Evaluation of the SD Tech Fund™ of Sustainable Development Technology Canada

Second Interim Evaluation Report

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Technology Canada

Robinson Research, in association with
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I INTRODUCTION AND HIGHLIGHTS

A. SUSTAINABLE DEVELOPMENT TECHNOLOGY CANADA

The Government of Canada created and financed a foundation, Sustainable Development Technology Canada (SDTC) to "act as the primary catalyst in building a sustainable development technology infrastructure in Canada." The Act establishing the foundation came into force on 22 March, 2002.[1]

The first Funding Agreement, which was signed on 26 March 2001, provided a grant of $100 million that was to be invested over five years. The agreement specified that funds should be available for new projects until at least 31 December 2005, should be disbursed by December 2008 and over the life of the agreement, 80% of the funds should support projects that address climate change issues and 20% should primarily support clean air projects.[2] The agreement specified the purpose of the Fund as follows:

(a) fund the development and demonstration of new Sustainable Development technologies related to climate change and clean air, in order to make progress towards Sustainable Development;

(b) foster and encourage innovative collaboration and partnering amongst diverse Persons in the private sector and in academic and not-for-profit organizations to channel and strengthen the Canadian capacity to develop and demonstrate Sustainable Development technologies with respect to climate change and clean air; and

(c) encourage rapid diffusion of the new Sustainable Development technologies in all sectors throughout Canada.[3]

On March 31, 2004 an amendment to the Funding Agreement provided an additional $250 million. This agreement directed that the funds should be available for projects up to at least 31 December, 2007 and that the funds should be totally disbursed by December 2009. The amendment maintained the focus of the funding at 80% for climate change and 20% for clean air projects. In addition, it specified that over the life of the agreement, SDTC should make available at least $50 million for projects directed

[1] *Canada Foundation for Sustainable Development Technology Act*, S.C. 2001, c. 23.
[2] *Funding Agreement Toward the Sustainable Development Technology Fund,* 26 March 2001, Section 4.01.
[3] This statement of the purpose of the fund appears in Section 2.01 of each funding agreement.

to the hydrogen economy and another $50 million for projects related to clean fossil fuels.[4]

One year later on March 31, 2005, a third Funding Agreement came into effect. This agreement provided an additional $200 million which is to be directed to projects that are primarily focused on clean water or clean soil, based on the demand and the merit of the proposals received.[5] The agreement extended the period for funding new projects to December, 2010 and directed that the Foundations should endeavour to disburse project funds each year until 2012 and to disburse all project funds by December 2012.

The Funding Agreements set out in detail the procedures, contracting conditions and the like that SDTC must follow. Briefly, at least once per year[6] SDTC must conduct calls for Statements of Interest (SOI) from proponents who propose to develop qualifying new technologies. An assessment of the SOIs identifies promising projects and the proponents of those projects are invited to submit full proposals which must meet a number of conditions, for example describing the work to be done, the involvement of a consortium which typically includes an end user of the technology and projecting eventual market performance and environmental impacts. A technical and business review and due diligence procedure identifies successful proposals. Approved projects must enter into contracts that meet a number of conditions including specifying eligible costs, project milestones and the involvement of the consortium. Upon completion of the project, proponents must submit a final report that specifies the project results and updates the market and environmental projections for the technology.

The Funding Agreements also require that SDTC develop an evaluation framework and complete two independent interim evaluations and a final evaluation.

B. THIS REPORT

The Funding Agreements require that the interim evaluations should "assess whether the Fund is meeting its purposes and objectives and, to the extent possible, whether adjustments to the program can and should be made." They should "focus on the administration of the Fund and provide commentary on the overall operation of the Foundation in meeting the purposes of the Fund as outlined in Section 2.01, including an evaluation, in aggregate, of the Project Impact and Market Impact, of Funded Projects by Market Sector as estimated as of the date of the evaluation."[7]

[4] *Amended and Restated Funding Agreement Pertaining to the Sustainable Development Technology Fund*, 31 March 2004, Section 9.01 to 9.04.
[5] *Funding Agreement Three Pertaining to the Sustainable Development Technology Fund*, 31 March, 2005, Sections 4.02, 9.01, 9.04.
[6] SDTC has chosen to conduct two funding rounds per year.
[7] *Funding Agreement Three Pertaining to the Sustainable Development Technology Fund*, 31 March, 2005, Article 10.10.

The First Interim Evaluation was presented to Government in June 2006. This report responds to that requirement for a second interim evaluation for operations up to 31 December, 2008. The timing of this report, just over two years before all funds are to be committed to projects, suggests that the report could inform any consideration of recapitalizing the Fund. Our work has been conducted with that possible use of the report in mind.

Since the report for the First Interim Evaluation was completed, SDTC launched a second fund, the $500 million Next Generation Biofuels Fund™ (NGBF). The NGBF supports the establishment of first-of-kind commercial scale demonstration facilities for the production of next-generation renewable fuels and co-products. These next-generation technologies, which are capital equipment intensive, were not progressing to market because they present too great a risk for the debt finance community. The result is a High-Capex (Capital Expenditure) gap. The aim of the NextGen Biofuels Fund is to help bridge this gap and remove the final elements of technology risk in bringing next-generation biofuels into the market.

When the first interim report was written, SDTC had only one fund. Accordingly, that report did not differentiate between SDTC and the Fund. In recognition of the presence of the NGBF, this report adopts different terminology, using the recently-adopted name for the Fund that is the subject of this report, the SD Tech Fund™. We should note that those SD Tech Fund projects that support the development and demonstration of biofuel technologies may wish to proceed to market with support from the NGBF for a first market-scale plant. However some SD Tech Fund projects that employ other technologies with capital requirements of the same order as biofuel technologies will not have access to the NGFB funds.

C. HIGHLIGHTS

1. Methods

SDTC convened an Evaluation Advisory Committee of departmental officials, a member of the SDTC Board of Directors and representatives of industry and the investment community to review the work plan for the evaluation. That plan, modified in response to the input from the committee, has guided the work of this evaluation.

The evaluation draws upon a number of information sources including:

- **Key informant interviews.** The principal investigator for the evaluation completed over 30 personal interviews with key informants, senior officials of government departments and representatives of the investment community and stakeholder organizations.
- **Interviews of project proponents.** Our associates at TNS Canadian Facts conducted telephone interviews of proponents whose proposals were not

successful and who were not planning to re-submit a revised proposal. Also the survey attempted to interview non-respondents from the 2006 survey, for a total of 44 qualified candidates for the interview. The interviewers made extensive efforts to locate and interview proponents and ultimately achieved a 72% response rate. TNS used a combination of internet and telephone techniques to interview proponents of successful proposals, with 79 qualified respondents. This survey also achieved a 72% response rate.

- **Administrative data.** SDTC provided numerous documents and special tabulations of project data. SDTC also provide information from subscription services that provide data and reports on venture capital activities.
- **Case studies of completed projects.** We completed case studies for 16 completed projects. In each case we interviewed the project proponent and some members of the project consortium.
- **Cost Benefit analysis. We conducted a cost-benefit analysis** of 25 completed or near-completion projects for which environmental impact data were available.

2. Findings and Recommendations

a) The Rationale for the SD Tech Fund is Strongly Supported

All of the lines of investigation that examined the rationale for the SD Tech Fund found strong support for the need for the Fund and for its continued existence. The Fund is aligned with the current priorities of the Government of Canada. The funding gap continues to exist and the evidence indicates the Fund does not displace private sector funding for projects. Government's principal policy documents indicate that the Fund's objectives remain aligned with the current priorities of the Government of Canada. The need for the Fund is unquestioned among all key informants and they voice strong support for the role it is playing in the development of clean technologies in Canada

b) Funds Directed to Technology Sectors

We conclude that the level of funding directed to the CCCA sector is readily supported by the flow of SOIs. In contrast, it appears that the Funding Agreement did not correctly anticipate the level of activity in technology development for water and soil or the barriers to mounting demonstration projects. Developing projects in these technologies has required more extensive efforts to identify potential projects and solicit SOIs and proposals. It appears that these efforts may now be developing a flow of potential projects that is consistent with the intended rate of investment in these technologies.

c) SD Tech Fund Operations

This evaluation describes a large number of initiatives undertaken by the Fund since the last evaluation that taken together, evidence a significant program of continuous improvement. The results of these initiatives are visible in the findings reported for Fund operations. The SOI success rate has climbed to about 20%. The contracting process has been substantially enhanced and results show continuing improvement. The proposal success rate has climbed to almost 80% of proposals that enter the review and approval process. The average time to complete a contract has decreased from a high in 2006 and appears to be approaching the level seen in the early funding rounds. The incidence of a number of the reasons for delay in contracting has fallen sharply. Proponents report a significant reduction since the 2006 surveys in the proportion of time waiting for the Fund to respond during the contracting process. The time taken to review milestone reports and process progress payments has decreased remarkably and now meets a self-imposed target. Perhaps reflecting the strengthened proposal and contracting processes, proponents' adherence to schedule has improved substantially since 2005.

Projects face considerable difficulty and delay during the contracting phase when securing outside financing. If recapitalization is being examined a suggestion from project proponents should be considered; that the limit on the Fund's contribution to a project should be raised. Shifting a larger share of project risk to the Fund would facilitate outside financing and expedite the contracting process.

Our findings provide further support for the importance of efforts to simplify the SOI, proposal and contracting procedures, reducing the burden on proponents and perhaps completing the funding process more quickly.

We recommend that the Fund should continue to review the SOI, proposal and contract requirements to identify any areas that may call for detail in excess of that required for prudent project management and protection of public assets. The ongoing scrutiny of the processes, typically a review after each funding round, should ensure that each stage only calls for the critical information used to identify projects that should proceed to the next stage. Wherever feasible the information required at each stage should relate directly to that provided in the previous stage.

The time to complete the requirements for the holdback payment for completed projects appears excessive.

We recommend that the Fund should continue its work to identify the reasons for delays in the release of holdback funds, segregating time under the Fund's control, which includes the time taken by its subcontractors, and identifying strategies to minimize the time under its control. Any extended payment periods should be attributable to the proponents' delays in providing the required submissions.

d) Accounting for Commitments and Disbursements by Primary Environmental Benefit

The Funding Agreement assigns funding targets for technology sectors. It requires that the Fund identify a primary benefit for each project and assigned the project to the technology sector for that primary benefit (clean air climate change, hydrogen, clean fossil fuels, water or soil). Our examination of this process suggests that the sector selected is sometimes arbitrary, since some projects yield significant benefits in more than one sector.

We recommend that this approach be re-examined in any future funding agreements. We suggest that when projects have significant impacts in more than one sector, allowing more than one benefit for those projects would more accurately reflect the reality of the technologies being developed.

e) Commitment of Funds and Disbursement Targets

The Fund has made considerable investments in capacity building with projects, for example entering into a more proactive relationship at the SOI and proposal stages. The efforts to identify potential water and soil projects and where appropriate, to encourage them to submit SOIs and proposals, goes well beyond the scope of the interactions with projects what was anticipated in the Funding agreements. While such additional efforts appear to have yielded substantial benefits, we are concerned that they may be limited by the operating budget.

We recommend that the operating budget be reviewed to ensure that it supports the full scope of capacity building efforts that have been developed by the Fund.

The wording of the Funding Agreement appears to allow some latitude in the timing to achieve the commitment targets. Since current projections show full commitment of the target amounts by 2011, we judge that this performance, if realized, would comply with the terms of the agreement.

We conclude that the SD Tech Fund has met the expectations of the Funding Agreement in that it has endeavoured to disburse funds as quickly as allowed by the agreement's requirements for contracting and the time required to complete the work plans of the projects selected for funding. However the experience to date indicates that Funding Agreement's anticipated two year lag between full commitment and full disbursement of those funds is unrealistic. Therefore the Fund is unlikely to meet the disbursement target set by the Funding Agreement unless it substantially alters its operating procedures for the remainder of the period of the current agreement. In our view, making such alterations for the sole purpose of meeting the disbursement target should be avoided.

We recommend that the Funding Agreement should be revisited to establish a disbursement target date that is more in keeping with the nature of the projects that have emerged from Canada's technology development community.

f) Recapitalization Provisions

The key informant interviews pointed out that the Funding Agreement was drafted with no consideration of renewal. We recommend that, if the agreement is renewed or modified, consideration should be given to specifying a date that would trigger consideration of future renewal at least two years in advance of the termination of the renewed agreement.

The issue of recapitalization is a matter of current concern. The funds for CCCA projects are essentially fully committed and any remaining funds should be directed toward hydrogen and clean fossil fuel projects in order to complete the allocation to those sub-sectors. Therefore the flow of CCCA projects will be substantially reduced from this point forward. Given recent developments, it appears that the water and soil commitments will be completed by about the target date of 2010.

We recommend that the issue of recapitalizing the Fund should be addressed in the near future. The largest component of the Fund, climate change and clean air projects, has committed virtually all of its funds. If disruption is to be avoided in the Fund's operations and in the development of new clean technologies, a clear indication of the government's intent with regard to recapitalization should be available in the next few months.

g) Management of the Instrument, SDTC

SDTC continued to work on the relationship issues discussed in the First Interim Evaluation and it efforts have been applauded by colleagues in government departments who strongly support the Fund's communication initiatives. Our current research suggests that additional initiatives should be considered. We recommend that SDTC initiate discussions with appropriate government officials to identify additional communication channels. Ideally, the channels would respond to the information needs/expectations of both sides while avoiding imposing additional burdens on either side. .Possible avenues:

- Periodic discussions involving SDTC staff and specialists with departmental scientists or officials to identify general findings that could be shared while protecting the confidentiality and intellectual property of projects. This should be an exchange, responding to the interests of both SDTC and departments.
- When significant issues or questions arise that are not adequately covered by information already provided, meetings triggered by either side between senior SDTC/departmental/political levels to discuss those issues.

h) Cost Benefit Analysis

The findings of an extensive cost benefit analysis indicate that the Fund seems likely to generate significant net benefits over the next decades. For the 25 projects included in this analysis, the Fund contributed $61.6 million of the total investment of $215 million. We estimate that that the net present value of the total quantifiable benefits from this set of projects will range from about $446 million to $1.1 billion, with a central estimate of about $750 million. While the projected benefits may seem very high, another perspective, comparison with Canada's overall GHG emissions, may add context. The 25 projects reviewed are forecast to reduce Canada's annual emissions of CO2 by less than 1%.

The following factors should be kept in mind when considering the cost benefit results:

- **Some impacts are not quantified.** This analysis estimates the benefits from greenhouse gas and criteria air contaminants only. In particular, the current analysis does not include water and soil impacts since development work on the methods to estimate those impacts has not been completed. Also other positive and negative impacts from projects are unlikely to be included in any future analysis.
- **Potential spin-offs are not quantified.**
- **Estimates relate to a baseline year**, which may eliminate some benefits from consideration in the analysis.

The estimates used in this cost-benefit study pertain to a limited set of projects, including the first group of projects emerging from the SD Tech Fund and a small number of relatively mature projects in the final stage of their work for which updated environmental impact estimates are available. Therefore, the following limitations of our analysis should be kept in mind:

- **CCCA projects only.** All the projects in the analysis were approved as impacting on climate change clean air (CCCA). While some of these projects may also involve water, soil or other impacts, any such impacts have not been included in the analysis here, but will be considered in future analyses.
- **Early approvals.** These were among the first projects to be approved and practices have evolved considerably since those early days, so these projects may not be representative of the total portfolio of CCCA projects. Projects approved under the other funding targets, perhaps including clean fossil fuels and hydrogen and certainly including water and soil, may have significantly different levels of benefits.

There is a high degree of uncertainty inherent in the sales and GHG emission reductions forecasts, so our cost-benefit results should be treated with some caution. Several forms of sensitivity analysis were performed to attempt to consider alternative

scenarios and deal with this uncertainty. Overall, the sensitivity analysis we conducted, including the most pessimistic scenario, supports the view that total benefits outweigh total costs for the 25-project portfolio of reviewed projects. If subsequent projects are not systematically different from the analyzed set, these preliminary results suggest that the overall portfolio of projects has a high likelihood of generating significantly positive net benefits.

These findings are remarkably positive. While it is generally the case that other candidates for government funds do not offer a similar analysis for comparison with the SD Tech Fund, we are confident that these results are of the highest order. The net benefits are very large. This implies that increasing the scale of the SD Tech Fund activities would generate a continuing net social gain and recapitalizing the Fund should rank high among government's investment opportunities.

We recommend that the cost-benefit results be taken into account when the government considers recapitalization of the Fund.

II METHODS

A. EVALUATION PLAN

The project began with the development of a work plan describing the general approach proposed for this evaluation, the differences from the First Interim Evaluation and the detailed steps of the work plan that was recommended for the second interim evaluation.

1. Context for this Evaluation

During the development of the work plan, we conducted an extensive review of the literature on evaluation of similar technology development programs. Several programs in Canada, the U.S. and other jurisdictions provide funding to support basic research, RD&D initiatives and other climate change action within a framework similar to that of the SD Tech Fund. We found that many existing evaluations of similar programs, while informative, lack sufficiently detailed data to quantify program impacts to the extent that we propose for the SD Tech Fund. The fund's data collection and monitoring efforts provide sufficient data to conduct a detailed quantitative evaluation. The available literature suggests that our overall evaluation approach is consistent with recommended best practices.

2. Evaluation Advisory Committee

SDTC recruited an Advisory Committee comprised of representatives from departments including Natural Resources Canada and Environment Canada, a member of the SDTC Board, and representatives from the investment community and industry. SDTC circulated the work plan to the committee members and convened a meeting to discuss the plan and invite comments or suggestions to ensure that the evaluation would meet the information needs of stakeholders in the evaluation. The work plan, as modified in response to the advisory group's comments, has guided this evaluation.

B. INFORMATION SOURCES FOR THE INTERIM EVALUATION

1. Qualitative Interviews

We conducted a series of qualitative interviews, exploratory discussions that provided a broad initial understanding of the respondents' views. The key informants drawn from a number of settings:

- **Venture capital**, respondents who participate in venture capital financing, six identified by SDTC and two from our contacts.
- **Stakeholders** representing organizations with an interest related to SDTC's mandate. SDTC identified nine interview candidates and we completed interviews with eight.
- **Government officials**. SDTC identified 13 candidates and we completed 10 interviews.

2. Project proponents

a) Unsuccessful Proposals

SDTC provided contact information for 46 rejected proponents including all those rejected in recent rounds and non-respondents from the 2006 survey of rejected applicants. The list included one duplicate and we had one disqualification. Removing these cases effectively reduces our sample size to 44. TNS Canadian Facts conducted a telephone interview of the candidate respondents. After expending considerable effort to locate respondents and complete the interview the survey achieved a 72% response rate.

b) Successful Proposals

SDTC provided contact information for 79 potential respondents to the survey, which was planned to be conducted using the Internet. When the internet survey did not yield the desired response rate, TNS completed the survey using telephone techniques. In total 73% (58 of 79) of the possible respondents completed the questionnaire, which represents a lower bound for the true response rate.

3. Review of Documents and the Fund's Current Developments

We reviewed numerous documents supplied by the Fund, including reports of the Fund-initiated environmental reviews of completed projects, summaries based upon the project database, of Statements of Interest (SOIs) received, proposals requested and received, approval of proposals for funding, time to complete a contract and reasons for any delays, progress of funded projects, final payments on contracts, and post-project reports of market performance.

We have maintained regular contact with staff of the Fund and have received reports from services, such as venture capital monitoring reports, where SDTC maintains a subscription. As well, we have obtained clarification and substantiation of recent developments with respect to the topics addressed in this report.

4. Case Studies

As part of the research for the First Interim Evaluation, we completed case studies for seven projects that had completed the work supported by the SD Tech Fund. For this evaluation, we completed an additional 16 case studies of completed projects. These results are incorporated in the various sections of this report as they are relevant.

5. Review of Administrative Data on Venture Capital Activity

Thomson-Reuters maintains an extensive database on Canadian venture capital and private equity (VC) transactions called VCReporter.[8] We used this resource to analyse Canadian venture capital activity.

6. Updated Cost Benefit Analysis

We updated the cost benefit model developed for the First Interim Evaluation and incorporated current information on costs and environmental benefits.

[8] For more information, see http://www.canadavc.com/

III RATIONALE

A. THE RATIONALE FOR THE SD TECH FUND

The stated purposes of the funds granted to SDTC indicate that Canada requires assistance to stimulate the development and demonstration of new sustainable development technologies related to climate change and clean air (the focus was broadened by the third Funding Agreement to include clean water and clean soil). Funded projects should support collaborations that will strengthen the Canadian capacity to develop and demonstrate these technologies. The projects should be designed to encourage diffusion of the demonstrated technologies.

B. FINDINGS AND RECOMMENDATIONS FROM THE FIRST INTERIM EVALUATION

The report of the First Interim Evaluation of the SD Tech Fund provided the following observations and recommendations on the rationale for the Fund:

> The evaluation found strong evidence of a continuing need for SDTC's funding support. The funding gap remains a major barrier to emerging technologies. While SDTC's initiatives may be strengthening the Canadian infrastructure for new technologies, without SDTC, the existing infrastructure is unlikely to access the financial resources required to bring these technologies through the development and demonstration phase.[9]

The following sections revisit the examination of the rationale for the Fund, reviewing the economics of the rationale, the existence of the funding gap, the alignment of the Fund with the current priorities of government, the continued need for the Fund and the adequacy of the deal flow, statements of interest and approved projects, to produce the level of investment expected of the Fund.

C. INTERNATIONAL CONTEXT

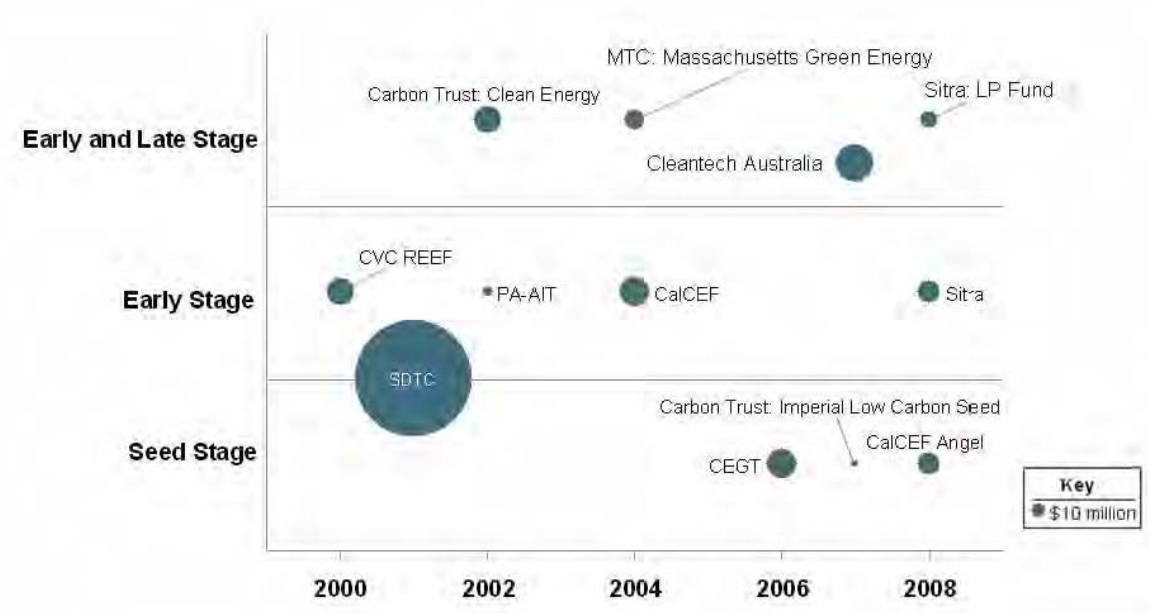
In 2008, an international coalition, the UNEP SEFI Public Finance Alliance (SEF Alliance), was formed under the auspices of the Sustainable Energy Finance Initiative (SEFI) of the United Nations Environmental Programme (UNEP). Members are public

[9] Evaluation of Sustainable Development Technology Canada: Interim Evaluation Report – Final, Robinson Research in Association with TNS Canadian Facts, June 27, 2006, pp 20 – 21.

and publicly backed organizations including SDTC, which finance sustainable energy markets and technologies in various countries. During its first year of operation, the SEF Alliance commissioned New Energy Finance, an independent agency specializing in clean energy market research and analysis, to examine clean energy venture capital, with a particular focus on the role of public finance. The report of this project, the Public Venture Capital Study, offers a useful overview of the international context for the SD Tech Fund.

The Public Venture Capital Study supports the rationale for the SD Tech Fund, identifying funding gaps as market failures and describing public venture capital as an effective response to the issues faced by emerging technologies. While the study indicates that early in this decade funding gaps existed at every stage, it notes that the seed gap has proven the most persistent. The study describes the characteristics of public venture funds in terms of their year of inception, target investment stage and funds available in a graph reproduced as Exhibit III-1.[10]

Exhibit III-1 Map of Public Clean Energy Venture Capital Funds by Target Investment Stage, 2000 – 2008



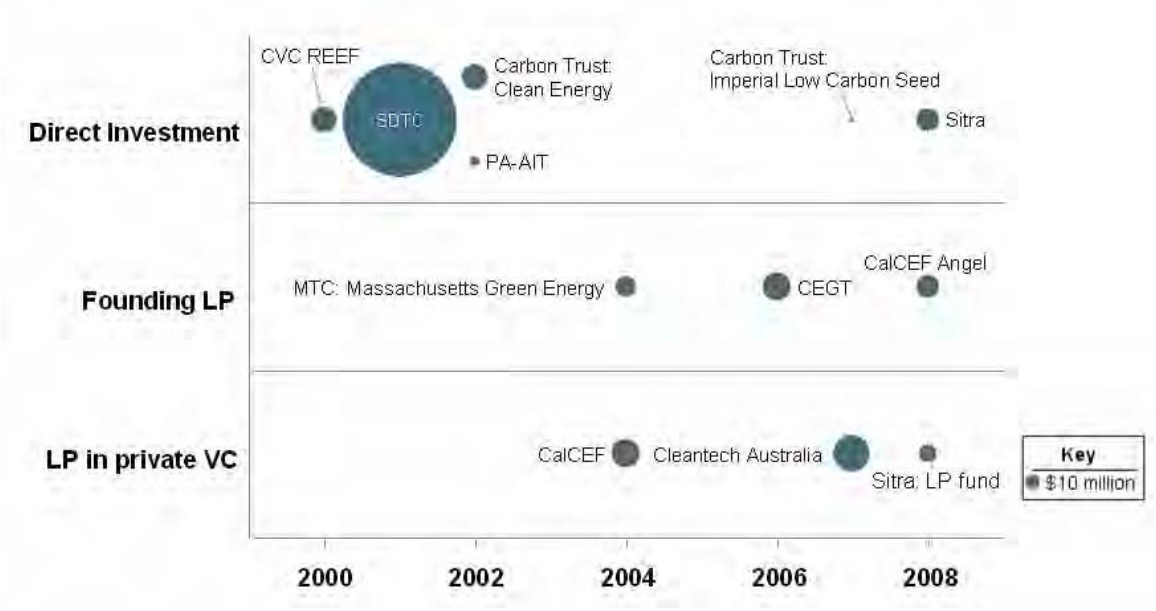
Note: Date represents Funds inception, size of bubbles represents relative investment fund size. Refer to key for scale of fund size.

The SD Tech Fund is the largest fund in the study and unique among the early-established funds in its focus on the critical seed and early investment stages.

[10] *SEF Alliance Publications: Public Venture Capital Study*, New Energy Finance Ltd. and the United Nations Environment Progamme on behalf of the UNEP Sustainable Energy Finance Initiative Public Finance Alliance, p. 28

The SEF Alliance study scans the structures employed by the various funds in its universe. "A public entity considering venture capital can directly invest in companies. Alternatively, it can be a Limited Partner in a "middleman" organization to deploy capital at arms-length, through either a private venture capital firm, its own fund manager that it created, or a private fund manager it has contracted."[11] Exhibit III-2 shows the distribution of funds according to these structural alternatives.[12]

Exhibit III-2 Map of Public Clean Energy Venture Capital Funds by Fund Structure, 2000 - 2008



Note: Date represents Funds inception, size of bubbles represents relative investment fund size. Refer to key for scale of fund size.

The SEF study characterizes the SD Tech Fund as a direct investor employing a unique funding strategy, a combination of grant and venture capital "a carefully crafted hybrid between grant and venture capital can offer benefits of both grants and venture capital. SDTC does not take an equity stake; rather it funds a company's proof of concept and demonstration projects. . . In essence, SDTC acts as a venture capitalist but uses the financial distribution mechanism of a grant."[13]

The rationale for the consortium is also addressed "Additionally, by requiring every SDTC dollar to be matched, on average, by two dollars from other project partners, (in cash or in kind), SDTC ensures that the entrepreneur must seek out relationships with private investors and industry partners, considering the financing steps beyond SDTC's investment. These relationships are formed with corporate partners who have a stake in

[11] Ibid p. 34
[12] Ibid.
[13] *Ibid*, p. 24

the success of the technology and can often provide the company additional guidance and help in the development of its technology, as well as in kind material and labour support."[14]

The study advocates an approach to environmental metrics that generally reflects SD Tech Fund practice "While all clean energy venture capital funds seek to maximize environmental benefits and profitability, it is rare that these environmental benefits are quantified in the same way as potential monetary benefits. It is important to note that this does not mean that environmental benefits are unimportant, just that the environmental benefits are not quantified or used to choose between two comparable companies. . . . For funds seeking co-investors in the future, it is also important to evaluate companies on a commercial basis, as any private investor would do. The ultimate success of the company will require profitability measures to be met and thus public venture firms can't ignore this fundamental driver in its investment criteria."[15] While the Fund's decision processes do not monetize environmental benefits, decisions consider both environmental benefits and profitability to select the projects that are judged to represent the best return for Canadians. This evaluation does use the more rigorous environmental impact data that are available as projects are completed to monetize environmental benefits and consider both those benefits and profitability in the cost-benefit analysis.

In summary, the SEF Alliance report describes the Fund this way "SDTC's strategy exemplifies how taking aspects of different financial mechanisms can be very effective."[16]

D. THE ECONOMICS OF THE RATIONALE

The rationale for the SD Tech Fund is strongly supported in the economics literature. Government's expectations of the SD Tech Fund include the funding of projects that develop and demonstrate new sustainable development technologies related to climate change and clean air, water and soil, in order to make progress towards sustainable development. In our assessment of the rationale for these SDTC activities, we have reviewed the related economics literature. This literature makes it clear that SDTC investments in sustainable development technology can make potentially important contributions to the Canadian economy and Canadian society. These contributions have their basis in the standard economic framework for analyzing public support for research and development, which focuses on factors that lead to market failure. A large literature exists on market failure related to R&D which shows that the market will generally provide a lower than socially optimal amount of investment in R&D. [17,18,19] The reason for under-provision of R&D by market participants is that those

[14] Ibid.
[15] Ibid p. 31.
[16] Ibid.
17 Arrow, Kenneth J. (1962), "Economic Welfare and the Allocation of Resources for Invention", in R. Nelson (ed.), The Rate and Direction of Inventive Activity, Princeton University Press.

who fund research must pay all the costs of their research and development but other investors (the free riders) may appropriate the R&D results at no cost to them. This argument is strengthened by the issue of incomplete information, and barriers to adoption of new technologies.

In the case of new technology in the energy-environment area, the rationale for public support of specific technologies is stronger than in other areas because of the large potential social benefits they can produce. Economists have identified two inter-related reasons for this, as explained by Jaffe *et al* (2004):

- **Free rider effect** means that where such social benefits exist, the market generally fails to produce the level of investment that is optimal from society's point of view.
- **Negative environmental externality.** Private investors make production and investment decisions based on the costs that they incur and the returns they can earn from those investments. Yet we know that pollution-related impacts on the environment may have severe negative impacts (social costs) on society. Therefore, technologies that improve environmental quality are particularly attractive for public support in that they are likely to have relatively large social benefits from reducing environmental damage.

Through the SD Tech Fund, government seeks to correct these perceived problems of market allocation for technologies related to sustainable development and move the market most effectively toward the social optimum.

In the area of technology policy, the evaluation literature suggests that those government institutions that work within a market context, funding groups of firms or consortia and employing market-oriented elements, are most likely to make the largest positive contributions. The structure and focus of the SD Tech Fund embodies this strategy. As well, the literature review suggest there is growing support for the use of technology development and demonstration programs as the central policy response to issues of climate change.

E. THE FUNDING GAP

The development of a new technology passes through a number of stages from fundamental research to market entry.[20] Although this is an iterative process, for

18 Levin, R., A. Klevorick, R. Nelson and S. Winter (1987), "Appropriating the Returns from Industrial Research and Development", Brookings Papers on Economic Activity, volume 3.

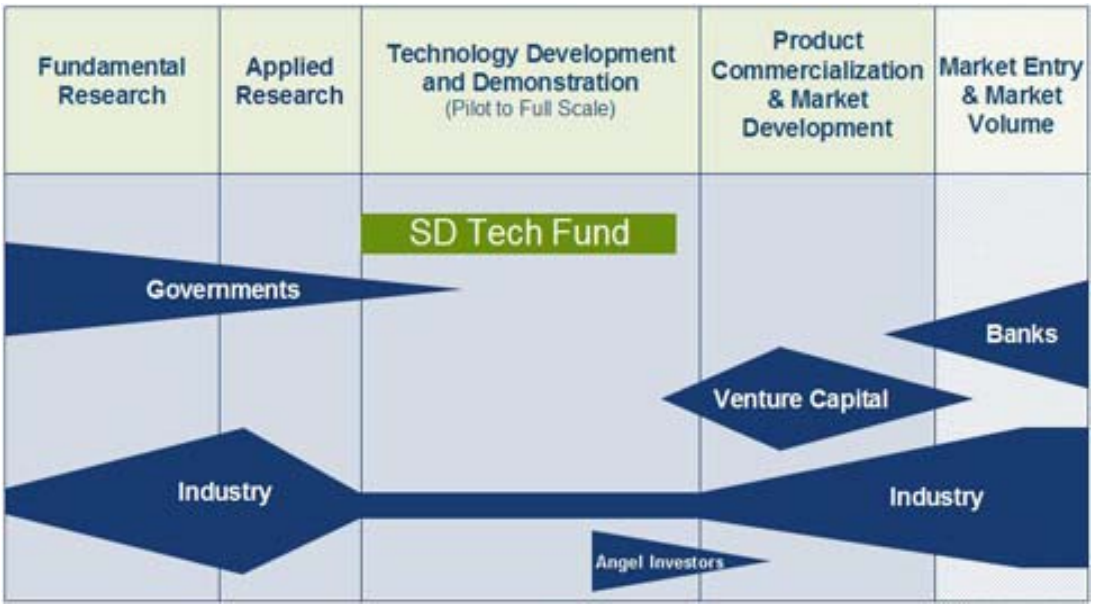
19 Hall, Bronwyn, (1996), 'The Private and Social Returns to Research and Development", in B. Smith and C. Barfield (eds.), Technology, R&D and the Economy, Washington, D.C., Brookings Institution.

[20] The SDTC web site offers a more detailed description of its analysis of the development process and associated risks and sources of funding support.

simplicity SDTC identifies five stages of development. Governments, industry, angel and venture capital investors, and banks all play a role financing the development of new technologies. SDTC has developed the graphic shown in Exhibit III-3 to summarize its view of the stages and the sources of funding.

The SDTC analysis describes a 'funding gap' in the technology development and demonstration phase. When technologies move from the prototype stage to full demonstration, most are spun out from academic institutions to private research laboratories, individual entrepreneurs and small or medium sized enterprises. The exhibit reflects the view that most funding sources in the private sector are unwilling to accept the high risks associated with the development and demonstration phase. Further, SDTC asserts that the situation is more severe for sustainable development technologies, which tend to be relatively capital intensive and require longer development cycles.

Exhibit III-3 Positioning of the SD Tech Fund



The SDTC analysis concludes that promising Canadian sustainable development technologies face extreme difficulty in reaching the market. As a result, it is necessary to provide a substantial funding commitment to this sector to develop sufficient critical mass of sustainable development technology developers, manufacturers and suppliers and to build awareness in the financial community. The SD Tech Fund aims to bridge the gap in the Innovation Chain by funding promising companies and institutions that join together to provide solutions for climate change and clean air problems.

F. ALIGNMENT WITH CURRENT PRIORITIES OF THE GOVERNMENT OF CANADA

How well are the objectives of the SD Tech Fund aligned with the current priorities of the Government of Canada? This basic question takes us back to the principal policy documents of the government, the Speech from the Throne and the Budget.

The 2008 Speech from the Throne recognized the importance of the environment:

> Our Government understands that Canada's economic prosperity cannot be sustained without a healthy environment, just as environmental progress cannot be achieved without a healthy economy.[21]

The Speech confirmed governments continuing focus on technology development as a centrepiece of Canada's environmental initiatives:

> Our Government has committed to reducing Canada's total greenhouse gas emissions by 20 percent by 2020.
>
> To meet the challenge posed by climate change, we will also need to make greater use of technologies that do not emit greenhouse gases.[22]

The Budget presented on January 29, 2009, confirmed these directions and announced significant new investments, the Green Infrastructure Fund:

> Targeted investments in green infrastructure can improve the quality of the environment and will lead to a more sustainable economy over the longer term. Green infrastructure includes infrastructure that supports a focus on the creation of sustainable energy. Sustainable energy infrastructure, such as modern energy transmission lines, will contribute to improved air quality and lower carbon emissions.
>
> Budget 2009 provides $1 billion over five years for a Green Infrastructure Fund. Funding will be allocated based on merit to support green infrastructure projects on a cost-shared basis.[23]

The Clean Energy Fund supports clean energy research development and demonstration projects, including carbon capture and storage:

> To further support Canada's leadership in clean energy, Budget 2009 provides $1 billion over five years to support clean energy

[21] http://www.sft-ddt.gc.ca/eng/media.asp?id=1378
[22] Ibid.
[23] Canada's Economic Action Plan: Budget 2009, Department of Finance Canada, pp. 144 – 145.

> technologies. This includes $150 million over five years for research, and $850 million over five years for the development and demonstration of promising technologies, including large-scale carbon capture and storage projects. This support is expected to generate a total investment in clean technologies of at least $2.5 billion over the next five years.[24]

Given these positions taken by government in recent months, it seems clear that the mission statement for SDTC and the objectives of the SD Tech Fund as stated in the Funding Agreement between SDTC and Canada, remain aligned with the current priorities of the Government of Canada.

G. CONTINUING NEED FOR THE FUND

1. Availability of Seed Funding for Canadian Clean Technologies

The evaluation design considers the possibility that the SD Tech Fund may be crowding out investments from other private sources. Given the pre-commercial state of the technologies in the Fund's portfolio, the most likely source of funds is venture capital. To provide a context for the information presented in the following section, we note that the Fund completed two funding rounds in 2008 that committed a total of $104 million to 34 projects. When the leveraged investments are included, the total value of these projects amounted to $355 million.

a) Canadian Venture Capital Activities

As might be expected from the general economic situation and the state of the stock market, venture capital activities in 2008 showed a substantial decline from previous years. The technologies addressed by the SD Tech Fund are most closely aligned with the Energy and Environmental Technologies sector and the funding is typically at the Seed stage. Exhibits III-4 and III-5 show the Canadian results for this sector at all stages of financing.

[24] Ibid p. 179.

Exhibit III-4 Amount Invested in Canada in Energy and Environmental Technologies by Stage ($million)

	2003	2004	2005	2006	2007	2008
Seed	$0.4	$3.1	$1.8	$1.5	$15.3	$6.4
Startup	$5.8	$11.3	$17.3	$6.6	$14.7	$12.2
Other Early Stage	$16.6	$16.2	$23.5	$33.0	$30.5	$64.5
Expansion	$55.7	$59.7	$31.2	$69.2	$122.9	$83.2
Acquisition/Buyout					$12.1	$21.1
Other Stage				$10.1	$2.6	

Source: Thomson-Reuters Special Tabulation
Note: The values are approximate because financial details may not be available for some deals.

Exhibit III-5 Number of Companies Invested in Canada in Energy and Environmental Technologies by Stage

Stage (All) | Date (All)	2003	2004	2005	2006	2007	2008
Seed	2	3	3	3	5	3
Startup	9	11	8	3	5	4
Other Early Stage	12	11	12	10	7	10
Expansion	10	12	9	9	12	14
Acquisition/Buyout					2	1
Other Stage				1	2	

Source: Thomson-Reuters Special Tabulation

The results for 2007 show an apparent increase in number and value of deals at the Seed stage. However much of the reported increase represents co-funding of projects supported by the SD Tech Fund (two of the five deals with a total value of $11.5 million.) Taking this into account, the number investments at the seed stage seems stable at about 3 per year and the average value of those investments has increased from about $1 million to about $2 million per deal.

b) International Venture Capital Activities

The Cleantech Group, a leading source of information on the cleantech sector, publishes a quarterly review of investment activity. Its most recent review for the fourth quarter of 2008 concludes that "2008 witnessed the end of this first cleantech boom"[25] The data show that seed funding, the stage most closely aligned with the Fund's

[25] 2008 Annual Review & 4Q08 Quarterly Investment Monitor, Cleantech Group LLC, Volume 7 / Issue 4, p. 5.

activities, decreased from a peak in 2006. Exhibit III-6 shows the results for the United States for the cleantech sector by stage of investment for the five quarters ending in December 2008.[26] The data support the view that the boom has ended. Note that the seed stage shows a low level of activity in all five quarters.

Exhibit III-6 North American Investments by Quarter and Stage, Showing Total Disclosed Investment and Number of Projects[27]

	4Q07		1Q08		2Q08		3Q08		4Q08	
Stage	$ million	# Projects	$ million	# Projects	$ million	# Projects	$ million	# Projects	$ million	# Projects
Seed	$8	5	$6	3	$7	2	$2	2	$2	3
First Round	$378	18	$151	17	$283	18	$172	20	$139	19
Follow-on	$821	53	$1,139	38	$1,340	42	$1,600	55	$973	34
Total	$1,207	76	$1,296	58	$1,630	62	$1,774	77	$1,114	56

c) Summary

The data on venture capital activities in Canada and North America show no evidence that the SD Tech Fund may be crowding out private investments. They also describe a North American boom in venture capital investments in cleantech over the last few years that ended in 2008. The seed stage showed an earlier decline, beginning in 2007. The Canadian data show a level of investment in cleantech seed stage projects that amounts to a small fraction of the SD Tech Fund investment in that sector and stage. Any apparent increase in VC activity is accounted for by co-funding investments in SD Tech Fund projects.

2. The Views of Key Informants on the Continuing Need for the Fund

a) Availability of Funding for Technologies at the Seed Stage

All key informants in senior positions in government, venture capital and stakeholder organizations who felt qualified to comment were unanimous in their support of the Fund and the continued need for its existence. Venture capital respondents saw no conflict or competition between the activities of the Fund and any desire to invest venture capital funds at the seed stage. They commented that investments at the seed stage are relatively rare and those who participate at that stage mentioned their interest in joining projects that had been approved for funding by the SD Tech Fund.

A number of the key informants commented on the state of capital markets in Canada. Respondents working in the financial market described a ‘depression in the VC sector in Canada’, a ‘dearth of capital in the sector’ that has ‘created a severe shortage of funds for the seed stage.’ Government respondents and stakeholders agreed: ‘in the

[26] Ibid p. 48.
[27] Ibid

economic downturn, the availability of capital is less that it would have been a year ago.' '(the Fund) is necessary, if anything (the situation) is getting worse', 'even more necessary today, given the negative economic environment'.

Key informants from all sectors strongly supported the extension of the Fund's mandate to include water and soil technologies. They pointed out that the mission of the Fund addresses sustainable development technologies, a perspective which goes well beyond the climate change clean air technologies that were the focus of the first two Funding Agreements. However they also commented that the technology sectors are at very different states of development. In the words of one key informant "Developments in water are where climate change was about 15 years ago, and soil is further behind." From the venture capital point of view, "Water is just starting to take off, VC funds and some major companies are beginning to focus on water technologies."

b) Does the Current Structure Serve the Goals of the Fund?

Key informants strongly supported the current structure of the Fund. A number from each group, senior government officials, stakeholders and venture capitalists specifically highlighted the importance of its private sector orientation and arm's length relationship with government. They confirmed the view that decisions based on a strategic view of the technologies vying for support and private sector-like investment criteria and are most likely to identify high potential technologies and in the longer term, build viable and perhaps great, world-leading companies. "If you want to succeed in the market, develop the project using the market's best practices." This was contrasted with traditional government programs that could be subject to vested interests that may exist in departments or to political pressure.

c) Has the Fund Accomplished its Stated Goals? Does the Need Still Exist?

The goals of the SD Tech Fund are oriented toward process, funding projects in order to make progress toward sustainable development, fostering collaboration and partnering to channel and strengthen Canadian capability to develop technologies and encouraging rapid diffusion of new technologies. Clearly the Fund has made progress in each of these areas. The structure of the Fund focuses on these goals and previous reviews and audits have confirmed that it has adhered to these requirements.

However accomplishing the Fund's stated goals is quite another matter. This evaluation takes the view that the Fund will have accomplished these goals when its intervention is no longer necessary for these processes to continue. In other words, clean technology developments at the seed stage will be fully supported by private investments, the Canadian technology development infrastructure is capable of identifying and carrying forward the promising technologies that emerge from Canadian research and the companies that develop the technologies are capable of rapidly diffusing the technologies throughout Canadian markets. Key informants were unanimous in their view that while impressive progress has been made, there is still a long way to go before these conditions

will be met without the continued intervention of the SD Tech Fund. The review of venture capital investments, summarized above, supports this view.

d) Does the Fund Duplicate or Compliment Other Government Programs?

Key informants were unanimous that the Fund does not duplicate other government programs and some cautioned that even if duplications should exist, they are not necessarily bad.

There are obvious hand-offs, for example technologies developed with assistance from the National Research Council's Industrial Research Assistance Program (IRAP) may apply to the SD Tech Fund for assistance with their next step toward commercial success. A carbon capture technology demonstrated at a sub-commercial scale by the SD Tech Fund may find support for a scaled-up demonstration from NRCan's ecoENERGY Technology Initiative (ecoETI) program. Recently additional funds were made available for cleantech technologies, notably the new money directed to the Clean Energy Fund. One key informant commented that while the Clean Energy Fund may "reduce the uniqueness" of the SD Tech Fund, "it still plays an important and valid role."

Key informants pointed out that some duplication was welcome, and in some cases has provided some of the balance of public funding that is allowed for SD Tech Fund projects. The Green Municipal Fund has put up money for a number of SD Tech Fund projects. Some provincial programs are becoming active in this role.

H. SOI VOLUME

The analysis reported below indicates that some technology sectors, particularly water and soil, have experienced relatively low volumes of SOIs. However the initiatives undertaken by SDTC staff appear to have created an enhanced flow of potential projects. Very recent data tend to confirm that the flow of SOIs in each technology sector appears sufficient to support the level of funding activity anticipated by the Funding Agreements.

I. CONCLUSIONS AND RECOMMENDATIONS FOR RATIONALE

1. The Rationale for the SD Tech Fund is Strongly Supported

All of the lines of investigation that examined the rationale for the SD Tech Fund found strong support for the need for the Fund and for its continued existence. The Fund is aligned with the current priorities of the Government of Canada. The funding gap continues to exist and the evidence indicates the Fund does not displace private sector funding for projects. Government's principal policy documents indicate that the Fund's objectives remain aligned with the current priorities of the Government of Canada. The

need for the Fund is unquestioned among all key informants and they voiced strong support for the role it is playing in the development of clean technologies in Canada

2. Funds Directed to Technology Sectors

We conclude that the level of funding directed to the CCCA sector is readily supported by the flow of SOIs. Developing projects addressing water and soil technologies has required more extensive efforts to identify potential projects and solicit SOIs and proposals. It appears that these efforts may now be developing a flow of potential projects that is consistent with the intended rate of investment in these technologies.

IV SD TECH FUND OPERATIONS

A. FINDINGS OF THE FIRST INTERIM EVALUATION

The First Interim Evaluation provided the following observations and recommendations on the operations of the Fund:

> Since SDTC has recently increased its complement of staff and assigned additional people to project management, it is not surprising that project proponents describe changes in the staff assigned to their project. However the comments about responsiveness and lack of clarity of requirements call for careful attention. We recommend that SDTC build on its examination of the contracting process to identify changes in procedures, forms and communications with project proponents. This examination should seek to minimize the time lags in the contracting process that are attributable to SDTC, to improve the rate at which contracts are completed and if possible, to reduce the time and resources required for project proponents to respond to SDTC's requirements. In this examination, SDTC should review the merit of the procedures required by the Funding Agreement and by related government expectations, to ensure that only necessary project controls are provided. If any procedures or controls are identified that could be relaxed or made less burdensome to proponents without degrading SDTC's project management or protection of public funds, those should be highlighted and re-negotiated with government.
>
> We recommend that SDTC continue to monitor delays that can be attributed to SDTC. This approach may highlight aspects of the procedures that could be improved and thereby reduce delays. We recommend that SDTC communicate the information on delays to individual proponents so that proponents gain a better understanding of the SDTC process and of their performance relative to the expectations of that process.
>
> We recommend that SDTC continue its examination of the process to debrief proponents of unsuccessful SOIs and proposals. While this procedure has been the subject of much attention and review, the feedback from proponents indicates a need for further improvement.

The following sections review these and other aspects of the current operations of the SD Tech Fund.

B. AWARENESS OF THE SD TECH FUND

People involved in sustainable development technologies in Canada are generally aware of the SD Tech Fund. Key informants cite the regular appearances at conferences, the wide circulation of the call for Statements of Interest (SOI) for each funding round and the large number of SOIs already received by the Fund. A number of key informants suggested that the Fund is one of the few funding sources available and people working in the area know those sources well. In the words of one proponent, "It's the only game in town." One person in venture capital suggested that if a proponent was not aware of the Fund, "that would count against him."

Proponents who responded to the surveys generally agree that the level of awareness is high. We should note that the responses show considerable spread. Clearly some respondents did not think SDTC was all that well known: about one in four (26%) responded 2 or 3, (below the mid-point of the 7 point scale.) The information we have from the survey does not allow us to classify respondents by their technology sector. However the case study interviews suggest that some sectors tend to be relatively insular. People in such settings may be less aware of general developments in clean tech or the SD Tech Fund.

We conclude that continued efforts to build awareness with new players in established technology development sectors such as climate change and clean air, and in less mature sectors or niche areas such as soil, water, or marine technologies, are well justified.

C. SELECTING AND FUNDING PROJECTS

1. The Process

The details of the process followed by the Fund to select and fund a project are available on the SDTC web site and are communicated to all applicants for funding. In general, from the call for statements of interest to the approval of funding takes about 39 weeks or about 9 months.

2. Overview from Key Informants

The SD Tech Fund plays a role similar to a venture capital investor. It focuses on commercial viability as the end-point for most of its projects and seeks to structure projects to maximize the probability of commercial success. In doing so, it also works in ways that consciously focus on building the capacity of proponents and of the entire community to develop new technologies, seeking to strengthen Canada's sustainable development infrastructure. A number of key informants pointed out that it must be tempting for the Fund to step in and do the work, solve the problems that are stalling

projects, but quite correctly, it has not taken that initiative. To do so would frustrate the Fund's objective to build the competence of proponents.

Key informants from all backgrounds described the processes to select, contract and manage projects in very strong terms "extremely rigorous", "the gold standard" in the market, "rigorous assessment and evaluation provides a level of confidence, in a way, a seal of approval for a project", "the level of due diligence done by the SDTC team is outstanding", "the gold standard for accountability." At least in part because of this reputation, the Fund has been called the 'funder of first resort.' Projects often come to the SD Tech Fund first with the expectation that once the Fund support is in place, it will be much easier to line up other funders. At this early stage in the development of a technology, many of the proponents will not have experience launching new technologies or securing funding to support the launch. Many will be relatively inexperienced, with scant background in the steps and skills required for this work.

Some contrasted the Fund's approach with that taken by venture capital investors (VCs) in a way that may be helpful in interpreting the findings of this evaluation. Here are some key points:

- VCs spend the majority of their time working with projects and deal with new prospects one at a time as they arrive. The Fund issues semi-annual calls for SOIs that create a flood of potential projects. Each funding round is dealt with according to a timetable for screening SOIs, invitations to submit a proposal, review and acceptance of the best proposals. This process likely takes longer for a proponent to complete than would be required for the same proponent to secure funding from a typical VC.
- The Fund is dealing with public funds and must exercise a high standard of care to protect the funds and invest them wisely. While VCs answer to investors and shareholders, they have greater freedom to tailor a project, perhaps take calculated risks that are not available to a public funder.
- VCs have greater freedom to winnow projects at an early stage whereas the Fund has to be fair, and be seen to be fair, to all applicants. This creates a considerable workload that could slow the Fund's review process.
- Both the Fund and VCs assess a project's technology and management, but VCs tend to focus more strongly on management and the ultimate market for the technology. The Fund places more emphasis on the technology itself and requires environmental impact information that is not required by VCs. This information may not be familiar to some proponents and may require additional time and/or assistance to assemble and submit.
- Both regularly see proponents who exhibit a wide range of management and technology development skills. Some have all the skills and background required to move ahead promptly and others will take a long time and a lot of hand holding before they will be ready to enter the market. VCs have the flexibility to move ahead quickly where the proponent is ready while the Fund

must goes through all the prescribed steps before a project can be funded. VCs may more frequently reject proposals on the basis of management competence while the Fund is more likely to be patient, supporting a proponent and waiting for the project to complete all of the requirements for a signed contract.

VCs generally indicate that they require a significant period from initial contact to approval and funding for a project that is ready to go and they note that very few are indeed 'ready to go.' In the best case, one key informant estimated it would take four to six months and another estimated 6 to 9 months to get money in the hands of the project. They will take longer and sometimes much longer if the project is promising but not in all respects ready to proceed.

VCs emphasize that speed to market is generally less important than "getting it right." One said "these sectors are not moving at internet speed, we are not talking about the next iPod." Clean technologies are largely aimed at mature sectors that generally move slowly and are risk-averse. They also note that the sectors addressed by these technologies are very complex and there will not be just one winning technology, there will be many. The technologies that ultimately become important in a market are not likely to be the first to emerge. They will be the technologies that convincingly demonstrate technical and financial success. "It is not so important to be the first, it is far more important to be the best." In the view of key informants, if a project is rushed it will run a serious risk of failing to adequately demonstrate the merits of its technology and its business potential.

A number of key informants had heard that the Fund's selection process was arduous and painfully slow, in the view of some of their informants, not worth the effort. However most noted that these comments were initiated by unsuccessful proponents. In any case, it appears that this image seems to be broadly held because it arose in a number of interviews across all types of key informants. On the other hand, there is also a strong view among key informants including those from the VC sector that completing an SD Tech Fund project yields important benefits. "Companies that have gone through the SDTC process have a higher probability of getting capital investments and of success in the market."

Key informants also commented on the status of the selection process, noting that the funds for CCCA projects were almost completely committed. One noted that the Funding Agreement did not contain a provision that would trigger consideration of recapitalization on a timetable that would maintain the momentum of the fund and avoid disruption of operations arising from any uncertainty about continuation of the fund. Others commented on the disruptive effect of an impending completion date for an activity such as the Fund. They emphasized that staff morale and the Fund's place in Canada's technology development infrastructure would be at risk if recapitalization was not addressed well in advance of the 2010 target date for full commitment of the Fund.

3. The SOI Stage

a) The SOI Process

The SD Tech Fund has two calls for Statements of Interest each year. The calls are widely circulated and publicized, using email notifications to individuals and organizations, advertisements in selected publications and updates on the SDTC web site. The SOI process has been in place from the first funding round and in response to the 14 calls completed to date over 1,500 SOIs have been received and reviewed. Much has been learned from this experience and a range of improvements have been incorporated in the process since the First Interim Evaluation was completed in 2006.

b) Proponents' Views of the SOI Process

The surveys for the first and second interim evaluations asked "The SOI should provide sufficient detail about a project idea so that those who review the SOI can clearly understand the project. In your view, did the SOI requirements ask for too little detail, about the right amount, too much detail?" About three-quarters of respondents to the 2009 surveys indicated "about the right level" of detail. Given the nature of the SOI, this appears to be a satisfactory response.

The surveys asked a similar question about the time and effort required to complete the SOI. The results were almost unchanged between 2006 and 2009. In both surveys, 65% of successful proponents indicated the level of time and effort was acceptable and 35% said too much time and effort was required. Unsuccessful proponents were slightly less positive. About 40% said too much time and effort was required.

The survey concluded the discussion of the SOI by asking respondents about their level of satisfaction with the support and guidance provided by SDTC when they prepared their most recent SOI. Respondents assessed the SDTC performance in terms of helpfulness and timeliness. Among successful proponents, the average rating was 5.4 (on a 7 point scale) for both helpfulness and timeliness in the 2006 survey and again in 2009. A very gratifying result, although about 10% of respondents offered ratings of 1, 2 or 3. As might be expected, unsuccessful proponents gave less favorable ratings. Their satisfaction with helpfulness averaged 4.6 in 2006 and 3.9 in 2009 and the ratings for timeliness were 4.4 and 4.0 respectively. While both ratings by unsuccessful proponents were lower in 2009 than 2006, those differences are not statistically significant.

c) SOI Success

The success rate of SOIs is an important indicator for the SOI process. The SOI is intended to impose an initial screen that allows the Fund to identify promising projects that can proceed to the more intensive proposal stage without putting less promising projects through the rigours of developing a full proposal. In this context, a low success

rate suggests that the process may be imposing a significant burden on unsuccessful respondents while a very high rate suggests that the SOI process may not be serving as an initial screen.

The Fund experienced an initial surge of SOIs and thereafter the number of SOIs received each funding round has stayed at about the same level. Over that period, the success rate has climbed steadily. In its first year, the Fund received over 500 SOIs and the success rate was correspondingly low, 3% of SOIs resulted in approved projects. During 2003 the Fund approved 6% of new SOIs and in total 7%, counting re-submitted proposals. By 2005 the approvals had climbed to 13% of new SOIs and 17% counting re-submitted proposals and by 2008 the rates were 17% and 21% respectively.

d) Summary, the SOI Process

In summary, our examination of the SOI process does not indicate any major issues. A reduction in the time and effort required of proponents, without impairing the quality of the selection decisions, would be a welcome improvement. However proponents did not offer any specific suggestions on how to achieve such reductions.

4. The Proposal Stage

a) The Proposal Process

Successful SOIs are invited to submit a full proposal for funding and the responsibility for dealing with potential projects shifts to the Screening and Evaluation group. Proponents have about three months to submit their proposal. Similar to the SOI process, the proposal process has become more interactive since 2006 and a number of changes have been incorporated in the process.

b) Proponents' Views of the Proposal Process

The survey asked proponents about the level of detail in the proposal. The question was framed similar to the question on the SOI "A proposal should provide sufficient detail about a project so that those who review the proposal can clearly understand the project. In your view, did the proposal requirements ask for too little detail, about the right amount, too much detail?" About three-quarters of successful proponents who were interviewed for the 2006 and the 2009 surveys indicated the proposal preparation involved about the right level of detail. Virtually all others replied "too much detail". As would be expected, unsuccessful proponents were less positive. Just over half thought that the proposal required about the right amount of detail, and the remainder (33% in 2006 and 41% in 2009) said the proposal required "too much detail". The apparent increase from 2006 to 2009 is not statistically significant.

The question on the time and effort required asked "Considering the size of the contribution you were requesting in your proposal and the need of SDTC to ensure that

public funds were being invested wisely, how do you view the time and effort you and your team were required to spend to prepare your proposal?" Proponents' views on the proposal process were remarkably consistent from the First Interim Evaluation in 2006 to this Second Interim Evaluation in 2009. The majority feel that considering the SDTC role to invest public funds wisely, the proposal requires a generally acceptable level of time and effort and the remainder (about 1/3 of respondents) say it took too much time and effort.

c) Proposal Success Rate

The proposal success rate offers an insight into the decision processes of the Fund. If the rate is very low, the process will have imposed a significant cost to proponents to develop proposals that were rejected. However if the rate is very high, it would appear that the selection process may not be offered a sufficient volume of viable proposals from which to select those of greatest merit. The picture becomes more complex when we consider the success of re-submitted proposals, those that were rejected in a previous round, revised and submitted for additional consideration in a later round.

Our examination showed an increasing number of new proposals being invited, from those whose SOIs were successful. We calculated an 'Adjudication Rate' rate, reflecting the proportion of those invited proposals that actually were submitted and continued through the review and approval process. Some new invites decline to submit a proposal and others withdraw the proposal before it enters the adjudication process. The adjudication rate has dropped from about 80% in 2002 to about 60% in 2007 and 2008, perhaps reflecting the results of the interactions with staff during the proposal preparation and review process. The success rate of adjudicated proposals has risen correspondingly from 30% in 2002 to the 70% - 80% range in the last two years. In other words, those proposals that complete the process are likely to meet the expectations of the review process and be funded, so it appears that the Fund's interactions with proponents during the proposal development and review are addressing those aspects of the proposals that are critical to acceptance and funding.

Proponents who begin to prepare a proposal and withdraw from a funding round or are not successful at the adjudication stage may be invited to resubmit. The number of re-invites grew rapidly to about 50 per year by 2006 and at the same time the proportion of projects that responded with a proposal and continued to the adjudication stage fell from about 90% in 2003 to the 20% - 30% range in the last three years. Some of the projects that did not continue may have declined the invitation to resubmit and others may have withdrawn their proposal before it was submitted for adjudication. In any case, it appears that in the last three years, a substantial proportion of proponents whose proposal had sufficient merit to warrant an invitation to re-submit have decided either to decline the invitation or to withdraw from the proposal preparation process before the adjudication process began. Those who continued through the process were almost as likely to be funded (mid 65% to almost 90%) as proposals submitted for the first time.

The low rate of re-invites who proceed to a second proposal is puzzling. We suggest that this rate of should be investigated further to ensure that the Fund understands the factors influencing this behaviour.

d) Summary, the Proposal Process

Overall, the proposal process shows the results of the changes incorporated in the process. The volume of new proposals remains high and the success rate has climbed to quite a high level, with approval rate in the range of 70% - 80% of proposals. This range probably represents a reasonable limit for a review and approval process of this type.

The decline in the proportion of proposals that proceed through the review and approval process and the high probability of success for those that do complete the process likely reflect the increased interaction with proponents during the process. This should have the effect of reducing the amount of work asked of proponents for proposals that have a relatively low probability of success.

5. The Contracting Stage

a) The Contracting Process

The basic requirements of the contract are set out in the Funding Agreements. While the successive Funding Agreements for the SD Tech Fund introduced a number of changes, they did not significantly change the contracting requirements. However experience with the early projects identified a lack of precision in the terms of the contract, such as details of the project plan and metrics for deliverables. The contracting process was tightened up considerably and the 2006 evaluation noted that the time to complete contracts had increased with each successive funding round. Since 2006, a number of changes in the contracting process have been introduced, principally encouraging a problem solving approach to contracting, and refining guidelines for interpreting the requirements of the contract.

b) Proponents' View of the Contracting Process

The survey of successful proponents asked whether or not the requirements were clear and whether or not they were reasonable. The responses showed a significant improvement from 2006 to 2009. In the earlier survey, respondents were evenly divided, half saying the requirements were clear and reasonable and half saying they were not. The 2009 respondents were much more positive, with 69% saying they were clear and 78% saying they were reasonable.

The survey asked respondents to describe any problems they had in the process to sign the contract. Their responses generally reflected the issues that had been identified and addressed by the initiatives described above, but some may point to areas for further development.

The earlier work on the evaluation noted that respondents were concerned about the amount of time during the contracting process that they spent waiting for SDTC to respond. The survey addressed this issue this way; "We expect that you required some of that time (before the contract was signed) to complete the SDTC requirements and the remainder was time that passed while you were waiting for SDTC, for example when SDTC was reviewing your documents. Please estimate the percentage of the total time that you were waiting for SDTC." On average, respondents to the survey in 2006 estimated that about half of the total time was spent waiting for SDTC. The 2009 responses showed a significant improvement. Respondents estimated on average that they spent 28% of the time waiting and only 16% of respondents estimated they spent over 50% of the time in the contracting phase waiting for SDTC.

The SDTC goals include an expectation that it will improve the Canadian capacity to develop new sustainable development technologies. Accordingly, one would expect that the selection and contracting process would typically yield benefits to project proponents. The questionnaire to explore this aspect of the Fund, the questionnaire asked: "Some project proponents have said that the time and effort invested before the contract was signed yielded benefits to their projects, for example, it improved their ability to secure funding required for market entry, improved their project definition and work plan or clarified the involvement of consortium members. When you look back, did the time and effort you invested before the contract was signed benefit your project?" The 7 point response scale ranged from 1, no benefits of any kind to the project, to 7, the time and effort led to very important benefits to the project. The results were quite positive, 26% responded with a 1 or 2 indicating there was little or no benefit, 42% responded with a rating of 3, 4, or 5 indicating some benefit and 31% responded 6 or 7 showing important or very important benefits. The average response was 4.3, above the mid-point on the scale.

c) Time from Board Approval to a Signed Contract

For each funding round, the Investment Committee and then the Board of Directors reviews proposals and the Board approves funding for a number of projects. Then the projects must satisfy the requirements of the standard contract and can only begin work if they are willing to accept the risk that if they do not complete the contract they will have to bear the total cost of the work done. The contracting process involves a number of requirements, such as finalizing arrangements with other funders and completing agreements with each member of the consortium. These may take months or years to complete so this process can substantially extend the final completion date of the project.

It should be noted that objectives of the Funding Agreement include an expectation that the Fund will "channel and strengthen the Canadian capacity to develop and demonstrate Sustainable Development technologies." Fulfilling the requirements of the SD Tech Fund contract, particularly securing the additional funding and completing arrangements with consortium partners, is one aspect of this capacity building process.

For those projects with experienced management and a well-developed project proposal and plan, the process can proceed relatively quickly. Where the proponent is less well prepared, the Fund tends to be patient, allowing the project the time it requires to complete the requirements. The extent of this patience depends on a number of factors including the potential of the project in terms of benefits, the priority of the specific technology, the remaining amount of funding, etc.

d) Administrative Data on Time to Complete a Contract

As noted, the First Interim Evaluation identified the time to complete a contract as a concern. Exhibit IV-1 presents the updated information for all projects approved by the Board for 13 funding rounds, in total 184 projects. Our analysis considers the time to contract for projects as follows:

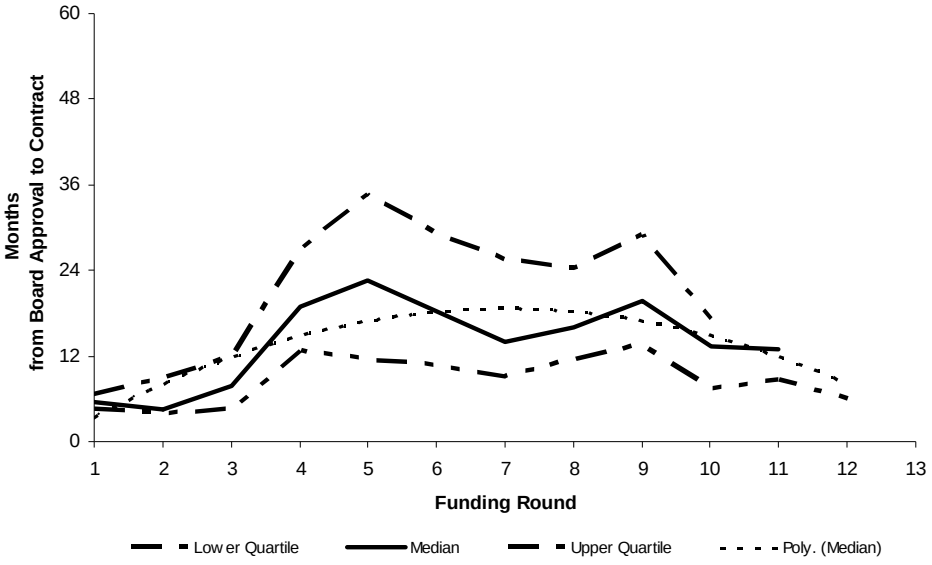
- **Cancelled**. A total of 29 projects did not complete the contracting process because they were cancelled by SDTC or withdrawn by the proponent. The analysis counts the time from approval to the date of the cancellation.
- **Still in the contracting process.** For the 48 projects that are still engaged in the process to complete a contract, the elapsed time was calculated as the time from the Board meeting that approved the project for funding to the effective date of the analysis, 31 December 2008. On that basis, the time that projects have been engaged in completing the contracting process ranged from 4.1 months (16 projects from funding round 13) to 57.6 months (one project from funding round 4).
- **Contract signed.** A total of 107 projects have a signed contract. The time required to complete the process ranged from 0.2 to 50.1 months.

Because some projects have been in the contracting process for a very long time (in the extreme case almost five years), the average time for a funding round may be heavily influenced by a few projects that took an unusually long time to reach an end point. To minimize the distortion caused by presence of these few projects, we used the median values to represent the typical time to contract for all projects in a funding round. When we order the projects according to the time taken for the project to complete the process, the median project is at the middle of the list. We also show the lower and upper quartile values (the projects that fall at the ¼ and ¾ points of the list.) For example for funding round 10, 2006B, the most recent round for which the upper quartile value is available, the Board approved 19 projects. The median value is the time taken for the 9th project, just over 13 months. The lower quartile value is 7.3 months and the upper quartile is 17.2 months.

The exhibit shows that projects from the first three funding rounds proceeded quickly to sign contracts, with median values rising from about 5 to 8 months. The median time peaked in round 5 (2004A) at about 22 1/2 months. Since then the median has generally declined and for round 11 (2007A), the last for which a median value is available, was just under 13 months. This is the lowest time from Board approval to

signed contract since round 3. The exhibit shows a trend line for the median time which reflects the rise and subsequent fall in median time to contract.

Exhibit IV-1 Time to Complete Contracts by Funding Round, Showing Median and Quartile Values



To provide further context, the exhibit also shows a fitted trend line for the median values. The trend line shows an initial increase until about round 8 then turns downward.

Overall, the exhibit suggests that while the time to contract escalated rapidly from rounds 3 to 5, since then the results have tended to improve. The lower quartile appears to track the median quite well and might serve as a leading indicator for the median value. Note that the decline in the time for the lower quartile from round 9 to 12 supports the picture of improvement for recent funding rounds and the continued decline from round 11 to 12 is encouraging.

e) Key Informant Views on Time to Complete a Contract

A comparison with information gathered from VC key informants may provide additional context to these results. If a cleantech seed stage project is ready to proceed in all respects, and VC commentators caution that few are ready, our interviews of VC key informants suggests that about 6 months is a fair estimate of the time required from initial meeting to first payment to the project. A scan of the results for rounds 10, 11 and 12 (2006B to 2007B) shows that the Fund approved 15 to 20 projects per round. To correspond to the VC concept of a project ready to proceed in all respects, we can look at

the Fund's quickest time from approval to contract for those rounds, 5 months, 5 months and 3 months respectively. To match with the VC estimates, we should add about 9 months to account for the time from the initial call for SOIs to the board's decision to fund a project. On this basis, the Fund takes about 12 to 14 months for the projects that are best prepared to proceed, as compared to the VC estimate of about 6 months.

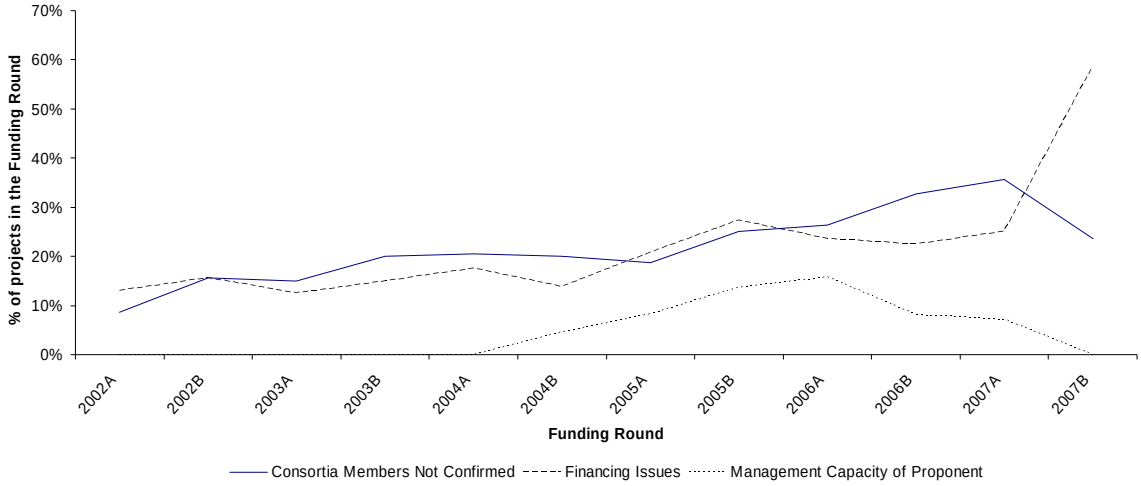
Unfortunately we found no comparable data from Canadian or other government sponsored funding programs on the time required to select projects for funding and complete the necessary contracts.

Both VCs and the Fund deal with projects that are less well prepared and for those projects, the time for the initial payment will stretch out for months. To some extent, the work to bring along a less well prepared proponent reduces the time difference between VCs and the Fund. The VC will have to invest additional time to work with the proponent to develop a business plan, market strategy financing plan etc., activities that are included in the SOI and proposal stages of the Fund's process. Again, given the Fund's mandate and its focus on capacity building, it may be more patient with less well prepared projects, allowing them to proceed as best they can through the steps to a contract. A VC will likely focus on the time and resources invested and the probability of a return on that investment, which could lead the VC to abandon projects that are not proceeding at a satisfactory pace.

f) Reasons for Delays in Contracting

The Fund presents a monthly report to SDTC management that includes data on the reasons for delays in contracting. When a project is encountering difficulties in the contracting process, project managers record the nature of the issue(s) in the project file. Exhibit IV-2 shows the principal reasons for delays that have remained intractable over the history of the Fund.

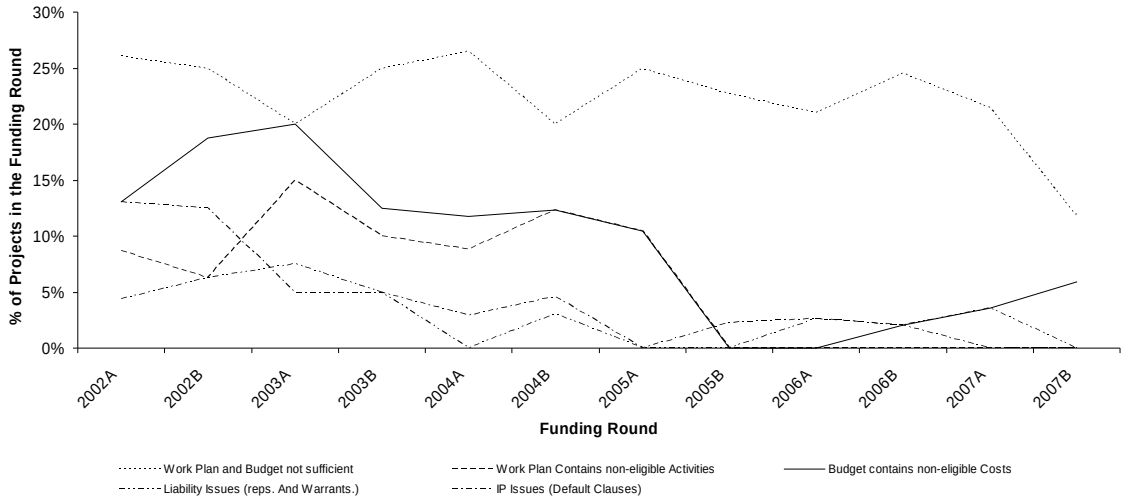
Exhibit IV-2 Principal Reasons for Delays in Contracting



As might be expected, the incidence of financing issues appears to have increased substantially for projects in the last funding round. The analysis of venture capital investing reported above, shows the long-term dearth of capital support for projects. The recent spike, likely reflecting current conditions in the financial markets, exacerbates the situation. In the view of some project proponents, this calls for raising the limit on SDTC funding for a project. In other words, the Fund would assume a larger share of the risk and facilitate the arrangements for the remaining capital for the project. Such an initiative could be achieved by changing the funding formula, for example adopting proponents' suggestion that capital assets be included in eligible project costs.

The initiatives taken by the Fund to provide guidance on contracting issues and to seek practical solutions that conform to the requirements stated in source documents may be reflected in Exhibit IV-3. The exhibit tracks the occurrence of the non-critical reasons for delays that had nevertheless led to considerable delays in the early rounds. "Work Plan and Budget not sufficient" is included in this group because this factor usually reflects financing and/or consortium issues that are tracked as critical issues, shown above.

Exhibit IV-3 Non-Critical Reasons for Delays in Contracting



g) Contracting Summary

The contracting process that was a matter of concern for the First Interim Evaluation has shown substantial improvement. The delays arising from financing and consortium issues call for further attention in these areas. Unfortunately we were not able to identify any comparable data available from other government-sponsored funding programs in Canada or elsewhere on the time they require from identification of a possible project to completion of contractual arrangements. While Venture Capital funds can proceed more quickly to a contract, a comparison with the Fund's experience must recognize the large number of projects screened by the Fund as compared to any Venture Capital organization. Therefore, while we strongly encourage efforts to continue the improvement in contracting times reported above, we judge that the issues identified in the First Interim Evaluation are being addressed and see no grounds for concern with the current performance.

6. Overall Reactions to the Funding Process

The rationale for the SD Tech Fund includes an expectation that at each stage of the process, the Fund will both manage the investment process and also build the capacity of respondents and of the clean tech community to develop new technologies. During the selection and contracting stages, respondents face stringent requirements that embody high standards for the protection of public funds and best private sector practice for the development of a new technology. In other words, the process is intended to yield benefits to the proponent in terms of skill development and for the project, creating solid plans, financial arrangements, protection of intellectual property and the like. To explore the Fund's performance in the area, the survey asked respondents to assess the extent that the contracting process yielded benefits for their project. The survey positioned this somewhat complex issue in this way:

> "Some project proponents have said that the time and effort invested before the contract was signed yielded benefits to their projects, for example, it improved their ability to secure funding required for market entry, improved their project definition and work plan or clarified the involvement of consortium members. When you look back, did the time and effort you invested before the contract was signed benefit your project? Please respond using a scale of 1 to 7 where 1 means the time and effort led to no benefits of any kind to the project 7 means the time and effort led to very important benefits to the project."

The results showed that the average estimate of benefit in the 2006 survey was 4.8 on a 7 point scale and in 2009 it was lower, 4.3, both above the mid-point of the response scale. While the decrease is noticeable, it does not achieve statistical significance.

Respondents offered a number of comments and suggestions to reduce the time taken or the work required to complete the funding process. Those suggestions have been submitted to SDTC for consideration. We should note that some survey respondents may have completed many of the steps in the process a number of months ago, before some of the recent innovations and improvements in the SDTC processes were implemented.

D. MANAGEMENT OF FUNDED PROJECTS

1. The Project Management Process

The Fund has tracked the progress of contracted contracts, separating the performance of the proponent from the performance of the Fund. In general, proponents are responsible to submit required reports at each milestone in their project schedule and the Fund is responsible to review the reports, seek any required clarifications or additional information and process the milestone payment. The final holdback payment follows a different process because it requires completion of other reports and submissions from the project and the Fund conducts audits of projects and expert reviews of their environmental impact reports.

2. Proponents' View of Management of Contracted Projects

Proponents rated the performance with respect to the Fund's management of contracted projects in terms of speed of response and technical expertise of the people involved. The 2009 survey responses were quite favourable, averaging 5.5, well above the mid-point of the 7 point scale.

3. Adherence to Project Schedules

The data on project progress summarized from the project database show a consistent improvement in conformance to project schedules. At the time of the First Interim Evaluation, the average delay submitting reports was about 130 days, just over four months. That average delay has dropped by about one month each year. While the data for 2008 reflect the first three quarters, for those reports the average delay was just over one month.

4. Review and Processing of Initial, Milestone and Holdback Payments

The First Interim Evaluation recommended that the Fund should examine its performance in project management by identifying the occasions when the project was waiting for the Fund, then monitoring the time it took and working to reduce those times.

The Fund identified the delays around project milestones as an area that could be monitored and improved. The data from the project management database supported an analysis of delays by the proponents, typically reports delivered after the target date established in the project plan, and the delays on the part of the Fund, reviewing the report and processing payments. The Fund established a target of 45 days for report review and payment processing.

In 2005, the Fund changed the requirements for the initial payment so it can be made upon signing of the contract. In other words, no documents have to be reviewed and approved before the payment can be released. This change significantly reduced the average time for the initial payment.

The days required for milestone payments increased from 78 days in 2004 to 134 days in 2005. During the period, staff was increased, the monitoring reports were initiated and a number of changes were introduced into the process. Since then, the days to release milestone payments have decreased each year and in 2008 the average time was 44 days, just under the target for this process.

Release of the holdback, which is 10% of the Fund's contribution to the project, involves satisfying more requirements than are involved in milestone payments. When the project is completed, the Fund must conduct and review a number of reports including a financial audit and an environmental audit, both of which are conducted by external contractors on behalf of the Fund. Also, it should be noted that only a relatively small number of projects have been completed and received payment of the holdback, so the Fund is still working actively to develop and refine its procedures.

A scan of the data on the first 20 completed projects suggests that some improvement has been made. However the last seven payments, which were all made in the last quarter of 2008, ranged from 200 to 300 days (average 306 days) from the receipt of the project's final report until the payment was made. In our view, unless the vast

majority of the delay is under the control of the project, a delay of almost a full year for release of the 10% holdback is excessive.

E. STAFFING

The First Interim Evaluation commented that staffing levels had recently been increased. The changes added the largest numbers of staff in the critical project-involved areas of applications, screening and evaluation, contracting and project management and finance and accounting.

The research for this evaluation captured a number of comments from the 2009 survey of project proponents reflecting these additions and changes. The open-ended comments were sprinkled with mentions of multiple changes in the assignment of individuals to their project and the need to introduce each new person to the project. This may in part reflect the hand-offs between the SOI and proposal stage and again from proposal to contracting and project management. However from the number of comments, there was clearly a problem in this area. We noted a number of positive comments from proponents, praising the staff, complimenting their hard work and positive attitude. Key informants also commented on staffing, typically more senior staff with whom they had personal contact, in terms such as "very professional and hard-working".

F. CONCLUSIONS AND RECOMMENDATIONS FOR FUND OPERATIONS

This evaluation describes a large number of initiatives undertaken by the Fund since the last evaluation that taken together, evidence a significant program of continuous improvement. The results of these initiatives are visible in the findings reported for Fund operations. The SOI success rate has climbed to about 20%. The contracting process has been substantially enhanced and results show continuing improvement. The proposal success rate has climbed to almost 80% of proposals that enter the review and approval process. The average time to complete a contract has decreased from a high in 2006 and appears to be approaching the level seen in the early funding rounds. The incidence of a number of the reasons for delay in contracting has fallen sharply. Proponents report a significant reduction since the 2006 surveys in the proportion of time waiting for the Fund to respond during the contracting process. The time taken to review milestone reports and process progress payments has decreased remarkably and now meets a self-imposed target. Perhaps reflecting the strengthened proposal and contracting processes, proponents' adherence to schedule has improved substantially since 2005.

The Fund has made considerable investments in capacity building with projects, for example entering into a more proactive relationship at the SOI and proposal stages. The efforts to identify potential water and soil projects and where appropriate, to

encourage them to submit SOIs and proposals, goes well beyond the scope of the interactions with projects what was anticipated in the Funding agreements. While such additional efforts appear to have yielded substantial benefits, we are concerned that they could well strain the operating budget.

We recommend that the operating budget be reviewed to ensure that it supports the full scope of capacity building efforts that have been developed by the Fund.

Projects face considerable difficulty and delay during the contracting phase when securing outside financing. If recapitalization is being examined a suggestion from project proponents should be considered: that the limit on the Fund's contribution to a project should be raised. By shifting a larger share of project risk to the Fund, the change would facilitate outside financing and expedite the contracting process.

Our findings provide further support for the importance of efforts to simplify the SOI, proposal and contracting procedures. The issues identified in the previous report have been addressed and the process has been improved substantially. However continuing efforts may reduce the burden on proponents and allow them to complete the funding process more quickly.

We recommend that the Fund should review the SOI, proposal and contract requirements to identify any areas that may call for detail in excess of that required for prudent project management and protection of public assets. The ongoing scrutiny of the processes, typically a review after each funding round, should ensure that each stage only calls for only the critical information that is used to identify projects that should proceed to the next stage. Wherever feasible the information required at each stage should relate directly to that provided in the previous stage.

The time to complete the requirements for the holdback payment for completed contracts appears excessive.

We recommend that the Fund should continue its work to identify the reasons for delays in the release of holdback funds, segregating time under the Fund's control, which includes the time taken by its subcontractors, and identifying strategies to minimize the time under its control so that any extended payment periods are attributable to the proponents' delays in providing the required submissions.

V FLOW OF SOIS AND PROPOSALS RELATIVE TO THE COMMITMENT AND DISBURSEMENT TARGETS

A. BACKGROUND

The Funding Agreements were summarized above in Chapter I. Since the stipulations focusing funds on technology sectors and the requirements to commit and disburse funds are important to this discussion, here is a brief summary of the salient points.

In total, the agreements direct $350 million toward technologies focused on climate change (80%) and clean air (20%). The second agreement added a stipulation that within this amount, the Fund should make available at least $50 million for projects directed toward the hydrogen economy and at least $50 million for projects related to clean fossil fuels. The third Funding Agreement added a further $200 million "made available for Projects that are primarily Clean Water Projects or Clean Soil Projects, based on demand and merit of proposals received."[28] In other words, the Funding Agreement made no specific allocation between clean water and clean soil. The Foundation should "use reasonable efforts to ensure that there are funds available to commit to funding to new projects up to at least the end of December 2010."[29] It should:

> "endeavour to:
>
> (a) where Eligible Projects warrant, disburse funds in each year up to 31 December 2012:
>
> (b) with the exception of a reasonable amount reserved from the Fund for related monitoring and evaluation, and proper wind-up provision, have disbursed the Fund in totality by 31 December 2012."[30]

The structure set out in the Funding Agreements anticipates that from its inception until 2010 the Fund would commit funds to approved projects at about the same rate per year within the two larger envelopes, climate change and clean air (CCCA) and water and soil. Within the CCCA envelope, the hydrogen and cleaner fossil fuels projects would follow the same general pattern. Disbursements would trail commitments and would exhaust the available funds by about the end of 2012.

[28] *Funding Agreement Three Pertaining to the Sustainable Development Technology Fund*, 31 March, 2005, Article 9.04
[29] Ibid, Article 9.02.
[30] Ibid

The evaluation plan identified the volume and quality of Statements of Interest (SOIs) and proposals as key indicators of the continued validity of the rationale for the SD Tech Fund. The First Interim Evaluation examined the situation at that time, almost exclusively CCCA SOIs, proposals and approved projects, and concluded:

> In summary, it appears that the volume of SOIs has maintained a level that should allow SDTC to select the most promising proposals from an array of viable candidates. The exhibit also shows a steady rise in the probability that a proposal will be funded, from about 25% in the first funding round to over 75% for 2005A. This suggests that SDTC's input and advice to proponents has resulted in stronger proposals that are more likely to be accepted by SDTC's Investment Committee.

The discussion below begins with an examination of the allocation of a project to one of the technology sectors identified in the Funding Agreements. The following sections examine the flow of SOIs, proposals and approved projects for each of the technology areas identified in the Funding Agreements.

B. DESIGNATION OF THE PRIMARY ENVIRONMENTAL BENEFITS OF A PROJECT

In its 2009 corporate plan, SDTC took the position that identifying projects according to their 'primary' economic benefit "is an overly narrow way of assessing technology impacts."[31] Since the Fund's progress against the funding targets set in the Funding Agreements is an important aspect of the Fund's achievement of its operational objectives, this section examines the data on environmental benefits.

As required by the Funding Agreements, the Fund identifies a primary environmental benefit for each of its projects. As well it identifies other impacts as 'co-benefits.' Exhibit V-1 summarizes these data. The exhibit shows the benefits and co-benefits of all 154 projects approved to the December 2008.

The rows of the exhibit summarize projects with a specific primary benefit and the count of projects with that primary benefit is **bolded**. For example, the first row shows that 99 projects record the primary benefit as climate change and 85 of those also claim clean air co-benefits, 15 show water co-benefits and 18 show soil co-benefits. The last row shows that of the 13 soil projects approved to date, 12 show co-benefits for climate change, 11 for clean air and 11 for water. The columns show the count of projects with either primary or co-benefits in one category. For example the Fund has approved 13 soil projects (soil is the primary benefit). However 18 climate change projects claim soil co-benefits, along with one clean air and 10 water projects. So in total, 42 projects show soil benefits or co-benefits.

[31] SDTC 2009 Corporate Plan, p. 11.

Exhibit V-1 Number of Projects with Primary and Co-Benefits in a Technology Sector

	Primary and Co-Benefits			
	Climate Change	Clean Air	Water	Soil
Where Climate Change is the primary benefit, the co-benefits	**99**	85	15	18
Where Clean Air is the primary benefit, the co-benefits	18	**25**	2	1
Where Clean Water is the primary benefit, the co-benefits	11	8	**18**	10
Where Clean Soil is the primary benefit, the co-benefits	12	11	11	**13**
Total projects showing primary or co-benefit in a sector	140	129	46	42

This analysis raises a basic question: how should we identify the 'primary' benefit? In some projects the choice is obvious, for example where there is only one benefit identified, but only 19 projects fall into that category. While it might be appealing to specify the benefit that shows the greatest value to Canada the data to support that analysis are typically not available when projects are approved. Proponents might prefer to categorize the project according to the dominant reason they decided to pursue the project. On a practical level, it could be that the sector identified represents the funding category that was available at the time the proposal was submitted for approval. (Invitations for the first seven funding rounds called for climate change clean air projects only.)

An example drawn from the completed projects, illustrates the issue. Highmark Renewables processes cattle manure from a large feedlot operation. Using an anaerobic digestion system, it produces electricity, bio-based fertilizer and reusable water. When asked to identify the most important impact, the project proponent said "On the air side (climate change), if you are looking at carbon emissions, it is fairly significant. I am not sure if that would get a higher weighting than the nutrient balancing for the soil." "For the standalone feedlot, the primary benefit is reducing the nutrient load on the soil." However "the carbon reduction is important." On balance, his personal judgment is "Probably air is bigger because it can significantly offset fossil fuel based energy; but if soil is not first, it is a close second."

Overall, it appears that in at least some cases, the allocation of a project to a technology sector is essentially arbitrary. The example cited above suggests an alternative approach. The Highmark project has significant impacts on both CCCA and soil and selecting the primary impact seems to depend on the perspective taken. Perhaps both should be counted. In other words, rather than requiring that a project has only one

primary benefit, where a project yields significant benefits in more than one sector, the Fund could count both benefits as it accounts for the impacts of projects. However the Funding Agreement establishes targets for commitment of funds by sector. With this background in mind, we turn to an examination of the volume of SOIs, proposals and investments by sector of primary benefit.

C. SOIS AND PROPOSALS BY TECHNOLOGY SECTOR

As one would expect, the flow of SOIs and approved projects reflects the underlying conditions of the different technology sectors. Discussion with key informants and SDTC staff have highlighted the extent that the sectors are dissimilar in terms of the research efforts focused on creating new technologies and the receptiveness of the sectors to new technologies. The following sections examine each sector in turn to describe progress to date and to consider the implications of the current situation for the investment targets and timelines established by the Funding Agreements.

1. Climate Change and Clean Air

The strong flow of SOIs and proposals for CCCA technologies described in the First Interim Evaluation has continued. While it is recognized that some SOIs may not represent viable projects for the Fund, the total value of SOIs in a funding round is a useful indicator of the flow of potential projects. Recently the Fund instituted a review process to identify projects considering an SOI that may not be well suited for the SD Tech Fund. The Fund may suggest more appropriate development steps for those projects. Even with this pre-screening of SOIs, the volume continues at a high level.

The value of CCCA SOIs has averaged about $250 million per funding round; a level that is about 13 times the prorated target value of projects ($19.4 million per round.) A key concern for the evaluation was that the value of SOIs may decrease over successive funding rounds. The data show that this has not materialized. The flow of SOIs has maintained about the same level in recent funding rounds (11.4 times target). The value of funds committed to approved projects in the first few funding rounds did not meet the prorated target but in the following rounds exceeded that level and by funding round 2008A, with five funding rounds scheduled before the target completion date of December 2010, the Fund had committed $318 million of the $350 million target.

Given the strong flow of requests for funding from the CCCA technology community and the depleted state of this component of the Fund, it would appear timely to consider re-capitalization.

a) Hydrogen

Projects directed toward the hydrogen economy are included in the CCCA component of the SD Tech Fund. Funding round 2003A recorded the first commitment

to hydrogen projects. However the hydrogen SOIs were not identified and tracked separately until round 2005B so the record of SOIs for the first seven funding rounds is incomplete.

The pattern of hydrogen SOI value per funding round is somewhat erratic, ranging from one project calling for $0.08 million to eight projects asking for a total commitment of $48.4 million from the Fund. However on average the SOIs have amounted to about 5.5 times the prorated value of projects per funding round that is required in order to commit the available funds by 2010. While we must rely only on recent results, it appears that the flow of hydrogen SOIs is producing a flow of opportunities for investment that is appropriate for the $50 million target.

A projection of future commitments to projects in the hydrogen economy reflects the results of a review of projects in the pipeline, SOIs and proposals under development, with an estimate of the likely result in committed funds for those projects. The high value of recent SOIs raises the possibility that if the recent experience continues, commitments may well exceed historical averages and the Fund may approach the target of committing all funds by 2010.

b) Clean Fossil Fuels

The SOI data on Clean Fossil Fuels (CFF) SOIs are also not available for early funding rounds. Similar to hydrogen, the value of SOIs per funding round seems erratic. The average value of SOIs in recent rounds amounts to about 4.9 times the funds required to be committed each funding round to meet the target of $50 million by 2010. However in contrast to Hydrogen projects, commitments in the early funding rounds to CFF projects have averaged about the target level. The commitment of funds to CFF projects generally tracks the prorated target and a projection based on recent performance shows that the funds would be committed by 2011 if the trend continued and the Fund took no initiative to complete the commitment by 2010.

Overall it appears that the flow of SOIs for CFF projects is sufficient to support the current level of investment and the funds should be committed by about the target date.

2. Water and Soil

While the third Funding Agreement combines water and soil, it appears that the technologies differ in terms of interest in and barriers to development of new clean technologies. So we have treated them separately here and combine them later in a comparison to the targets set out in the Funding Agreements.

a) SOIs for Water Technologies

The flow of SOIs for water projects contrasts sharply with that for CCCA projects. The flow of SOIs for water technologies is a fraction of that for CCCA, averaging about $19 million for the recent rounds when water projects were eligible for funding or about 2.2 times the prorated commitment target (assuming for purposes of this analysis that the water and soil targets are equal.) This comparison suggests that the number of SOIs and proposals for water projects may not be sufficient to allow the project selection process to exercise its collective judgment to select the most promising of the water proposals, in the manner anticipated by the Funding Agreements and exhibited by the process for CCCA projects.

Discussions with SDTC staff confirm that they share the view of the venture capital key informants: the water sector appears poised for rapid growth in the months and years ahead. But potential projects are often blocked or delayed and until the factors causing those delays are addressed, the volume of potential projects will remain low.

b) SOIs for Soil Technologies

The flow of SOIs for technologies focused on clean soil resembles that for water technologies. SOIs have averaged about $14 million per funding round or about 1.6 times the prorated target. While the long term potential for soil technologies is similarly high, key informants were less enthusiastic about its prospects in the short term. This sector may present greater challenges than water in terms of committing funds to projects in the short term.

c) Water and Soil Combined

Given this situation, the Fund has taken a more pro-active role than was required for CCCA projects, working with potential proponents to structure water and soil projects that should have a high likelihood of meeting the Funds investment criteria and approval of the Investment Committee and the Board. On this basis, one would expect that the quality of the SOIs would be higher than seen in CCCA submissions, particularly in the early funding rounds. However, this approach raises a concern that the screening and selection processes may not generate a sufficient number of alternative projects for the Fund to be able to exercise its judgment to select the water and soil proposals of highest merit. An examination of the data on acceptance rates for water SOIs and proposals indicates that this issue has not materialized. The proportion of successful SOIs and proposals that lead to approved projects is comparable with recent experience for CCCA projects. We also discussed this potential concern with members of the Investment Committee. They reported that while water and soil proposals have been relatively rare, in their judgment the quality of those projects that were approved was comparable to the approved CCCA projects.

The Funding Agreement established a combined target of $200 million to be committed to projects with primary benefits for clean water or clean soil. The prorated target calls for commitments of $18.2 million per funding round. Up to round 2007A, the Fund committed an average of $5.6 million per round but 2007B saw $20.8 million committed and round 2008A results show $14.1 million committed to water and soil projects. As recently as late 2008, the Fund was projecting the current rate of about $10.5 million commitment per round would continue and the commitment target would be accomplished in about 2015. However the most recent projection anticipates a rate of about $25 million per funding round, well in excess of the pace to date.

In large part, the projected increase in commitments per funding round reflects the results of recent initiatives to identify potential water and soil projects, to contact them and where appropriate, to solicit SOIs and proposals. SDTC staff now report that this work has built a significant pipeline of water and soil prospects that should yield an expanded and continuing flow of SOIs and proposals over the next few years. According to current projections, the $200 million directed to projects with water and soil primary environmental benefits should be fully committed during 2011.

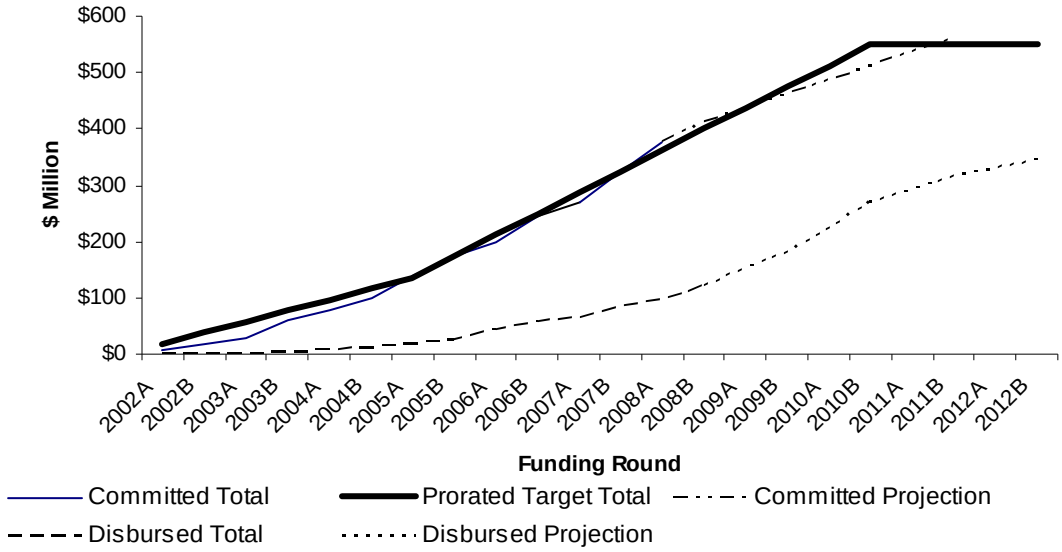
3. Summary Commitments and Disbursements

a) Commitments to Projects

Combining the analyses for CCCA and water and soil, Exhibit V-2 shows the current status and projections for the Fund.

The exhibit reflects the dominance of CCCA projects in the SD Tech Fund's early performance. For this analysis, we have assumed that hydrogen and clean fossil fuel projects will follow the overall projections for CCCA, in other words they will meet the 2010 target date for commitments. To date, the shortfall of water and soil commitments from their target is offset by the above-target commitments in recent funding rounds for CCCA projects. As noted, the CCCA commitments are approaching the target and the activity in water and soil projects is projected to increase substantially so that the commitments should reach the overall target in 2011, as compared to the target of committing all funds by December 2010.

Exhibit V-2 Cumulative Values for Commitments and Projected Commitments, Actual and Planned Disbursements and Prorated Target Commitments



b) Disbursements to Projects

This exhibit summarizes the data related to the Funding Agreements' second target, the rate of disbursement for projects. The exhibit shows the scheduled payments for all committed and funded projects. The inflection in the line that occurs at about 2010B likely will be corrected as initial and milestone payments are made to projects not included in the analysis, those projects that sign a contract in the interim and begin receiving payments from the Fund.

Clearly, the disbursement results do not conform to the expectations of the funding agreements, which anticipate that disbursements will be essentially complete by 2012, two years after the commitment target. The rate of disbursement has risen slowly as projects have completed contracts and have begun to receive payments from the Fund. In recent months the rate of disbursements has matched the rate of new commitments and we anticipate that this relationship should hold, with the disbursements trailing commitments by about four to five years.

Chapter IV above discussed the contracting process, progress against project milestones and the time required to make payments once milestone reports are submitted to the Fund. That analysis shows that, once contracts are signed, projects make reasonable progress in achieving their milestones and payments follow promptly on accomplishment of those milestones, with the sole exception of the final holdback payment. That analysis indicates that the rate of disbursement shown in Exhibit V-2 is slower than anticipated for two principal reasons:

- Experience has shown that it takes a number of months after commitment of funds to a project to complete the contract.
- Most importantly, once the contract is in place, the planned duration of projects exceeds the two years that was anticipated in the Funding Agreements. For contracted projects, approved plans show an average duration of 3.6 years. Only 14% of project plans called the project to be completed in two years or less and 14% of project plans extend beyond five years.

On this basis, and given the projection of commitments outlined above, the final payments for the last SD Tech Fund projects will be completed a number of years after the 2012 target established in the Funding Agreement.

The Fund has considerable latitude to establish or alter operating procedures. It is possible that some selection criteria for projects or procedures for contracting and managing projects could be adjusted to accelerate the disbursement of the Fund's contribution to projects. However that would alter arrangements that have been developed and refined since 2002 to select the proposals of greatest merit and to follow recognized best practice to manage ongoing projects. In our view, making such alterations for the sole purpose of meeting the disbursement target should be avoided

D. CONCLUSIONS AND RECOMMENDATIONS

1. Accounting for Commitments and Disbursements by Primary Environmental Benefit

The Funding Agreement assigns funding targets for technology sectors. It requires that the Fund identify a primary benefit for each project and assigned the project to the technology sector for that primary benefit (clean air climate change (and where appropriate, hydrogen or clean fossil fuels), water or soil.) Our examination of this process suggests that the sector selected is sometimes arbitrary, since some projects yield significant benefits in more than one sector.

We recommend that this approach be re-examined in any future funding agreements. We suggest that when projects have significant impacts in more than one sector, allowing more than one benefit for those projects would more accurately reflect the reality of the technologies being developed.

2. Targets for Commitment and Disbursement of Funds

The wording of the Funding Agreement appears to allow some latitude in the timing to achieve the commitment targets. Since current projections show full commitment of the target amounts by 2011, we judge that this performance, if realized, would comply with the terms of the agreement.

We conclude that the SD Tech Fund has met the expectations of the Funding Agreement in that it has endeavoured to disburse funds as quickly as allowed by the agreement's requirements for contracting and the time required to complete the work plans of the projects selected for funding. However the experience to date indicates that Funding Agreement's anticipated two year lag between full commitment and full disbursement of those funds is unrealistic. It appears that the Funding Agreement did not correctly anticipate the time to negotiate contracts that conform to the conditions required by the agreement nor did it accurately predict the duration of a typical project. Therefore the Fund is unlikely to meet the disbursement target set by the Funding Agreement unless it substantially alters its operating procedures for the remainder of the period of the current agreement. In our view, such alterations for the sole purpose of meeting the disbursement target should be avoided.

We recommend that the Funding Agreement should be revisited to establish a disbursement target date that is more in keeping with the nature of the projects that have emerged from Canada's technology development community.

3. Recapitalization Provisions

The key informant interviews pointed out that the Funding Agreement was drafted with no consideration of renewal. We recommend that, if the Funding Agreement is renewed or modified, consideration should be given to specifying a date that would trigger consideration of future renewal at least two years in advance of the termination of the renewed agreement.

The issue of recapitalization is a matter of current concern. The funds for CCCA projects are essentially fully committed and any remaining funds should be directed toward hydrogen and clean fossil fuel projects in order to complete the allocation to those sub-sectors. Therefore the flow of CCCA projects will be substantially disrupted from this point forward. Given recent developments, it appears that the water and soil commitments will be completed by about the target date of 2010.

We recommend that the issue of recapitalizing the Fund should be addressed in the near future. The largest component of the Fund, climate change and clean air projects, has committed virtually all of its funds. If disruption is to be avoided in the Fund's operations and in the development of new clean technologies, a clear indication of the government's intent with regard to recapitalization should be made available in the next few months.

VI MANAGEMENT OF THE INSTRUMENT, SDTC

SDTC represents a novel policy instrument of government. As an arm's length foundation, it is beyond the influence of bureaucrats or politicians who may wish to advocate a particular technology or proponent. Funding agreements structure this relationship, calling for SDTC to fund proposals which in the opinion of the Board have greatest merit. The Fund takes a private sector-like approach to projects, technology and management screening, protection of intellectual property, market projections, business plans, and the like.

The First Interim Evaluation provided the following observations and recommendations on the operations of the Fund:

> We recommend that SDTC should continue to pay close attention to relationships with government programs and departments. The evaluation notes progress in this area. However it will require continuing attention from SDTC and its government counterparts to maintain an appropriate balance between the independence that is the hallmark of an arm's length organization and the cooperation and collaboration needed to achieve maximum impact from all of government's initiatives in this area.

A. COMMUNICATION WITH RELATED GOVERNMENT DEPARTMENTS

1. Monthly Meeting

Key informants described continuing improvement in the communications between SDTC and departments. Representatives from both sides attend a monthly meeting that is consciously designed to identify and respond to the interests and information needs of participants. The meetings have recently been expanded to include representatives from Finance and Foreign Affairs and International Trade. The general format calls for participants to talk about "what is happening that others should know about." SDTC, the host for the meeting, has circulated a questionnaire and emails asking if the meetings are worthwhile and requesting suggestions for topics that could be addressed in future meetings. The responses were supportive of the meetings and led to additional topics being identified. The discussions are quite wide-ranging, for example, recent meetings have seen a presentation from government on the Weyburn project and from SDTC on the project portfolio and examples of achievement.

Participants strongly supported the meetings. "Communication is improving by leaps and bounds. We should recognize that we are moving very well in the right

direction." Both government and SDTC generally recognize the limitations faced by the other. Government must respect the confidentiality of development work on such issues as policy initiatives, possible regulatory actions, budget discussions and the like. SDTC must respect the commercial confidentiality of projects and project plans and must protect proponents' intellectual property. However the practical application of such limitations may sometimes not be recognized.

SDTC routinely provides a substantial volume of information to government, principally Natural Resources Canada and Environment Canada, through vehicles such as the Annual Report, the annual Corporate Plan, special purpose documents, briefings, presentations and informal discussions. Nevertheless key informants commented that departments were left with some important questions for which they did not have satisfactory explanations. More than one key informant characterized the apparently missing information as analogous to the type of information a corporation would provide to a principal shareholder. As we explored this point, the discussions pointed to information with respect to the rate of disbursements and the rate of progress of applications.

We examined the information that SDTC had provided to departments on these topics and found that they had been addressed in some detail. In our view, the documentation provided sufficient information and explanation to address the concerns as we understood them. However we recognize that SDTC's documents are a very small part of the information flow to departments. We should not expect that all relevant details that had been provided would be retrieved and applied when a policy issue was being discussed. Nevertheless there should be a communication channel that would be used routinely when such concerns arise.

Departmental and SDTC key informants identified a number of situations where, in their view, more information could be shared to the benefit of SDTC and the government:

- Policy discussions that may be strategic to the success of a technology in a market sector.
- Intelligence gained from experience of selecting, managing projects and from conducting research in government labs.
- Dissemination of SDTC internal research.
- Total environmental impacts including both the emission intensity (measured as part of the project requirements) and measurement of other possible environmental impacts.

This 'wish list' of communication and information sharing is extensive. Responding substantively to all of these could involve a major investment of resources. Clearly that was not the intent of the key informants who contributed to these discussions. If initiatives were undertaken in these areas, they should avoid significant time demands, particularly on the small staff of SDTC. We suggest that the monthly meetings with

departmental representatives might offer an example of an appropriate format, informal exchanges conducted at mutual convenience with a minimal requirement for documentation and support.

B. CAPACITY BUILDING, THE RENEWABLE TECHNOLOGY INFRASTRUCTURE

SDTC invests considerable effort in raising awareness of the Fund, outreach and offering input and advice where it is requested. Senior members of staff attend relevant conferences, participating on panels and/or making presentations. They also provide policy briefings and make presentations at senior levels across the government and to House and Senate Committees. Senior members of staff have participated in key national working groups in sustainable development issues, offered input on how various governments could develop a cleantech focus and participated in trade missions. Some key informants were aware of these initiatives and voiced appreciation for the extent of the investment of scarce resources in these activities and praise for the quality and value of the SDTC contributions. We should note some key informants felt that SDTC needed to do more to raise the SDTC profile, to build support for the organization and ultimately, to secure re-capitalization "I worry about continuing support for SDTC. SDTC must step up, increase its profile in the Canadian innovation system." "Within government their profile could be higher."

The structure and operations of the Fund have been examined and to some extent used as a model for other funding programs/organizations that were being established in other countries and at the federal and provincial levels in Canada.

C. CONCLUSIONS AND RECOMMENDATIONS

SDTC has continued to work on the relationship issues discussed in the First Interim Evaluation and its efforts have been applauded by colleagues in government departments who strongly support the Fund's communication initiatives. Our current research suggests that additional initiatives should be considered.

We recommend that SDTC initiate discussions with appropriate government officials to identify additional communication channels. Ideally, the channels would respond to the information needs/expectations of both sides while avoiding imposing additional burdens on either side. Possible avenues:

- Periodic discussions involving SDTC staff and specialists with departmental scientists or officials to identify general findings that could be shared while protecting the confidentiality and intellectual property of projects. This should be an exchange, responding to the interests of both SDTC and departments.

- When significant issues or questions arise that are not adequately covered by information already provided, meetings should be triggered by either side between senior SDTC/departmental/political levels to discuss those issues.

VII COST-BENEFIT MODEL UPDATES AND REFINEMENTS

A. WHY USE COST-BENEFIT ANALYSIS?

For this evaluation, we employ a cost-benefit analysis model to assess the impacts of the SD Tech Fund. In reviews of investments in new technologies, the central underlying question frequently involves a comparison of what the investments achieve relative to their cost. This means that cost-benefit perspectives are being used implicitly. Explicit use of cost-benefit analysis makes the assessment clearer and more meaningful and provides important information for decision makers.

Cost-benefit analysis is a tool for better public sector decision-making. Private sector organizations routinely carry out detailed financial studies related to their decisions to commit new funds to a project. They also review rates of return on past investments as a guide to future investment decisions and in general, consider only those impacts that generate revenue or cost streams for the organization itself. The major difference between private sector financial assessments and social cost-benefit analysis is in their inclusiveness. In principle, public sector decision-makers should consider all of the positive and negative impacts of the expenditures that are being reviewed. (Positive impacts are benefits while negative impacts are costs) All benefits to members of society, not just benefits to proponents of programs like SDTC, should be taken into account. In other words, cost-benefit analysis goes beyond a narrow financial perspective to capture all of the impacts, positive and negative, of pursuing particular courses of action such as providing support for new environmental technologies.

Cost-benefit analysis is simply an organized way of assembling and presenting data on the impacts of a set of activities. Investment expenditures can be assessed in terms of their positive impacts relative to their costs when these are measurable. In cases in which some of the important impacts cannot be assessed quantitatively, cost-benefit analysis is still an effective organizing framework to assist decision-makers.

Cost-benefit analysis converts the impacts of a policy or program into dollar units. Under the assumptions of the benefit-cost model the dollar magnitudes reflect levels of well-being for members of society. Dollars are being used as a common yardstick to measure well-being as perceived by members of society. Policies or programs with a greater excess of benefits over costs would be preferred by members of society to alternatives with fewer benefits relative to costs. In the case of support for environmental technologies, a key challenge is to develop estimates of the relationship between well-being and what members of society are willing to pay for the impacts (cleaner air, for example) associated with the new technologies. Economic analysis provides information on benefits and costs to allow policy options to be compared and ranked.

B. THE SD TECH FUND COST BENEFIT MODEL AND RESULTS

1. The Model

To explain the cost-benefit model for the SD Tech Fund, we follow the calculation based on 25 projects. This portfolio of projects includes all completed projects and a few that are nearing completion and have completed the final emission estimates. The model uses data provided by projects, drawn from the refereed literature, developed from results of surveys conducted for this evaluation and informed judgment of experts in the area. For each factor we chose values that we believe are realistic and conservative, in other words the analysis tends to err on the side of lower estimates of the value of benefits. Recognizing the uncertainty involved, we estimated low, benchmark and high values for each factor. The calculation involves these steps:

- The Fund granted $61.6 million to 25 projects. Private investors including the project proponent made up the balance of the total project cost, $215 million.
- The projects were asked to develop sales projections for a 20 year period. If they provided estimates for a shorter period, the model assumes that sales will continue at the level of the last year of the company's estimate.
- The model estimates that the 'economic rent', returns in excess of normal profits, will be 5% of sales. This is applied to pay back the cost of the project and the remainder is the net benefit to investors.
- The model uses the sales projections and emission reduction estimates to calculate the impact of the 25 projects on greenhouse gas (GHG) and criterion air contaminant (CAC) emissions over 30 years, 20 years of sales and a further 10 years of useful life. Our review of the refereed literature indicates a consensus value for GHG emissions of $12 per tonne of CO2 and the range of low, benchmark and high values of $6, $12 and $20. For CACs the equivalent values are $3, $5 and $10. Using these values, the model estimates the value of the benefits of reduced emissions.
- A number of factors are used to adjust the value of the estimated benefits to reflect the uncertainties of the estimates:
    - **Social discount rate** to estimate the value in 2005 of the value of benefits that occur in future years. The economics literature on this subject is extensive. When we consider that this analysis is dealing with long run environmental benefits, the literature suggests values (low, benchmark and high) of 2%, 3.5% and 5%.
    - **Incrementality**, the probability that Fund's contribution was essential to a project's success. Without the Fund's support, projects could have: proceeded unchanged; proceeded at a different scale (typically smaller) or pace of progress (typically slower) and as a result face a different probability of success (typically lower) or; been abandoned. The survey of

successful and unsuccessful proponents indicates incrementality values of 55%, 65% and 75%.

- **Business performance**, the probability that projects will achieve their sales projections. They could fail or if successful, could under or over-achieve the projections. The literature offers only marginally related estimates, principally with respect to the 5 year survival rate of new technology companies (that did not have the experience of a SD Tech Fund Project).[32] Venture capital informants agree that the business risk is very difficult to predict. We chose what we think are conservative values, 10%, 17% and 25%.
- **Technology performance**, the probability that in commercial settings the technologies will achieve the emission reductions estimated at the end of the demonstration projects. On average, the estimates of emission reduction developed from technical reviews at the end of the demonstration projects were about 65% those provided in the project proposals. The model uses 50%, 65% and 80% for the technology risk after market entry.

- Using the benchmark values, which we take as representing the most likely outcomes, the model indicates that the $61.6 million that the Fund contributed to the 25 projects stimulated further investment and the total project cost amounted to $215 million (2005 dollars). The present value (2005 dollars) of the net benefits (i.e. after repaying the project costs) resulting from these projects amounts to $741 million.

Most of the net benefits arise from environmental benefits, which total $639.2 million. The net private benefits from the analyzed projects total $107.6 million.

A few of the projects do not generate environmental benefits directly themselves, but are required "enabling" technologies that are necessary to make a complementary sustainable technology viable. For example inverters are required that can handle the load characteristics of different renewable power applications. While the inverters do not have a significant direct environmental benefit, the renewable energy technologies they enable do. These projects are included as having only net private benefits. These may be negative, however, reflecting the fact that needing special inverters is a net cost to society of using new renewable technologies to supply energy, compared to existing simpler technologies. Their environmental impact should be counted in the other project impacts. However if the users of the technology are not supported by the Fund, we will not have data required to quantify the environmental impacts of these technologies, and our

[32] Song, M., K. Podoynitsyna, H. van der Bij, and J. Halman. (2008), "Success Factors in New Ventures: A Meta-Analysis," *Journal of Product Innovation Management*, 25(1), pp.7-27. The study found that of 11,259 new technology ventures established between 1991 and 2000 in the U.S., only 21.9% of the firms with more than five-full-time employees had survived for five years.

quantified benefit estimates will likely underestimate the environmental benefits of those enabling technologies.

2. Sensitivity Analysis

a) Sensitivity Analysis Varying One Parameter at a Time

We conducted a sensitivity analysis using scenarios in which we allow each parameter to take its low or high value while holding all other parameters at their benchmark value. The results show that under all scenarios considered, the present discounted value of the total net benefits is positive. Values ranged from $381 million to $1,165 million.

The cost-benefit results are most sensitive to the business performance parameter. The value assigned to a tonne of C02 is the second most influential factor followed by the social discount rate. The least influential parameter is the incrementality value.

b) Sensitivity Analysis Varying Multiple Parameters

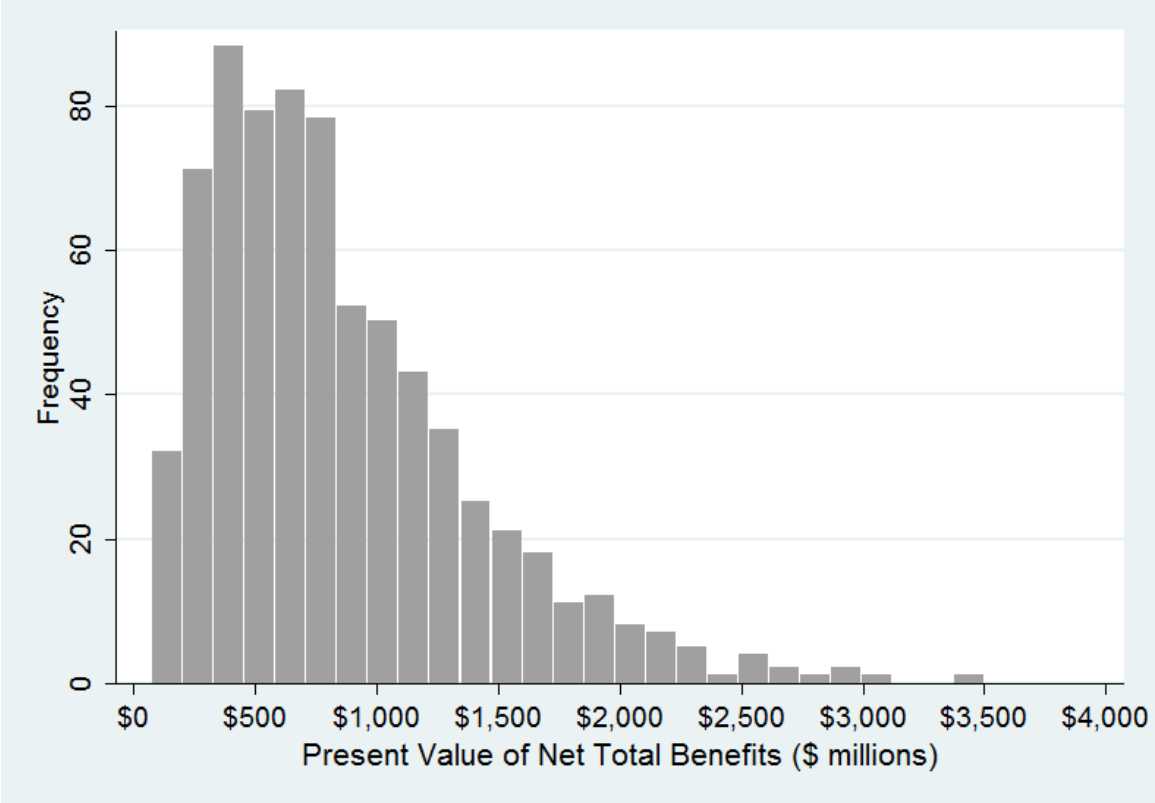
We have developed a small sensitivity analysis program to try all the different parameter combinations and calculate the outcomes of the cost-benefit model for these different scenarios. Since there are six parameters that can each take three different values, there will be 3^6, or 729 different combinations. This analysis assumes that the parameters are independent of one another. The graph in Exhibit VII-1 shows the results of running the model for the available projects using all the possible scenarios for the parameter values.

The distribution of possible outcomes is highly skewed such that the majority of total net benefits are clustered around the low end of the range, with a long tail indicating a few scenarios that generate high values. The central tendency from these scenarios for the discounted value of total net benefits is fairly close to our benchmark estimate reported above of $741 million. The mean from all the scenarios is $855million, and for the median scenario, the discounted value of total net benefits is $724 million.

The minimum value, where ***all the parameters are set to their low*** values still yields positive values for the discounted value of net total benefits. However the private benefits in the "all-low" scenario become negative. Specifically, the all-low case yields a discounted value of net private benefits of -$22 million. The environmental benefits are $98million, so the present discounted value of total net benefits is $77million.

A reasonable range of outcomes to consider for the discounted value of net total benefits is the interquartile range, which contains the middle 50% of observations between the 25^{th} percentile and the 75^{th} percentile. Using this measure, we find that the cost-benefit model results for the discounted present value of Net Total Benefits range from $446 million to $1,125 million for the 25 projects reviewed.

Exhibit VII-1 Sensitivity Analysis: PDV of Total Net Benefits from 25 Project Portfolio– All possible parameter value scenarios



c) "Breakeven" Value for Probability of Sales Success Parameter (P1)

All the cost-benefit results are derived from the sales projections and GHG emission reduction projections supplied by the project participants. While the cost-benefit model uses probability parameters to adjust these forecasts downward, there is still reason to be concerned about the quality of these forecast data. It is inherently difficult for project participants to provide sales projections for new products that embed new technologies.

The business performance parameter, the probability of achieving the sales projections, is especially important as units sold drive the resulting GHG reductions and environmental benefits. Therefore we have calculated the value of the business performance parameter at which the net present value of private benefits becomes negative. In this way we can capture a sort of "break-even" value for business performance.

We find that business performance must be 9.7% or higher (assuming all other parameters at their benchmark values) for the present discounted value of the private benefits to be positive. This finding is also quite dependent on the large sales revenues

projected by the project that is the largest contributor of benefits. Ignoring the largest project, business performance must be at least 16% before the total set of projects generates a positive present value of net private benefits. This is quite a stringent test as it requires the private benefits alone to outweigh the costs.

To calculate the "break-even" value for business performance considering total net benefits, we must include the environmental benefits, which tend to be quite large. Since the business performance parameter must be at least 9.7% before the discounted present value of net private benefits is positive for the current set of projects., this suggests that even if the sales projections supplied by participants are heavily reduced, the 25 project portfolio should generate benefits that outweigh costs. For instance, setting the business performance parameter to 9.7% and everything else at benchmark values results in discounted present value of total (both private and environmental) net benefits of $365.0 million.

3. Context for the Results

The size of the net benefits we estimate from the 25 project portfolio is quite large, and most of the estimated benefits stem from the value of reductions in GHG emissions. We have therefore compared the expected emissions reductions from the 25 projects reviewed with overall Canadian GHG emissions estimates. Environment Canada estimated that Canada's GHG emissions were 721 megatonnes of C02 equivalent in 2006.[33]

We find that the 25 projects in total are projected to reduce C02 emissions by 80.7 megatonnes over 30 years, averaging 2.7 megatonnes per year, or less than 0.4% of 2006 Canadian emissions. (Note that the estimates for project emissions reductions have included the application of the sales and GHG emissions probability parameters which reduce the participants' projections considerably.) SDTC-funded projects are usually expected to have a larger impact in later years as more are commercialized and in operation. Therefore, while the 25 projects are expected to reduce C02 emissions substantially, the estimates are not large compared to recent national emissions amounts.

C. DISCUSSION OF THE COST BENEFIT ANALYSIS

A cost-benefit analysis framework provides a useful tool for assessing the impacts of investments in sustainable development technologies such as those funded by SD Tech Fund. The cost-benefit results presented here represent our best estimates for assessing the quantifiable impacts of funded projects.

[33]Environment Canada (2008) *Canada's Greenhouse Gas Emissions: Understanding the Trends 1990-2006.* November 2008.

There are, however, also some important limitations to note:

- **Some impacts not quantified.** We cannot quantify all the potential impacts of the projects assessed. In particular, at present the model does not incorporate a method to quantify the potential environmental benefits related to soil and water improvements or damage prevention that SD Tech Fund projects could bring about. Development of an analytical approach to quantify soil and water impacts has begun so further analyses should include these impacts. However we do not have a means of quantifying other potential negative results, such as impacts on ecosystems of other emissions from projects (for example fugitive emissions from projects using bio-engineered organisms) or positive secondary impacts (for example benefits resulting from reduction in harmonics in the electricity grid) so such impacts cannot be included in the analysis.
- **Potential spin-offs not quantified.** We cannot know if one or more of the SD Tech Fund projects will produce an enabling technology that will yield large spin-off effects in the future. The potential spin-off benefits of such a possibility are not quantified here.
- **Estimated benefits relate to a baseline year.** The environmental benefits estimated here quantify the economic value of reductions in emissions relative to a baseline that necessarily assumes existing technology. However, in some cases the SD Tech Fund projects will displace existing technologies, making environmental improvements by reducing emissions and introducing other quality improvements that are not possible or too costly to be employed for the existing technology. For example one project provides solar-powered lighting in bus stops or street sign. The existing baseline technology that is being replaced may be bus stops or signs that are unlit because, in the absence of solar technology, lighting will require expensive connections to the grid and consumption of electricity. The additional safety from lighting more bus stops and signs may provide additional social benefits. However, for the purpose of the current cost benefit analysis the benefits from these quality improvements are not quantified.

The estimates used in this cost-benefit study pertain to a limited set of projects, including the first group of projects emerging from the SD Tech Fund and a small number of relatively mature projects in the final stage of their work for which updated environmental impact estimates are available. Therefore, the following limitations of our analysis should be kept in mind:

- **CCCA projects only.** All the projects in the analysis were approved as impacting on climate change clean air (CCCA). While some of these projects may also involve water, soil or other impacts, any such impacts have not been included in the analysis here, but will be considered in future analyses.
- **Early approvals.** These were among the first projects to be approved and practices have evolved considerably since those early days, so these projects may not be representative of the total portfolio of CCCA projects. Projects approved under the other funding targets, perhaps including clean fossil fuels and hydrogen

and certainly including water and soil, may have significantly different levels of benefits.

D. CONCLUSIONS AND RECOMMENDATIONS

Our findings indicate that the SD Tech Fund projects seem likely to generate significant net benefits over the next decades. Using the available data for 25 projects, we can say that the $61.6 million that the Fund contributed to the 25 projects stimulated further investment to cover the total project cost of $215 million (2005 dollars). The present value (2005 dollars) of the net benefits (i.e. after repaying the project costs) resulting from these projects are likely range from about $446 million to $1.1 billion, with a central estimate of about $750 million. While these projected benefits may seem very high, another perspective, comparison with Canada's overall GHG emissions, may add context. The 25 projects reviewed are forecast to reduce annual emissions by less than 1%.

There is a high degree of uncertainty inherent in the sales and GHG emission reductions forecasts, so our cost-benefit results should be treated with some caution. Several forms of sensitivity analysis were performed to attempt to consider alternative scenarios and deal with this uncertainty. The value of the business performance parameter, the probability the sales projections will be achieved, is particularly important. As a result we considered further scenarios with low values of business performance.

Overall, the sensitivity analysis we conducted, including the most pessimistic scenario, supports the view that total benefits outweigh total costs for the 25-project portfolio of reviewed projects. If subsequent projects are not systematically different from the analyzed set, these preliminary results suggest that the overall portfolio of projects analyzed has a high likelihood of generating significantly positive net benefits.

These findings are remarkably positive. While it is generally the case that other candidates for government funds do not offer a similar analysis for comparison with the SD Tech Fund, we are confident that these results are of the highest order. The net benefits are very large. This implies that increasing the scale of the SD Tech Fund activities would generate a continuing net social gain and recapitalizing the Fund should rank high among government's investment opportunities.

We recommend that the cost-benefit results be taken into account when government considers recapitalization of the Fund.