# INNOV-R

## FUNDING PROGRAM FOR COLLABORATIVE RESEARCH

## APPLICANT'S GUIDE

Fondsvert

Québec

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## 1. CONTEXT OF THE INNOV-R PROGRAM CALL FOR PROJECTS

Sustainable development in response to environmental concerns in general and to climate change in particular is viewed as one of the greatest challenges facing the world population in the 21st century. This has been a priority for over a decade now in Québec, which is taking action simultaneously on two fronts, namely reduction of its greenhouse gas emissions and increasing its capacity for adaptation to climate change. Québec has set very ambitious greenhouse gas emissions reduction targets of 20 % relative to the level of 1990 by the year 2020 and 37.5 % by the year 2030.

The carbon cap and trade market, the Green Fund and the CCAP 2013-2020 climate change action plan, under the responsibility of the *ministère de l'Environnement et de la Lutte contre les changements climatiques* (MELCC) and the Green Fund management committee, constitute the principal thrust of the Québec government's commitment to reducing greenhouse gas emissions.

## 2. REDUCING GREENHOUSE GAS EMISSIONS IN QUÉBEC: ALL SECTORS OF THE QUÉBEC ECONOMY ARE SOLICITED

The Québec economy as a whole will be mobilized to identify possible actions to undertake in order to reduce the province's emissions of greenhouse gases (GHG). Seven (7) Sectoral industrial research groups (SIRG) have been identified for the deployment of the INNOV-R research program. Financed by the Green Fund, this initiative will allow implementation of CCAP 2013-2020 action 4.4, which is intended to fund collaborative industrial research projects that promise to generate GHG-emissions-reducing technologies suitable for application in Québec.

The Québec government has designated these research groups as organisations mandated to oversee the arrangement and financing of collaborative R&D. They are thus expected to foster knowledge transfer and the appropriation of innovative technologies by businesses in various key sectors of the Québec economy. These seven groups are described in Appendix A.

## 3. ADMISSIBLE COLLABORATIVE RESEARCH PROJECTS

To be admissible for funding through the INNOV-R program, an R&D project must display significant potential for the development of a technology or practice applicable to GHG emissions reduction in Québec.

Projects will be admissible in either of two categories, as a function of the technological readiness level (TRL) according to the current definitions: projects at TRL 1–3 and projects at TRL levels 4–6.

Definition of technological readiness level (TRL)

- TRL 1–3: Laboratory-scale proof of concept
- TRL 4–6: Validation and demonstration in a simulated operational environment (e.g. pilot scale)

Projects must involve the participation of a business established in Québec and conducting in-house production or R&D activities and of at least one university, College Centres for the Transfer of Technologies (CCTT) or public research centres. Other partners such as non-profit organizations, Crown corporations, public entities, municipalities, businesses outside of Québec and others may also be involved in the project.

## 4. REIMBURSABLE EXPENDITURES AND PROJECT MANAGERIAL FEES

### 4.1 Reimbursable expenditures

Reimbursable expenditures include direct costs incurred by the institutional partner (university, CTTC or public research centre) in the course of carrying out the research project. These are as follows:

- Salaries, remuneration and benefits
- Student bursaries
- Supplies, consumable products and lab-ware
- Equipment rentals
- Managerial fees
- Intellectual property usage fees
- Professional fees
- Travel and lodging costs
- Knowledge dissemination costs
- Cost of access to technological platforms

In-kind contributions from the business and partners are considered eligible expenses for the project. These in-kind contributions are allowed if:

1. The expenses are auditable (their value can be reasonably established and supported by supporting documents);
2. They are essential for the realization of the selected project;
3. They correspond to expenses incurred specifically to carry out the project;
4. They represent an element for which it would otherwise be necessary to pay at equal or greater cost.

### 4.2 Indirect costs of research

Indirect costs (university overhead costs) shall be reimbursed at the flat rate of 27 % of the project direct costs in the following categories:

- Salaries, remuneration and benefits
- Student bursaries
- Supplies, consumable products and lab-ware

### 4.3 Managerial fees

A managerial fee equal to 5 % of eligible project expenses will be charged to offset the cost of administering the program. The amount payable (including the applicable taxes) will be divided between the MEI (3 %) and the industrial partners (2 %).

## 5. TERMS OF FINANCING BY INNOV-R

| Technological readiness level (TRL) | 1 to 3 | 4 to 6 |
|---|---|---|
| Minimal number of companies located in Québec | 1 | 1 |
| Admissibility of a business located outside of Québec | Yes, as 2nd business | Yes, as 2nd business |
| Admissibility of "other partners" (NPOs, Crown corporations, public entities, municipalities, others) | Yes, as 2nd partner | Yes, as 2nd partner |
| Minimal number of Québec public research institutes or QPRI (university, CTTC or public research centre) | 1 | 1 |
| Maximal funding by INNOV-R, % of reimbursable expenditures | 50 %, increased by 10 % if businesses from 2 industrial sectors participate | 50 % |
| Minimal funding input from business and other partners | 20 % of reimbursable costs, of which up to 50 % may be in kind | 40 % of reimbursable costs, of which up to 50 % may be in kind |
| Sources of complementary funding strongly encouraged | NSERC (CRD, ARD, Canada research chairs, industrial research chairs, etc.), NRC-IRAP, MITACS, other sources (municipal, provincial or federal) | |
| Maximal duration of projects | 3 years | 3 years |
| Maximal INNOV-R funding (may vary depending on the industrial sector) | Up to $500,000/y ($1.5 million maximum) | Up to $500,000/y ($1.5 million maximum) |

## 6. PROJECT EVALUATION CRITERIA

Projects submitted for INNOV-R funding will be evaluated in two (2) stages, the first being scientific evaluation, which will contribute 50 % of the final score, followed by evaluation of the potential for GHG emissions reduction in Québec, which will contribute the remaining 50 %. Two (2) forms must be filled out: the general application form from the sectoral industrial research group (SIRG) to which the project is submitted, and the appended INNOV-R form.

These two forms each have a distinct purpose. The industrial sector general application form contains information about the R&D project to be funded. The INNOV-R form appended thereto contains an estimation of the potential for GHG emissions reduction during the first 10 years of commercial use of the innovation to be developed in the course of the research project.

### a) Scientific evaluation of the proposed project

A techno-economic committee representing the industrial sector to which the project is submitted will be constituted for the purpose of this evaluation. The scientific evaluation criteria are as follow:

- Scientific merit
- Degree of innovation
- Quality of the research team
- Ability of completing the project
- Expected benefits for the industrial partners
- Quality of the public-private partnership
- Expected scientific and technological advancement
- Expected social, economic or other benefits for Québec society

### b) Evaluation of the potential for GHG emissions reduction in Québec

A committee composed of experts in greenhouse gases will perform this evaluation. This committee will evaluate specifically the section "Potential for GHG emissions reduction" of all projects submitted, regardless of which SIRG is concerned. The evaluation criteria for the GHG aspect are as follows:

- Demonstration of the aptness of the proposed innovation to reduce GHG emissions in Québec during the first 10 years of its commercial use (40 points)
- Estimation of the quantity of GHG emissions to be eliminated or avoided, in metric tons of $CO_2$ equivalents per year in Québec (10 points)
- Estimation of the cost per metric ton of eliminated or avoided emission of $CO_2$ equivalents in Québec (10 points)
- Risks inherent in the implementation of the technology
  - How much further development is needed for commercialisation (10 points)
  - Scale of the investments needed for commercialisation (10 points)
- Quality of the methodology used with reference to part 2 of ISO standard 14064-2 for demonstrating GHG reduction potential
  - Realism of the hypotheses (10 points)
    Example:
    - Is the predicted penetration of the market by the innovation realistic?
    - Is the projected sales growth plausible in terms of commercialisation and licensing?
    - Others.
  - Rigor in the estimations (10 points)
    Example:
    - Have the applicants applied the precautionary principle set forth in the ISO standard?
    - Have they used the proper conversion factors?
    - Others.

## 7. GUIDELINES FOR FILLING OUT THE APPENDIX INNOV-R FORM

This section lists the information to be provided in the application form "Potential for GHG emissions reduction in Québec" (Appendix INNOV-R).

### Section 1. Identification

Since the INNOV-R form is appended to the general application form, this section must be filled out completely.

### Section 2. Selection of the applicable industrial research sector

Check (☑) the box corresponding to the **sectoral industrial research group** (SIRG) to which you are submitting your application for funding.

### Section 3. Demonstration of the aptness of the proposed innovation to reduce GHG emissions in Québec during the first 10 years of its commercialisation phase

In this section, the applicant must explain how the proposed innovation will lead to reductions in GHG emissions in Québec if it is commercialized or otherwise implemented. This must be in reference to the principles of standard ISO-14064-2. The applicant must state clearly the hypotheses, methods, criteria and calculations used to estimate the reductions in GHG emissions to be achieved in Québec thanks to the project. For the purposes of the INNOV-R program, the estimated quantities of GHG must be expressed in metric tons of carbon dioxide equivalents.

#### 3.1 Context of the research project and statement of the GHG-emissions-associated problem

Present the context of the research project and the current issue related to GHG emissions that is being addressed. Identify the current conditions, including regulations, market, and any other relevant elements before the start of the project, as well as the reasons for quantifying the GHG emission reductions in Quebec. If the project is part of a broader initiative, summarize the overall initiative.

#### 3.2 Description of the proposed solution

Introduce the solution, that is, the new or improved technology or practice, the use of which will result in a reduction of GHG emissions compared to existing solutions. Explain how the research project solution could reduce emissions, for example compared to current practices.

#### 3.3 Reference scenario

Present and justify the reference scenario, that is, the technology or process that would likely be used in the absence of the proposed solution. The baseline scenario should provide a description of the intended market for the solution. It starts in the first year of marketing, after the remaining development period (see section 4.1). The reference scenario must present an annual portrait of GHG emissions in Québec over 10 years.

The reference scenario is chosen on the basis of known information and must respect the precautionary principle. In the case of a lack of data, conservative assumptions, values and procedures can be used to ensure that the GHG emission reduction calculation is not overestimated.

### 3.4 Estimation of the reduction or avoidance of GHG emissions (in metric tons of $CO_2$ equivalents per year) that could be achieved in Québec by implementing the innovation

Based on the elements in the previous sections and Section 4.2, estimate the amount of GHG emissions that can be reduced or avoided during the first 10 years of the solution's commercialization phase. GHG emissions in Appendix B). This estimate includes a high level of risk and uncertainty (see Section 4).

First, present the methodology, the assumptions and the calculation to the estimate of the GHG emissions quantity of the solution and the reference scenario (in tons of CO2e / year). Referring to ISO-14 064-2, identify and quantify GHG emissions for all sources, sinks and reservoirs (SPR) related to the solution. Refer to the Appendix for more details on the quantification of SPRs. The precautionary principle must be applied so as not to overestimate the reductions or the absorption gains.

In a second step, present the calculation to the estimate of the quantity of GHG emissions using solutions or emissions in Quebec, thanks to the solution (in tons of CO2). This calculation is done in the ratio between the estimate estimates for the baseline scenario and the estimates for the solution.

Note that the evaluation focuses on the speed of the estimated reductions (evaluators determine whether or not)

### 3.5 Estimation of the cost per metric ton of $CO_2$ equivalent eliminated or avoided in Québec

Based on the elements presented in the previous sections, as well as in section 4.2, estimate the cost per tonne of CO2e reduced or avoided in Quebec during the first 10 years of the commercialization phase of the solution (see cost per tonne in Annex B). Present the calculation and the assumptions leading to the ratio between the cost of the solution and the tonnes of CO2e reduced or avoided in Quebec during the first ten years of commercialization. This estimate necessarily includes a high level of risk and uncertainty (see Section 4).
Note that the evaluation addresses the significance of the costs of achieving the solution (ie evaluators will determine whether the cost per tonne is high or not).

## Section 4. Risks inherent in implementing the innovation

The following two (2) criteria are intended to assess the uncertainties and risks surrounding the marketing and transfer project. It is strongly suggested to include the solutions envisaged to overcome the uncertainties identified. In this section, indicate how, once the research project is completed, the development of the solution will continue duration of development remaining (4.1) and scale of investments required (4.2).

### 4.1 How much more development is needed to make the innovation ready for the market?

This is the time between the end of the research project and the start of sales, this criterion reflects the timing of the commercialization scenario. Describe how the solution will be progressively transferred to the identified market. Present the steps remaining before the marketing and transfer and the estimated duration of these.

Note that the longer this period is, the higher the risk and this could be reflected in the evaluation of this section. It is strongly suggested that solutions be considered to mitigate the identified risks.

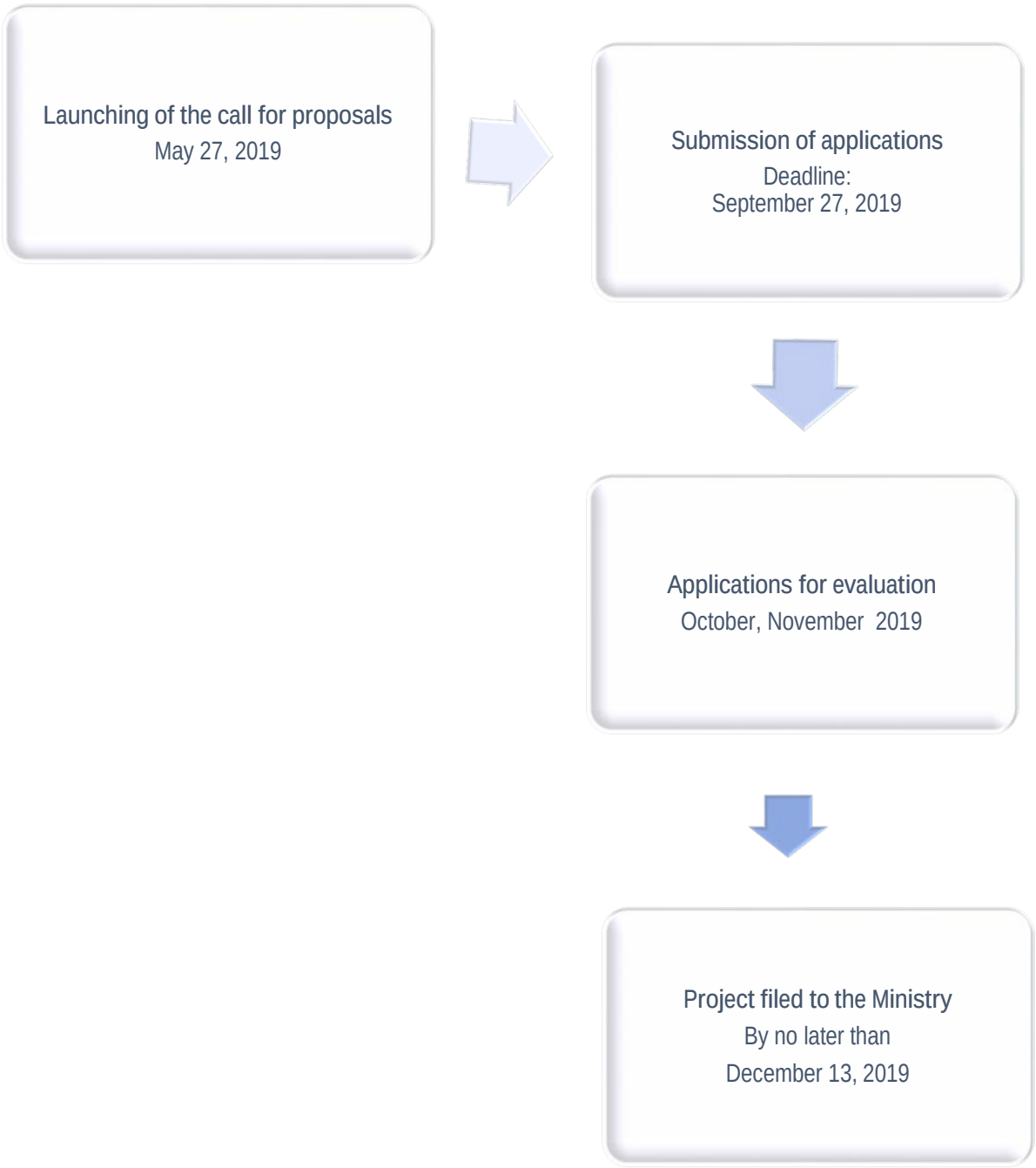
### 4.2 Estimate the amount of investment needed in order to commercialise the innovation

Describe the investments needed to commercialize the solution, including forecasts of market penetration and annualized sales projections. Describe how the solution will progressively enter the market, for example by replacing existing technologies or practices and thereby reducing GHG emissions. The commercialization of the solution begins after the remaining development period (section 4.1).

Note that the evaluation will consider the realism of the assumptions presented regarding the forecast of market penetration or sales growth, for example. Thus, the higher the investment required after the end of the research project, the higher the risk of the commercialization and transfer project. It is strongly suggested that solutions be considered to mitigate the identified risks.

8. Call for proposals calendar

*Please note that the process may vary depending on the SIRG to which the proposal is applicable.*



# APPENDICES

# Appendix A - Industrial research sectors (SIRG)

## Innovation in electrical energy (InnovEE)

The mission of InnovÉÉ is to support the development and financing of collaborative projects relating to the electrical industry, intelligent networks, electrification of transportation and connected vehicles by pooling the expertise and resources of industrial partners and research institutions.

Funding is offered for R&D projects aimed at developing new technologies relating to:

- Electrification of transportation (land, rail and floating)
- Autonomous vehicles and intelligent transport systems
- Reduction of vehicle weight
- Production of electricity (hydraulic, solar, wind, etc.)

Transportation, distribution, storage and optimized use of electrical energy

Contact:
Maxim Doucet, project lead
✆514 416-6777 extension 205, mdoucet@**innov-ee.ca**

## CRIBIQ (CONSORTIUM DE RECHERCHE ET INNOVATIONS EN BIOPROCÉDÉS INDUSTRIELS AU QUÉBEC)

The mission of the CRIBIQ is to unite businesses and public research institutions in order to create value through the promotion of innovation and funding of collaborative research projects in the fields of bio-sourced products and bioprocesses, with particular emphasis on 3 industrial sectors:

- Industrial bio-products (bio-energy, bio-sourced chemicals, bio-sourced materials)
- The environmental sector
- The bio-agri-food sector

Contact:
Hari Randrianarisoa, Ph. D, Innovation and business development advisor – greenhouse gases sector
✆ 418 914-1608 poste 208 – hari.randriana@cribiq.qc.ca

## PROMPT

PROMPT is an industrial research consortium in the field of digitization and information and communications technologies in Québec. It promotes the creation of partnerships and provides resources for project design as well as funding of R&D involving industrial and institutional research groups. Projects in all sub-sectors of this vast domain may be funded, including development of software, hardware, components, networks and applications. As innovation brokers, PROMPT aims to revitalize the ICT innovation and collaborative research network. With financial support from the government of Québec and the private sector, PROMPT stimulates the creation of new alliances that improve the R&D capabilities of Québec businesses, stimulates private-sector investment in research and fosters the development of highly qualified personnel to maintain or increase the competitiveness of Québec. PROMPT is a proud partner of TechnoPolys and of QuébecInnove.

Contact:
Madeleine Jean, vice-president, operations and business development
✆ 514 875-0032, mjean**@promptinnov.com**

## CRIAQ (CONSORTIUM DE RECHERCHE ET INNOVATION EN AÉRONAUTIQUE AU QUÉBEC)

The CRIAQ is a unique model of collaborative research led by businesses of all sizes and mobilizing the resources of universities and research centres. It promotes collaboration between industry and full-time scientists to optimize the design and execution of developmental projects focused on industrial needs.

Through the CRIAQ, businesses have access to the knowledge and skills of renowned researchers and to financial resources that allow them to upgrade considerably their initial R&D budget.

A CRIAQ-funded research project must meet the criteria of one of its two programs:

- Low TRL program (TRL 2–4)
- Intermediate TRL program (TRL 4–6)

Contact:
Clothilde Petitjean, Director of programs
✆ 514 313-7561, ext. 2408 - clothilde.petitjean@criaq.aero

## PRIMA Québec (PÔLE DE RECHERCHE ET INNOVATION EN MATÉRIAUX AVANCÉS DU QUÉBEC)

PRIMA Québec (advanced materials research hub) supports and vitalizes the advanced materials research network, a motor of innovation and growth for the Québec economy. By providing guidance and financing, it contributes to maintaining and improving the competitiveness of Québec businesses by allowing them to benefit from research expertise.

Its high-priority themes are the development of new materials, formulation of high-performance materials or products, additive manufacturing, surface treatments, novel techniques of characterization/simulation. The targeted sectors of application are primarily transportation, infrastructures, energy, environmental protection, microelectronics, telecommunications, health, chemicals and textiles.

Contact:
Michel Lefèvre, B. eng., Ph.D., chief advisor in technology and innovation
✆ 514 284-0211, extension 231, michel.lefevre@**prima.ca**

## CRITM (CONSORTIUM DE RECHERCHE ET INNOVATION EN TRANSFORMATION MÉTALLIQUE)

The non-profit organization CRITM (metal-works research and innovation consortium) is the 9th industrial research sector recognized and financed by the Québec government.

The mission of CRITM is to grow the wealth of metal-works businesses by supporting innovation. It thus contributes to the success of applied research projects involving businesses and research institutions in the following areas:

- Process development
- Design of advanced metal products
- Reduction of ecological impact
- Reduction of energy consumption

Contact:
Jean-François Pouliot, CEO
✆ 418-914-1163 - jfpouliot@critm.ca

Mariem Zoghlami, project manager
✆ 418 914-1163, mzoghlami@**critm.ca**

## CQRDA (CENTRE QUÉBÉCOIS DE RECHERCHE ET DE DÉVELOPPEMENT DE L'ALUMINIUM)

Created in 1993, the CQRDA (Québec centre for aluminum research and development) actively supports networking between small-to-medium-sized businesses, teaching institutions and both public and private-sector research centres in Québec.

The CQRDA provides technical and financial support for creative and innovative promoters of R&D projects that propose promising new uses for aluminum.

Through its R&D watch and networking activities, the Centre has spent the past 25 years seeing to the productive transfer of knowledge and know-how and of new technologies that are contributing to the wealth of Québec.

The CQRDA is an invaluable reference on current progress in the Québec aluminum industry.

Contact:
France Tremblay, director of networking and guidance
✆ 418 545-5520, france.tremblay@**cqrda.ca**

## Appendix B - Explanation of GHG Assessment Criteria

The three criteria below constitute the "capacity" of the solution to reduce GHG emissions in Quebec. The demonstration makes it possible to arrive at the two estimates requested.

Demonstration of the aptness of the proposed innovation to reduce GHG emissions in Québec during the first 10 years of its commercial use (40 points);

- The researcher presents a current issue regarding GHG emissions. He explains how the solution targeted by his research project could reduce emissions, for example compared to current practices.
- He explains how, once the project is finished, the development of the solution will continue during of the remaining development and scale of the necessary investments.
- After indicating the duration of the remaining development, this indicates the year in which the reference scenario and the marketing and transfer project begin.
- In the reference scenario, a description of the market for the solution should be indicated.
- In the commercialization and transfer project, the researcher describes how the solution will progressively enter this market, for example by replacing existing technologies or practices and thereby reducing GHG emissions. The researcher should include a market penetration rate and annualized sales forecast.
- The demonstration makes it possible to arrive at the two estimates mentioned in the following points. It necessarily includes a high level of risk and uncertainty.

Estimation of the quantity of GHG emissions to be eliminated or avoided, in metric tons of CO2 equivalents per year in Québec (10 points)

- Definition on appendix C.
- The evaluation addresses the scope of the estimated reductions (ie the evaluators will determine whether or not the estimated quantity is high in the context of the submitted project)

Estimation of the cost per metric ton of eliminated or avoided emission of $CO_2$ equivalents in Québec (10 points)

- Definition on appendix C.
- The evaluation addresses the significance of the costs of achieving the solution (ie the evaluators will determine whether the cost per tonne is high or not in the context of the submitted project)

Risks inherent in the implementation of the technology:

The following two (2) criteria are intended to assess the uncertainties surrounding the marketing and transfer project. It is strongly suggested to include the solutions considered to overcome the uncertainties identified.

Duration of development remaining before commercialization (10 pts);

- This is the time between the end of the research project and the start of sales.
- This criterion reflects the timing of the commercialization scenario.
- The longer this period is, the higher the risk and this could be reflected in the evaluation of this section.

Scale of the investments needed for commercialisation (10 points);

- If the investments required after the end of the research project are high, this increases the risk of the commercialization and transfer project.

Quality of the methodology used with reference to part 2 of ISO standard 14064-2 for demonstrating GHG reduction potential:

These criteria are designed to evaluate the rigor of the demonstration.

Realism of the hypotheses (10 pts);

- Examples:
  - Is the prediction of the market penetration rate by the solution is realistic?
  - Is sales growth in the marketing and transfer project plausible?
  - etc.

Rigor in the estimates (10 pts);

- Examples:
  - Has the ISO concept of caution been applied?
  - Were the correct conversion factors used?
  - etc.

# Appendix C - Helpful definitions

### Commercial use or licensing of (the innovation)

This refers to GHG emissions in Québec over a period of 10 years if the developed innovation is progressively purchased, licensed, adopted or otherwise utilized by the milieu concerned.

### Estimation of the quantity of GHG emissions to be eliminated or avoided, in metric tons of $CO_2$ equivalents per year in Québec

This is best expressed as the GHG emissions attainable by commercializing the innovation relative to emissions produced under the reference scenario.

### Estimation of the cost per metric ton of eliminated or avoided emission of $CO_2$ equivalents in Québec

This is best expressed as the cost of implementing the innovation relative to the metric tons of $CO_2$ equivalents eliminated or avoided in Québec during the lifetime of the innovation.

### Further development needed; ready for the market

These expressions refer to the period between the end of the research project and the beginning of the commercial use (or licensing) of its results.

### Innovation

New or improved technology or practice, of which the utilization brings about a reduction in greenhouse gas emissions relative to existing practices

### Reference scenario

This should be a portrait of annual GHG emissions over a 10-year period if the innovation were not purchased, adopted or utilized by the milieu concerned.

### Research project

Project carried out over a two-year or three-year period, during which a technological innovation is developed or an existing technology is substantially improved

### Reservoir

A physical entity or component of the biosphere, the geosphere or the hydrosphere, capable of storing or accumulating a greenhouse gas withdrawn from the atmosphere by a sink or captured at the source

### SIRG

Acronym for *"sectoral industrial research group"*, an administrative grouping of industrial concerns designated as promoters of R&D in a sector of strategic importance to Quebec

### Sink

A physical entity or process that removes a greenhouse gas from the atmosphere

### Sources

Physical entities or processes that emit greenhouse gases into the atmosphere

# Appendix C - Estimation of the potential for GHG emissions reduction in Québec

The estimation of the potential for GHG emissions reduction must take into consideration the principal effect, that is, all emissions and/or removals due to sources, sinks and reservoirs associated with the innovation.

If known sources, sinks or reservoirs relevant to the project are not included in the quantification, explain why not [e.g. quantity of GHG emissions is negligible, relevant and reliable information is too difficult to obtain, the innovation will have no impact on emissions via the source, sink or reservoir, etc.].

## Methodology for identifying the relevant sources, sinks and reservoirs

It is recommended that a systematic approach be used to identify the sources, sinks and reservoirs that are relevant to the innovation.

The following steps may be helpful for estimating the energy and material flows associated with the innovation as well as all activities carried out before, during and after the periods upstream and downstream from the implementation of the innovation:

1. Identify the applicable model, based on the project activities.
2. Identify the principal activities that define the goal of the project [e.g. production of innovative materials by the project promoter].
3. Identify the inputs and outputs [materials, energy] associated with the principal activities.
4. Identify other project activities by performing a follow-up analysis of the input and output materials and energy flows throughout the product or process lifecycle.
5. Examine all energy flows of all activities to ensure that all relevant activities have been identified.

Once the sources, sinks and reservoirs have been identified, these may be categorized according to their status as:

- Controlled: GHG sources, sinks and reservoirs of which the functioning is under the direction or influence of the project leader with regard to GHG emissions through financial mechanisms, managerial policies or others.
- Associated: GHG sources, sinks and reservoirs having input, output or internal material or energy flows that are not under the direct control of the project but are associated with the GHG emissions of the project.
- Affected: GHG sources, sinks and reservoirs influenced by project activity through physical removal or through modification of market supply and demand for products or services that are associated.

In order to show the rigor of the estimations, justifying the inclusion or exclusion of sources, sinks and reservoirs in the quantification of GHG emissions is recommended. This may be presented as a Table that lists, describes and categorizes the sources, sinks and reservoirs as well as the justification.

## Quantitative estimation

The quantitative estimation of the potential for GHG emissions reduction is provided on a differential basis. GHG emissions estimated for the reference scenario are subtracted from those estimated for the innovation. Only those processes and activities that are modified relative to the reference scenario are thus quantified.

In general, a common measurement or unit of measurement [such as surface area covered or the volume of manufactured product] is used for the comparison of the innovation to the reference scenario in terms of emissions.

The chosen emissions factors must be of recognized origins and must be appropriate for the type of activity considered at the moment of quantification. The references listed in Appendix D include reliable sources for the choice of emissions factors.

## Global warming potential [GWP]

The concept of "global warming potential" has been devised to allow scientists and decision-makers to compare and rank greenhouse gases in terms of relative atmospheric heat-trapping (retaining) capacity. By definition, the GWP is the change in radiative forcing of atmospheric temperature due to the instantaneous emission of 1 kg of gas expressed relative to the radiative forcing of the liberation of 1 kg of $CO_2$. In other words, the GWP is a relative measurement of the warming effect that emission of a radiative heat-transferring gas (greenhouse gas) would have on the surface troposphere. The GWP of a GHG takes into consideration both the instantaneous radiative forcing due to a progressive increase in its atmospheric concentration and its half-life in the atmosphere. The 100-year GWP values recommended by the Intergovernmental Panel on Climate Change [IPCC] in its assessment report published in 2007 and used for the establishment of inventories under the United Nations Framework Convention on Climate Change [UNFCCC, adopted by the Parties at the third conference] may be used as a source of information.

The INNOV-R program refers to the GWPs in the IPCC 2007 assessment report [Table below] along with the Québec GHG emissions inventory published in 2014. However, it should be noted that the rule on mandatory declaration of atmospheric contaminants (Règlement sur la déclaration obligatoire de certaines emissions de contaminants dans l'atmosphère] and programs offered by the Québec ministry of energy and natural resources [MERN] refer to the factors published in the IPCC assessment report published in 1995.

Table: Global warming potential [GWP][1]

| GREENHOUSE GAS | CHEMICAL FORMULA | 100-YEAR GWP |
|---|---|---|
| Carbon dioxide | $CO_2$ | 1 |
| Methane | $CH_4$ | 25 |
| Nitrous oxide | $N_2O$ | 298 |
| Nitrogen trifluoride | $NF_3$ | 17,200 |
| Sulphur hexafluoride | $SF_6$ | 22,800 |
| HYDROFLUOROCARBONS [HFCS] | | |
| HFC-23 | $CHF_3$ | 14,800 |
| HFC-32 | $CH_2F_2$ | 675 |
| HFC-43-10-mee | $C_5H_2F_{10}$ | 1,640 |
| HFC-125 | $C_2HF_5$ | 3,500 |
| HFC-134a | $C_2H_2F_4$ [$CH_2FCF_3$] | 1,430 |
| HFC-143a | $C_2H_3F_3$ [$CF_3CH_3$] | 4,470 |
| HFC-152a | $C_2H_4F_2$ [$CH_3CHF_2$] | 124 |
| HFC-227ea | $C_3HF_7$ | 3,220 |
| HFC-236fa | $C_3H_2F_6$ | 9,810 |
| HFC-245fa | $C_3H_3F_5$ | 1,030 |
| PERFLUOROCARBONS [PFCS] | | |
| Perfluoromethane | $CF_4$ | 7,390 |
| Perfluoroethane | $C_2F_6$ | 12,200 |
| Perfluoropropane | $C_3F_8$ | 8,830 |
| Perfluorobutane | $C_4F_{10}$ | 8,860 |
| Perfluorocyclobutane | c-$C_4F_{10}$ | 10,300 |
| Perfluoropentane | $C_5F_{12}$ | 9,160 |
| Perfluorohexane | $C_6F_{14}$ | 9,300 |

[1] Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2007: The Physical Science Basis: The Working Group I*, contribution to the IPCC Fourth Assessment Report, Table 2.14, https://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html, consulted in April 2018.

# Appendix D - References

Here are a few helpful and/or practical references:


- ISO 14064-2: 2006. Greenhouse gases – Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements [https://www.iso.org/standard/38382.html]
- ECOinvent center. https://www.ecoinvent.org/
- Environment Canada: National Inventory Report 1990-2016. https://www.canada.ca/fr/environnement-changement-climatique/services/changements-climatiques/emissions-gaz-effet-serre/sources-puits-sommaire-2018.html
- Règlement sur la déclaration obligatoire de certaines émissions de contaminants dans l'atmosphère, Québec. http://legisquebec.gouv.qc.ca/fr/ShowDoc/cr/Q-2,%20r.%2015
- IPCC – Intergovernmental panel on climate change. http://www.ipcc.ch/index.htm
- Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques. (2018). *Inventaire québécois des émissions de gaz à effet de serre en 2015 et leur évolution depuis 1990* http://www.mddelcc.gouv.qc.ca/changements/ges/2015/inventaire1990-2015.pdf
- Chaire de gestion du secteur de l'énergie. (2019). *État de l'énergie au Québec* http://energie.hec.ca/wp-content/uploads/2019/05/EEQ2019_EN_WEB.pdf
- Plan d'action sur les changements climatiques [PACC-GES] 2013-2020 – MDDELCC http://www.mddelcc.gouv.qc.ca/changements/plan_action/pacc2020.pdf