SECTION 11: ITER CANADA PLAN TO HOST ITER

EXPLOITING THE TECHNOLOGY IMPACTS OF ITER

11.1 INTRODUCTION

Civilization urgently requires a sustainable and benign source of energy, and fusion energy holds out that promise. Fusion energy has the potential to dramatically lower humanity's dependence on fossil fuels and speed its transition to alternative energy futures, such as the hydrogen economy. The energy and environmental benefits of a practical alternative to fossil fuels will be enormous. A workable fusion technology solution holds the key to immense social and economic benefits for society; this point should not be overlooked when considering Iter's future technological impacts.

The challenge of generating the science and engineering knowledge required to design and build an operating fusion reactor is immense. Some of the best minds in the world have spent decades in this quest, and many more decades of research and experimentation lie ahead before fusion becomes an everyday source of energy for the world. Such long-term research requires a substantial, sustained financial commitment on the part of world governments.

However, investments of this magnitude can be hard to defend when the benefits lie far in the future. The willingness to forego short term rewards in favour of long term ones is one of the principal achievements of modern government. Still, proponents of long-term science projects need to plan ways to maximize the technological payoff to society - the spin-offs - throughout the life of the undertaking.

Fortunately, the history of science and recent experience demonstrate that the very process of conducting long term research can also yield short and medium-term technological benefits for society.

A number of organizations such as CERN, TRIUMF, Princeton Plasma Physics Laboratory, and the European Space Agency have conducted formal studies documenting their technological and economic impacts. In all instances these have been positive, and examples of all the potential technology benefits can be found. This is particularly impressive because in most cases the primary purpose of the research being undertaken was not to produce technology benefits per se, but rather to advance our understanding of the natural world; that is, to produce knowledge.

Canadian science projects in the fields of fusion and astronomy were reviewed, and found to have had a similar experience with producing impressive technology benefits. It was found that the organizations that perform the best have formal programs designed to produce technology benefits as a by-product of their scientific research. What are those benefits?

11.2 THE MAIN BENEFIT CATEGORIES

11.2.1 **Research Training:** Large projects such as Iter offer outstanding potential to train young researchers. Because of their scientific and technical complexity, they necessarily span a wide range of natural science and engineering fields and disciplines; from civil engineering to plasma physics. Research students at the Masters, Doctoral and Post-Doctoral level will have an opportunity to work with Iter personnel throughout the life of the project. Research training opportunities such as these are well-established features of large science. Less well appreciated is that research training opportunities also abound in the social sciences and humanities, in such disciplines as Management, Business Administration, Sociology, History, and Law.

11.2.2 **New Products:** One of the characteristics of large science projects is that they frequently demand that their builders and operators develop customized technologies and processes in order to meet their research requirements. Solutions developed for these specialized applications can often find use in other fields or industries. Thus, large science activities can lead to the development of new products and processes which can be used by other researchers or in industrial applications. For instance, materials or techniques initially developed for one purpose can find use in other areas. Thus photolithography, which was originally perfected for the printing ink on paper was eventually adapted to etch microelectronic structures onto silicon.

11.2.3. **Improvements:** Large science projects often place exacting demands on suppliers to provide the best available products and services. Companies frequently use the specifications of such projects as an opportunity to adapt and improve current equipment to higher performance levels. For example, in the aviation industry, new airframe designs are constantly challenging engine manufacturers to improve the performance of current products through modifications and upgrades.

11.2.4. **Software:** Many "high tech" activities have a significant software component. Large science projects are renowned for their sophisticated software requirements. Often, software or software components (e.g. software "objects") can be applied in other situations. For example, computational fluid dynamic modeling software developed in the aviation industry can be applied in designing ships or cars.

11.2.5. **Intellectual Property (IP):** Intellectual property - such as patents, industrial designs, and formulations - is a frequent outcome of scientific research nowadays. Interest has grown over the past two decades in capturing the IP benefits of scientific research. IP can be sold, licensed or traded. Normally, additional engineering and design work needs to be done to convert IP into market-able products.

11.2.6. **Spin-off Companies:** Some of the best-known technology-based corporations arose from research originally undertaken in a science setting - a university, research institute, or large science project. Every country has examples of its own it can point to. There is growing interest in how scientific research can form the basis for new companies and to create new jobs, products, sales and exports.

11.2.7. **Know-How & Methods:** Much of the valuable technical knowledge that is generated in large-scale scientific projects is in the form of know-how or experience. Because of the large scale of enterprises or their technical complexity they are unique undertakings. Companies who help to build or operate them can acquire a considerable amount of knowledge and experience that is not of a type to which IP protection is applicable. Know-how is not restricted to physical infrastructure; it also relates to improvements in organizational capability, for example, new managerial techniques and improvements in product quality control. This type of knowledge - know-how - is embodied in people and organizations. Companies can apply it in subsequent projects. They can also use the experience gained to promote their capabilities.

11.2.8. **Linkages & Networks:** Another technological benefit of large science projects is the research linkages and networks that arise from them. These in turn can "breed" additional opportunities. For example, over time large scale scientific projects can have a regional economic development impact by creating "clusters" of companies, universities, colleges who supply one another with ideas, personnel, products, etc. These clusters become self-sustaining entities that are capable of attracting and generating new activity. Research networks need not be geographic, they can also be "virtual". In virtual networks widely dispersed participants can collaborate on projects of mutual interest.

11.3 KEY QUESTIONS REGARDING THE BENEFITS

All the foregoing are examples of technology benefits that can arise from large science projects such as Iter. As such, two key questions present themselves.

11.3.1 ***What is the extent to which the experience of large science projects similar in scale and scope to Iter, can confirm corresponding benefits for Iter?***

It is hard to predict in advance what will arise from a particular large science project. Thus, no one could have foreseen that the World Wide Web would be developed as an offshoot of research undertaken at CERN, the European high-energy research facility. And indeed, nobody at CERN set out to develop the Web as a commercially valuable undertaking; instead it was intended to be a tool that would help researchers communicate with one another to achieve a larger scientific objective. Eventually the tool launched an entirely new industry, the Internet! This illustrates the essentially volatile and unpredictable nature of scientific research and the benefits it produces.

By their very nature large science projects are unique undertakings that stretch the boundary of current science, technology and knowledge; no two are truly alike. For this reason, it is hard to directly transpose the experience of one large science project onto another. The technologies involved and fields of inquiry are often quite different (e.g. high energy physics versus genomics). Time to market and market size for the resulting technologies can vary considerably. The participating organizations are diverse. The local and regional socioeconomic context varies. So, although there are common lessons to be learned, each project needs to be explored on its merits.

11.3.2 *What can Iter Canada and its international partners do to maximize the flow of technological benefits from the investment that will be made in the project?*

This question is not only important for Iter Canada in its effort to attract the project to Canada, but for all the international partners, who will want to show that their government's investment in Iter will yield intermediate benefits.

It is possible to ensure and accelerate the benefit stream through planning and by adopting a set of proven strategies and techniques. We are confident that if the Iter Parties and the management of the Iter Legal Entity take proactive steps to facilitate a technology strategy, there will be a significant payoff for all concerned.

However, proactive actions will be needed in order to achieve the potential technological benefits that Iter can deliver. In order to optimize conditions for broad impact of Iter technology beyond that of fusion energy development, Iter Canada proposes the Iter Legal Entity establish a variety of initiatives that would facilitate this achievement.

11.4 INITIATIVES TO ENSURE AND ACCELERATE TECHNOLOGY BENEFITS BEYOND FUSION ENERGY:

11.4.1 **Intellectual Property Philosophy and Regime:** Iter should adopt the mandate of acting as a "technology engine" to produce intermediate technology benefits for its financial sponsors. Iter will need to adopt appropriate intellectual property and technology commercialization accords in order to facilitate this transition.

11.4.2. **Integration into International, National and Regional Networks:** In order to maximize Iter's technology impact and benefits, it will be extremely important to integrate Iter into local, regional, national and international innovation networks.

11.4.3. **Links to Universities and Colleges:** In particular, capitalizing on Iter's research training potential demands that Iter and its highly qualified personnel be integrated with local universities and colleges, in addition to their home institutions.

Of special note is the initiative being taken by The Ontario Institute of Technology (Canada's newest university) located in the Durham Region within a few kilometers of the Clarington site. As part of the establishment of this new university, there will be a school of nuclear technology dedicated to the advancement of knowledge and training in the nuclear field. Iter Canada has established a strong bond with this new organization and this will greatly enhance the success of the Iter project. The president of this University sits on the Board of Directors of Iter Canada.

11.4.4. **Technology Transfer/Industrial Liaison Office:** Establishing an office dedicated to maximizing Iter's technology benefits through technology transfer and industrial liaison is a highly effective mechanism that has been used successfully by other large science projects. Such an office can manage a variety of projects and initiatives that will do much to speed the flow of technology benefits from this long-term science project.

11.4.5. **Business Incubator:** Including a small business incubator as part of the Iter infrastructure is deemed to be a useful mechanism for encouraging the development of start-up companies based on Iter technology.

11.4.6. **Centres of Excellence:** Integrating Iter with existing Networks and Centres of Excellence in the respective territories of the Iter Parties, or forming a new centre around Iter, would be an excellent vehicle for maximizing interaction among Iter, industry, and the higher education sector, and would go far in ensuring technology benefits for all those participants.

11.4.7. Laboratory/Office Building: The Iter Canada recommendation is to locate the Laboratory/Office Building at the northern end of the Clarington site, near the highway 401 as shown on Attachment 5-D. This location would make this facility the "anchor" for a broad based technology park to be developed in conjunction with the local municipality, Region and province of Ontario.