

The Role of Utilities in Enabling Technology Innovation: The BC Hydro Alternative & Emerging Energy Strategy

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Abstract

In order for renewable energy to play a dominant role in the global electricity supply mix, emerging renewable energy technologies – such as wave, tidal, enhanced geothermal, and 3rd generation photovoltaic technologies – must prove their technical merits and achieve cost parity with conventional sources of supply. For early stage technologies, this process of innovation and commercialization is referred to as “Crossing the Chasm of Death”. The relatively high technical and market risks inherent with emerging technologies coupled with the scarcity of financing sources capable of managing those risks, means that many promising technologies are unable to cross the chasm towards commercial viability. BC Hydro, a government-owned electric utility in British Columbia, Canada, launched an Alternative and Emerging Energy Strategy that describes its role as an enabler of technology innovation and a progressive utility working to facilitate promising technologies to cross the chasm. The strategy calls on BC Hydro to work in concert with funding agencies, regulatory authorities, technology developers, and early technology adopters to achieve four objectives. Objective one: demonstrate early stage technologies in controlled grid-connected environments. Second, streamline internal utility processes around planning, interconnection and integration. Third, bring leadership to the development of supportive regulatory environments and highly qualified personnel. And finally, develop new business processes to acquire energy from technologies at the market entry stage. This paper describes BC Hydro’s goal, objectives and actions to accelerate the commercialization of emerging renewable energy technologies that will yield a diversity of supply options and a growing, local clean-tech cluster.

** This paper was prepared as of December 5, 2009 and reflects BC Hydro’s current thinking.*

Introduction

In British Columbia, across Canada and around the world, governments are challenged to address the realities of today's changing environment, from taking action on climate change to finding solutions to the economic slowdown that has impacted global and regional markets. To address these concerns, governments are looking for ways to facilitate sustainable energy solutions, stimulate new market developments and create new, high-value jobs. Electrical utilities, the entities charged with delivering power to customers, can find business opportunities while contributing to climate change and economic development objectives.

The global electricity utility industry works within existing policy frameworks to advance these objectives in three main ways¹:

- It helps bring to market more efficient and cleaner technologies guided by its market understanding and public research,
- It directly or indirectly invests in clean energy technologies, taking into account relative costs of technologies and local resource and policy circumstances, and,
- It undertakes long term planning and infrastructure investment in generation and transmission assets that enable clean technologies and that mitigate the potential future impact on business operations.

The commercialization of emerging renewable energy technologies is central to electrical utilities continuing to make a positive contribution the climate and development challenges is. At the end of 2008, the world's total installed base for wind energy reached 120 GW, of which 27 GW was installed in 2008 alone. In the EU, 43% of all new power installations were wind, well ahead of gas (35%) and oil (13%)². However, the success of wind energy technologies was decades in the making, involving the co-ordinated activities of many different sectors to drive the modern three-bladed horizontal axis wind turbine from the lab into the field. The scale of the climate challenge demands a variety of sectors continue to facilitate the development of the pipeline of promising technologies that can be deployed en-masse by future generations. Wave energy, tidal energy, enhanced geothermal and 3rd generation photovoltaics are technologies that need to mature in the market and in their development as wind energy has done. The next section of the paper will focus on the policy and resource context for BC Hydro.

BC Hydro – Policy and Resource Context

BC Hydro is a vertically integrated electric utility with a mandate to generate, purchase, distribute, and sell power and meet the need in BC in a cost effective and reliable manner. The third largest electric utility in Canada, BC Hydro serves more than 94% of the residents in British Columbia and operates 11 GW hydroelectric and natural gas fuelled thermal power plants generating between 43,000 and 54,000 GWh annually.

¹ World Business Council for Sustainable Development (2008), "Power to Change"

² Renewable Energy Focus, April 2009

BC Hydro is a crown corporation set up and wholly owned by the Provincial Government. This means, BC Hydro reports to the Provincial Government, receives policy direction from the Provincial Government and is regulated by the British Columbia Utilities Commission (BCUC). The BCUC is responsible for ensuring that customers receive energy services at fair rates; that the shareholder is afforded an opportunity to earn a fair rate of return on its invested capital; and that the competitive interests of BC are not frustrated. In essence, BC Hydro is charged with implementation of some aspects of Provincial policy, and the financial prudence of its implementation is ensured by the regulator.

In the two decades that followed the creation of BC Hydro in 1961, British Columbia undertook some ambitious hydroelectric construction projects on the Peace and Columbia rivers. These large-scale hydroelectric facilities now generate more than 90% of the power sold in British Columbia at consumer electricity rates averaging approximately \$60 / MWh - among the lowest rates in the world.

The 2007 British Columbia Energy Plan, entitled “A Vision for Clean Energy Leadership,” sets the policy direction for BC Hydro. The plan and subsequent legislation are a commitment to leadership through the adoption of legally binding greenhouse gas emission targets, clearly stated energy conservation goals, the institution of an Innovative Clean Energy Fund and the introduction of a revenue neutral carbon tax. The plan maintains that BC Hydro will continue to acquire all new sources of electricity supply through purchases from the private sector (i.e. BC Hydro no longer builds and owns new generator facilities and instead hosts competitive calls for power to meet its needs), but further stipulates some world-leading clean energy targets, including:

- Ensure clean or renewable electricity continues to account for at least 90% of total generation,
- All new electricity generation projects will have zero net GHG emissions
- By 2016, electricity sold by BC Hydro will have zero net GHG emissions with minimal use of carbon offsets.

British Columbia has a rich endowment of renewable resources with which to meet these aggressive clean energy targets. While there are few remaining opportunities for large hydroelectric development, there are untapped sources of bioenergy, geothermal and marine energy throughout much of the province. According to the *Endless Energy Report* produced by The GLOBE Foundation, British Columbia is one of the few areas in the world where clean energy leadership is possible without depending on fossil fuels. As Figure 1 indicates, the available renewable energy resource in BC is 36575 PJ per year - or 10,000,000 GWh per year – several hundred times greater than the current electrical demand in BC.

ORDER OF MAGNITUDE ESTIMATES		
B.C.'s RENEWABLE RESOURCE ENDOWMENTS		
ENERGY SOURCE	NATURAL ENDOWMENT ESTIMATES 100% EFFICIENT ENERGY CONVERSION	PJ / YEAR
Solar	Insolation 1,350 KWhrs/m ² /year on urban lands within municipal boundaries	20,000
Geothermal	High potential land area ~43,000 Km ² 1,700 high grade deposits to 3 Km depth based on comparable US data	13,500
Wind	Energy of air mass flow at mapped 7 m/s wind sites to 50m height over 3,000 Kms (mostly mountainous or coastal regions)	1,000
Ocean Wave	Ocean Wave energy nearshore mapped at 30 - 48 KW/m ²	900
Hydro	Energy potential at existing and potential large and small hydro sites	700
Forest Biomass	Annual allowable cut ~70 million m ³ , density 455 Kg/m ³ , calorific value 10,900 MJ/m ³	350
Ocean Tidal	Tidal energy at 8g measured sites: Mainland and Vancouver Island coasts	100
Agri-Biomass	Energy value of total annual tame hay harvest ~1.4 million tonnes 18.1 MJ/Kg	25

Figure 1 - BC Renewable Resource Endowment (Source: GLOBE Foundation)

The fundamental challenge in meeting the clean energy targets and delivering upon the policy mandate for clean energy leadership is to tap into these enormous and diverse resources in a cost effective manner. The key to meeting this challenge is through the refinement and commercialization of technologies appropriate for use in BC.

Technology Commercialization Pathway and the “Chasm of Death”

British Columbia is rich in alternative energy resources that provide the province a range of technology options to consider for market development. These new energy technologies fall within the six-stage technology commercialization pathway shown in figure 2 below. Each stage is comprised different players and defines different development challenges.

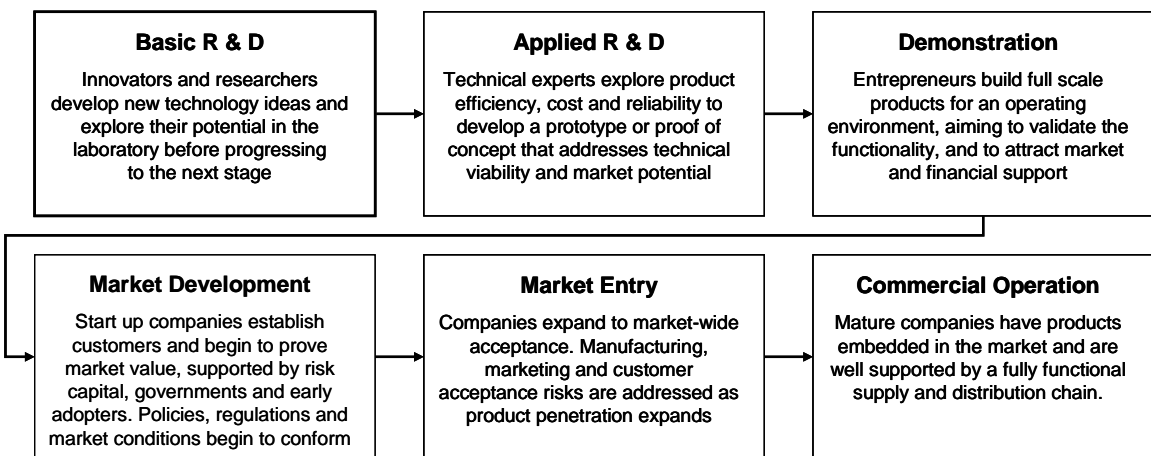


Figure 2 - Technology Commercialization Continuum

Technologies must systematically address technical, market and financial challenges in order to progress through the pathway. Governments, industry, financial institutions and private investors need to address these various challenges throughout the pathway.

Figure 3 highlights the degree of financial participation of each organization at each stage. For example, governments have significant involvement at the basic research stage that declines as the technology enters the demonstration phase. A government’s investments can include providing research grants, government research laboratories, and research infrastructure.

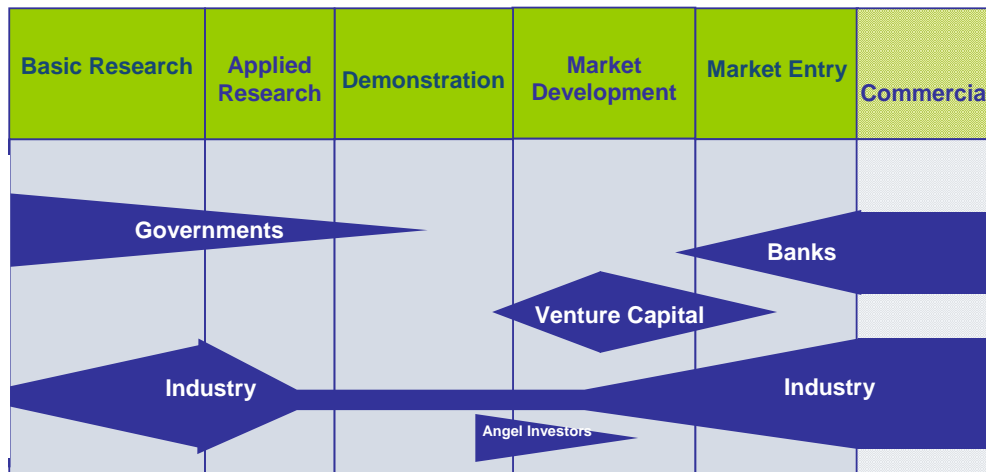


Figure 3 - Technology Commercialization Pathway (Source: SDTC)

Figure 3 clearly shows that once government support tapers off, and before industry support increases, there is little institutional support for emerging technology. This gap is often called the “Chasm of Death” and the complex mix of risks makes it challenging for any one institution to carry forward a project. In order for technologies to cross the “Chasm of Death” they must merit and attract technical, market and financial assistance to undertake the often costly full-scale integrated demonstrations to conclude the demonstration phase, as well as build preliminary supply chain and institutional support to enter the market development phase.

BC Hydro’s Role in Bridging the Chasm of Death

BC Hydro’s role to date in developing emerging technology has been limited by its mandate to protect ratepayers and, to some extent by governing regulation based on lowest cost. Consequently, the corporation acts only at the commercial stage of clean energy development through existing power acquisition processes, which demand fully commercial systems that are free of any significant technology, market or financial risks. BC Hydro’s current participation in the pathway is depicted in Figure 4.

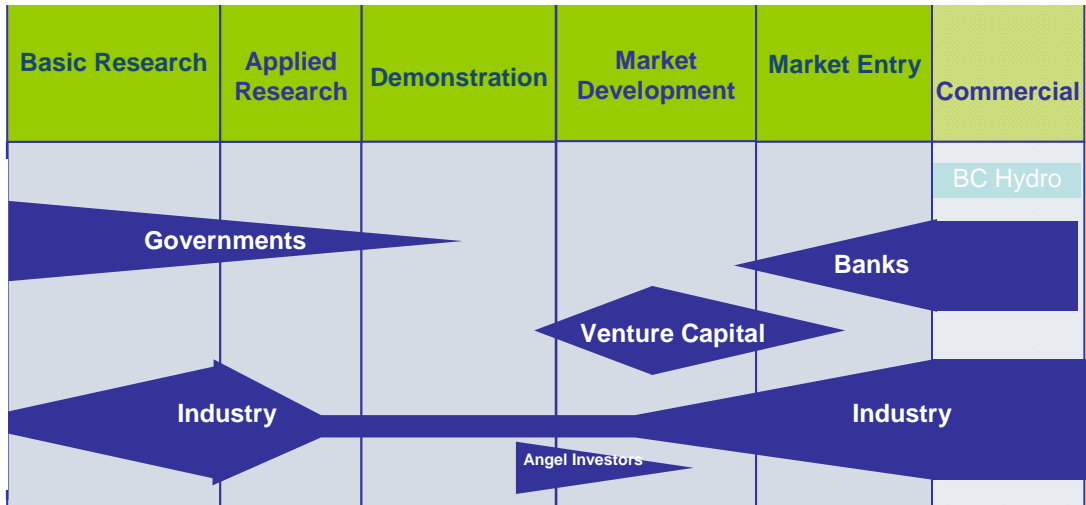


Figure 4 - BC Hydro's existing role in commercialization pathway

In light of the 2007 Energy Plan and changes in the electricity business, BC Hydro has created the Alternative and Emerging Energy Strategy that outlines how BC Hydro will incorporate carbon and long-term energy security concerns. This means BC Hydro will initiate activities to grow the Province's alternative energy sector by facilitating the development of a range of emerging technologies.

Investing in emerging technologies is paired with a process of evaluating the risks. Due to the special nature of a crown corporation, BC Hydro does not invest in basic R&D, nor develop the alternative energy technologies, nor directly invest in companies. BC Hydro focuses on these main areas:

- Guide development and deployment of technology. As a customer of alternative energy technology companies, the focus here helps the corporation meet the goals of the Province and ratepayers.
- Shape the local alternative energy market. Through the design of power acquisition processes or the allocation of costs and benefits between the alternative energy project developer and the ratepayer, BC Hydro has the institutional authority to move forward the local alternative energy market.
- Supply physical and soft infrastructure. Physical infrastructure can include: transmission, distribution, communication and interconnection facilities; soft infrastructure can include: interconnection procedures, safety and engineering support, connect with end-users, and data collection and services.

Although BC Hydro does not have a scientific research infrastructure or the ability to make speculative investments, it can still play a role in these areas without incurring significant risk.

- BC Hydro has a strong engineering competency to manage technology risks at the late demonstration phase, specifically the impacts on power quality and the health

of the network assets. In this way, BC Hydro mitigates the transfer of risk to ratepayers that may occur in demonstration technologies.

- BC Hydro collaborates with BC institutions, governments, other utilities and industries, and the financial sector, whose core business is providing capital and financial support to emerging technology companies. Partnering with other technology enablers to facilitate development of promising technologies minimizes risk to ratepayers.

Within BC Hydro’s Alternative & Emerging Energy Strategy, the risks associated with emerging technologies are highlighted and the strategy details the steps needed to manage these risks for the long-term benefit of shareholders, ratepayers and all British Columbians. BC Hydro will focus on activities in the integrated demonstration phase through to the market entry phase as an extension of, and complement to existing power acquisition activities. Leveraging BC Hydro’s unique role in the electricity market will create an environment that facilitates the rapid demonstration and early market deployment of emerging, pre-commercial alternative energy technologies. The Alternative & Emerging Energy Strategy goal is:

BC Hydro will have access to 1,000 GWh of new, previously unavailable, alternative energy by 2016

Figure 5 depicts BC Hydro’s new position in the technology pathway through the implementation of the Alternative & Emerging Energy Strategy.

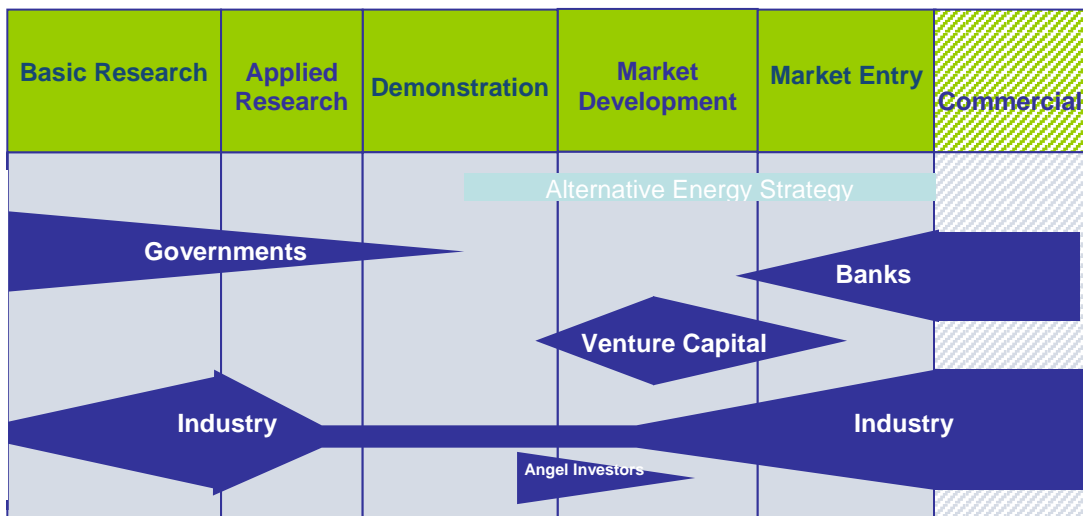


Figure 5 - BC Hydro's New Position in the Technology Pathway

Accelerating the Commercialization of Promising Technologies for BC

Six emerging technology areas: wind, biomass, geothermal, ocean, solar and energy storage have the most potential in BC because of the size of BC’s renewable resource endowment and the potential for global deployment of the technologies once commercialized. Once these technologies are mapped in the commercialization pathway,

it is clear which technologies fall within the Alternative and Emerging Energy Strategy. For example, on-shore wind is located in the commercial operations stage of the pathway, and energy from on-shore wind technology is accessible to power acquisition programs that BC Hydro currently hosts. In contrast, off-shore wind energy is at an earlier stage of maturity and may still face some technical challenges such as the deployment and reliability of large off-shore wind farms, and an ill-defined permitting and regulatory process in BC. It is through the activities of the Alternative and Emerging Energy Strategy that emerging technologies may find support with the goal of increasing BC Hydro’s potential for access to energy from emerging technologies through existing or new power acquisition processes.

Basic R&D	Applied R&D	Demonstration	Market Development	Market Entry	Commercial Operation
					On-Shore Wind
		Off-Shore Wind			
			Low-Speed Wind		
					Combustion
		Gassification			
		Pyrolysis			
				Anaerobic Digester	
					1 st Gen Biofuel
		2 nd Gen Biofuel			
				Hydrothermal	
	Enhanced Geothermal				
	Wave				
	Tidal				
					1 st Gen PV
				2 nd Gen PV	
3 rd Gen PV					Batteries
		Advanced Batteries			
		Hydrogen			
			Flywheels		
			Compressed Air		
Super-Conducting Magnets					

Wind
Bioenergy
Geothermal
Ocean
Solar
Energy Storage

Figure 6 - Technologies of Interest in the Technology Pathway

Objectives and Initiatives to Achieve the Goal

BC Hydro will pursue four co-ordinated objectives to focus its action plan. In order for BC Hydro to reach its goal of having access to 1,000 GWh of new alternative energy, we must accelerate the commercialization of emerging technologies through the demonstration and market development phase, while at the same time extending BC Hydro’s power procurement activities further into the market entry stage. The four objectives that make up the strategy will spur the implementation of demonstration projects, create the market and policy foundations for early technology deployment, and introduce new business models to support the market entry of promising technologies into BC.

Objective 1: Connect demonstrations to the grid to evaluate and enhance technology performance

There are two key reasons why BC Hydro is creating opportunities to connect demonstration projects to the grid. First, utilities often require demonstrated safety and reliability performance of technologies prior to offering access to the grid system or an energy purchase agreement. Paradoxically, that demonstration is difficult to accomplish

without a grid connection. Secondly, demonstration projects are a first step in establishing local technology entrepreneurs and technical expertise that is essential to fuel and accelerate the commercialization of technology and development of needed supply chains.

Objective 2: Implement leading utility practice today to grow alternative energy over the long term

A key function of utilities is long-term planning. This can often extend to 20 years to ensure the energy system is sufficiently flexible and resilient to provide reliable power at low cost in a variety of future scenarios. Consequently, BC Hydro needs a strategy that addresses two key barriers to market entry for alternative energy technologies. The first is to plan the transmission infrastructure where the energy resources are located, and the second is to ensure that the grid can interconnect and integrate a variety of energy sources.

Objective 3: Foster the skills and regulations to support sustainable technology development

The regulatory environment has a significant impact on the development of alternative energy. Unfortunately, regulations are currently designed for mature technologies and the consenting authorities are unfamiliar with how new technologies work. To address this barrier, BC Hydro is working to accelerate the development of policies and market conditions for new technologies. We are also working with and assisting the institutions charged with training the workforce that will be responsible for the installation, maintenance, management, certification and regulatory oversight of alternative energy technologies.

Objective 4: Support the launch of market-ready technologies

Facilitating alternative energy technologies to market face an additional hurdle because although they may be market ready, these technologies still have a price premium compared to energy generated from established technologies. BC must develop business models that allow it access to alternative energy technologies that are progressing down their cost curve. Such business models can include: finding specialized customers and niche markets, and investigating preferred pricing options for alternative technologies.

BC Hydro has identified actions to support each initiative, as described in figure 6 below.

Goal	BC Hydro will have access to 1,000 GWh of new, emerging, clean, alternative energy by 2016			
Objectives	Connect demonstrations to the grid to evaluate and enhance technology performance	Support emerging technologies through BC Hydro processes and infrastructure decisions	Foster the skills and support advancement of regulations needed for technology deployment	Facilitate the launch of market-ready technologies
Actions	<ul style="list-style-type: none"> • Build collaborative partnerships with public sector funding agencies • Provide seed money for demonstration feasibility studies • Utilize existing and develop new demonstration infrastructure to evaluate emerging technologies potential in a grid connected environment • Assess and develop appropriate procurement mechanisms (e.g., an emerging energy standing offer program) for promising emerging energy technologies 	<ul style="list-style-type: none"> • Develop knowledge base of emerging technology trends and timelines • Streamline interconnection processes for emerging technologies • Understand BC's alternative energy resource potential to support other strategic plans (e.g., BCTC, Powerex, etc.) • Explore the potential of energy storage technologies to integrate variable output renewables 	<ul style="list-style-type: none"> • Provide insights and expertise to the development of mature permitting processes • Support the governance of the ocean and off-shore renewable energy resource • Partner with academia and professional associations to train the workforce in a green energy economy 	<ul style="list-style-type: none"> • Initiate programs for early deployment of technologies in remote community applications • Explore programs to support alternative energy in communities and industry • Explore the potential of select pricing programs that provide an appropriate price signal to facilitate early deployment of emerging technologies

Figure 7 - Objectives and Actions in the Strategy

Conclusion

BC Hydro's Alternative and Emerging Energy Strategy is a considered response to the challenges and opportunities stemming from Provincial Government leadership in clean energy technologies. In developing the strategy, BC Hydro considered how the unique position and capabilities of our electric utility can be used to facilitate the commercialization of emerging clean energy technologies.