plans to adapt and/or develop solutions with TUAHI in those areas where, effectively, and demonstrably, there are no proven technologies available so far. They must indicate and justify the gaps and challenges that will be addressed and the technological milestones that will enable progress towards the commercial phase of the proposal.
2. Define a portfolio of projects that altogether can resolve the gaps and/or challenges associated with the sector(s) of the proposal, as stated in the previous point.
3. Determine the projects that will be part of the portfolio, as well as their objectives, based on the background information mentioned in numeral 6.1. above, through a TRL level definition.
4. Establish the main activities to be developed for the achievement of the objectives of each project, as well as their results and deadlines, among other aspects.
5. Define modelling systems, parameters measurement and critical factors for the evaluation of TUAHI performance based on the challenges currently presented by the companies of the targeted sector and the companies associated to the Technological Programme.

6.3 Conditions and capabilities´ development to enable scaling-up and commercialisation of results.

1. Develop and implement an effective and efficient linking methodology with companies (national and/or international) that belong to the targeted sector, in order to promote the advantages provided by the integration of TUAHI for productive transformation with the purpose of reducing the technological gaps and encouraging the adoption of the technology.
2. Generate alliances with local suppliers or other participants in the value chain to transfer their know-how and the usage, development, implementation and/or adaptation of TUAHI, which can be scaled up and commercialised, in order to increase the capacity to massify the use of the developed solutions in the companies of the selected sector.
3. Design and implement a strategic plan for the scaling and commercialisation of technology products.

6.4 Strengthening the technological programme management, through the following components:

6.4.1 Governance Model

The Governance Model must describe the decision-making process and the organisational structure established for the Programme's management, explicitly specifying the coordination mechanisms, giving particular emphasis to the following:

- Ensure a structure which provides interests between the sector/industry and other stakeholders, especially the competent authority.
- Consider operating models based on collaborative innovation.

[9] Set of industrial resources and processes of a given sector or product.

- Clear definition of roles of the management entity, the Board of Directors or Strategic Council, and the committees that are formed.
- Ensure transparency in administrative and financial aspects.
- Establish procedures for the resolution of possible conflicts.
- Ensure the active incorporation of women in the governance of the programme and in the team executing the programme's projects.

The Consortia will be managed by a Director/Manager proposed by the Technology Manager together with the Strategic Council, who shall have leadership, negotiation and management skills, market knowledge with experience in the industry, technology transfer knowledge and coordination skills of public-private entities and technical knowledge to work with the executors of the initiatives. The Programme should also consider governance with at least the following governance structures:

- **Strategic Council:** in addition to what is indicated in the guidelines of the technological programmes instrument, this council should consider 1 representative of the Subsecretariat of Economy, Development and Tourism and 1 representative of the Hydrogen Committee. Once 50% of the execution period has been completed, the incorporation of a representative of an investment fund or a specialist of the sector should be considered for a transitory participation who will guide the work team in the development of capacities for the negotiation process with the investment funds for the productive and commercial scaling up. In particular, this council will be responsible for monitoring the measuring of the scalable and marketable products' progress, in accordance with the information provided by the Technical Council, in order to accelerate the production of products that have been determined as competitive and commercially attractive.

- **Technical Council:** in addition to what is indicated in the guidelines of the technological programmes instrument, this council must consider 1 representative of the Subsecretariat of Economy, Development and Tourism. The purpose of this council is to control and verify that the results with the greatest commercialisation potential can be obtained within the established period and/or the critical factors for obtaining them are raised.

6.4.2 Policy of Intellectual property rights and technology transfer

- Definition of all the valuable results' ownership derived or produced with direct or indirect resources of this Technology Programme for the use and adoption of hydrogen in energy production, E.g., any request or registration of patents, creations, tangible or intangible developments and/or any other form of intellectual property that exists or may exist in the Technology Programme.
- Rules on joint ownership must be determined between the participants, considering previous contributions and those made during the Technology Programme for the Use and Adoption of Hydrogen in the Industry. Whenever there are two or more owners, someone needs to be individualized as responsible to protect intellectual property rights or to transfer or the commercialization of those rights.

- Information management and knowledge developed during each project through the following mechanisms E.g.: labelling the information according to the sensitivity level, custody of knowledge through physical, digital and legal means, set confidentiality clauses, demand written authorization for publications or presentations in order to prevent intellectual property rights violation, make the revelation of project´s results mandatory, keep record or a repository of intangible value activities in order to facilitate the management, valuation, protection and later transfer.
- Respect intellectual property rights, verifying the proper use of protected resources by others within the project through the necessary analyses in order to ensure future transfer of results obtained from the project.
- Someone in charge of the management, protection and knowledge and technology transfer which enable the TUAHI development.
- Design and set up strategies for the protection of TUAHI deployment, on the basis of the following: report on state of the TUAHI promotion technique (patents, markets, scientific information, etc.); competing technologies and competitiveness of them; market potential.
- Define rules for conflict of interest to ensure all participants favour program objectives over individual interests or those of organizations involved in the project development.
- Consider a forecasting technology model, specifying and extending its scopes to both the project level and the Technology Programme, clearly indicating, its indicators and the productive sector in which this model will be applied.
- The ownership associated with the TUAHI development components of the elaborated products and services shall be entirely at the disposal of the Technology Programme for the Use and Adoption of Hydrogen, guaranteeing that future incorporation of new modules during the implementation of the Technology Programme portfolio of projects is under no circumstances apprehended by the Technological Manager, as well as the information generated.

6.4.3 Quality Management System and regulatory frameworks associated with productive/environmental transformation activities through the deployment of TUAHI systems with productive purposes.

- Description of the preliminary strategy to set up a quality management system for the control of the technological development activities of the TUAHI with productive purposes in the Programme, using international best practices, specific requirements of the technologies/services to be developed and the potential customers/market, including all certifications and accreditations that shall be implemented.

- The previous requirements are needed so all generated developments can comply with target market demands, complying with the current regulatory framework so that they can be scaled up to be replicable and reproducible innovations in an efficient and effective manner.

6.4.4. Risk Management Plan

- Development of a risk management plan for the achievement of results and/or activities (related to objectives and results), identified risks, occurrence probability, programme impact, control mechanism and timeliness, mitigation actions, etc.

6.4.5. Communication Strategy and Diffusion of results to companies in the targeted economic sector.

- Create diffusion material.
- Presentation of the Portfolio of Technological Projects' results to companies in the targeted sector.
- Presentation and diffusion of TUAHI products/services for the implementation of productive transformation developed by the Technology Programme to tackle the challenges of the Use and Adoption of Hydrogen in the Industry.

6.4.6. Establish a measuring model of results and economic, ethical, social and environmental impact of the products and services developed, which considers at least the following.

- Develop and establish a methodology for the identification of causality concerning the planned developments of productive transformation technology under the Technology Programme for the Use and Adoption of hydrogen in production.
- Describe and determine indicators, verification methods and goals associated with the portfolio projects and/or the products developed for productive transformation through the deployment of the TUAHI.
- Identification and specification of data collection techniques, measuring and analysis units, among other relevant aspects, for the assessment of results and impacts of the products developed within the framework of the Technology Programme for the Use and Adoption of Hydrogen in Production.
- Indicate the analysis techniques (metrics) to be used in the definition of the results and impacts of the products developed.
- Consider a baseline survey to be provided by CORFO to the companies associated to the awarded proposal(s). This will be carried out both at the beginning of its execution, and during the progress and completion of each stage.

The previous aspects must be organised in accordance with the traditional programme measurement schemes, which correspond to the definition of the baseline (according to the characteristics defined in this technical guide), measurements of the progress of the programme and its portfolio, final and ex post (considering at least the results indicated in this technical guide).

In order to follow up and monitor the programme and its results and impacts, in addition to the model presented in the proposal, the Technological Capacities Division will apply a monitoring model based on the logical framework of the initiative (programme and project objectives), with the respective indicators

that the proposal establishes and others that the Corporation may request to be added. The above in accordance with what is described in numeral 11 of the General Administrative Guidelines.

7. FINANCING AND TIMELINES

Corfo will co-finance up to 60.00% of the total cost of the Technological Programme, with a ceiling of up to $3.500.000.000 (three thousand five hundred million Chilean pesos). With regard to the contribution of the participants:

Contribution Nature	Percentage
Minimum contribution of participating entities (including pecuniary and non-pecuniary cost. contributions)	A minimum **of 40% of the program's total**
Minimum pecuniary participation by participating entities.	A minimum **of 20% of the Program's total**

The Technological Programme may have a lifetime of up to 5 (five) years, considering at least 2 stages.