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MAIN SUBJECT

ENERGY

Innovation as the Driver for a Sustainable Energy Future



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What role national governments play in energy innovation process?

National governments in general, and in the case of Canada provincial governments since they have primary jurisdiction over energy resources, play a key role in providing the necessary policy certainty, incentives and R&D support through specific programs to promote and foster development of new energy resources. This is partly because the private sector enterprises have a lower appetite for the investment risks associated with next generation technologies where the payoffs are uncertain. Recent examples include carbon capture and sequestration projects, bioenergy for electricity generation or transport fuels or the next generation battery technologies and the associated infrastructure for a “smart grid” to enable electrification of the transport sector.

I note that policy instruments such as renewable portfolio standards, feed in tariffs, establishment of cap and trade or carbon tax regimes or specific tax policies for accelerated depreciation or direct incentives for consumers and producers have all played a role in different OECD countries to promote renewable energy resources such as solar, wind, biomass, geothermal. The reasons for success or failure of some of these instruments vary from one jurisdiction to another and very much depend on the context. For example feed-in-

tariffs (FITs) as implemented in Germany, Spain, Ontario – Canada are effective in promoting rapid implementation of some green technologies such as wind and solar but the high costs have been a concern for governments because of a potential consumer backlash. Unfortunately, the FITs are not a particularly effective mechanism for promoting innovation and depending on the level at which the tariffs are set they simply permit unbridled economic rent seeking by producers at the expense of consumers and their contribution to overall net social welfare remains an open question.

What is the ratio of public/private investments?

The ratio's of public/private investments in R&D are a simple metric that provides one high level view of what may be the enablers for innovation to take hold but comparing across countries we must recognize this as partial view. The role of governments in providing the funding for fundamental research in universities and other research focused institutions is one important element of building the necessary capacity to support innovation. There is an equally important role for private sector companies to create the market for testing new ideas and making the necessary investments through effective collaborations to create profitable products and services.

Figure 1: Innovation Chain

Innovation Chain

Supply Side Innovation Policies

- Strategic priority areas
- One time decisions
- Adjusts to changing political priorities
- Research focus
- Outputs not linked to business goals

Demand Side Innovation Policies

- Focus driven by business needs
- Creates an obligation to support innovation R&D
- Build capacity inside utilities
- Closer to direct customer benefit
- Lower cost, better reliability



On the left hand side tends to be the focus of government policies that establish, what I would call, the supply side of innovation capacity. In Canada this includes agencies and funding councils such as the NSERC, the MRC and SSHRC that provide ongoing support for research at universities, and then on an ad hoc basis governments also intervene to

provide special funds for strategic priority areas, either at the Federal or Provincial level (SDTC, OCE, MRI). In addition, there is government funded research in government labs in support of departmental objectives. This is a model similar to U.S. and most of the OECD countries. In the chain this is essentially the “inventive” part of the supply side of innovation capacity. In Canada, we believe the research base and the capacity to generate new ideas is reasonably well funded and great potential exists to participate in the evolution of the green energy system.

Equally important is the exploitive part of the chain that is driven primarily by business needs and the development of methods, tools and implementation that is in close coordination with the in-house experts in the business. The key point that has become somewhat compelling is that stimulating innovation requires sustained collaboration and a systemic response by different individuals and institutions in the innovation system working together. Also providing a mechanism of funding that creates an in-house capacity in businesses, industry and energy utilities to absorb ideas is crucial.

A mainstream of energy innovation is “green” energy. Why alternative energy is crucial today?

The need for a transformation of the global energy system with a lower environmental footprint is now widely recognized among decision makers in government and the political leadership, the corporate business sectors and the major national academies as well as non-governmental organizations around the world. A drastic re-alignment of the global energy system on a large scale is an urgent priority to ensure that the performance and growth of the economy remain in harmony with the goals of a cleaner “green” environment.

Our reliance on existing fossil fuels based sources of energy and their associated detrimental impact on the environment, whether related to poor air or water quality or impact on forests, land use and sensitive ecosystems or climate change, have been well documented and articulated over the last three decades. What remains at the heart of the challenge is the growing demand for energy services arising from a combination of global population demographics and shifting income levels in developing countries. A comprehensive set of innovative but credible energy solutions are required for rapid implementation that strike a balance between economic growth and a sustainable environment.

It is clear that cleaner, but affordable, and at the same time reliable energy services are indispensable for enhanced human development and quality of life. It is unconscionable that a third of humanity (approximately 2 billion people) have no access to electricity. This suggests a yawning gap in the capability of the current energy systems to deliver effective energy services to meet the needs of the world’s poor. Whether these solutions are labeled as “green” or otherwise, there is a compelling need to expand access to modern energy services through innovation and at the same time maintaining a close scrutiny on the biophysical impacts on the environment.

Scientific and technological innovation combined with effective policy instruments will be required to help meet some basic goals similar to those identified by the UN as part of the Millennium Project to reduce poverty and to improve the health of citizens. For instance, in the absence of a reliable supply of energy, neither health clinics nor schools

can function properly nor can clean water and sanitation be provided without effective pumping capacity. Thus, making the transition to a sustainable energy future is one of the central challenges we face. This can be achieved only through effective investments in critical energy infrastructure allowing innovation to spur cost reductions to ensure affordability for the largest number of people.

What are the latest technological trends in energy innovation? Can you elaborate on some recent breakthroughs?

In simple terms, as the picture below shows, there are two interrelated propositions: Innovate to change the game?... Or Innovate to improve?

Figure 2: Innovate to change the game... innovate to improve

Innovate to change the game...innovate to improve

- | | |
|--------------------------|---------------------------------|
| • Higher risk | • Lower risk |
| • Big bets on the future | • Careful control |
| • Transformational | • Essential for steady progress |
| • Can be very high value | • Good value |



Whether an entity wishes to participate in innovation that is game changing or to participate in activities through allocation of limited funds for innovation that provide incremental improvements, we need to re-enforce both since they have value and a specific company will of course determine on the basis of unique circumstances and its level of risk appetite.

In the clean energy sector, several game changing innovation from the supply side of the chain are what we may call transformative technologies:

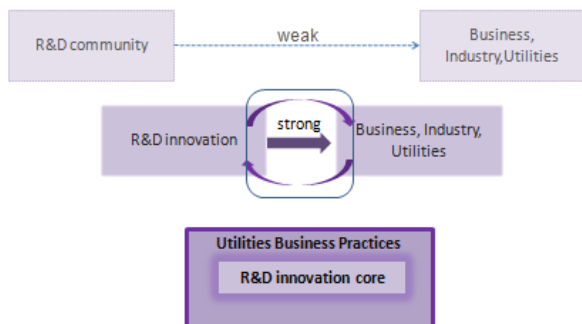
- plug in electric vehicle technologies and advancement of battery technologies,
- large-scale storage on the electricity system, very high efficiency solar photovoltaic devices to provide affordable energy for the masses,
- a range of developments under the umbrella of “smart grid technologies” that involve real time feedback of energy use and a significant convergence of the information systems science with the power sector,
- self sustaining “renewable based” micro grids for remote and rural communities,
- second generation biofuels,
- super conducting magnetic energy storage systems and conductors and others.

But we should not underestimate the right hand side that can also create equally compelling value propositions for operating energy utilities that would include, for example, advanced measures to control voltage, improve fault detection on the system, power flow management, on line condition monitoring and asset management for end of life recognition and seamless integration of distributed generation resources into the distribution system.

For implementation on a wide scale, there is a broader compelling need to make innovation the core of business practice (see Figure 3).

Figure 3: Make Innovation the core of business practice

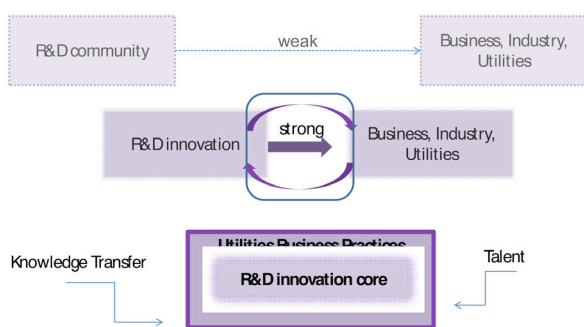
Make innovation the core of business practice



Innovation comes from how people create, share, refine and combine their ideas. It is a little naive to believe that most new ideas come as a flash of inspiration. The lone ranger; the brilliant scientist with frizzy hair and so on is an endearing image but the ultimate goal of producing goods and services through innovation is a more complex subject. Innovation is very much a development through collaboration, dialogue and through the application of a range of different skills from different organizations. An individual's skills, talents, ideas and knowledge are crucial for innovation but it is the team that is key. Thus the need for a strong linkage and a culture that is receptive to establishing very strong links between the R&D community and the business sector and energy utilities is one path. If we accept that innovation and skills are linked and a skilled workforce is better able to generate and adopt new technologies and organizational change, then we need to find the right stimulus and incentives for fostering a business culture that promotes strong links.....almost to the point where it has become core practice. It would be a positive development if every CEO, without blushing, will openly state that innovation is at the core of our business because that is our path in delivering value to our customers.

Figure 4: Open innovation ... an idea whose time has come

Open innovation ... an idea whose time has come



Beyond the concept of making innovation a core business practice, there is the idea of open innovation that has a good potential in the clean energy sector. This is where firms increasingly collaborate with their customers, suppliers and

research institutions. Compared to more linear and internal models of innovation, open innovation offers considerable benefits to the organization and to the wider economy and the society.

In summary, I would like to quote from a famous paper that Friedrich Hayek wrote in 1945 called "The Use of Knowledge in Society." He distinguishes between scientific knowledge as organized knowledge and disorganized knowledge on which the functioning of a constantly changing modern economy depends, namely "the knowledge of the particular circumstances of time and place", which every one of us has. This is "unique information of which beneficial use might be made, but of which use can be made only if the decisions depending on it are left to him or are made with his active co-operation."

It is this unique information that is available to an individual at the workplace armed with the knowledge of particular circumstances that are best qualified to spur innovation.

Is there a progress or a standstill in the sphere of thermonuclear energy? Can it become a viable alternative to other energy sources? How "green" it may develop?

On the subject of fission based nuclear energy, for the next generation of "safe" reactors, there has been significant progress on the technical front but the wide scale adoption has been slower. This is largely due to a number of related economic and social factors. The nuclear option has significant potential to make a positive contribution to the global energy supply mix in a manner that has a lower negative footprint on the environment. Nuclear energy being a highly dense form of energy translates to a lower environmental impact on land use, in terms of energy output per land area (i.e. MWh/m²). It is a centralized source of energy. However, I note that the emerging innovations often categorized as Generation IV reactors and in particular the small modular nuclear reactors in the range of 25-50 MW capacity of each module appear to be a promising innovation. They are designed to address the issue of high upfront capital costs associated with the big 1000MW generation plants. The reactors are modular, scalable, emission free power can be provided at lower financial risk. The small modular reactors could power small towns and remote communities off the grid. This development needs to be monitored and promoted and it is an innovation that may just be right in time to help displace fossil fuels based generation.

How is clean energy R&D incorporated into national innovation systems in general? What role do governments play or should play in developing clean energy?

As discussed above, the incorporation of clean energy R&D into the national innovation chain is a "hit and miss" type of proposition. The speed with which innovative solutions could be incorporated into blood flow of a business entity needs to be improved. In Canada, this, however, is a generic problem not necessarily confined to just the energy sector.

Recently, we have made some significant strides to help improve the collaboration and integration of new knowledge and ideas into business practices. Government agencies such as the Natural Science and Engineering Council (NSERC), the Ontario Centers of Excellence (OCE) and the Ministry of Research and Innovation (MRI) are playing an influential role in fostering, promoting and funding initiatives to bring ideas to the market place.