Clean and Renewable Energy Development:

Supports & Incentives

Prepared For: Renewable Energy Development Branch, BC Ministry of Energy and Mines

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EXECUTIVE SUMMARY

Energy touches almost every aspect of our lives and is a vital component of modern economic activity. Since the industrial revolution, the ability to harness new forms of energy has been an ongoing mark of economic progress and an important determinant of prosperity. Increased access to, and use of, different forms of energy have not been without negative side effects, however. The combustion of fossil energy sources is associated with increased atmospheric mercury content, acid rain, and more recently, has also been inextricably linked to the increase of atmospheric greenhouse gases (GHG) and climate change. This report has been undertaken for the British Columbia (BC) Ministry of Energy and Mines' (MOEM) Renewable Energy Development Branch and addresses the following research question: *What supply side policies and measures would best incentivize and accelerate the development of clean and renewable energy projects and technologies in BC*?

The BC MOEM (or the ministry) is responsible for the oversight and development of the province's energy and mineral resources. The objectives of the ministry are to "increase energy sector jobs, investment and revenue, while ensuring that Government's self-sufficiency, greenhouse gas reduction and environmental objectives for the energy sector are achieved" (MOEM, 2011a, p. 6). British Columbians are among the highest per capita energy users in the world. The total primary and secondary energy use of the province in 2009 was 910, 372 terajoules and this amount is projected to increase by as much as 40% over the next 20 years (Statistics Canada, 2011; BC Hydro, 2012). The BC Government administers numerous policies, programs, and tools to support the development of clean and renewable energy projects and technologies. These instruments include small-scale programs to support personal and community scale energy projects, granting programs to support the development of new technologies, mechanisms to acquire electricity from new independent power producers, and economy wide instruments such as the carbon tax.

Literature Review

Due to the multiple market failures at work in the energy sector, the literature review revealed that no single policy, such as a carbon tax, would be able to achieve the diverse yet related goals of GHG emission reductions, energy supply development, economic development, energy supply diversification, and energy technology development as effectively or efficiently as a coordinated suite of policy instruments. In addition, as a result of the large capital requirements and long time frames associated with energy projects and technology development, the review identified that one of the primary goals of most supporting measures was to increase investment certainty to decrease the overall investment risks. Creating this certainty has been challenging for many jurisdictions, however. The literature emphasizes that programs and policies need to be transparent and predictable, have stable administrative arrangements, and be backed by a secure long-term vision and political commitment.

For the development of projects using commercialized clean and renewable energy technologies, production requirements, tax credits, the provision of supporting infrastructure, and GHG emissions pricing mechanisms were identified as effective and efficient instruments. Iterations of these policies that create greater certainty were also more desirable, such as using carbon taxes instead of cap-and-trade schemes, the latter of which will often result in emissions pricing volatility. For the development of technologies that are further from being cost competitive, the literature reveals that specific policies and measures have strengths and weaknesses depending on where they are targeted on the

technology development continuum. The direct provision of funds through mechanisms such as grants is important for technologies in the pilot and demonstration stages. In the commercialization stage, loan guarantees are an effective and efficient tool for allowing projects to be built, but can create increased risks for governments due to the potential for information asymmetries. The literature also suggests that instruments that allow for the exposure of new technologies to market scrutiny are important for capturing learning-by-doing improvements and eventual widespread deployment. Feed-in Tariff (FIT) policies have had some success in this regard, but these successes have generally required that the tool be used as a broad electricity acquisition tool to drive the needed market pull to derive the desired benefits.

Methodology

The design for this project consisted of semi-structured interviews with clean and renewable energy experts and practitioners. Semi-structured interviews entail an open-ended questioning format designed to provide an overall interview framework, while still allowing the interviewer to ask relevant non-predetermined questions. Interviews were conducted with 29 individuals ranging from government departments, crown corporations, not-for-profit organizations, universities, industry associations, and within the energy industry itself. Interview data were organized thematically, using analytic categories that were inductively determined. The categories and themes derived from the data were generated through a constant comparative method of analysis.

Interview Findings

There was recognition amongst participants that the development of clean and renewable energy in BC, while supported, was subject to barriers that were unique to the BC context in both kind and scope. These included: the unsettled nature of First Nation rights and title claims in BC; entrenched biases towards large projects at BC Hydro; limited social license for developers to operate; uncertainties regarding the provision of transmission infrastructure to electricity projects; the small market for additional clean and renewable capacity in BC and; the low cost of more established incumbent energy sources. Participants emphasized numerous potential policy and program design considerations during discussions, and continually highlighted the need for increasing the stability and predictability of all policies and programs that pertain to energy.

GHG emissions pricing was seen as an important mechanism for driving a long-term energy transition and there was a general preference for carbon taxes over cap-and-trade schemes for this purpose. For electricity acquisition, the current boom and bust cycle of the calls for power were identified as presenting challenges for industry in BC. In addition, there was good support for programs such as the Standing Offer Program (SOP), despite limitations it presented for particular technology streams such as wind and geothermal. For technology development, there was strong support for using different tools to support the development depending on the technology's stage of development continuum, but there was no consensus on this point as some participants preferred technology agnostic policies, meaning no differentiation of support depending on technology type or stage of development. Granting programs were generally seen as important for the development of technologies as well as building connections between industry participants and between academics and industry. The FIT was generally identified as a sub-optimal policy for technology development for jurisdictions that could not drive the market pull needed to provide its benefits. There was no consensus on where the financing should ideally come from to support energy policies and programs, but there was support for the idea of linking the funding to the area where the benefits from the program are expected to accrue. While there was disagreement over the benefits of picking winners at a company level, there was greater support for the idea of picking winning areas or resource areas to focus limited resources on. Broad support and long-term vision was also emphasized as significant for providing credibility to energy programming and delivering increased certainty for investments.

Discussion

The discussion explores specific areas for policy consideration by BC. Electricity acquisition policies are currently serving the provinces interest well, but the long time frames between general Calls for Power and uncertainties regarding the provision of transmission infrastructure have created uncertainty and challenges for industry. In the area of technology development, focusing resources into strategic areas of investment increases the probability for returns on investments. In addition, support programs and policies are ideally matched to particular stages of the technology development continuum for best results. Granting mechanisms are appropriate tools at the pilot and demonstration stages, and loan guarantees are widely supported for use at the late demonstration and early commercialization stages. FIT policies have had some success at the commercialization stage, but have generally required the establishment of a mass market to drive learning-by-doing effects, which may not be possible in BC.

The environment in which energy supports and incentives operate also has implications for the efficiency and effectiveness of these instruments. Ideally program processes are simple, transparent, predictable, and include peer review mechanisms. Finally, to create the desired certainty, a credible and broadly supported long-term energy vision is needed.

Recommendations

Seven recommendations were developed based on the analysis of the interview findings and literature review:

1. Commit to the Carbon Tax
2. Develop a loan guarantee program for commercial demonstration projects
3. Do not proceed with the proposed Feed-in Tariff program
4. Conduct more regular Calls for Power
5. Develop a BC Ocean Energy Technology Strategy
6. Renew the BC Energy Plan to deliver a long-term energy vision
7. Establish a provincial equivalent of Sustainable Development Technology Canada

Conclusion

The materials considered for this report emphasized the need for predictability and stability for all policies and programs that pertain to energy due to the long time frames and large sums of money associated with energy developments. BC has the opportunity to build on its solid foundation and further develop a coherent constellation of programs and policies to support the development of the projects and technologies that will deliver economic benefits and power the province for the coming century.

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1. INTRODUCTION

Energy touches almost every aspect of our lives and is a vital component of modern economic activity. Since the industrial revolution, the ability to harness new forms of energy has been an ongoing mark of economic progress and an important determinant of prosperity. Increased access to and use of different forms of energy have not been without negative side effects, however. The combustion of fossil energy sources is associated with increased atmospheric mercury content, acid rain, and more recently, has also been inextricably linked to the increase of atmospheric greenhouse gases (GHG) and climate change. The search for alternative energy sources has long had theoretical appeal, but it was not until the 1973 oil crisis, which demonstrated the fragile state of the global energy supply, that many jurisdictions began to seriously investigate alternative forms of energy production and use. Current concerns over peak oil have further emphasized the importance of this investigation. Likewise, issues of climate change and the un-sustainability of extensive fossil energy use have highlighted that new energy resources must not only come from alternative sources, but also be clean and renewable.

This report has been undertaken for the British Columbia (BC) Ministry of Energy and Mines' Renewable Energy Development Branch to investigate clean and renewable energy supply side management policies and measures, including those for the further development of new supply technologies. The report specifically addresses the following research question:

What supply side policies and measures would best incentivize and accelerate the development of clean and renewable energy projects and technologies in British Columbia?

For purposes of this report, 'clean and renewable' will follow the definition provided in the BC *Clean Energy Act* where "'clean or renewable resource' means biomass, biogas, geothermal heat, hydro, solar, ocean, wind or any other prescribed resource" (Government of BC, 2010a). This definition focuses the discussion on commonly accepted forms of clean and renewable energy resources, while eliminating nuclear energy and potentially cleaner forms of fossil fuels such as natural gas or clean coal technologies. Development is defined as pertaining to the development of projects for the harnessing of new energy resources, such as hydroelectric developments or wind turbines, or the development of new technologies that allow for the harnessing or carrying of energy, such as ocean energy technologies, second generation biofuels, or hydrogen fuel cells.

The report is divided into seven chapters. Chapter two provides background information related to the client, the energy context in BC and an overview of the key current policies and measures either contemplated or already in use in BC. Chapter three outlines the literature review, which provides an overview and analysis of the primary incentive structures available for the development of clean and renewable energy projects and technologies. The incentive structures explored generally fall into four broad categories: legislative and regulatory policies; research and technology development; fiscal measures; and other assisting or voluntary measures.

The semi-structured interview research methodology is outlined and discussed in chapter four. This chapter also contains information regarding the selection of interview participants through Internet searches, background reading, and consultations with the client. The interview findings are organized thematically and outlined in chapter five. Themes described include current barriers to clean and renewable energy development in

BC, program and policy design considerations, and long-term vision. Chapter six contains a discussion of the project findings in relation to the literature review and the context of BC. The discussion focuses on the areas of long-term vision and its relationship to jurisdictional goals and increased investor certainty; the consideration of the impacts of clean and renewable energy and the consequences for energy exports and; policy portfolio considerations. Finally, chapter seven provides recommendations to BC to aid future policy decisions regarding clean and renewable energy development, and chapter eight offers concluding remarks.

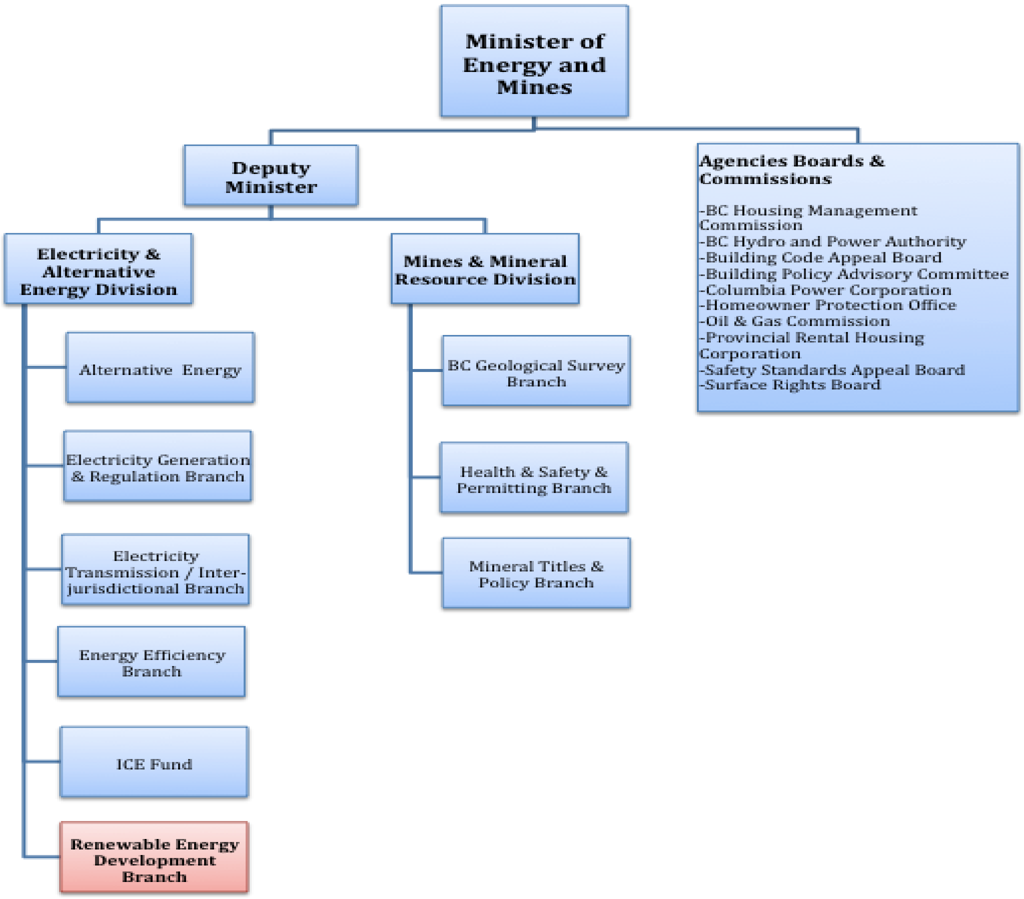
2. BACKGROUND

This section will provide background information on the client organization, the British Columbia (BC) Ministry of Energy and Mines' (MOEM) Renewable Energy Development Branch and provides a description of the Ministry and Branch's mandates. The BC context, and a brief overview of the main existing or proposed programs and policies to support the increased and accelerated development of clean and renewable energy resources and technologies in BC will also be described below to help provide the information needed to relate the findings of this report back to the context of BC.

2.1. BC Ministry of Energy and Mines- Renewable Energy Development Branch

The BC MOEM (or the ministry) is responsible for the oversight and development of the province's significant energy and mineral resources. The objectives of the ministry are to "increase energy sector jobs, investment and revenue, while ensuring that Government's self-sufficiency, greenhouse gas reduction and environmental objectives for the energy sector are achieved" (MOEM, 2011a, p. 6). To do so, the MOEM administers all or part of the province's 16 public statutes and one private act pertaining to energy. A list of these statutes has been provided in Appendix I. The ministry's organization chart is shown in Figure 1 below.

Figure 1. BC Ministry of Energy and Mines' Organizational Chart



(Government of BC, 2011; MOEM, 2011c)

The ministry also has responsibilities under the *Utilities Commission Act* such as the enforcement of the terms of an energy operation certificate granted under the act, and the *Oil and Gas Activities Act* such as the ability to regulate conflict of interest rules for the Oil and Gas Commission members (MOEM, 2011a).

The ministry delivers a wide variety of initiatives including those related to energy efficiency and conservation, the promotion of new energy technologies, alternative energy sources, and the responsible management of the province's petroleum and natural gas resources. These programs are aimed to help achieve BC's energy objectives, such as the reduction of GHG emissions and to contribute to economic development and growth throughout the province (MOEM, 2011a). Appendix II contains a complete list of BC's clean energy objectives as contained in the *Clean Energy Act.*

The Renewable Energy Development Branch's specific mandate is to develop and administer programs to support the commercialization of new clean and renewable energy technologies, increase the implementation of existing technologies, and build awareness and capacity for renewable energy options. This broad mandate requires significant collaboration with stakeholders and citizens, and other levels of government. This project has been undertaken in support of the energy objectives of BC and the mandate of the Renewable Energy Development Branch.

2.2. The BC Energy Context

BC is Canada's Western most province sharing borders with the province of Alberta, the Yukon Territory, and the US states of Alaska, Idaho, Montana, and Washington. The province has a long history as a natural resource based economy due to its colonial roots and abundance and diversity of resources. In recent decades the economy has diversified substantially and the service producing industries are currently BC's largest overall gross domestic product (GDP) contributors (Conference Board of Canada, 2011). BC's current population is 4,530,960 and its GDP by income in 2009 was over $191 billion (Statistics Canada, 2011).

British Columbians are among the highest per capita energy users in the world. The total primary and secondary energy use of the province in 2009 was 910, 372 terajoules and this amount is projected to increase by as much as 40% over the next 20 years (Statistics Canada, 2011; BC Hydro, 2012). Table 1 contains a summary of province's 2009 energy use, production, and export. See Appendix III for a discussion and description of important energy related terminology.

Table 1. BC 2009 Energy Use, Production, and Export Summary

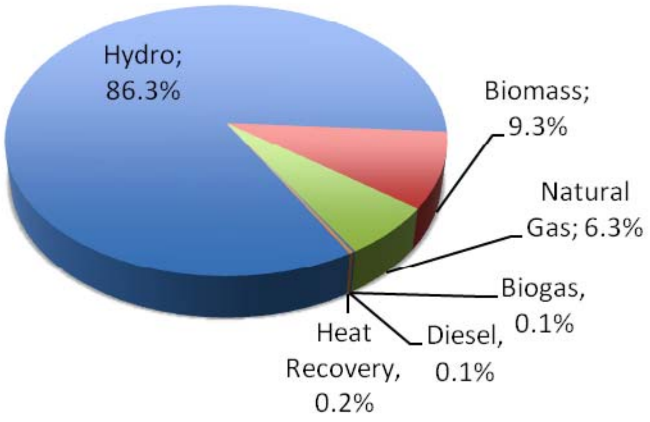
Total Energy (terajoules)	
Total Primary and Secondary Energy Use	910,372
Crude Oil and Equivalent (1,000 m³)	
Production	1,941.1
Exports	228.8
Refined Petroleum Products Domestic Sales (1,000 m³)	
All Products	9950.5
Motor Gasoline	4636.2
Aviation Turbo Fuel	724.6

Diesel Fuel	2900.1
Light Fuel Oil	73.7
Stove and Kerosene	6.9
Heavy Fuel Oil	895.1
Natural Gas (1,000 m^3)	
Total Production	33,097,900
Deliveries of Marketable Gas	27,494,900
Total Utility Sales	3,572,100
Coal (kilotonnes)	
Production	21,168.0
Exports	20,741.6
Biomass (kilotonnes, 2010)	
Wood Pellet Production	1,200
Wood Pellet Export	~1,200
Electricity (MW.h)	
Total Generation	62,205,609
Exports to the United States (US)	6,601,959
Imports from the US	11,226,173

(Statistics Canada, 2011; BC Ministry of Forests, Lands and Natural Resource Operations (MFLNRO), 2011)

Electricity is essential to the daily functioning of the BC economy. As noted in Table 1, the total electricity generation output of BC in 2009 was 62,205,609 megawatt hours (MW.h), and over 90% of this capacity was generated from clean and renewable sources (Figure 2).

Figure 2. BC 2009 Electricity Generation Mix by Source: Five Year Average



(MOEM, ndb)

The primary utilities in BC are the provincially owned Crown Corporations BC Hydro and Power Authority (BC Hydro) and its main subsidiary the BC Transmission Corporation (BCTC), which generate and deliver electricity to 94% of the population (Healey, 2010). Several private and municipal utilities also operate in the province, such as Nelson Hydro and the City of New Westminster. Fortis BC is the largest private utility in BC delivering electricity to communities in the Southern Interior and Natural Gas to a significant portion of the province including the Lower Mainland (Fortis BC, 2011a; Fortis BC, 2011b). Additionally, independent power producers (IPP) are considered utilities under the *Utilities Commission Act.* All provincial utilities are subject to regulation by the provincial government and the BC Utilities Commission (BCUC), but IPPs are exempted from price regulation by Ministerial Order. However, the electricity purchase agreements (EPA) between IPPs and the distributing utilities are regulated by the BCUC (MOEM, nd).

The province's transmission network is interconnected with the Albertan and US electricity markets. BC regularly participates in domestic and international electricity trading through BC Hydro's subsidiary, Powerex. While Powerex was originally established to market BC's surplus power in the late 1980's, the province has been a net importer of electricity in five of the last ten years (Statistics Canada, 2011; Powerex, nd).

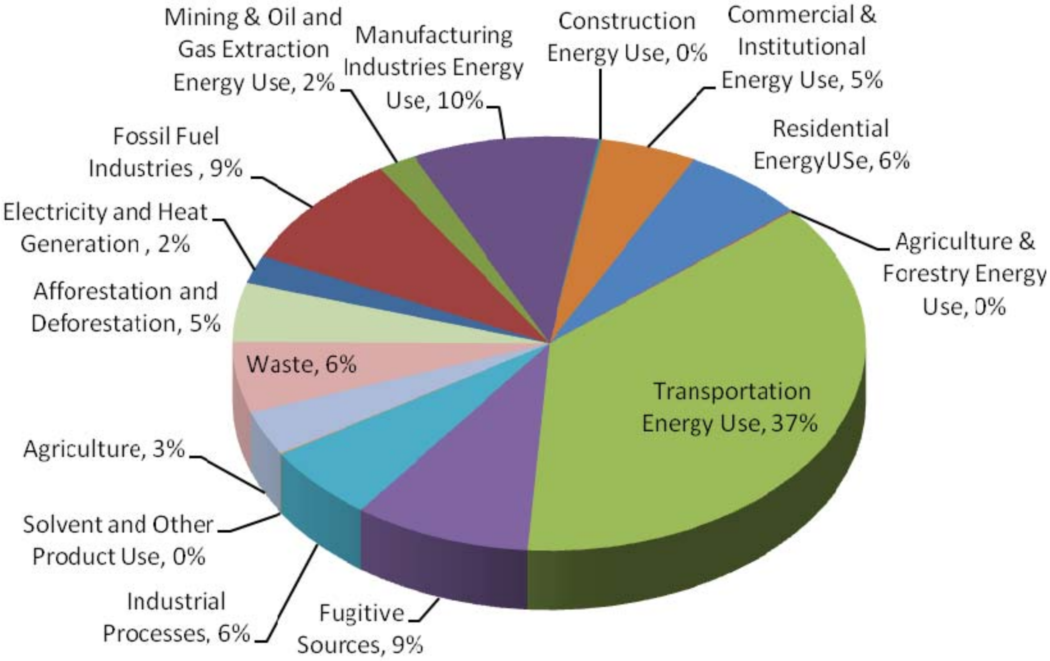
The petroleum and natural gas sectors are also important economic drivers in the province and generated over 50% of BC's resource revenue in fiscal year 2009/10 at $1.35 billion (BC Oil and Gas Commission (BCOGC), 2011). The high revenue from these sources also makes the province vulnerable to commodity market fluctuations, as was the case during the recent 2008 global economic downturn (MOEM, 2011a). This, among other factors, contributed to a BC Government balance in 2010-2011 of negative $1.3 billion (Conference Board of Canada, 2011).

To address some of this volatility and help guide the future of energy in BC, the province has released two energy plans in the past decade: *The 2002 Energy Plan* and *The BC Energy Plan: A Vision For Clean Energy Leadership* released in 2007. The 2002 plan increased the profile of environmentally motivated policy actions such as energy efficiency and conservation initiatives. Additionally, it secured public ownership of the province's "heritage assets", decoupled BC Hydro and the BCTC, and laid the framework for increased energy acquisition from IPPs. The heritage assets refer to a portfolio of 36 existing and proposed (e.g. Site C project and new Revelstoke capacity) generation, storage, and transmission facilities. The majority of the generation facilities are hydro stations built in the 1950's, 60's and 70's, but facilities such as the Burrard Thermal plant are also listed (BC Hydro, 2010c; Government of BC, 2010a). The 2007 plan further focused the province's strategy and outlined 55 policy actions that the government would take to secure BC's energy future, increase energy efficiency and conservation, position BC as a leader in the development and implementation of clean and renewable energy technologies, and reduce the GHG emissions associated with energy (MOEM, 2008; MOEM, 2009).

The following year, with growing concern over climate change and its potentially catastrophic impacts, the BC government released its *Climate Action Plan* (CAP). The CAP set a GHG reduction target of 33% below 2005 levels by 2020, and outlined a broad range of options and strategies to address emissions in every sector (Government of BC, 2008a). The energy plan became a key component of this initiative due to the high GHG emissions associated with the energy sector.

Figure 3 contains a percentage breakdown of BC's 2008 GHG emission contributions by sector. BC emitted 68,719 kilotonnes of GHG in 2008 of which energy use accounted for 80.4% (BC Ministry of Environment (MOE), 2010). See Appendix IV for a tabular representation of BC's GHG emissions by sector between 2000 and 2009. As shown in Figure 3, BC is also in a unique position as only 2% of total GHG emissions are from electricity and heat production, whereas these activities accounted for approximately 41% of GHG emissions globally (MOE, 2010; International Energy Agency (IEA), 2010).

Figure 3. BC 2008 GHG Emission Percentages by Sector



(MOE, 2010)

To assist in the implementation of BC's energy strategies and help meet the objectives of the CAP, the province appointed the Green Energy Advisory Task Force in November 2009. The task force consisted of policy and technical climate and clean energy experts, First Nations and community representatives, environmentalists, and industry representatives. The task force was divided into four different groups each responsible for making recommendations to government under their specific mandate:

1. Carbon Pricing, Trading and Export Market Development;
2. Procurement and Regulatory Reform;
3. Resource Development; and
4. Community Engagement and First Nations Partnerships.

The resulting report contains 71 recommendations on a wide range of areas including technology development, energy procurement practices, infrastructure investments, and consultation procedures (Government of BC, 2010d).

In April of 2010 the Government of BC released the task force report to the public and tabled the new *Clean Energy Act,* which came into force in June 2010. The *Clean Energy Act* directly built on 41 of the recommendations contained in the Green Energy Advisory Task force report (MOEM, 2010c; MOEM, 2010d). The Act outlines 16 energy objectives for the province including achieving electricity self-sufficiency by 2016, producing 93% of electricity from clean or renewable sources, meeting 66% of future electricity demand through conservation and efficiency measures, reducing GHG emissions by encouraging fuel switching to lower emission energy sources, encouraging First Nation and rural community development through the development of clean or renewable energy resources, and to reduce the GHG emissions of other jurisdictions through clean and renewable energy exports from BC (see Appendix II for a full list of objectives; Government of BC, 2010a). Additionally, the *Act* recombines BC Hydro and the BCTC, and changes the regulatory jurisdiction of the BCUC by removing it from the approval process of long-term planning decisions and major projects, but retaining its authority over electricity rate regulation (Government of BC, 2010a; Hoberg, 2010)

Energy objective 'n' in BC's *Clean Energy Act* is "to be a net exporter of electricity from clean and renewable resources with the intention of benefiting all British Columbians and reducing greenhouse gas emissions in regions in which British Columbia trades electricity…" (Government of BC, 2010a). This has changed the direction of electricity energy policy from one of self-sufficiency to an export focused model (Hoberg, 2011). The next section will briefly outline the main programs and policies that BC has in place or is contemplating implementation for the support and development of clean and renewable energy resources and technologies.

2.3. Current and Proposed Clean and Renewable Energy Development Programs in BC

BC has been taking action in recent years to support the development of clean and renewable energy resources. This section outlines the key tools and programs that have been, or are planned to be implemented to achieve the BC's energy objectives and encourage the development of clean and renewable energy resources in the province. Many of these initiatives are not specifically designed to support energy projects, but do include energy related projects in the eligibility requirements. Due to the number of economic development trusts, funds, and grants, not all will be discussed in detail in this report, as most have a limited focus on energy supply related projects.

2.4.1. BC Bioenergy Strategy

The BC Bioenergy Strategy was launched in 2008 to support the goals of the BC Energy Plan, create opportunities for rural communities, spur innovation, reinvigorate the forestry and agricultural sectors, and increase waste to energy conversion in the province (Government of BC, 2008c). The primary initiatives included a new Bioenergy Network, requiring BC Hydro to initiate a two-phase bioenergy call for power, and supporting the production of liquid biofuels within the province.

BC Bioenergy Network

The BC Bioenergy Network (BCBN) is an industry-led initiative established in 2008 with a $25 million grant from the BC government. The purpose of the network is to support bioenergy research, technology deployment, and capacity building through loans and grants typically supporting between 10% and 30% of project costs (BCBN, nda). The network targets funding at eight strategic areas within the forestry (solid wood residues, pulp and paper residues, and harvesting and pelleting), municipal (existing municipal landfill, municipal wastewater, municipal solid waste, and heat and power systems), and agricultural sectors (agricultural residues). To date the network has invested a total of $12.5 million in 21 separate projects with a combined worth of over $74.2 million (BCBN, ndb; BCBN, ndc).

Bioenergy Calls for Power

BC Hydro made two requests for proposals (RFP) to obtain electricity produced by IPPs from woody debris or other biomass resources (BC Hydro, 2011e). Both RFP processes were limited to projects that could provide hourly firm electricity to BC Hydro. The first RFP took place in 2008 and was open to projects that did not require forest tenure. BC Hydro received 16 different project proposals of which four were ultimately selected representing 579 gigawatt hours (GW.h) of electricity per year (BC Hydro, 2009a).

The second phase of the call was launched in March 2009 and aimed to procure 1,000 GW.h per year of firm electricity from projects including wood waste sourced from new forest tenure. BC Hydro received a total of 13 proposals representing a total capacity of 3,300 GW.h per year. In January 2011 this list was reduced to eight "preferred proponents" with a potential combined capacity of 1,639 GW.h (BC Hydro, 2011f). The second phase is still ongoing and at the time of writing this report BC Hydro has not yet entered into EPAs with any of these proposed projects.

Renewable and Low Carbon Fuel Requirements

The *Renewable and Low Carbon Fuel Requirements Regulation* came into force January 1st, 2010 (MOEM, 2008d). The legislation requires all fuel suppliers in BC to ensure a 5% renewable fuel content of fuels sold, on a provincial average basis. A notable to exception to this is that the requirement for diesel providers is being phased in by 1% per year over three years to give industry time to address technical and supply issues with biodiesel, and will be 5% as of January 1st 2012. Additionally, the regulation requires fuel suppliers to lower the average life-cycle carbon intensity of transportation fuels by 10% by 2020 (MOEM, 2011b). While the new fuel requirements are not necessarily specific incentive measures for the development of bioenergy in BC, they do send a clear long-term signal for the direction of transportation fuels in the province, which can add greater certainty to investors. The province has also published the aim to produce 50% or more of the province's renewable fuel requirements within province by 2020 and has invested over $10 million to support the production and demonstration of liquid biofuels technology (Government of BC, 2008d; Government of BC, 2008c).

2.4.2. Carbon Tax

The BC *Carbon Tax Act* was passed in May 2008. The tax targeted GHG emissions from the combustion of fossil fuels, tires, and peat, which covers approximately 77% of the province's total emissions (Government of BC, 2008b; BC Ministry of Finance (MOF), nd). Starting on July 1st 2008 prescribed activities were charged $10 for every tonne of carbon dioxide equivalent (CO_2eq) emissions they released. This amount increased by $5 annually until 2012 at which time further increases may be contemplated. The carbon tax is revenue neutral where all revenues collected are recycled through personal and corporate tax cuts, and cash rebates for low income individuals and families who may have been disproportionately impacted by the new tax (Government of BC, 2008b).

The carbon tax is designed to send a predictable price signal to individuals and businesses that fossil fuels will become increasingly expensive in the future, and to encourage the reduction of GHG emissions associated with their combustion. As such, the carbon tax acts as an incentive to spur innovation, increase energy efficiency and to move towards clean and renewable sources of energy. This incentive was quite small at first given the low per tonne carbon dioxide equivalent (CO_2eq) charge, low elasticity of demand for many fossil fuel products such as gasoline, and financial and behavioural lock-in to activities involving the combustion of fossil fuels (Flood, Islam and Sterner, 2010; Carley, 2011). As the price per tonne of CO_2eq emissions increases it is expected to have a more significant impact on behaviour, purchasing decisions, and investment. The current impact of the carbon tax on the development of clean and renewable energy resources is difficult to determine, but it does send a clear message to investors regarding the longer-term direction of the province.

2.4.3. Clean Power Call

The Clean Power Call (CPC) RFP was launched in June 2008 by BC Hydro. The objective of the CPC was to secure up to 5,000 GW.h per year of clean and renewable energy from IPPs (BC Hydro, 2010a). Qualifying projects must deliver a minimum of 25GW.h per year of seasonally or hourly firm energy, and have a commercial operation date (COD) of 2016 or earlier (BC Hydro, 2010b). The CPC is therefore one of BC Hydro's primary power acquisition processes to fulfill its legislated responsibility to provide over 93% of BC's electricity from clean and renewable sources and to be energy self sufficient by 2016 (Government of BC, 2010a).

To attempt to leverage the most cost effective new energy supply, BC Hydro designed the CPC as a competitive process with added flexibility as proponents were able to make changes they deem to be of substantive importance to BC Hydro's preferred EPA terms. In November 2008 BC Hydro received a total of 68 proposals, which were then evaluated for areas such as risk, financial strength, technical aspects, First Nations engagement, required permitting and approvals, and energy source data. This process was monitored and evaluated by an independent observer to ensure the fairness of the approval process (BC Hydro, 2010c).

To date, of the 68 original proposals, 27 were selected resulting in a total 25 signed EPA agreements, as three proposals were combined. The 25 EPAs represent 1,168 MW of capacity and 3,266 GW.h per year of firm energy from 19 run-of-river hydro projects, six wind projects, one storage hydro project, and one waste heat project (BC Hydro, 2010c). However, BC Hydro adjusts these totals for planning purposes subtracting an assumed attrition factor of 30% bringing the firm energy to 2,286 GW.h per year (2010c).

2.4.4. Hydrogen Initiatives

The 2007 BC Energy Plan contained the goal of developing a leading hydrogen and fuel cell economy in the province. This was primarily to be achieved through continued support for the industry led Hydrogen and Fuel Cell Strategy for BC (MOEM, 2009). The cornerstone initiative of this strategy was the construction of the Hydrogen Highway between Victoria and Whistler in advance of the 2010 Winter Olympic Games. The highway consists of seven separate demonstration fuelling stations, and is currently mostly used by hydrogen vehicle demonstration projects (MOEM, 2010a).

The provincial and federal governments partnered to invest $89 million in the fuelling stations and the purchase and operation of 20 hydrogen fuel cell busses for the Whistler regional transportation system (Government of BC, 2007). The Vancouver Fuel Cell Vehicle Program (VFCVP) is another hydrogen demonstration project. The three year program is an $8.7 million joint initiative between the Canadian Hydrogen and Fuel Cell Association (CHFCA), Ford Motor Company, and the BC provincial and Canadian federal governments

(CHFCA, nd). The province has also implemented Motor Fuel Tax exemptions for hydrogen used in fuel cell vehicles (MOEM, 2010a).

Ultimately, the vision of the Hydrogen Highway was to see it extend all the way to San Diego. The BC Government has been working with the governments of Washington, Oregon, and California to further implement this goal. An “alternative highway” memorandum of understanding (MOU) was signed between BC and Washington State to further this end and a “hydrogen highway” MOU is under development with California (MOEM, 2009).

BC currently has the largest hydrogen and fuel cell industry cluster in Canada with over 35 organizations employing approximately 1,200 people. Since 2003, industry has invested over $100 million annually on hydrogen R&D, and demonstration (MOEM, 2010a).

2.4.5. Innovative Clean Energy Fund

The Innovative Clean Energy (ICE) Fund was launched in 2007 to help support the introduction, commercialization, and development of new clean energy technologies “with the potential to solve everyday energy, and environmental issues, and create socio-economic benefits for British Columbians” (Government of BC, 2010b, p. 4). Qualifying projects are either pre-commercial or existing commercial technologies not currently in use in BC, and can be in an array of potential areas including energy efficiency, renewable energy, transmission, and GHG reductions and sequestration from conventional energy sources. The fund receives $25 million annually to support such projects through a 0.4% levy on the final sale of energy products not including transportation fuels (Government of BC, 2010b). Since the establishment of the fund, the BC Government has conducted four calls for proposals. Table 2 contains a summary of the project numbers supported, investment dollars, and total project values.

Table 2. ICE Fund Project Numbers, Investment, and Total Value

ICE Call For Projects and Year	# Of Projects	ICE Fund Investment	Project Value
First Call-2008	15	$24,236,801	$80,769,941
Second “Rural” Call -2009	19	$22,681,732	$96,499,683
Liquid Biofuels Call- 2009	5	$6,995,000	$22,704,800
“Showcase” Call (first intake)- 2010	2	$6,600,000	Not available
Total	41	$60,513,533	>$235,000,000[1]

(Government of BC, 2010b; Government of BC, 2010c)

The BC Government is investigating alternative streams of revenue for the ICE fund as the 0.4% levy was eliminated with the introduction of the HST in July 2010, and the program is not currently accepting applications for funding (Government of BC, 2011). The ICE fund was included in the MOEM 2011/12-2013/14 Service Plan, and MOEM has adopted a performance measurement ratio of 3:1 calculated by taking the total project value minus

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[1] Total value of >$235 million taken from BC Government News Release

total ICE funding and dividing it by the total ICE funding. The service plan currently allocates just under $15 million to the ICE fund, which is a $10 million decrease from the previous annual funding amount (MOEM, 2011a).

2.4.6. Net Metering

BC Hydro's Net Metering program came into force in May 2004 and was designed as an incentive measure for residential and commercial customers to install small scale clean generating units with a capacity of 50 kW or less (BC Hydro, 2011a). Under the program, BC Hydro agrees to off-set energy generated by the customer against their overall electricity bill. If the customer is producing greater than their current consumption the amount is carried over to future bills, and if annual generation is greater than consumption BC Hydro will compensate the customer for the energy at the customer's applicable rate schedule (BC Hydro, 2009b).

Due to the high initial investment costs of energy systems, however, some program participants have argued that the program does not give sufficient incentives for large numbers of participants to take advantage of the Net Metering Program (Bryan and Skuce, 2006). Additionally, concerns were raised during stakeholder consultations and the program review conducted in 2005 regarding the 50 kW project limit of the program (BC Hydro, 2005). BC Hydro determined that increasing the limit above 50kW resulted in increased technical complications for connection resulting in potentially unacceptable increases in the expense of the program. However, at this time BC Hydro also committed to investigating programs to capture projects that were over 50kW but that were not captured by their existing electricity procurement practices (BC Hydro, 2005). Currently, the Standing Offer Program (discussed below) encompasses projects above 50kW.

The program review conducted in June 2005 reported that a total of ten customers had signed net metering agreements with BC Hydro, and a further six were either preparing to sign or under technical review at the time of writing. These 16 projects combined for a total installed capacity of 74.04 kW with an annual electricity output of 100,350 kW.h (BC Hydro, 2005). Proper evaluation of the program is difficult, as no additional program review has been made publicly available since the release 2005 report. This may be due to a diminished importance of the net metering program due to the development and operation of other incentive programs.

2.4.7. Standing Offer Program

The Standing Offer Program (SOP) was launched in April 2008 to acquire proven clean and renewable energy from IPPs with proposed projects between 0.05MW and ten MW of capacity. The program was developed to decrease the transaction costs for small-scale energy developers by streamlining and simplifying the application process (BC Hydro, 2011b). The program committed BC Hydro to paying eligible and approved projects eight different rates between $74.23 per MW.h and $88.76 per MW.h depending on the region of the province the project would be constructed in. The rates were also differentiated for the time of delivery and by month whereby BC Hydro would pay more for electricity delivered during periods of peak demand than for off-peak periods (BC Hydro, 2011c). To provide added stability to program participants and investors the program did not install a cap or quota for the capacity BC Hydro was permitted to acquire. This was deemed to be essential to the success of the program due to the amount of preliminary work that applicants must undertake to submit a complete application (BC Hydro, 2011g).

As of October 2011, 28 applications had been received by BC Hydro, nine EPAs had been signed, 15 applications were still under evaluation, and four are not proceeding. The 20 projects either approved or under review represent a capacity of 145.04 MW (BC Hydro, 2011h).

As a result of the program review several changes have been announced to the previous SOP rules, including:

- the extension of the program to include non-proven technologies,
- increasing the upper limit for qualifying projects from 10MW to 15MW,
- changing the delivery pricing table to include a super-peak delivery period,
- eliminating compensation for project-interconnection delays,
- the inclusion of a "buyer turn-down right" for BC Hydro,
- increasing the payment rate between 14-29% depending on region to more closely reflect the rates achieved in the most recent competitive call for power process, and
- allowing BC Hydro to exercise discretion to approve programs that do not meet the letter of the SOP rules but are in keeping with its overall objectives (BC Hydro, 2011g)

While many of the changes to the SOP program are likely to be well received by stakeholder groups, several concerns with the program were raised during a stakeholder webcast meeting on February 23, 2011. Some participants were concerned that the elimination of compensation for interconnection delays introduced a significant level of risk that was entirely outside the developer's influence. BC Hydro's position is that this practice is consistent with their other power acquisition methods and that BC Hydro does not receive compensation for delays in the completion of power projects. Additionally, considerable interest was expressed regarding the required transfer of "environmental attributes" to BC Hydro. This practice is required for BC Hydro to meet its obligations to provide 93% clean and renewable electricity under the *Clean Energy Act* (BC Hydro, 2011d). Despite these concerns, it is too early to tell how the larger stakeholder population will react to the revised program. It appears likely given the interest in the original SOP that the increased rates will increase participation despite some increased risks.

2.4.8. Remote and Community Initiatives

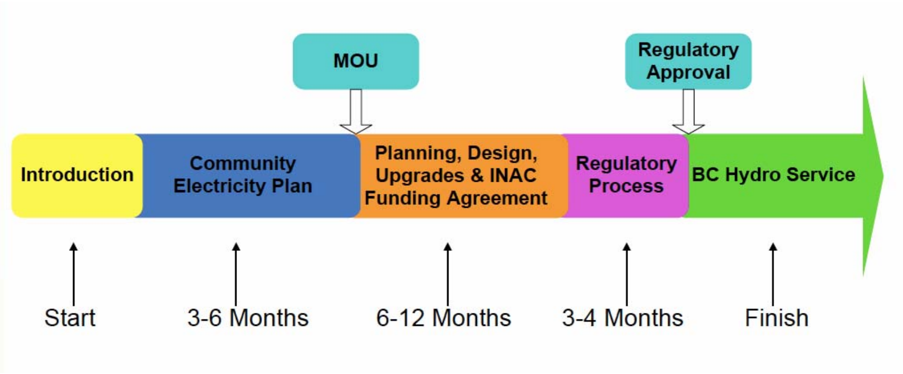
There are numerous remote and community based development initiatives currently active in BC. While there are several distinct energy focused initiatives, many of the different projects or funds are not specifically tailored to support energy projects. Additionally, initiatives targeted at the community level often strive to increase local capacity to further foster new development initiatives and economic growth.

Remote Community Electrification (RCE) and Remote Community Clean Energy (RCCE) Programs

The RCE program was launched by BC Hydro in 2005 to offer remote off grid communities the option of receiving service from BC Hydro. Approximately 70 remote and First Nation communities in BC are not connected to either the electricity or natural gas utilities, and rely on diesel generators to supply a significant proportion of their energy needs. These communities often suffer from energy unreliability, high energy costs, and limited potential to support local economic development (MOEM, 2008b).

BC Hydro services 17 off grid communities, and the goal of the program is to provide service to another 30-40 eligible communities (BC Hydro 2011c). In some cases this is just a matter of connecting the community to the grid but many others require their own generating facilities. The program has a target to use 50% renewable resources and is required to implement renewable options whenever feasible (BC Hydro, 2010d). Eligible communities are required to submit a community energy plan and initiate concurrent demand side management initiatives. To build the projects, communities could choose to build, own, operate the facility themselves, or have an IPP or BC Hydro take on these responsibilities for them (BC Hydro, 2010d). The program typically takes between 12 and 22 months to complete each project (Figure 4).

Figure 4. Typical RCE Program Timeline



(Source: BC Hydro, 2010d)

To help further the goals of the RCE program, BC Hydro launched the RCCE program in 2008 to provide over $20 million in funding to support remote communities develop and implement their community energy plans, contribute to major capital energy projects, and improve energy efficiency (MOEM, 2008b; MOEM, 2008c). Because small communities often have capacity restraints that function as barriers for long-term and technical planning, providing support to remote communities for every stage of an energy project is viewed as critical.

Remote Community Implementation (RCI) Program

Initiated through a $1.65 million grant from MOEM, the RCI program supports eligible remote communities to implement both supply and demand side energy management solutions. Administered by the Fraser Basin Council (FBC), the program aims to fund projects that help lower energy costs in remote communities, reduce GHG emissions, and either partially or entirely eliminate diesel powered electricity generation. Minor projects are eligible for grants between $25,000 and $45,000, and major projects for funding between $100,000 and $300,000. The RCI program also offers a “community-to-community” mentorship stream to help communities network, share potential energy project ideas, and build capacity within those communities (FBC, nd).

Remote Community Energy Network (RCEN)

The RCEN is a collaborative effort between the Province of BC, Aboriginal Affairs and Northern Development Canada (AANDC), BC Hydro, and the First Nation Technology

Council to assist remote communities implement demand and supply side energy solutions. The main purpose of the RCEN is to help interested communities navigate and coordinate access to the network members' programs (MOEM, nda). With a variety of funding options for energy projects available, the RCEN attempts to diminish the transaction costs of dealing with multiple organizations for remote communities who already have limited capacity.

Towns for Tomorrow

Launched in 2006, the Towns for Tomorrow program is an example of a small community focused funding program, which funds a variety of initiatives including "environmental energy improvement projects"(Government of BC, nda). Eligible communities must have a population of 15,000 or less. Eligible costs include engineering, design, capacity building, and construction costs. In communities under 5,000 people projects are eligible for up to 80% of project costs to a maximum of $400,000 and communities between 5,000 and 15,000 are eligible for 75% funding up to a the maximum of $375,000 (Government of BC, nda).

First Nations Clean Energy Business Fund

The First Nation Clean Energy Business Fund was established under the *Clean Energy Act* and later specified under the *Clean Energy Business Fund Regulation.* The fund was established to provide a revenue sharing mechanism for the land and water revenues from IPP projects, and help facilitate First Nation involvement in the clean energy sector in BC. The initial balance of the fund was $5 million and it will receive payments from prescribed land and water title revenues for energy projects (Government of BC, 2010a; Government of BC, 2010e).

2.4.9. Solar BC

The Solar BC program was launched in September 2008 through a $5 million grant from the Government of BC and $1.6 million in secured rebate funding from Natural Resources Canada (NRC). The program is administered by the BC Sustainable Energy Association (BCSEA) in collaboration with Eaga Canada Service Inc. (Solar BC, 2009). Primarily established to aid and speed the delivery and use of solar hot water (SHW) systems, the program has also administered a limited number of solar photovoltaic (SPV) grants to schools in BC.

To achieve the program's goal of 100,000 solar roofs in BC by 2020, the program is subdivided into six smaller programs: Residential, Local Government Buildings, Schools, Social Housing, Solar Communities, and First Nations (Solar BC, nd; Harris, 2010). Providing funding for the conversion to SHW systems is one of the key components of all five Solar BC programs. Financial incentives that were available under the program include:

- low and zero interest loan schemes,
- up to $3,250 for existing homes, and $2,00 for new homes to install SHW,
- up to $20,000 for Schools for SHW,
- Local government, First Nation, and Social Housing Buildings qualify for up to 25% of SHW project costs from NRC ecoEnergy grants up a maximum of $400,000 with a matching grant from Solar BC of up to $40,000 (Harris, 2010), and
- grants between $10,000-$20,000 for participating communities to develop high profile SHW demonstration projects (Solar BC, 2009).

Solar BC's activities also include building awareness for SHW through outreach programs and information sessions, helping build the capacity of plumbing and building inspectors and solar installers, connecting interested customers with contractors in their area, assisting removing barriers to SHW, and providing capacity support and policy advice surrounding SHW to interested communities throughout BC (Solar BC, 2009).

The future of the program currently appears uncertain as funding ended on December 31st, 2010 with the exception of a three-month extension for the residential program for Vancouver residents. Additionally, changes to other incentives such as the NRC's ecoEnergy Retrofit Program, loss of the federal home improvement tax credit, and the loss of Provincial Sales Tax (PST) exemption with the introduction of the Harmonized Sales Tax (HST) have increased SHW project costs for individuals and created uncertainty in the B.C. solar market (Solar BC 2009). The future tax status of solar technologies is currently uncertain given the transition back to the PST after the HST was defeated by referendum in August 2011.

2.4.10. Pacific Carbon Trust

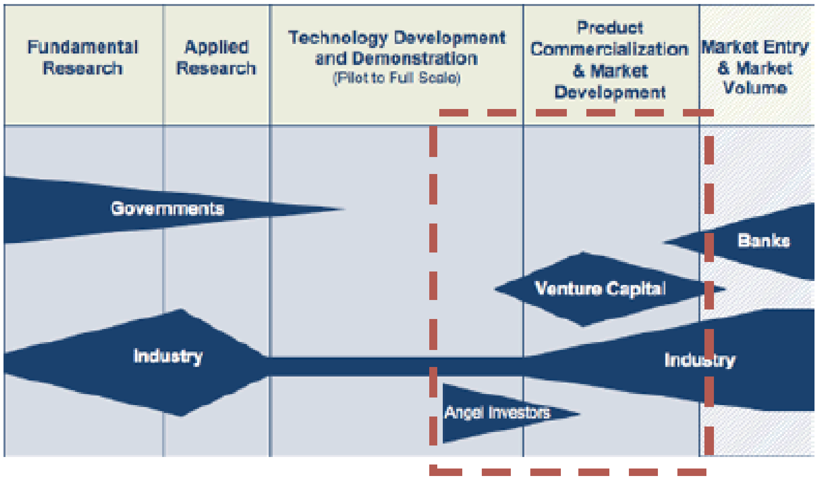
The Pacific Carbon Trust (PCT) is a provincial Crown Corporation created in 2008 primarily to help public sector organizations meet their GHG emission reduction goals by providing high-quality carbon offsets. The PCT now provides this same service to private sector organization and is charged with developing the carbon trading market in BC. Organizations that reduce GHG emissions or projects such as clean and renewable energy can sell credits to the PCT, which then sells these credits to other organizations to offset their GHG emissions. Money raised through carbon credit purchases does not necessarily support clean and renewable energy initiatives, but clean and renewable energy project are among the many types of emissions reducing projects that qualify to sell offsets. Only proven clean and renewable energy technologies qualify, as the offsets need to have a quantifiable and verifiable CO_2eq value (PCT, 2011).

2.4.11. Feed-In Tariff

Section 16 of the *Clean Energy Act* authorized the BC Government to establish a feed-in tariff (FIT) to meet the province's energy objectives. FITs are also sometimes referred to as renewable tariffs and, generally speaking, provide premium rates for electricity delivered to the grid from a variety of clean and renewable technologies. While FITs exist in many other jurisdictions the actual design of the various FIT programs differ substantially. For example, some jurisdictions, such as Germany, use FITs as a general clean electricity acquisition tool, while others choose to limit the application to specific technology types or project sizes, such as is the case the with proposed FIT in BC (Mendonça, Jacobs, and Sovacool, 2010; MOEM, 2010b)

In August, 2010 the MOEM released a consultation paper to inform the public and stakeholders on the government's intention to develop a FIT program in BC. The consultation paper also provided an outline of the objectives and design considerations to elicit comment from stakeholders. The BC FIT design, as indicated by the consultation paper, would not be a general electricity procurement tool. Rather, the FIT would support emerging clean and renewable technologies at the later phases of development and commercialization (Figure 5), and existing commercial clean and renewable technologies in specified areas, such as non-integrated areas serviced by BC Hydro (MOEM, 2010b)

Figure 5. Proposed BC FIT Program's Targeted Phase of the Technology Development Continuum



(Source: MOEM, 2010b)

Other notable components that would set BC's proposed FIT apart from other jurisdictions' programs are a five MW project limit, five year contracts, no solar or wind energy, and a $25 million annual spending limit above the cost of acquiring the electricity through the SOP (MOEM, 2010b). The deadline for submitting responses on the proposed FIT was September 30th, 2010, and the MOEM was originally expected to release the final FIT Regulation in 2011, but the release has been likely been delayed due to the BC Government review of BC Hydro's proposed rate increases in April 2011(BC Hydro, 2010d).

2.4.12. Cap-and-Trade (Western Climate Initiative)

The Western Climate Initiative (WCI) was created in February 2007 by the governors of Arizona, California, New Mexico, Oregon, and Washington to reduce GHG emissions and fight climate change. The WCI's primary tool to achieve its proposed long-term GHG reductions targets is a broad based cap-and-trade system. In April 2007 BC passed the *Greenhouse Gas Reduction (Cap and Trade) Act,* which enabled the province to put legal caps on GHG emissions and join the WCI. The initiative was later joined by Ontario, Quebec, Manitoba, Utah, and Montana (WCI, 2010; MOE, nda).

The WCI has set a GHG emissions reduction target for member jurisdictions of 15% or greater below 2005 levels by 2020. The cap-and-trade system is a two-phase initiative with the first phase coming into force on January 1st, 2012 and the second in 2015. All industries either producing or selling products that emit over 25,000 metric tonnes of CO_2e annually will be required to participate in the program and comply with both GHG reporting and regulatory requirements. Phase one will cover emission from electricity (including imported quantities), industrial processes and large industrial combustion sources. Phase two will include all sources from phase one and transportation and space heating fuels (WCI, 2010a). The WCI will also recognize the use of other fiscal tools to address transportation and heating fuels such as the BC carbon tax (WCI, 2010b). Jurisdictions will be required to auction at least 10% of emissions allowances in 2012 and 20% in 2015 with the revenue from these auctions going to support other GHG emission reduction programs including the development of clean and renewable energy (WCI, 2010).

As with carbon taxes, cap-and-trade systems are not specifically tailored incentives towards the development of clean and renewable energy, but due to the high GHG intensities of many energy technologies, they do in fact provide a direct price incentive to move to lower emitting forms of energy. Domestic impact of the cap-and-trade system on clean and renewable electricity will likely be modest as electricity and heat production in the province only accounts for 2% of its total GHG emissions (EC, 2010b).

3. LITERATURE REVIEW

This literature review focuses on contextual information and an overview of available program and policy options for accelerated clean and renewable energy development as seen in the academic and professional literature. The review relies primarily on the physical collections and research databases of the University of Victoria, the databases of Statistic Canada and the International Energy Agency (IEA), news scans, Internet searches including Google Scholar, and the websites of think tanks, industry associations, not-for-profit organizations, and governments.

3.1. Review of Available Incentive Structures

There is general agreement in the energy literature that public policy has an important role to play in meeting future long-term energy challenges, and in "triggering the necessary changes to achieve societal goals" (Lund, 2007, pg 627). These societal goals also play an important role in informing the types of tools that are both appropriate and effective in achieving public policy aims. The Global Renewable Energy database of the IEA lists 37 policies and measures for the support and acceleration of clean and renewable energy development (IEA, 2011). This list represents a comprehensive collection of the general instruments available, which can generally be organized into five broad categories:

1. legislative and regulatory policies,
2. research and technology development,
3. fiscal measures,
4. information dissemination and awareness raising, and
5. other assisting or voluntary measures

(Source: Lund, 2007, p. 628)

Not all policies fit perfectly in each of these five categories individually. For example, one could argue that a Feed-in Tariff (FIT) is both a fiscal measure and technology development tool. Additionally, many policies and measures have built in elements for information dissemination and awareness-raising. These considerations aside, the following section will discuss popular and widely adopted policies and measures which primarily fall into the first three categories, and some of the successes and challenges jurisdictions have had with their use. Category four, while important generally, is not relevant to this investigation of incentives and supporting measures and is therefore not investigated in this report. Category five is less relevant to the discussion of incentives and will only be briefly covered.

It is difficult to determine the exact impact of any one policy or measure, given the presence of more than one supporting mechanism or mitigating factor. Included below is an analysis and description of the individual policies of some of the more successful jurisdictions to help determine a possible effective and efficient constellation of policies for adaptation and use elsewhere.

3.1.1. Legislative and Regulatory Policies

Legislative and regulatory policies encompass a broad category that varies from command and control-type regulations such as Renewable Portfolio Standards (RPSs), to more market-based instruments such as a carbon tax or cap-and-trade programs. All of these tools set quantity or price requirements of one form or another, whether for minimum amounts of clean and renewable generation, or maximum amounts of greenhouse gas

(GHG) emissions permitted. This section discusses RPSs, renewable and low carbon fuel standards, tradable permit systems, and carbon taxes.

Renewable Portfolio Standards

An RPS requires a minimum amount of a jurisdiction's electricity to be produced by renewable sources and has become a globally popular policy for the promotion of renewable electricity generation. Objectives for these policies are usually some combination of economic development; GHG reduction and other environmental and public health benefits; increasing energy security, reliability, and diversity (Yin and Powers, 2010; Hurlbut, 2008). The fact that RPS policies are seen to address several major policy objectives at once is seen as a major reason for the widespread proliferation of the policy (Lyon and Yin, 2010). In their review of U.S. State and Federal commitments to renewable energy, Heiman and Solomon suggest that an "RPS may be the most efficient way to secure long-term contracts essential for renewable energy development where up-front capital costs account for most of the investment, and power delivery at relatively steady prices can be assured for the project life" (Heiman and Solomon, 2004, p. 111).

Typically, an RPS policy will set a target goal for the jurisdiction and have a stepped requirement for percentages of the generation mix that must come from clean and renewable sources by specific dates. For example, in October 2008, Michigan passed an RPS whose ultimate target of ten percent is to be achieved by 2015. This RPS has intermediate requirements of two percent by 2012, 3.3 percent by 2013, and five percent by 2014 (Yin and Powers, 2010). While this type of requirement is the essence of RPS policies, the policy details can vary significantly from one jurisdiction to another (Yin and Powers, 2010). Another example is the European Union (EU) Renewable Directive, which requires the EU as a whole to have 20% of their final energy consumption come from renewable sources by 2020. This overarching percentage is broken down into specific targets for each member state, and has spawned numerous national level policies as countries attempt to comply with the directive (Toke, 2008). For instance, the United Kingdom (UK) has received a final energy requirement from the EU of 15% by 2020, which encouraged the UK to adopt a target of 30% renewable supply for electricity by 2020 (Toke, 2011).

The greatest variability in RPS design pertain to the definitions of the type of generation that qualifies, whether the jurisdiction allows for trading of permits such as renewable energy credits (RECs) or Tradable Green Certificates (TGCs) to meet the prescribed quotas, and the existence and type of punishments for utilities that fail to meet the obligations. The variation of the types of qualified generation included in the definition of 'renewable' under an RPS policy can be significant. Some jurisdictions such as California do not include technologies such as large hydroelectric, and others will only permit the inclusion of generation sources built after a specified date. Further, some jurisdictions, such as Pennsylvania, allow technologies such as coal gasification to qualify (Sovacool, 2011). These policy details are often attempting to avoid giving wind fall profits to existing suppliers of renewable energy, and encourage further development of new projects to meet the quotas. Additionally, jurisdictions may require that all or part of the new renewable generation capacity must come from sources within the jurisdiction's boundaries in an attempt to stop the leakage of economic benefits to other regions (Sovacool, 2011).

Enforcement of RPS policies is most often done through tradable permit markets (RECs in the United States (US) or TGCs in the EU) but jurisdictions sometimes use utility-specific quotas or enforced electricity purchase agreements. There may also be a penalty for utilities that fail to meet the specified renewable quota, or there may be an Alternative Compliance Payment system in place whereby there is an upfront alternative payment mechanism for utilities which do not wish to invest in additional renewable capacity (Yin and Powers, 2010). Some argue that the existence of a tradable permit market is essential for the success of RPS policies (Hurlbut, 2008). Others suggest that, depending on the goals of the program, allowing REC free-trading can significantly diminish the incentive to develop new renewable capacity within the jurisdiction (Yin and Powers, 2010).

The goals of the jurisdiction are paramount in determining the efficiency of a program or policy. If the goal is to reduce GHG emissions, there is strong evidence to suggest that a cap-and-trade program or carbon tax policy is more efficient at meeting this objective than a RPS. Additionally, an RPS is often argued to be a sub-optimal policy for encouraging technological progress (Yin and Powers, 2010).

In an attempt to fine-tune RPS policies to encourage greater technological development, some jurisdictions have instituted quotas of the RPS obligation for specific technology groups. Critics of this approach argue that policy makers should define the characteristics they are looking for from generation technologies such as electricity quality, affordability, land use characteristics, distance from load centres, or specific environmental benefits, and then leave the means of meeting those challenges up to the technology and project developers (Apt, Lave, and Pattanariyankool, 2008). Other observers argue that support should be differentiated between technology streams (Philibert, 2011). According to these observers a failure to do so would not promote the utilization of other less established renewable energy sources which would diversify the supply mix and may be necessary for a complete transition away from fossil fuel generation (Philibert, 2011). This is evidenced by the experience of Texas under its RPS policy.

Texas was one of the first states to implement an RPS policy in the US in 1999. The state's program has been seen as successful and largely responsible for the wind power boom over the past decade (Barradale, 2010). Texas has easily met its legislated targets under the RPS, and in fact surpassed its 2,000 megawatt (MW) goal in 2005—not 2009, as required (Hurlbut, 2008). One of the explanations for this success was that by forcing utilities to gain experience in generation sources like wind, the utilities discovered that it was not as expensive as previously thought, and quickly acquired additional capacity (Barradale, 2010). It is also argued that the state's non-discriminatory transmission connection policies aided this expansion (Hurlbut, 2008). As the program was undifferentiated between technology streams, and wind was currently the most economical option for the state, almost all of the additional renewable capacity was from wind installations (Hurlbut, 2008). Recognizing this dependency on wind, Texas' renewed 10,000 MW capacity target for 2025 has a 500 MW carve-out for technologies other than wind (Hurlbut, 2008). RPS policies, albeit dependent on certain policy and implementation details, appear to be effective instruments to increase the proliferation and percentage share of the most mature clean and renewable electricity technologies (Yin and Powers, 2010; Goodward et al., 2011).

Renewable and Low Carbon Fuel Standards

It is widely recognized that dedicated policies are needed for the promotion of clean and renewable energy in the transportation sector because of its complex nature and the existence of more than one market failure. Such failures include inadequate R&D and pollution externalities. Transportation is also subject to network externalities from the need for extensive coordination among vehicle manufacturers and fuel producers and distributors, as well as long time frames for the development of necessary infrastructure. Competition externalities also exist due to the lack of direct competition among fuel types, along with the market power of the incumbent oil companies and vehicle manufacturers (Yeh and Sperling, 2010). One of the most common and effective policies for promoting the production and use of renewable fuels is a quota-based policy called a Renewable Fuel Standard, which, much like an RPS for electricity, sets a percentage of a jurisdiction's fuel mix that must come from renewable sources by a specified date (Yeh and Sperling, 2010).

Numerous jurisdictions have implemented mandated targets for renewable fuels including the EU, US, and Brazil. As in Canada, individual US states or EU member states are also able to implement more stringent requirements of their own (Janauan and Ellis, 2010). Brazil's fuel ethanol program is seen as the world's most successful as the country has made significant inroads moving away from fossil transportation fuels and achieved oil independence in 2006 (Yeh and Sperling, 2010; Sorda, Banse, Kemfert, 2010). The roots of this success date back to the oil crisis of the 1970's when Brazil initiated the National Alcohol Program. "The objective was to limit energy supply constraints, provide a stable internal demand for the excess production of sugar cane and counter weight variations in international sugar prices" (Sorda, Banse, and Kemfert, 2010, p. 6981). Perhaps the most striking evidence of Brazil's success is the fact that its fuel ethanol is price competitive with oil when sold at $30 per barrel. While this transformation was informed by other policies such as dedicated R&D funding and taxation incentives, quantity mandates played a pivotal role (Sorda, Banse, Kemfert, 2010).

Despite possible difficulties with transference of lessons between jurisdictions, renewable fuel standards are seen as essential policy tools to create the demand needed for the establishment of alternative fuel industries (Januan and Ellis, 2010). In the US, the Renewable Fuel Standard (along with concurrent subsidies) has directly influenced corn ethanol production, which has increased more than eightfold between 2000 and 2010, from 6.17 billion litres to 50.08 billion litres with the number of active ethanol plants in the US increasing fourfold to 204 over the same period (Yeh and Sperling, 2010; Renewable Fuels Association, 2011a). The revamped US Renewable Fuel Standard established by the 2007 *Energy Independence and Security Act* requires the use of over 136 billion litres of biofuels by 2022, effectively raising the demand for alternative fuel sources (Yeh and Sterling, 2010).

Renewable fuel standards are implemented to meet a number of different policy goals, but chief among these is energy security and climate change. Concern has been raised over the relative life-cycle greenhouse gas (GHG) footprint of such fuels. The life-cycle GHG footprint of a fuel is the total amount of emissions released in the extraction, refining, transport, and consumption of the fuel. Depending on specific circumstances, alternative fuels may have higher overall GHG footprints than gasoline and diesel. This is the case with electricity generated from coal and with biofuels that demonstrate significant land use impacts, both direct and indirect (Yeh and Sperling, 2010, p. 6957). In light of such considerations, California was the first jurisdiction to build life-cycle GHG requirements into the state's renewable fuels standard. This move was quickly followed by other jurisdictions, such as the US Federal government and the EU. BC's low carbon fuel standard (LCFS) was designed after the California model and also includes life-cycle GHG targets (S&T^2 and Cheminfo, 2011).

Mandating lifecycle requirements for the fuels drives innovation and GHG reductions in the fuel supply chain. California's standard was technology agnostic, meaning that the standard identified requirements that were applied consistently across technology types, which allowed consumers to comply in the manner they chose (Yeh and Sperling, 2010). This is one of the key differences between renewable versus low carbon fuel standards. Renewable fuel standards require certain blending requirements for biofuels, whereas low carbon fuel standards allow for more flexibility for how industry can meet the new standards. LCFSs are seen as one of the more robust policies that might be pursued to ensure emissions reduction from the transportation sector (Sorda, Banse, and Kemfert, 2010).

That said, the impact of LCFSs may be mitigated. As Yeh and Sperling point out, ”because transport fuels are internationally traded commodities, leakage and shuffling are inherent problems with any climate policy that targets energy” (2010, p. 6961). Due to the increased focus on lifecycle GHG emissions, policies have now also started to take into account direct and indirect land use changes associated with fuel production. These concerns primarily stem from the fact that the initial conversion of land to agriculture results in a huge carbon debt that can take decades to eliminate, and concerns over linking food prices more closely with the energy market. For example, in the EU it is required that “[n]o bio-feedstock shall originate from primary forests, highly bio-diverse grassland, protected territories and carbon-rich areas” (Sorda, Banse, and Kemfert, 2010, p. 6982). Similarly, the US requires that all bio-feedstocks must come from land that was in production before December 17, 2007 (S&T^2 and Cheminfo, 2011). Further, the US Environmental Protection Agency disqualifies batches of fuels if the entire feedstock is not verified to come from certified renewable sources. This last requirement has essentially halted exports of canola seeds and canola oil for biodiesel production, and corn ethanol from Canada to the US (S&T^2 and Cheminfo, 2011).

Some observers argue that the inclusion of direct and indirect land use changes into lifecycle GHG calculations will further encouraged the development of second generation biofuels from organic waste, cellulosic energy crops, crop residues, and forest wastes (Yeh and Sperling, 2010). Fuels produced from second generation feedstock also use less land than dedicated crops, require fewer agricultural inputs, have higher yields per area of land, “and cause less soil erosion and loss of biodiversity” (Yeh and Sperling, 2011, p. 6962).

Tradable Permit Systems

The creation of transferable property rights has long been argued to be one of the most efficient and effective ways to correct for the negative externalities associated with various types of pollution and lack of investment in socially advantageous activities (Yeh and Sperling, 2010). Under tradable permit schemes the government can set the optimum amount of pollution permitted or the minimum amount of an activity desired, and then the market sets the price of the permits based on supply and demand. Tradable permit schemes have been implemented in a variety of ways that support the development of new clean and renewable energy. The two most widely discussed systems are cap-and-trade systems to control the quantity of GHG emissions produced and the certificate trading schemes associated with RPS requirements.

Cap-and-Trade

Cap-and-trade systems create a market for pollution. In the case of climate change policies, a total allowable quantity of GHGs (generally described in carbon dioxide equivalent (CO_2eq)) is established by a jurisdiction (or multiple jurisdictions depending on the nature of the program), and is divided into specific quantities of emission allowances. These allowances are either auctioned or allocated to the regulated industries included under the system. Cap-and-trade systems are designed to give emitters the flexibility to reduce the GHG emissions in the most economically viable way by either implementing specific reduction technologies and changes in practice or by purchasing excess emission allowances from other participants. In this way, emissions allowances are treated as commodities whose prices are set by market forces. Emissions allowances are decreased over time to spur innovation and meet longer-term emission reduction targets (WCI, 2009; WCI 2010a).

Programs that target a reduction in GHG emissions will also generally have a stimulatory effect on clean and renewable energy development (Yin and Powers, 2010). When first initiating a cap-and-trade scheme, a government has a choice to either provide emission permits through a bidding process, or allocate permits to current emitters. Due to the initial cost to polluters of a bidding process, this strategy is often viewed as politically unpopular and is difficult to implement in practice. For example, under the EU Emissions Trading Scheme permits were allocated to incumbent emitters for no charge, based on past emissions. Since emissions had not been historically monitored emitters were provided a incentive to emit more heavily during the early years of the program to receive a higher allocation (Sovacool, 2011). Additionally, EU "regulators compromised on a five-year commitment period therefore providing little incentive for long-term low-carbon investments (such as buildings or power plants) spanning more than the five-year window" (Sovacool, 2011, p. 581).

One of the difficulties experienced by cap-and-trade schemes is the potential for volatility of the price of permits (Sovacool, 2011; Yin and Powers, 2010; Campoccia, Dusonchet, Telaretti, and Zizzo, 2009). This is exemplified by the EU Emissions Trading Scheme where permit prices were seen to fluctuate between a peak of €30 per ton in April 2006 to near collapse of €0.10 per ton in September 2007 (Andrew, 2008). This volatility in turn contributed to household electricity and general industrial product prices rising by 5% and 16% respectively when averaged across Europe (Sovacool, 2011). While some of this volatility in the case of the EU Emissions Trading Scheme could be blamed on the program design compromises made in the face of political pressure, price uncertainty is still likely to be an issue with well designed schemes as the price is still subject to market forces and the human behaviour "wild card" (Sovacool, 2011, p. 583). The uncertainty created by the EU Emissions Trading Scheme made market actors' carbon abatement decisions difficult as they weighed the costs of investing in projects to diminish their emissions versus purchasing permits with an uncertain future value, thus diverting needed investment in clean and renewable energy (Sovacool, 2011).

Another problem with cap-and-trade schemes is that their effectiveness has a tendency to be diminished by technological and geographical leakage. For example, several large electricity companies in Europe withheld carbon credits from the market to raise their value, which created profits of $112 billion that were largely directed back into coal and natural gas power plants outside the boundaries of the scheme. In addition, there is always the risk that energy intensive industries such as chemical firms will relocate to jurisdictions outside of the borders of any cap-and-trade zone. This highlights the difficulties of meeting the goals of a cap-and-trade system if it is implemented over a limited geographic area, even if this area is most of Europe. In addition, this example demonstrates the capacity of larger, well-financed incumbent companies to use their market power to exploit the process to their own ends (Sovacool, 2011).

Transaction costs are another issue with cap-and-trade systems. To participate in the market a company must dedicate some of its resources to buying and selling permits. While this is less of a problem for large companies and utilities, small-scale operations suffer under cap-and-trade schemes due to a general inability to properly resource their permit trading activities (Sovacool, 2011)

Cap-and-trade systems do have the benefit of demonstrating high-level political commitment to the idea of emissions pricing and addressing climate change, but any certainty provided by such a commitment is severely diminished by issues such as permit price volatility. Even if cap-and-trade schemes were not subject to these limitations, it would be unlikely the single policy of choice to accelerate the development of clean and renewable energy projects and technologies. The presence of multiple market failures in the provision of investment for clean and renewable energy projects and technologies requires a coordinated and multi-faceted policy approach (Philibert, 2011; Shum and Watanabe, 2010). These market failures are exacerbated in the transportation sector due to the high levels of technological lock-in. It was estimated that the US's 2009 proposed Waxman-Markey Bill to establish a federal cap-and-trade system would raise gasoline prices by $0.81 per gallon by 2050 (Yeh and Sperling, 2010). Such a price increase is not likely to induce significant change either in the supply of low-GHG alternative fuels or consumer demand for them (Yeh and Sperling, 2010, p. 6956). Internalizing the GHG emissions externality of fossil fuels is one way which governments can support the development of clean and renewable energy, but the speed of this transition will also be heavily impacted by other market failures that are outside of the climate equation (Philibert, 2011; Shum and Watanabe, 2010).

Renewable Energy Certificates and Tradable Green Certificates

Tradable markets are also used in conjunction with RPS policies for electricity generation. The market acts as way to verify that quotas under the RPS are being met. Many US states use a system of RECs, while much of Europe uses TGCs to track compliance with their varied RPS policies. This discussion primarily focuses on RECs, but the concepts are generally consistent with TGC programs. Each REC is equivalent to one MW.h, and typically companies must have a sufficient balance of RECs to meet their requirements under the RPS, lest they face financial penalties (Sovacool, 2011). Some markets allow for an unbundling of the electricity from RECs so that electricity suppliers can meet their RPS obligations without having to physically purchase the associated electricity from that certificate. The premise is that, due to the required quota of energy from renewable sources under an RPS, RECs hold a value in addition to the levelized electricity cost, and can therefore support clean and renewable energy projects.

Texas was the first state to implement an REC market, but was followed quickly by numerous other states including New England, Washington, Oregon, California, and Hawaii (Yin and Powers, 2010; Sovacool, 2011). Due to political lobbying and varying policy goals, each state has different policies for eligibility under the RPS and for governing the REC trading itself (Sovacool, 2011). In many cases these differences reflect the diverse goals that the various jurisdictions try to meet through their RPS and REC policies. For example, in an effort to try to encourage in-state development of renewable energy resources, some states, such as California and Hawaii, do not allow out of state trading of RECs. Others will allow out of state trading but further encourage in-state development by putting restrictive conditions on out of state electricity. For example, Arizona provides one and a half RECs for in state supply. Still others allow complete free trade of RECs (Yin and Powers, 2010). The

UK differentiated its allocations by technology stream under its similar Renewable Obligation Certificates system. The UK offers two certificates for electricity produced using off-shore wind and the standard one for energy produced using on-shore wind and other more established technologies (Toke, 2011). Other common differences include variations in the expiry date of the REC and of the technologies eligible to generate the certified electricity. For instance, some US states allow the certificates to be traded for up to three years after production, and Pennsylvania includes non-renewable distributed generation and coal gasification under the state's RPS requirements (Sovacool, 2011).

The complexity of the various requirements and differing definitions has created prohibitive administrative requirements and transaction costs for market participants. This has made it extremely difficult for small and medium sized operations to participate in the market shifting market power towards incumbent producers (Sovacool, 2011). All of these issues have contributed to the problem of price uncertainty and volatility in REC markets, which exposes investors to risk (Campoccia et al., 2009; Yin and Powers, 2010; Wong, Bhattacharya, and Fuller 2010; Sovacool, 2011). "Such volatility of REC prices has limited investment capital available for new renewable energy projects, and the wild fluctuation of REC prices have been a significant deterrent to renewable energy investment" (Sovacool, 2011, p. 579). Additionally, some observers have noted that REC systems do not seem to encourage investment in innovation, but rather into incumbent technologies (Wong, Bhattacharya, and Fuller 2010).

Despite much support for tradable permit schemes as an efficient means of meeting a broad range of public goals (Heiman and Solomon, 2004; Tamas, Shrestha, and Zhou, 2010), there is growing criticism regarding issues that have been observed in various recently created markets. Political and human complications make permit markets incredibly complex and will also often constrain the efficiency of such markets. Transaction costs and the tendency for the existence of information asymmetries and information lags also impact the efficiency of tradable permit markets (Sovacool, 2011).

> Consequently, one should be wary about endorsing tradable permits as a panacea. The presence of transaction costs reminds us that tradable permits may be a favored mechanism precisely because they enable people and firms to make more money, not accomplish public policy goals. Tradable permits may have benefits over other forms of regulation and government intervention, but they can also be effective tools at giving the appearance of market efficiency all the while concentrating market power and conveying rents to a select number of firms and groups, often contrary to the greater public good.
>
> (Sovacool, 2011, p. 583)

Carbon Taxes

Carbon Taxes are examples of a classic Pigouvian tax, which seeks to internalize the externalities of a given action. This is done to prevent private actors from shifting the costs of their actions onto the public (Sovacool, 2008; Hammar and Sjöström, 2011). In this way, carbon taxes attempt to make firms and individuals internalize part, if not all, of the costs of their actions that result in the release of GHG emissions. Despite the theoretical appeal and simplicity of the carbon tax, only 22 jurisdictions worldwide have implemented or are currently considering its implementation.

The three main design decisions that need to be made when establishing a carbon tax are coverage, the tax rate itself, and what is to be done with the revenues. These features are intimately related. Jurisdictions are generally concerned about causing a dampening of economic activity in energy intensive industries, as this will often have little political appeal and can damage the local economy (Fischer and Newell, 2008). Shuffling of industries to locations outside the boundaries of the carbon tax is also a concern. To combat these potential issues, jurisdictions have generally implemented carbon taxes with an increasing rate over time to give industries time to adapt, and have provided exemptions or lower tax rates for important industries. In addition, it is widely viewed as more politically credible to recycle the revenue generated via tax breaks and credits (Heiman and Solomon, 2004). Alternatively, the revenues could be used to fund other emissions reduction strategies such as investments in public transit and clean and renewable energy projects, or jurisdictions could add the revenues collected to their general revenues.

An often discussed example of a successful carbon tax regime is that of Sweden. Implemented in 1991 at a rate of approximately US$ 36 per tonne of CO_2, the tax has increased over time and currently sits at approximately US$ 150 per tonne of CO_2 (Jamet, 2011). While this represents the highest carbon tax in the world, Sweden has exempted all non-fossil derived forms of energy from the tax, and also applies a 50% lower rate for industry, agriculture, forestry, and aquaculture (Jamet, 2011; Hammar and Sjöström, 2011). As of 2009, Sweden's GHG emissions were 17% lower than 1990 levels, and gross domestic product (GDP) grew by over 50% in this same time period (Swedish Environmental Protection Agency, 2011; World Bank, 2011). Revenues generated by the tax go into the general revenues and form approximately 1.8% of the country's entire tax revenue (Hammar and Sjöström, 2011).

Carbon tax regimes have several advantages when compared to other policy options, such as cap-and-trade programs. The first and potentially most significant is that carbon taxes provide far greater price certainty than cap-and-trade programs where the credit prices are often subject to significant volatility (Sovacool, 2011). Price certainty is of significance with regards to discussions of energy investment and technology development as these activities require substantial upfront costs and generally have long pay back periods (Nemet, 2010). Carbon taxes suffer from credibility problems, as there is no guarantee that a carbon tax will be politically desirable or needed once certain reduction targets have been met at some future date (Fischer and Newell, 2008). This will likely be an issue with most policy options, which highlights the importance of broad political and public support surrounding long-term issues such as climate change and energy (Fischer and Newell, 2008).

Second, carbon taxes "avoid the need to continually certify credits, monitor trades, and broker transactions between sellers and buyers, elements that add to transaction costs" (Sovacool, 2011, p. 583). This allows all sizes of actors to benefit from the policy without the need to dedicate additional resources to market monitoring and the trading of certificates, which is good for competition. Additionally, as opposed to other forms of taxation like a value added tax on the final product or a tax on energy use, carbon taxes allow for the greatest possible options for substitution. This drives efficient emissions reduction as consumers and businesses signal their preferences through market choices (Edenhofer et al. 2010).

A key criticism that observers level against carbon taxes is the inability to determine the exact quantity of GHG emissions reduction enabled by a specific tax level (Mitchell, 2008). This has been cited as the main determinant in jurisdictions opting to go with an Emissions

Trading Scheme rather than a carbon tax. Mitchell links the root of this problem with a concern that, as energy demand is seen as relatively inelastic, energy companies will simply pass on the cost of a carbon tax to the consumer without actually reducing their emissions (2008). In effect, the government would have raised energy costs for citizens without accomplishing any significant reduction in emissions. In practice, this criticism is seen to be only partly credible. For example, Sweden's carbon tax established in 1991 has significantly reduced the amount of emissions from all applicable sectors except transportation, where GHG emissions have grown by 12.6% from 18.3 to 20.6 million tonnes between 1990 and 2007. While this is still growth in emissions, it was at a much slower rate than most other jurisdictions, which suggests that high carbon taxes do have some positive effects on emissions in the transportation sector. For instance, the average growth in GHG emissions for the rest of the EU member states was 25.9% over this same period (Hammar and Sjöström, 2011).

These results point to the fact that, while carbon taxes may be able to address emissions in certain sectors, the additional locked-in aspects in areas such as the transportation sector create significantly higher inelasticity of demand for certain types of energy use (Yeh and Sperling, 2010). Some observers argue that a carbon tax that gives preferential treatment to alternative fuels would be an effective way to catalyze the development of a biofuels industry for transportation (Janaun and Ellis, 2010). As the Swedish carbon tax already exempts non-fossil derived energy including alternative transportation fuels, it suggests that further supporting measures are necessary in the transportation sector (Hammar and Sjöström, 2011).

Carbon taxes do not sufficiently address the other energy market failures related to the nature of knowledge (Edenhofer, Pietzcker, Kalkuhl, and Kriegler, 2010; Fischer and Newell, 2008). This is evident in areas such as private R&D investment. Knowledge is often spread through informal and formal means, and firms often benefit from, and copy advancements in, established production processes. Individual companies will therefore invest less in R&D than is socially optimal as society in general benefits more from a firm's investment than the firm does (Edenhofer et al. 2010).

In addition, other knowledge spillover effects such as learning by doing exist. It has been shown that critical learning occurs once a technology is exposed to the market. Learning by doing is evidenced by the concept known as the progress ratio, "defined as the reduction of cost as a consequence of the doubling of cumulative installed technology" (Philibert, 2011p. 12). This has been seen in the wind and photovoltaic sectors over the past several decades (Edenhorf et al., 2010; Philibert, 2011). Some argue that these externalities could be dealt with under a sufficiently high carbon tax, but numerous analyses point to the fact that renewable energy use would be far below optimum without accompanying policies such as other subsidies (Edenhorf et al. 2011). There is also a question as to whether such a high carbon tax could be realistically implemented (Heiman and Solomon, 2004).

While carbon taxes do drive efficient short-term reductions in emissions, by failing to sufficiently incentivize learning and innovation, the policy does not capitalize on future economic and emissions reductions opportunities. Investing in clean and renewable energy in the short-term can be seen as an expensive GHG emissions abatement strategy, but, when a technology reaches market competitiveness, the marginal cost of additional abatement essentially becomes zero (Philibert, 2011). For these reasons an "optimal portfolio of policies can achieve emissions reductions at a significantly lower cost than any single policy, although the emissions reductions continue to be attributed primarily with the emissions price" (Fischer and Newell, 2008, p. 144).

3.1.2. Research and Technology Development

R&D of clean and renewable energy technologies is seen as an essential component of any long-term sustainable energy transition (Philibert, 2011). As previously mentioned, this report does not explore early R&D support programs, which in Canada often involves funding sources such as National Research Council grants. Instead the discussion is limited to incentives and supporting measures directed at applied R&D as it occurs in the pilot (or development) stage of innovation and later. This section, while generally dedicated to R&D, will also include a discussion of innovation more broadly.

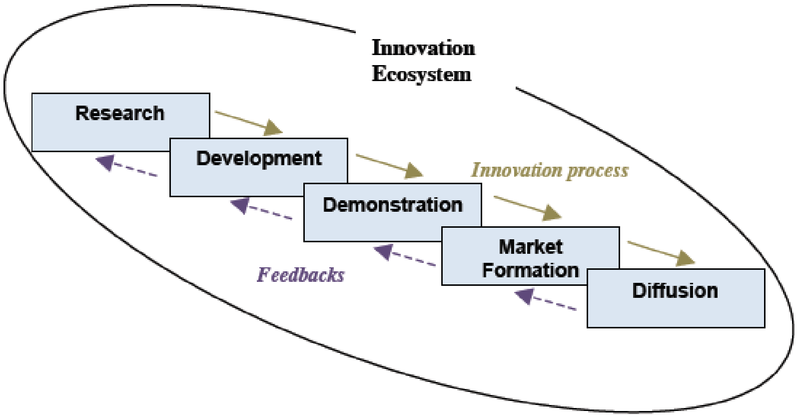
To meet the energy challenges of this century, the IEA has long called for a significant increase in research, development, and demonstration (RD&D) of clean and renewable energy technologies (Kerr, 2010). Of IEA member nations, RD&D spending has been increasing steadily since 1997, but due to large declines in these budgets in the 1980's and 1990's, actual RD&D amounts are only slightly above what they were in 1976. Energy related RD&D has also been declining as a percentage of total RD&D spending from 12% in 1981 to 4% in 2008 (Kerr, 2010). As discussed in the sections on carbon taxes and cap-and-trade systems, correcting for externalities surrounding the use of more conventional energy sources does provide some incentive for innovation of new clean and renewable energy technologies. However, due to the other externalities associated with nature of knowledge creation, investment in RD&D will remain below the optimal social level. This is particularly true of energy technologies where investment risks can be substantial for individual businesses due to large capital requirements, long deployment time frames, and regulatory uncertainties. The recent 2008 financial crisis has also seen a shift of RD&D investment towards more short-term low risk innovations. Additionally, frequently changing the policy support mechanisms for clean and renewable energy technologies raises investor risk and emphasizes the need to take steps to ensure policy stability and predictability (Kerr, 2010).

Linear Versus Iterative Innovation Models

Perspectives on how innovations actually occur have implications for how policies and programs are constructed. Innovation is often represented in the literature as a linear process with predictable stages, such as demonstration or market formation. This model can be useful for conceptual purposes as well as for analyzing where government investments typically occur as there is a growing understanding that funding approaches to new technologies need to be tailored to the specific stage of technology development (Kerr, 2010).

Numerous observers have noted though that the linear model does not capture how innovation occurs in practice, however (Mitchell, 2008; Philibert, 2011). In fact, even with a clear and relatively straightforward goal, innovation processes can be highly unpredictable (Klemperer, 2010). In place of the linear process model, Tawney et al. propose an Iterative Innovation Process model shown in Figure 6 below. This concept has recently gained traction and is suggested to more accurately represent how innovation actually occurs (Philibert, 2011).

Figure 6. The Iterative Innovation Process



(Source: Tawney et al., 2011)

The Iterative Innovation Process captures the linkages between the various different stages of technology development and the need for feedback between stages to more fully capture the learning from advanced stages.

Grants

While it is recognized that grants have an important role to play in early stage R&D, they can also be important sources of funds for later R&D efforts, and even for the demonstration stage (Goodward et al. 2011). Technologies at the demonstration stage often face the funding "valley of death" where even successfully piloted technologies have a hard time attracting commercial investment due to high costs and performance uncertainties (Goodward et al. 2011, p. 3; OECD, 2011, p. 57).

Successful grant programs have particular features in common. These include an open and competitive public application process, low costs for applications to encourage small projects to apply, and short, transparent, and predictable application turnaround times. For example, the Massachusetts Commonwealth renewable energy grant program conducts regular outreach, timelines are communicated upfront and can be as short as two to three months, and has simple and clear procedures (Goodward, et al., 2011).

Arms Length and Private-Public Institutions

An important consideration for technology funding models is also the placement and organization of the institution that is making the funding decisions. Programs that reside inside a government department may be criticized due to perceived political influence over the funding process and decisions. Concerns over the programs' continued existence with changing budgetary realities can also create uncertainty (Dinica, 2006). This increases investor risk and may reduce the number of applicants if concerns over selection bias are particularly acute. One potential solution to this issue is to administer the funding programs though an arms length or mixed public-private institution (Kerr, 2010).

The Canadian federal government uses the arms-length organization Sustainable Development Technology Canada (SDTC), which administers funding to, among other things, clean and renewable energy technologies. SDTC conducts regular request for proposal (RFP) processes, which have predictable timelines, incorporate peer review of proposals, and particularly target pilot and demonstration scale projects to support movement to commercialization. Another example is the new UK Green Investment Bank, which is tasked with leveraging private sector investment through green bond offerings, providing equity co-investment, and insurance products. The US government is currently considering the creation of a Clean Energy Deployment Administration to perform similar functions (Jenkins and Mansur, 2011; Kerr, 2010).

A key feature of these types of organizations is an increased ability to offer coherence to funding decisions that have traditionally been undertaken by disparate or loosely connected government departments or agencies (Kerr, 2010). A centrally placed organization is able to better keep track of the projects that have been successful and those that have had challenges. In addition, such an organization can provide a valuable function as a repository of past learning from projects, and a network to disseminate that information to project and technology developers. This leads to more efficient project funding decisions, as there would be less overlap for funding of technologies that have been shown to be unsuccessful (IEA, 2010).

It is also suggested that an organization of this kind would be able to better keep track of reasons why a project or technology has failed, determine new areas for investment to address those issues, and when it may be time to try investments in a particular idea again. For example, some technologies fail, not because the technology itself is unviable, but because a component technology on which this other technology relies upon is either underdeveloped or is currently uneconomical. Subsequent development in the component technology could therefore make new projects involving the larger technology system more appropriate and successful. In addition, the organization would be well placed to coordinate a technologies exit route, where public support is decreased as a technology becomes competitive or if it becomes apparent that it is doubtful to do so (IEA, 2010).

3.1.3. Fiscal Measures

Due to the high up-front costs and long time frames for returns on investment, one of the most difficult but important tasks for energy project developers is securing long-term financing. As such, many jurisdictions use financial instruments such as bonds to accelerate the development of clean and renewable energy projects and technologies. This section will discuss green bonds, tax credits, feed-in tariffs, and loan guarantees.

Green Bonds

Observers note that, while public investment in the area of clean and renewable development will undoubtedly be important, private financing will need to be mobilized in order to reach the scale of investment required for the energy system transformation needed (Mathews, Kidney, Mallon, and Hughes, 2010; Reichelt, 2010). The last decade has seen a rise in the number of investors who are incorporating environmental, social, and governance considerations into their investment decisions (Reichelt, 2010). Most of this investment has been concentrated in equity, which tends to be small. “Private equity allows investors to target ‘green’ investments like renewable energy more directly, but it also lacks liquidity and requires significant up-front due diligence costs” (Reichelt, 2010, p. 2). While equity markets will likely be an important source of funds for energy projects, accessing these funds can often be difficult under favourable circumstance let alone in times of fiscal restraint like today (Reichelt, 2010; OECD, 2011).

To mobilize the larger sums of money required, observers argue that investment products should be tailored to appeal to large scale investors such as pension funds, asset managers, sovereign wealth funds, and endowments (Reichelt, 2010; OECD, 2011). For example, pension funds alone have an estimated USD 28 trillion in assets (OECD, 2011). It is argued that to appeal to this category of investors it is important to offer a fixed income product, such as bonds. While these investors have been "increasing allocations to alternative asset classes", significant portions of their portfolios are still in fixed income investments (Reichelt, 2010, p. 2). Other important characteristics include standardized criteria for project eligibility, financial characteristics such as size, rating, and structure, designing products to provide liquidity, match risk/return characteristic of particular investors, offer portfolio diversification, and "transparent policies based on long-term, comprehensive and ambitious political commitment" (Reichelt, 2010; OECD, 2011, p. 71).

There have been a number of different products released in the past few years such as the World Bank's 'cool-bonds', 'eco-notes', and later 'green-bonds' that have demonstrated investors' increasing interest in targeted climate related bond issuances (Reichelt, 2010). In the 2009 US stimulus package the US Government issued US$ 2.2 billion in Clean Renewable Energy Bonds. In this case the interest payments were paid in the form of a tax credit to bondholders (Mathews et al., 2010). With the exception of the Clean Renewable Energy Bonds, most green bond offerings do not limit the scope of eligible projects to just energy development, but also target other climate change related areas such as energy efficiency projects. By 2012, all global green bond issuances total approximately US$ 11 billion. This represents a small fraction of the global bond market, which is estimated to be worth US$ 91 trillion (OECD, 2011). A scaling up of this market share is thought to be possible but would require developing further products with the above-mentioned characteristics, in particular, long-term political commitment (OECD, 2011). The recent announcement of the UK Government to establish a Green Investment Bank was seen as a step in the right direction by the OECD, but the bank is not expected to start issuing bonds until 2015 (OECD, 2011). In a time where global financial markets are looking for safe havens for their capital, it is suggested that tipple-A rated fixed income bond offerings would be attractive to both individual and institutional investors (OECD, 2011; Reichelt, 2010).

Tax Credits

Tax credits have been the primary tool of the US federal government to encourage the deployment of renewable energy technologies and the US tools are illustrative of tax measures generally. These credits have come in three main forms: the production tax credit (PTC), the investment tax credit (ITC), and volumetric biofuel tax credits (Sorda, Banse, Kemfert, 2010; Goodward, Perera, Bianco, and Heshmatpour, 2011; US Department of Energy (DOE), 2011a; US DOE, 2011b).

Created under the *Energy Policy Act* of 1992, the PTC is exclusively for the production of electricity resources and currently provides an income tax credit for the first ten years of a project's life of 2.2 US cents per kW.h for wind, geothermal, and closed loop biomass, and a credit of 1.1 US cents per kW.h for most other clean and renewable technologies (Barradale, 2010, US DOE, 2011c). This incentive measure is seen to be most effective for projects that have lower upfront costs and predictable energy output over the project's lifetime (Goodward et al., 2011).

The ITC has worked best for projects with high upfront investment costs and has also been able to apply more broadly than energy production infrastructure as certain manufacturing investments for renewable energy systems can also be eligible (Goodward et al., 2011). In addition, there have been a number of different iterations of the ITC, which apply to different scales (e.g. residential versus industrial) of renewable energy systems (US DOE, 2011d; US DOE, 2011e). The ITC has generally been for up to 30% of the total cost of the investment with maximum credit amounts capped but which vary by project and technology type.

One issue with the PTC and ITC is that, in order to take full advantage of the tax credit, one must have sufficient tax obligations, which is often not the case for developers in the early stages of a project. To address this issue the policies were modified to allow for the developer to be able to allocate the tax credits to investors with sufficient "tax appetite" that have taken an equity stake in the project (Goodward et al., 2011, p. 5). It is also suggested, however, that this approach "ultimately pins the success of the renewable energy industry on the tax appetite of external investors" (Goodward et al., 2011, p. 5).

Tax incentives have also been widely used in the US to encourage the development of biofuels. The Volumetric Ethanol Exercise Tax Credit (VEETC), along with quota obligations discussed above, has been credited with part responsibility for the explosion of ethanol production in the US over the past decade (Sorda, Banse, Kemfert, 2010; Renewable Fuels Association, 2011b). The VEETC provides fuel blenders a credit of 45 cents per gallon of fuel produced with no limitation on quantity (Sorda, Banse, Kemfert, 2010; US DOE, 2011b). In addition, to encourage the production of second-generation biofuels, the Cellulosic Biofuel Producer Tax Credit (CBPTC) was introduced and offers producers a tax credit against their income liability of up to US $1.01 per gallon (US DOE, 2011a). Similar tax credit incentives also exist for biodiesel (Sorda, Banse, Kemfert, 2010; US DOE, 2011a).

A key criticism of many tax credit policies is that there is a "tendency for these incentives to be short-term in life, small in scale, and low in dollar value but complex in implementation and use" (Garciano, 2011, p. 12). Within this list of issues, the volatility created by the uncertainty regarding the renewal of incentive regimes was seen to be particularly pernicious (Barradale, 2010). The US programs are due to expire sometime between the end of 2011 and 2013. While periodic reviews of incentives are important to ensure policy efficiency and avoid wind fall profits to more established technologies, it also creates greater uncertainty for investors and decreases long-term investment in other clean and renewable energy areas (Barradale, 2010). For example, the PTC was originally set to expire in June 1999 and has since been repeatedly renewed for one or two years at a time with the most recent renewal of three years occurring in February 2009 as part of the *American Recovery and Reinvestment Act*. The policy is once again set to expire for most technology types at the end of 2012 (Barradale, 2010; US DOE, 2011). The effect of this uncertainty can be observed in the US wind power industry where the amount of capacity added in the year preceding a program renewal decision was significantly reduced (Barradale, 2010; Goodward et al., 2011). The volatility was shown to have other harmful impacts on the wind industry such as "higher wind supply costs; greater reliance on foreign manufacturing; difficulty in rational planning of transmission expansion; and reduced private R&D expenditure" (Barradale, 2010, p. 7700).

The experience of each industry is likely to be somewhat unique, but the volatility of these programs has undoubtedly had similar negative impacts on investment decisions in other areas (Barradale, 2010). In addition, downturns in investment around program renewal years could also be mistaken to reflect the underlying unfavourable economics of a renewable energy technology, which would further discourage investment. "This impression matters most when the industry is in early stages of development, but continues as the industry matures” (Barradale, 2010, p. 7709).

In a review of tax incentives for renewable electricity production in EU member states, it was found that jurisdictions that had some form of tax incentives to complement other measures, such as quantity instruments, added more capacity than those that did not (Cansion, Pablo-Romero, Roman, and Yniquez, 2010). Tax credits may also not be appropriate for technologies at all stages of development. Goodward et al. found that tax credits are “most effective at promoting renewable technologies that are in the commercialization or early deployment stages” (2011, p. 6). For example, tax incentives were seen to be less effective than loan guarantees for technologies at the demonstration phase, “as the high perception of risk in this stage makes it difficult for project developers to access the needed capital” (Goodward et al., 2011, p. 6).

Feed-In Tariff

The Feed-In-Tariff (FIT) is discussed as one of the main policies available to jurisdictions to drive the development of clean and renewable electricity options (Mitchell, 2008). Observers generally point to Denmark and Germany as clear examples of successful FIT policies that have resulted in the deployment of significant clean and renewable energy capacity and technological innovation. However, results have also been mixed from other jurisdictions, such as in Spain (OECD, 2011; Goodward et al., 2011).

FITs are generally accepted to be the quintessential “market-pull” policy for electricity technologies. Exposure to market forces is seen as an essential step in the commercialization of technologies, as it encourages the process of learning-by-doing and subsequent price reductions associated with the progress ratio (Goodward et al., 2011; Philibert, 2011). While the progress ratio varies from one technology to another, it has been shown to be generally constant for individual technologies. The constant nature of the progress ratio means that learning-by-doing occurs more quickly for new commercial technologies than for established ones (Goodward et al., 2011; Philibert, 2011). Deployment to the market is an important source of information on the relative strength and weaknesses of a new technology and informs the direction of future targeted R&D efforts. Additionally, the prospect of market success is a vital stimulant of industry R&D spending. “Market development and technology development go hand in hand” (Philibert, 2011, p. 12).

A FIT is a subsidized rate, or tariff, paid for qualified electricity supplied to the grid. Important considerations when designing a FIT are which technologies and project sizes are eligible, the calculation of the tariff applied, the duration of the tariff, and the financing source for the tariff. Observers generally argue for a wide range of eligible projects and technologies with a tariff rate differentiated for each technology stream and various project sizes (Mendonça, Jacobs, and Sovacool, 2010). A flat tariff rate is another possibility, but this is criticized as not providing a sufficient incentive to technologies at different stages of maturity. FITs are generally seen to be useful for technologies that are at the commercialization and early deployment stages of development, as the technologies in these stages are technically proven but still have higher costs and potentially higher development risks (Goodward et al., 2011). Therefore, it is important to exclude technologies that are in earlier stages of development, as at these stages it is difficult to determine an appropriate level of support and there may still be significant performance uncertainties, which increases the risk of the policy (Goodward et al., 2011; OECD, 2011).

The calculation of the tariff rates for each technology is likely the most important decision in the development of a FIT. In Germany, the Federal Ministry of Environment (BMU) commissions a number of independent reviews of generation costs for all technologies every four years. The BMU then uses this information to set the tariff rate, and then generally applies an 8% interest rate on the capital invested (Mendonça, Jacobs, and Sovacool, 2010). These reports also help when making adjustments to the FIT under the periodic review, ensuring the rates are appropriately set. There are, of course, many other options for calculating the rate. For example, Denmark uses a competitive auction procedure for projects to help determine the tariff rate and France developed an equation using the average weighted cost of capital (Mendonça, Jacobs, and Sovacool, 2010; Toke, 2011).

Ultimately, it is important to set the rate high enough to ensure a reasonable rate of return for investors but not too high as to provide windfall profits and risk making the policy too expensive. Spain provides an example of what can happen when tariff rates are not established carefully. In 2007 Spain offered a tariff similar to Germany of €0.44 per kW.h for new solar installations and had an "overwhelming response" (Goodward et al., 2011, p. 8). Spain's Government had not taken into account the different solar radiation levels in Spain compared to Germany, which made the same rate far more attractive in the former than the latter. The Spanish Government retroactively repealed the standard offer to avoid paying the estimated €26 billion in subsidies over the life of the new solar plants (Goodward et al., 2011; OECD, 2011).

The most common source of revenue that jurisdictions have used for their FIT programs is through the electricity rates themselves. Proponents of this method argue that this allows for the large quantities of funds to be raised by only slightly raising the cost of electricity to the consumer and that this rate increase will further support demand side management initiatives (Mendonça, Jacobs, and Sovacool, 2010). For example, the German FIT has been funded through an electricity rate increase of approximately €0.015 per kW.h or 7.5% (Frondel et al., 2010). Rate increases of even this amount can damage highly energy intensive industries and therefore some countries have opted to give specific exemptions so as to minimize the disruption of economic activity (Fischer and Newell, 2008). Other funding options include specific taxes, general revenues, or some sort of fund scheme. These methods are argued to be less desirable as they open up the policy to other political risks, particularly in times of austerity (Mendonça, Jacobs, and Sovacool, 2010).

One of the key objectives of any FIT policy is to reduce investor risk and increase certainty (Mitchell, 2008; Mendonça, Jacobs, and Sovacool, 2010). This is primarily achieved through a tariff rate that ensures a reasonable rate of return for investors and by long-term contracts, which ensure this rate for 10-20 years. Some observers argue that 20-year contract terms are most successful, as they provide the most certainty for long-term planning and investment returns (Mendonça, Jacobs, and Sovacool, 2010). The certainty provided regarding investment returns is seen as an improvement over quota obligation/tradable permit programs (RECs, TGCs). In fact, the rates offered under a FIT have also been seen to be lower on average when compared to the average rates under such quota obligation programs (Mitchell, 2008; Nemet, 2010; Campoccia et al., 2009). The certainty provided under a FIT could also be achieved with shorter contracts but a higher tariff would be required (Mendonça, Jacobs, and Sovacool, 2010).

FITs are not without their skeptics, however. In fact, some observers deny FITs of almost all the benefits that they are normally associated with, such as positive innovation effects.

Such critics often argue that market-based instruments, in combination with dedicated R&D funding, would be a more efficient way to reduce GHG emissions and drive technology innovation (Frondel et al., 2009; Tamas, Shrestha, and Zhou, 2010). Typically, these observers primarily focus their arguments on the comparably high rates afforded solar photovoltaic (SPV) installations under FIT schemes. For example, it is estimated that Germany invested € 35 billion on solar PV installations between 2000 and 2008, but that these installations only account for 0.6% of Germany's electricity supply (Frondel et al., 2009). Observations such as this have lead prominent environmental writers, such as George Monbiot, to speak out against the subsidized rates for SPV under FITs (Monbiot, 2010).

Critics contend that, instead of promoting innovation, FITs provide perverse incentives to maintain high costs, and lock jurisdictions into existing less efficient technology iterations (Frondel, Ritter, Schmidt, and Vance, 2010; Tamas, Shrestha, and Zhou, 2010). Jurisdictions will often offer a decreasing tariff rate, typically of 5% per year, to encourage technology cost reduction and reduce the cost of the program to the ratepayers over time. Frondel et al. argue that policies of this kind encourage investors to implement existing technologies as quickly as possible to take advantage of the higher rates offered earlier in the program's life and thus lock much of the supply into existing less efficient technology (2009, 2010). In addition, others have argued that developers do not have an incentive to lower their costs as such reductions would only result in the reduction of the subsidies offered (Tamas, Shrestha, and Zhou, 2010). Arguments against the positive innovation effects of learning-by-doing in the market are not consistent with observations of the progress ratio, however (Philibert, 2011).

Finally, it is also hard to compare FIT policies against other programs and policies that do not have as varied goals. The observation that investments in clean and renewable energy, particularly solar PV, are among the most expensive options for GHG emission reductions is a fair criticism. However, FITs are technology, energy security, and economic policies, as much as they are climate oriented policies. The extra costs of the clean and renewable energy investment could be considered the cost of achieving these other goals along with the GHG emission reduction. In addition, when clean and renewable technologies "become fully competitive, the marginal cost of associated emission reductions falls to zero" (Philibert, 2011, p. 10). This point is important when considering long-term emissions reduction strategies. The deployment of some clean and renewable energy technologies may be a higher cost option for emissions reduction in the short-term, but the deployment of those technologies is vital to the cost reductions that will result in larger scale deployment, greater future emissions reductions, and then additional cost reductions (Philibert, 2011).

Loan Guarantees

Loan guarantees are arrangements between a government, a creditor (such as a bank), and a borrower, where the government agrees to underwrite some or all of the risk of a loan from the creditor to the borrower. These guarantees also sometimes lead to longer-term loans than would otherwise be offered, which can reduce costs to project developers through lower monthly financing costs (Goodward et al., 2011).

Loan guarantees are generally thought to be an effective measure for supporting the development of projects for technologies in the demonstration and commercialization phases (Goodward et al., 2011). During the demonstration phase, the perception of risk surrounding a technology can make securing financing difficult. Similarly, in the commercialization phase technologies are technically proven but may still have economic challenges or development risks that make it harder for project developers to secure financing. It has also been suggested that loan guarantees can be difficult for smaller developers to access, as the programs are prone to high transaction costs, which are a greater barrier to smaller developers (Goodward et al., 2011).

The largest loan guarantee program in the world is run through the US DOE. The program first began in 2005 but, due to unusually high administrative requirements at the outset of the initiative, the first project did not receive a guarantee until 2009 (Hobson, 2011). This emphasizes Goodward et al's point that, in order for loan guarantees to be effective, "the application process is straightforward, timely, and transparent" (2011, p. 5). Since 2009 the program has provided guarantees to 40 large-scale projects for a combined value of over UD$ 35.9 billion (US DOE, 2011f). While the US DOE has generally been viewed as successful, it has been receiving growing criticism recently due to the bankruptcy of Solyndra, a SPV firm that received a US$ 535 million loan through the guarantee program (Hobson, 2011).

Critics of the loan guarantee program reference the Solyndra bankruptcy as an example of its high risks and lack of viability. While there is evidence to suggest that Solyndra falsified claims to officials in their application, which is now under investigation by the FBI, the Solyndra story does bring to light one of the major risks of loan guarantee programs: project failure (Hobson, 2011). Project failure is unpopular and potentially costly to the guarantor of the loan, which has traditionally made governments risk averse. Unfortunately, any program that deals with new and emerging technologies will inevitably have some failures. Applications to loan guarantee programs need to be scrutinized to minimize this risk but this scrutiny should be balanced with the potential negatives associated with prohibitive administrative barriers, which can undermine program goals (Goodward et al., 2011).

3.1.4. Other Assisting and Voluntary Measures

Voluntary Purchase Programs

Many programs seek to increase the voluntary consumption of clean and renewable energy by requiring its provision by suppliers. In the electricity market these programs are often know as Green Power Voluntary Purchase programs, and offer consumers the option of purchasing "green" energy if even at a premium price. The programs rely on the altruistic activity of consumers to drive future clean and renewable capacity and shape the market (Heiman and Solomon, 2004). While these programs are almost exclusively applied to the electricity market, there is fundamentally little different with the current situation in the wider energy market, where consumers have the opportunity to purchase a clean or renewable option for a higher price. There are currently an increasing number of voluntary programs for the purchase of alternative transportation fuels being implemented in Europe, which aim to influence consumer behaviour through the labeling of alternatives and certification programs for biofuel feedstocks (S&T^{2}and Cheminfo, 2011). Voluntary purchase programs do differ from the status quo approach, as producers can often be mandated to provide alternative options, which will cut down on the consumers' transaction costs of seeking out cleaner or more renewable energy choices. Programs of this type are also generally tied to public information campaigns to try to increase consumer uptake (Heiman and Solomon, 2004).

Jurisdictions that have experimented with this type of incentive program have not shown encouraging results and the alternative fuel programs in Europe are too new to allow for evaluation of their potential merits. For the electricity programs, surveys conducted in the United States have suggested that over half of Americans would consider purchasing “green” electricity if given the opportunity. In practice, only one percent of households have actually made the switch when given the opportunity. Not surprisingly, evidence suggests that the nonresidential free market for clean or renewable energy is even weaker (Heiman and Solomon, 2004). The effectiveness of these programs is also diminished during times of economic downturn, as consumers are less likely to voluntarily choose a more expensive option during such times. There are also generally high costs associated with the education and registration of the voluntary consumers (Heiman and Solomon, 2004).

Infrastructure Investment and Planning

The development of clean and renewable energy projects often require the provision of supporting infrastructure to transport the energy to the end user. This is evident in the electricity sector where, unless the energy is being converted where it will be used, the electricity will need to be transported via transmission or distribution lines. This dependence will often create an issue for new clean and renewable electricity projects, as the location of some of the most promising new resources is not necessarily proximate to existing transmission infrastructure (Puga and Lesser, 2009; Schumacher, Fink, and Porter, 2009; Alagappan, Orans, and Woo, 2011). If there is not a guarantee that transmission infrastructure will exist to conduct the power to market upon its completion, many projects will simply not get off the ground. Access to the transmission grid is thus clearly interconnected to success of many new projects (Hurlbut, 2008; Puga and Lesser, 2009). Jurisdictions have a role to play in the provision of appropriate transmission infrastructure to take advantage of the best clean and renewable resources. Transmission infrastructure is expensive and large investments in additional capacity should not be taken lightly, however. In addition, regardless of the strength of a potential new resource, the greater the distance of the resource from the load centre, the higher the line losses associated with the project, which potentially makes projects in distant regions less economical (Hurlbut, 2008; Alagappan, Orans, and Woo, 2011).

The link between the provision of transmission infrastructure and the success of clean and renewable electricity projects can be seen quite clearly in the state of Texas. Prior to 2005, the addition of new transmission capacity and renewable energy projects was trapped in a “chicken-and-egg” dilemma (Hurlbut, 2008, p. 138; Puga and Lesser, 2009). State law required that new transmission capacity would have to be guaranteed to be used and useful before it could be constructed. Project developers (mostly wind power projects), however, generally required assurances that they would have sufficient capacity for their electricity before they could receive financing to proceed (Hurlbut, 2008). To move beyond this issue, the state mandated the establishment of competitive renewable energy zones (CREZs) for the addition of new transmission capacity. CREZs are designated areas that have been investigated and shown to have the best clean and renewable energy potential in a jurisdiction that can realistically be added to the generation mix (Puga and Lesser, 2009; Schumacher, Fink, and Porter, 2009). The jurisdiction then provides assurances that additional transmission capacity will either be guaranteed to project within these areas, or provided to those areas on a priority basis, which helps projects secure financing (Hurlbut, 2008; Puga and Lesser, 2009). In Texas the addition of this provision was seen to contribute to the success of the state’s RPS goals and potentially enabled up to 18,454 MW of new capacity in the future (Hurlbut, 2008; Lower Colorado River Authority (LCRA), 2011).

Other states such as California have also undertaken the development CREZs to help facilitate project development and avoid bottlenecks due to the long time frames often associated with transmission line construction. To investigate its potential CREZs, California established an initiative known as the Renewable Energy Transmission Initiative (RETI), which is conducted by a 29-member Stakeholder Steering Committee representing a broad range of energy market participants from consumers and permitting agencies, to transmission providers (Government of California, 2009; Government of California, 2010). RETI was undertaken to inform the state where to prioritize the development of additional transmission capacity in order to help meet the state's own renewable energy goals. The California process also explicitly took into account environmental as well as economic considerations in the evaluation of potential CREZs (Government of California, 2009).

3.2. Summary

This section reviewed the literature on the key clean and renewable energy development incentives and support measures available. Due to the multiple market failures at work in the energy sector, the literature review revealed that no single policy, such as a carbon tax, would be able to achieve the diverse yet related goals of GHG emission reductions, energy supply development, economic development, energy supply diversification, and energy technology development as effectively or efficiently as a coordinated suite of policy instruments. In addition, as a result of the large capital requirements and long time frames associated with energy projects and technology development, the review identified that one of the primary goals of most supporting measures was to increase investment certainty to decrease the overall investment risks. Creating this certainty has been challenging for many jurisdictions, however. The literature emphasizes that programs and policies need to be transparent and predictable, have stable administrative arrangements, and be backed by a secure long-tern vision and political commitment.

To accelerate and incentivize the development of projects using commercialized clean and renewable energy technologies that are already close to being cost competitive, production requirements, tax credits, the provision of supporting infrastructure, and GHG emissions pricing mechanisms were identified as effective and efficient instruments. Their utility does, however, depend on implementation and jurisdictional details. Iterations of the policies that create greater certainty were also more desirable, such as using carbon taxes instead of cap-and-trade schemes that may result in emissions pricing volatility. For the development of technologies that are further from being cost competitive, the literature suggests that specific policies and measures have strengths and weaknesses depending on where they are targeted on the technology development continuum. The direct provision of funds through mechanisms such as grants is important for technologies in the pilot and demonstration stages. In the commercialization stage, loan guarantees are an effective and efficient tool for allowing projects to be built, but can create increased risks for governments due to the potential for information asymmetries. This literature review also demonstrated that instruments that allowed for the exposure of new technologies to the market scrutiny were important for capturing learning-by-doing improvements and eventual more widespread deployment. FIT policies have had some success in this regard but these successes have generally required that the tool be used as a broad electricity acquisition tool to drive the needed market pull to derive the desired benefits.

4. METHODOLOGY

The design for this project consisted of semi-structured qualitative interviews carried out with clean and renewable energy experts and practitioners. The following sections describe the details of the interviews, the method of analysis, and notes potential methodological weaknesses.

4.1. Interviews

To gain additional information and perspective on the merits and drawbacks of clean and renewable incentive policies and measures, semi-structured interviews were conducted. Semi-structured interviews entail an open-ended questioning format designed to provide an overall interview framework, while still allowing the interviewer to ask relevant non-predetermined questions (Lindlof and Taylor, 2011; Mason, 2002; Whiting, 2008; Cohen and Crabtree, 2006). This interview style is sometimes referred to as qualitative interviewing (Mason 2002). As a data source, interviews prioritize the "knowledge, views, understandings, interpretations, experiences, and interactions" of individuals—in this case, individuals within in the energy sector in BC. Qualitative interviews also take for granted that the experiences and views of the informants being interviewed "are meaningful properties of the social reality" which this research intended to explore (Mason, 2002, p. 63). With respect to this project, such experiential data is understood and explored in light of the larger discussion of the clean and renewable energy supports and incentives literature presented above.

An advantage of a semi-structured approach to interview data is the ability to combine pre-determined, topic-specific areas of importance with the flexibility of non-predetermined questions, which allow the researcher the "opportunity for identifying new ways of seeing and understanding the topic at hand" (Cohen and Crabtree, 2006). The open-ended manner of many of the questions also helps to ensure that the a priori determination of interview topics does not unnecessarily impose predetermined categories upon research subjects' experiences.

In addition, a priori established questions allow for greater comparability of responses across a broad spectrum of energy sector involvement (Whiting, 2008). In this project, a small selection of predetermined informant-specific questions were included to more appropriately capture each participant's area of expertise (Lindlof and Taylor, 2011). As is common practice in semi-structured interviewing, questions did not have a defined order (Dearnley, 2005). Participants were invited to respond to open-ended questions, and the order of the remaining prepared questions was determined by their responses. A full list of the prepared questions can be found in Appendix V.

Invitations were emailed to 54 individuals from government departments, crown corporations, not-for-profit organizations, universities, industry associations, and within the energy industry itself. Individuals were selected based on their knowledge and experience in clean and renewable energy as determined through Internet searches and background reading, and through consultations with the report's client. Interviews were conducted with 29 of the 54 individuals contacted, a response rate of 53.7%.

Individuals contacted who did not participate in an interview either did not respond to the invitation, were too busy to participate at this time, or referred the author to a colleague who they felt would be more appropriate for the project. In total five interview participants were individuals who were referred by other potential participants. To increase the probability of a desirable mix of participants from various perspectives of the energy sector, the researcher over-sampled and more individuals than were expected to reply were invited to participate. While none of the contacted Canadian federal government public servants participated in the interviews the sample still represented a reasonable variety of the energy sector perspectives in BC. Of those that participated seven were academics, three were from provincial or federal crown corporations, four were from the BC provincial government, seven were from not-for-profit organizations, two were from industry associations, and six were from within industry. Three individuals from the sample fulfilled multiple categories of expertise.

Location of the interview can also be an important consideration, as participants are ideally made to feel as comfortable as possible in order for them to give honest and complete answers (Dearnley, 2005). Participants were given the opportunity to be interviewed in the location of their choice. Interviews were conducted in person at the participant's place of work or a public location nearby, on the phone, and via a voice over Internet protocol (VOIP) program (i.e. Skype). Interviews ranged in length from 32 to 80 minutes with the average interview length being 49 minutes.

Interviews were digitally recorded and transcribed, a practice that enables closer evaluation of the ideas and themes discussed (Lindlof and Taylor, 2011; Cohen and Crabtree, 2006). Recording of interviews also allows an interviewer to focus attention on the development of rapport and dialogue with the participants, characteristics that are seen as essential for semi-structured interviews (Lindlof and Taylor, 2011; Cohen and Crabtree, 2006).

4.2. Analysis of Results

The interviews were later transcribed by the author, which allowed for further immersion into the subject matter (Dearnley, 2005). The analysis of interview findings was carried out in a sequential fashion, whereby interview questions were refined over the course of the investigation, and emerging alternative avenues of inquiry were explored as interviews were undertaken. Interview data were organized thematically, using analytic categories that were inductively determined. The categories and themes derived from the data were generated through a constant comparative method of analysis, rather than utilizing pre-determined analytic themes. While some of the interview questions were established prior to a given interview, which may potentially import a categorization system onto data, the open-ended nature of the questions and semi-structured format of the interviews enabled a substantial amount of freedom in participants' responses. In that way, the thematic analysis was not limited by the initial interview framework. The sequential analysis and modification of questions—whereby data is used to beget further data—was also an important mechanism to ensure themes were reflective of the participants' experiences themselves, rather than the researcher's initial pre-conceptions of the material. Data reflective of analytic themes were grouped and re-grouped, and themes added or taken away in an iterative process.

4.3. Methodological Weaknesses

Selection bias is one of the concerns when using any form of non-randomized sampling. Selection bias was mitigated by approaching individuals from a broad range of organizations that generally represent most facets of the energy sector. While it is true that the client assisted with the selection of some of the participants, and that this may impact the objectivity of the results, the potential loss of objectivity was determined to be an acceptable risk, given the advantages of drawing on the client's vast knowledge of the relevant players in the energy industry in the province.

There was a risk that a desirable mix of interviewees from the sample group would not agree to participate, which would have jeopardized the quality of the results collected as specific groups within the sample population could have been over or under represented. If it was determined that there an underrepresentation of participants from a specific sample group (e.g. industry participants) it may have been necessary to expand the population invited to participate in order to specifically target greater representation from the desired sample group. However, a desirable mix of interviewees did participate in the project so no further expansion of the sample was deemed necessary.

Another potential weakness of the semi-structured interview approach is that the quality of discussion and information generated through the interview is highly dependent on the interviewer's skill to ask the right questions and subsequent follow-up questions. It would not be surprising to find that the quality of interview data generated toward the end of a study outstrips that of earlier interviews. In some ways, this is an internal correction mechanism, whereby carefully designed questions are improved upon over time. Once again, the diversity of the participant sample, and the over-representation of particular areas of expertise helped to minimize the impact of this variability.

5. INTERVIEW FINDINGS

This chapter outlines the findings from interviews conducted with 29 individuals involved in the energy sector in British Columbia (BC). These are organized thematically to allow for comparison of opinions across a broad cross section of energy sector involvement. In the interest of confidentiality, comments and direct quotations are not attributed to individual participants by name. Interviews predominantly focused on issues related to the BC energy context, specific program and policy considerations for the development of clean and renewable energy resources and technologies, and the need for long-term vision and goals when considering questions involving the energy sector. Interview findings are organized into three main sections below: development barriers in BC; program and policy design considerations; and long-term vision. The chapter concludes with a brief summary of the key findings.

5.1. Development Barriers in BC

Many programs and policies for the development of clean and renewable energy are specifically designed to address the barriers to market entry faced by those sources or technologies. In addition, if particular barriers are not simultaneously addressed, the effectiveness of other supporting programs and policies can be significantly curtailed. Below is an overview of the main barriers to clean and renewable energy development in BC as discussed by interview participants.

5.1.1. Cost

There was a consensus among interview participants that cost was one of the main barriers to the development of clean and renewable energy in BC. As one participant noted, “pricing is the killer for this province [BC]”. While several participants recognized cost as a fundamental impediment to almost any new technology, and particularly to most alternative energy sources globally, BC was seen by participants to have some unique features that add additional challenges. Two participants specifically noted that BC has the second lowest electricity rates in North America, and that over 93% of this is already produced using clean and renewable resources. These participants suggested that the low energy rates in BC make it challenging to develop any new clean and renewable energy project, whether it is with an established technology or a more experimental one.

Five participants also raised the issue that the cost barrier is often exaggerated for new technologies, as historic capital costs of previous infrastructure are not considered when making comparisons against new energy sources. Three interviewees noted that the costs of generating electricity from the heritage assets are mostly the operations and maintenance (O&M) costs, which does not take into account the billions of dollars spent on their construction over previous decades. These participants identified this incomplete calculation, coupled with the “lowest rate now” focus of the BC Utilities Commission (BCUC), made it challenging to operate projects in BC for even better established clean and renewable energy technologies. Eight participants noted that electricity technologies need to be extremely competitive to succeed in BC, due to the relative abundance of remaining untapped hydro resources that are generally more cost effective. Six of these individuals commented that this may also be viewed in a positive light, as it will mean lower rates for consumers when compared to other jurisdictions. This would also mean that the province will have considerable low cost clean and renewable potential in order to meet future demands. However, five participants also said that one could still make the case for diversification of supply or to support projects with new technologies where even the O&M costs may still be higher than the prevailing market price. One participant noted that there is also a tendency for the public to flash back to the myth that BC has adequate cheap electricity now and therefore the province does not need more. This same participant suggested that BC was in a flashback period now with the BC Hydro rate review, which was suggested to be highly motivated by populist politics.

The fluctuating cost of oil was another barrier identified by one participant who suggested that a project such as a biofuel refinery can be viable or not depending on what the assumed and actual price of oil will be. While oil prices have been steadily increasing, it was suggested that there was a real possibility it could not drop below $80 a barrel for a protracted period. The participant suggested that this would be enough to kill most biofuel refinery projects. This individual did also note that the prevailing market price for oil was outside the control of the province of BC.

The low cost of energy was also specifically identified as making it particularly difficult to make the business case for property scale individually owned installations such as solar photovoltaic (SPV) or solar hot water (SHW). Five participants said that the need to show a decent payback period for the investment made was critical to getting people to commit to these types of installations. These individuals felt that the long payback periods in BC due to the low costs of other forms of energy along with other uncertainties such as technology risks, meant that programs aimed at this scale often only captured the early adopters or pioneers.

5.1.2. Unsettled First Nation Rights and Title Claims

All industry and six other participants identified unsettled Aboriginal rights and title claims as a potentially significant barrier to the development of clean and renewable projects in BC. Four individuals wanted to emphasize that there had been some good work done in this area, but that building relationships with First Nations required ongoing work. Three participants felt that this created a particular barrier for small companies, as larger companies are better able to put in the time and resources necessary to build those relationships. These informants recognized that this work may make projects move more slowly, but that it may also pay dividends as First Nations were seen to be potentially good allies and partners for the development of projects if industry was willing to put in the work. Two participants emphasized that this was a unique BC issue, which still has the potential to create considerable uncertainty and increase the risks of projects across the province.

5.1.3. Entrenched Habits

Five participants saw entrenched institutional momentum as a barrier development in general, but also as a particular barrier against less established technologies. Some felt that BC Hydro's acquisition programs were inadvertently designed to accommodate hydro projects more than any other type of technology. There was no consensus on this point as three others felt that this was likely due to geography and felt that the programs were essentially technology agnostic with price acting as the filter against entry from other less competitive technologies. However, five participants still agreed that there may be some bias towards projects that BC Hydro is more familiar with and that until there were a few more projects from particular technologies it would be hard for that technology area to become established. Four of these same five participants suggested that this may be part of the reason why so few other technologies have been able to take hold in BC. As one participant noted: “if you haven’t designed a regime to support geothermal, you won’t get any geothermal”. Additionally, two participants noted that BC Hydro tends to have an institutional preference for large-scale projects, which could work against some of the more distributive technologies.

Three participants identified the tendency for Aboriginal Affairs and Northern Development Canada (AANDC) to heavily subsidize the cost of supplying diesel for electricity generation to remote First Nation communities. These participant did not want to see the elimination of the diesel subsidies to increase the impetus to invest in a clean and renewable generation source, but rather suggested a near term reinvestment to avoid the longer-term financial and environmental costs of diesel transportation, storage, and consumption. Additionally, one participant noted that the act of acquiring electricity from diesel ran “perpendicular” to the values of most First Nations, and ten participants indicated that there is strong general support for, and good movement on, implementing alternatives.

5.1.4. Market Size and International Considerations

Six participants suggested that BC would likely be unable to compete with the scale of incentives being offered in other jurisdictions such as Europe or the US. However, these participants also noted that there is still optimism for the development of a modest clean and renewable energy industry in BC. Four informants suggested that, from an electricity project development perspective, a key barrier was that, as BC Hydro is not doing any calls at the moment, there is a limited market for new electricity capacity. On the technology development side, six participants suggested that BC’s economy is too small for full commercial roll-out, but not for demonstrations of new technologies. As one participant argued, “being an exporter shouldn’t be a barrier.” This point was reiterated by the sentiment, that “energy as an output has an almost limitless market.” However, there was no consensus on this point. Five participants noted that the definitions of what other jurisdictions define as renewable could have very serious implications for the energy export prospects of BC. One interviewee noted that other jurisdictions could potentially disqualify products (e.g. pellets, electricity, or fuels) that use BC pine beetle wood, which would have impact on BC’s bioenergy exports. This was seen as part of a larger emerging potential trade dispute with the US over energy exports and with established interests in the US such as the corn ethanol lobby.

5.1.5. Transmission Uncertainties

Four participants identified concerns regarding uncertainties as to what BC Hydro will and will not do for the development of transmission infrastructure in particular areas. These participants also noted that while progress had been made in this area, this uncertainty was still seen as a particularly significant impediment for the development of geothermal and ocean energy projects. One participant noted that the length and complicated nature of negotiating transmission for a project essentially meant that a geothermal company would have to begin transmission negotiations at the same time they are doing initial explorations, which increases the risks for projects.

5.1.6. Administrative Barriers

A number of participants identified that BC deserves a lot of credit for making many of the improvements to the permitting process, and implementing the one window one process approach. While this was noted to be the right way to go, three individuals indicated that it was too soon to say if it this approach has been ultimately successful. One participant identified that the outdated and inconsistent nature of the energy policy framework for the various different technologies was a potential barrier to the development of projects. This interviewee suggested that this issue became more evident when the Independent Power Producer (IPP) industry matured and began noticing the inconsistencies in the policies for the different technologies. It was also indentified by this participant that there is a need to ensure that the framework policies match the operational policies. The Ministry of Energy and Mines (MOEN) was identified as the only ministry that retained control of their operating policies after most such policies were transferred to the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO), which has created some challenges for ensuring policy alignment.

Three industry participants noted that they wanted to see the permitting officials act more boldly for minor projects or components of projects where there are minimal or positive environmental impacts. One participant cited an example where an application to move a road took five months to approve even when this new road had a reduced environmental impact. This five month delay cost the project almost an entire building season, which lost the company considerable resources. Staff cut backs in the dirt ministries, retirements of senior staff, and the inexperience of some of the new permitting staff was identified as a possible contributing factor to issues such as this by these participants, as loss of capacity was seen to be creating a “bottleneck” for approvals, as the less experienced individuals are less likely or comfortable to waver from the letter of the policy.

One industry participant commented that barriers can also be created when policies are too prescriptive, and that it was advantageous for policies to be simple and clear. An example used was that policies may be too prescriptive regarding the definitions of what is classified as an emerging or commercial technology, which may have implications for the technology’s eligibility for funding through various programs. This individual was also an advocate for technology agnostic policies, but there was not agreement on this approach amongst participants.

5.1.7. Real and Perceived Negative Impacts

Five participants raised the idea that, even though projects are classified as clean and renewable, most are still industrial scale exercises that will still have potentially serious environmental concerns or have the potential for other disruptions such as noise. A lack of greater social license to operate was seen as one important barrier in BC by a three participants and one individual felt that the history of activism in the province was seen to give some in industry pause due to increased investment risks associated with potential delays from public outcry or protests. Alternatively, a different participant noted that even though distributed generation is more in your face, it still takes people some time to realize that the new infrastructure such as wind turbines are permanent fixtures of the landscape. This misperception was indicated to potentially cause further backlash later on and could increase the not in my back yard (NIMBY) effect, even if the impacts are relatively minor and would have previously been more accepted.

Seven participants argued that it was important to be direct and clear about what the potential impacts of projects will be, in order to avoid this possible increased backlash. Further investigation into the impacts of technologies was also seen by one participant as imperative to avoid making potentially serious mistakes before a more extensive commercial rollout; mistakes which could damage the technologies perception in the public and the wider market. The extra investigation into possible impacts would increase costs and likely cause delays, but would pay dividends for the wider industry and jurisdiction according to this participant.

5.1.8. Other Barriers

There were a number of other barriers that were identified in a limited way by individual participants. Some of these barriers were identified to not be unique to BC, such as technical barriers associated with particular technologies. Although not exhaustive, this list includes technologies such as wave energy converters, more BC-specific barriers such as a lack of capacity and access to financial tools at the community level, and, for small-scale installations such as SPV or SHW, a lack of human capital and contractors to hire. One interesting barrier proposed by one participant on technology development was that Canadians were too risk-averse, and did not embrace home grown innovations. This interviewee suggested that there was a general feeling that "if it is from here, it is not cutting edge". Finally, one participant raised the idea that the potential financial returns in the BC real estate market, particularly in Vancouver, were crowding out investment in other areas; especially high risk areas like clean and renewable energy.

5.2. Program and Policy Design Considerations

Future possibilities for program and policy designs were fundamental to this project's undertaking. The following section explores design considerations for clean and renewable energy development programs and policies as discussed with interview participants.

5.2.1. GHG Emissions Pricing

There was consensus among interview participants that placing a price on GHG emission was an important component of a long-term energy transition, and there was a general preference for carbon taxes over cap-and-trade systems. Six participants said that greater price certainty, generally lower overall price, and less administration are key advantages of the carbon tax. The carbon tax was seen as an important tool by 12 individuals, as it was felt to make the issue of climate change a more real and pressing. And while this may be the case for some investments, one industry participant specifically cautioned that the carbon tax barely factored into the equation when trying to establish financing to construct a $300 million biofuel refinery.

There was general consensus that the carbon tax was not at the level required to significantly influence behaviour or investment decisions. Thirteen participants cautioned against significantly increasing the level of the carbon tax unilaterally, as BC would be imposing penalties regionally but competing in a much larger market, which would hurt BC's economy. A widely applied carbon tax was identified as preferable but this was also not anticipated to be implemented in the near term. In addition, a tax level high enough was not seen to be realistic due to implementation problems because of a lack of political viability.

There was no agreement as to whether or not a sufficiently high carbon tax was more efficient than a combination of other policies. Six participants thought that theoretically the simplicity of the carbon tax was the more efficient option, but that the tax level and/or scope of the geographical coverage required could not be realistically implemented. Five other participants said that the existence of multiple market failures, such as those related to knowledge creation, required a more nuanced approach with multiple different types of policies, programs, and regulations. With respect to technology development, ten participants felt that the direct application of funds was a preferable method over the carbon tax.

Twelve participations suggested that the revenues from the carbon tax be used to fund areas other than corporate and personal tax cuts. Suggestions for using the extra revenue included funneling the money into supporting improved infrastructure and transportation systems, and to provide greater support to programs such as the Innovative Clean Energy (ICE) fund or the BC Bioenergy Network (BCBN). Participants agreed that BC should be commended for implementing the carbon tax, but seven interviewees cautioned that there appeared to be some uncertainty as to the tax's survival in the future. It was suggested that politicians needed to stand behind the carbon tax to make it a permanent part of the fiscal framework. Two participants suggested that this type of commitment was integral to the success of the policy due to a greater ability for individuals and firms to plan over the long-term.

5.2.2. Electricity Acquisition

This section captures the results from discussions with interview participants on the main electricity acquisition mechanism in use by BC Hydro: the Clean Power Calls and the Standing Offer Program (SOP).

Clean Power Calls

Ten participants identified the boom and bust cycle of the Clean Power Calls as a significant impediment to a stable clean and renewable energy industry in BC. Five industry participants said they would like to see a more steady procurement policy. One participant called for a "continuous progressive investment" and compared the boom and bust cycle as analogous to that of the BC Ship Building industry that was negatively impacted by similar cycles of government procurement policy. In addition, the long gaps between calls were also seen to make it more difficult for small and medium sized companies to compete, as they were less able to handle the "ups and downs" according to three participants.

Three other participants noted that a steady procurement policy would be extremely difficult to implement for a number of reasons. The Clean Power Call process itself was a three-year process to set up the contract terms and assess all of the applications, which creates issues regarding the capacity for BC Hydro to run concurrent call processes. There was also a feeling by two of these participants that more regular smaller calls would still not satisfy industry, as much fewer projects would be selected. However, four industry participants dismissed this and argued that the certainty afforded by a more predictable call process would outweigh the smaller number of projects selected. Another potential issue raised with more regular calls was that load forecasts are very difficult to get right and it was suggested that it is extremely unpopular to build in front of demand. "It's bad enough for BC hydro to overbuild…but at least it would be a BC Hydro owned asset".

Two individuals commented that the government has already attempted to go around the reduced current need for additional large-scale capacity by implementing the self-sufficiency requirements and increasing the export focus of the province. This was viewed as a dangerous move by one participant as it would result in more resources than are actually needed and at a higher cost than they would otherwise be. One industry participant said that they were "not a fan" of building ahead of need, but still thought the self-sufficiency was a positive move for the clean energy industry and the province in general.

There was also disagreement among participants as to whether the current IPP model for the province was the best approach. Five participants were critical of the IPP model because, by definition, acquiring electricity from private producers meant that one was paying for company profits and for executive salaries, and that BC Hydro might be better off to just build the projects themselves. Four participants suggested that the strength of the big utilities was for large project development and, as one participant noted, that "they tend to get a little out of focus when you are talking about projects of less than 300 megawatts" (MW). These participants suggested that much of the small-scale power developments in the province would not have happened if it were not for the IPP approach.

One industry participant suggested that offering greater price inducements for desirable project characteristics such as base load, and having increased flexibility for the electricity purchase agreement (EPA) terms, would be improvements to the current model. For example, geothermal projects face initial uncertainty as to the size of the underground resource until the project is already fairly advanced. The participant suggested that it would be useful to have more flexible EPA terms such that there would still be a minimum agreed to quantum of MWs to be delivered under the contract, but also that the EPA contract could be expanded if the resource was larger than previously thought. This participant did admit that there were challenges with this approach, such as the provision of appropriate transmission infrastructure.

Standing Offer Program

Of the 12 participants who spoke to the SOP program, all supported the program in general and the recent review and program rule changes. Ten participants identified that the main advantage of SOP was that gave greater certainty for developers. Five participants also noted, however, that the prices offered under the SOP, as they were based on the lower quadrant of prices from the Clean Power Call EPAs, were still "challenging". Despite this, the SOP was seen by two participants as a key component (along with the self-sufficiency requirements mentioned above) of support for a "modest" clean and renewable electricity industry in BC. One main criticism of the SOP raised in the interviews was that it did not work for certain technology types as they do not work at smaller scales. Three participants suggested that both wind and geothermal technologies were essentially eliminated from the program due to size requirements that dictated important economies of scale for these technologies.

5.2.3. First Nation Partnerships

Among the ten individuals who spoke to First Nation issues in BC, there was consensus that First Nations should be enabled to be more involved in the clean and renewable energy sector. Two individuals pointed to the First Nation's Development Fund in the *Clean Energy Act*, but most felt the sum provided in the *Act* was too small to allow for appropriately increased meaningful participation of First Nations across the province. One participant emphasized the need to involve First Nations while the industry was still on the "up-swing" and that a development fund of between $250-500 million would be required to make this happen. Three other participants suggested that there needed to be additional work put into helping First Nations develop template policies and pre-negotiation templates for private developers working with First Nations and to help First Nations share their experiences working in the clean and renewable energy industry. One participant noted that currently there are numerous one off agreements from band to band, which creates uncertainty for developers and First Nations.

5.2.4. Export

There was disagreement amongst participants as to whether establishing BC as a more prominent exporter of energy was a good idea. On the one extreme, it was suggested that there was an "almost limitless market" for energy. On the other hand six participants called the business case for export "questionable". Regardless, there was general support for further investigating trade with other jurisdictions as it was noted that BC's production potential "dwarfs" its domestic demand. Four participants cautioned that export markets were by no means certain. As one participant offered, "if you're in the Pacific Northwest you can't have four jurisdictions thinking they are all going to be export outfits". Two informants suggested that, when other jurisdictions began to cut back on fossil fuel use, the business case for export was going to be stronger, but that for now the cost of additional clean and renewable capacity was above the market value.

Five individuals noted there is no guarantee that, when demand for clean and renewable energy outside of BC does increase, these jurisdictions will recognize BC's resources as clean or renewable. Three of these individuals suggested that BC needed to strengthen international relationships and take a leadership role on trade with the provinces. One participant noted that these types of efforts would be aided if the Canadian government had a more prominent position on energy to argue against and avoid protectionist measures in the US. The possibility of a closer energy trade relationship with Alberta was also raised as a good idea by four participants—one that should be further investigated, rather than presuming that the export markets for BC's energy were only to the South. These four individuals noted that BC has the potential to make Alberta's fossil fuel energy development cleaner by powering the necessary infrastructure with clean and renewable energy. These participants also felt that more work should be done to establish a National Energy Policy, which would better enable these types of trade relationships and synergies between the provinces and internationally. One participant strongly believed that any such national policy would likely have to come out of the Western provinces due to their significant energy interests and the lingering "hangover from the National Energy Program" in the Eastern provinces.

5.2.5. Technology development

There was disagreement among participants on the relative merits of BC as a centre of potential innovation and technology development. At one extreme, one participant suggested that British Columbians were "hewers of wood and carriers of water" and that they perhaps did not have the "innovative spirit". At the other extreme seven participants thought that BC was strong on innovation and that the province had a fairly innovative knowledge based economy. One of these participants indicated that BC's real problem was with "connecting the dots". For example, this participant identified that BC was a world leader in wind power in the 1970's and again in battery technology in the 1980's, but that the province had lost the opportunities to other jurisdictions.

Six participants noted that BC generally had "technology agnostic" policies, meaning that the province did not intend to support one technology stream over another. This was seen by six participants to have potential advantages, as BC could allow for other jurisdictions to put in the considerable capital to develop these technologies, later implementing them when they were more cost competitive. Ten other participants said that these types of ideas would ensure that BC would always be a technology taker and would not lead to the development of a sustainable clean technology industry in the province. "We have always been a resource exporting economy, what comes next?" one participant asked. Two of these participants felt that there needed to be a "secure game plan" for the development of every single technology strand. One participant felt that all the solutions required for the energy transition were already available, but that the real issue was with their implementation.

Demonstration Projects

There was general agreement that the BC was well suited for demonstration projects to either showcase and/or test new energy technologies, but there was no agreement on where these projects should ideally be situated. Fifteen participants identified that the non-integrated communities in BC provided a good opportunity to showcase various new electricity technologies. Two others disagreed with this approach for a number of reasons. These participants felt that new technologies often carry performance risks, which may be harder to fix in a remote setting. Additionally, one of these participants raised a logistical consideration and suggested that showcasing a technology would ideally entail bringing prospective investors in through a major airport, "and not have to put them in another small plane for six hours" to get them to the demonstration site. This participant felt that, while there were opportunities for more established renewable technologies in remote areas, this did not apply to newer technologies.

Four participants recognized that the risks of taking new technologies into communities were potentially large due to liability concerns and visibility of any failures. Nevertheless, they still felt that it was a good opportunity for the province. One participant suggested that the province needed to do more to create a more risk free demonstration and pilot environment for new technologies that had a good proof of concept. The lack of a demonstration project for prospective technologies was also suggested to be seriously detrimental to efforts to generate financing or greater interest for it outside the borders of BC. One participant recounted a situation where they were attempting to sell the idea for a technology to a foreign country while on a trade mission accompanying Canadian federal government officials. The host country, while agreeing that the technology had merit, rejected it on the grounds that it had not been demonstrated in Canada yet.

Granting Programs and Building Connections

Interview participants generally supported granting programs such as the ICE fund as a mechanism for technology development. Seven participants felt that the ICE fund was "doing good work" and allowed projects to be built that would otherwise be struggling to find financing. However, 12 participants, including three of the seven, felt that there was a tendency to spread the money from the fund out too thin, which endangered the success of the overall projects as developers still had considerable difficulty finding the remaining financing. Six participants also felt that the ICE fund was not free from political interference, which increased risks and uncertainty for applicants. “The ICE fund is at the whim of the politicians” one participant offered. According to these six participants, providing stability, transparency, and predictability were the key features for programs such as the ICE fund, and anything that undermined these diminished the effectiveness of the program.

To solve this problem, 14 participants either independently suggested or supported the idea of establishing a provincial equivalent of the federal agency Sustainable Development Technology Canada (SDTC), which, as one participant offered, could run somewhat analogously to the current relationship between Genome BC and Genome Canada. Five participants suggested collapsing the funding for, and function of, the ICE fund and the BCBN into this new Crown agency. The external agency was seen by these 14 participants to be less prone to political interference and provide greater stability to technology developers. There was not complete agreement on this point, however, as two participants felt that politicians were not opposed to change the rules, even for external agencies, and that there was likely no arrangement that would provide the sought after stability. “SDTC is working because the government is letting it work” one participant stated. Despite the lack of consensus on this point, it was suggested that an external agency would also have several other advantages such as greater flexibility, potential to better understand the business environment, and that the agency would be able to “have the conversations that it needed to have”.

Six participants suggested that an external agency would also be better able to foster connections between the universities and industry, help coordinate funding between the federal and provincial governments, and build relationships between smaller and larger industry participants. For technology development, eight participants saw increased partnerships as essential, because, as two individuals offered, BC was not able to drive innovation in the same way as a country like the US could. In fact, developing partnerships between BC businesses and larger US firms with “deeper pockets” was one of the original goals of the BCBN according to one participant. Finally, to gain the benefits of having money and programming administered through an external agency, five participants saw it as very important to have a transparent process that was “calendarized”, and had mechanisms that allowed for peer review of the applications. These five participants thought that increasing researcher participation would potentially slow the process down, but would also provide for a more “sober analysis” of what was actually possible.

Feed-in Tariff

There was consensus among interview participants that BC did not need to implement a general FIT policy like Ontario, Spain, or Germany. Sixteen participants noted that BC had very different goals than these other jurisdictions as BC was not looking to add large amounts of clean and renewable energy to the province’s generation mix in a short time frame. There was also consensus among participants that the proposed $25 million cap on the BC FIT was far too low to be of any value. Meeting the goals of the program with this cap in place was described as “challenging” by some, to “absolutely ridiculous” and as “a dream” by others. Twelve interviewees noted that the capital required for commercial demonstration scale projects is huge and that the small FIT and the five-year contract terms were not enough to allow for private developers to secure the capital needed to build the desired projects. One participant was afraid the program would result in “a bunch of white elephants all over the province”. There was also recognition that the proposed FIT was small because the government was likely testing it to see how it performed.

Four participants felt that the FIT was perhaps not the best option for building the commercial demonstration scale projects that the policy was targeting and that perhaps loan guarantees would be a stronger policy option to ensure that the projects actually got built. While this idea was supported by a number of participants, four others noted that there is only so much that can be done from the policy end without providing the market opportunity. Three informants noted that the O&M costs for a newly commercial technology can be above the prevailing offer price from BC Hydro and that even if the project is built using a loan guarantee program there is very little keeping the project running after it is built. "There needs to be something at both ends" one participant offered. These same three and five other participants argued that there needed to be a suite of policies to see a technology through the development pathway, as no one policy could support a technology from concept, or even pilot, to commercialization and market deployment. Six participants did not see the FIT as a good policy for new technologies due to the extreme difficultly regarding where to set the tariff level in order to provide the correct inducement. As one participant suggested, "FITs are good but they go hand in hand with demonstration."

There were also three participants who were not supportive of the FIT tool in general. One participant in particular felt that the tool ensured private sector profit because of "shady bookkeeping" by government. This participant felt that the government was keeping the initially large capital investment off the government balance sheet, and that the government ended up paying more in the end rather than just financing the debt and building the projects itself. The only way the FIT was seen to make sense to this participant was if the private sector was able to develop these projects cheaper and/or better than government, but they were not convinced. However, two other participants felt that many of the IPP scale projects in BC would not have been built without private interests due to a supposed institutional preference for large projects at BC Hydro and lack of familiarity with particular technology types.

Picking Winners

There was considerable disagreement among participants as to whether or not they thought the concept of "picking winners" was a good idea. Five participants felt that the "messiness" of picking winners outweighed any potential benefits that could be enjoyed from the practice. The province's failed support for Ballard and the development of Hydrogen Fuel Cells was seen by two participants as a clear example of the potential negatives of picking winners. Those who generally supported more technology agnostic policies also tended to think negatively of picking winners and thought that the market should be deciding who succeeds rather than the government. Three other participants also raised the issue of the lack of technical knowledge of decision and policy makers which was seen as a potentially significant risk factor for picking winners.

Sixteen informants felt that technology programming in Canada had the tendency to spread too little money over too many projects. The "policies select and disqualify everyone" one participant noted. These participants felt that, by spreading the money too thinly, there was an increased risk that the supported projects would still not be successful. Political influence was also seen to be a problem in this regard as there was a perception that politicians wanted to spread money around as much as possible and potentially to their specific ridings.

One participant noted that they did not like the term "picking winners" and instead preferred the idea of "creating winners". This respondent suggested that the jurisdictions that BC and Canada competes with create winners by “piling on support” to initiatives that are leveraging the desired sector forward. Six participants also noted that there is less appetite in BC for supporting initiatives once they start to become commercial. These participants suggested that as a result support is reduced or eliminated right when a company is starting to become successful, which often jeopardizes their continued success as they are still at a fragile stage of development. One individual suggested that a potential reason for this lack of appetite is that the history of government support for commercial industries in other areas has been mixed, such as in the ship building industry in BC. Another participant suggested that the main failure of government support for the ship building industry had more to do with the boom and bust government procurement policy than anything inherently wrong with support for embryonic industries in general.

While opinion was strongly divided on the merits of picking winners from the individual company perspective, there was stronger general support for the idea of picking “winning areas”. Sixteen participants suggested that BC should focus more resources in areas that still required significant development and that BC has an abundance of resources in, such as bioenergy and/or ocean energy technologies. Three participants noted that in some cases even small countries that have focused on particular areas of technological development have been able to export them successfully, such as Denmark with wind technology.

Ten of the participants who supported the idea of picking winning areas also clarified that they did not want the focus to be on particular technologies, but rather on desirable characteristics of the energy (e.g. base load, liquid fuel etc.) and on specific fuel types (e.g. ocean, biomass etc.). Picking winning areas was seen as a potentially better way to pool limited public resources and make more strategic choices. This was expected by three participants to be resisted by some in industry, but that ultimately industry would understand the rationale for going in a particular direction if it was transparent and clear how and why the determination was made.

Flexibility

Four individuals raised the idea that the support that the government provided to various firms for technology development need not necessarily be only financial. It was suggested that, once the decision had been made to support a particular firm, there should be a discussion between the government and the firm to assess how the government can best support their efforts and increase the likelihood of their success. For example, one individual suggested that subsidized or free feedstocks, such as pine beetle wood, would also act as a significant incentive and support mechanism for bioenergy projects.

Managing Expectations

There was consensus among participants that there was a strong need to be realistic regarding the development of energy technology development. Twelve participants noted that raising expectations too soon can be potentially dangerous both politically and for a technology. Three participants used the case of hydrogen technology in BC as an example of what can happen when expectations are not grounded in reality. Energy technology development is “not like a dot com technology” as the capital required is huge and it usually takes decades to go from concept to commercialization, which makes it particularly hard to receive the needed financing from the private sector. In the case of hydrogen, two participants identified that there were beginning to be commercial applications now, but that there was increased cynicism towards the technology due to a failure to deliver on the

BC Government pronouncements of the late 1990's. Two other participants also noted that technological innovation is by no means a for sure thing and there was no guarantee that, even if heavily involved, any particular company or jurisdiction would be the ones to have the breakthrough.

Four participants felt that people and politicians will often become invested in projects, and that there is the potential for the projects to be funded well past the point where it is known to not be successful. It was suggested that in order to be effective in the area of technology development there needed to be a greater appetite to accept failure and to create mechanisms to learn from it. Eight participants noted that failure is a significant part of the process, and, as one interviewee offered, "if you are going to be a world leader in clean energy you have to be willing to get your hands dirty." Two participants saw BC as being half committed to technology development, as the province was unwilling to do what was necessary to be successful. To be successful it was suggested that BC needed to increase its support and to be realistic about what could be achieved at various levels of investment and in given time frames.

5.2.6. Financing Source

Ten participants said that the sources from which funds were drawn (e.g. a special levy, raised electricity prices, general revenues) to support various programs for clean and renewable energy development was an important consideration but there was no agreement on which sources were optimal. One participant suggested that it was best to leave considerations of this kind up to the Treasury Board or Ministry of Finance as they have the greatest expertise in this area. Six individuals suggested that the source of the funding should be tied to where the benefits of the proposed program accrue. For instance, if the main beneficiary of the program was the province at large, then it would make sense to draw the funds from general revenue. Alternatively, if the program was going to benefit the electricity system more specifically then it was suggested that the revenues should be drawn from the electricity rates.

In addition,12 participants suggested that the carbon tax revenues could be redirected from tax cuts toward infrastructure investments and programs, including those for clean and renewable energy. Two participants also suggested that the province could have a small levy on fossil fuel development and reinvest this money into a clean and renewable energy strategy. These participants suggested that this would make the further development of the fossil fuels contingent on the development of the cleaner options. Finally, three individuals specifically emphasized that, no matter where the funding was coming from, there should always be a clear and transparent justification for the source chosen.

5.3. Long-term Vision

There was consensus among participants that BC needed a more clearly defined long-term energy vision for the province. Ten participants stated that BC had done more than most jurisdictions, and that for industry, the framework developed leading up to the *Clean Energy Act* had been a move in the right direction. One participant suggested that the lack of a credible long-term vision may have something to do with the fact that no one has had to make a hard decision about energy for the past 20 years and that the province had been living off the investments of past generations. Four participants suggested that, while it appeared the government of BC was very committed to clean and renewable energy, a credible strategy on how to meet the province's proposed energy goals was still missing.

There was also seen to be too many small short-term solutions. Five participants identified that having incentives turn on and off over short time periods, such as in the case of Solar BC, was not helpful for providing the needed stability to establish new industries. Another participant suggested that society needed to redefine what was thought of as long tern and for BC to move the planning cycle beyond the general 20-year acquisition process.

Fourteen participants also emphasized that goals set have important implications for the policy direction. As one participant stated: "What are we looking for? That is the crux of the discussion. What is the goal?" It was seen as important to these 14 participants to be clear about what specific programs were trying to achieve in the near and long-term, whether it be technology development, diversification of supply, or GHG emissions reduction. Five participants also asked questions around what types of supply and energy characteristics did the province desire for its generation mix over the long-term. Defining the characteristics of the energy and not necessarily the specific technologies that allow for those characteristics was seen as an important long-term strategy for setting the direction of technological development and for the diversification of BC's energy supply mix. This, it was suggested, would allow for clearer mandates and long-term planning, and allow for policy and programming to better address the benefits and limitations of the various technologies.

Long-term planning was seen as a fundamental challenge of BC's political system by ten participants. Three participants suggested that the change in leadership of the BC Liberal party had given industry pause due to the BC Hydro rate review and general uncertainty about the party's direction. However, there was not a consensus on the impact of political change. One participant suggested that governments would come and go and would rebrand the same projects under different names. According to this participant it was up to the utilities and industry to move beyond the politics and make "no regrets decisions". Five other participants did not share this view and instead saw the building of broad political support for long-term decisions as the solution to creating more stability and reaching difficult energy goals. Three participants suggested that there was a need for a stable and clear policy direction that successive governments could sign onto. As one of these individuals offered; "we need to somehow to separate out the longer provincial strategic plan from the day to day politics, and the short political duration we have for different parties."

5.2. Summary

This chapter thematically organized and recounted the findings from 29 interviews conducted with energy sector participants in BC. There was recognition amongst participants that the development of clean and renewable energy in BC, while supported, was subject to particular barriers unique to the BC context in both kind and scope. These included: the unsettled nature of First Nation rights and title claims in BC; entrenched biases towards large projects at BC Hydro; limited social license for developers to operate; uncertainties regarding the provision of transmission infrastructure to electricity projects; the small market for additional clean and renewable capacity in BC and; the low cost of more established incumbent energy sources.

Participants emphasized numerous potential policy and program design consideration during the discussions, and continually highlighted the need for increasing the stability and predictability of all policies and programs that pertain to energy. GHG emissions pricing was seen as an important mechanism for driving a long-term energy transition, and there was a general preference for carbon taxes over cap-and-trade schemes for this purpose. For electricity acquisition, the current boom and bust cycle of the calls for power were identified as presenting challenges for industry in BC. In addition, there was strong support for programs such as the SOP, despite limitations it presents for particular technology streams such as wind and geothermal. For technology development, there was support for using different tools to support the development depending on the technology's stage of development continuum, but there was not a consensus on this point as some participants preferred technology agnostic policies. Granting programs were generally seen as important for the development of technologies as well as building connections between industry participants and between academics and industry. The FIT was generally identified as a sub-optimal policy for technology development for jurisdictions that could not drive the market pull needed to provide its benefits. There was not a consensus on where the financing should ideally come from to support energy policies and programs, but there was good support for the idea of linking the funding to the area where the benefits from the program are expected to accrue. While there was disagreement over the benefits of picking winners at a company level, there was greater support for the idea of picking winning areas or resource areas to focus limited resources on to ensure greater return on investment. High level and broad political support and long-term vision were also emphasized as significant for providing credibility to energy programming and delivering increased certainty for investments.

6. DISCUSSION

The aim of this report has been to evaluate the efficiency and effectiveness of various incentives and measures for the development of clean and renewable energy projects and technologies in BC. To that end, this chapter presents a discussion of the key interview findings in relation to the literature review and the BC context. The first section of this chapter discusses the main policy portfolio considerations taken from the literature review and the interview findings, and focuses on instruments that are relevant to the BC context, including a discussion of some existing policies and measures. The section is divided into three parts: greenhouse gas (GHG) emissions pricing, considerations for electricity acquisition and considerations for technology development. The material considered for this report has also emphasizes that, while the choice of support or incentive instrument is important, the environment with which the instrument operates is also an important consideration. The second section of this chapter provides a discussion of the key considerations for the operating environment most widely raised by interview participants and in the literature. These include policy and program administration considerations, the link between energy impacts and exports, and the need for long-term vision and goals to increase certainty for energy projects and investments.

6.1. Policy Portfolio Considerations

The energy literature and interview data both generally suggested that a portfolio of policies was the preferable approach for the development of clean and renewable energy project and technologies (Yin and Powers, 2010; Fischer and Newell, 2008). There was also theoretical support in the literature and among participants for the idea that a single overarching GHG emissions pricing mechanism may be able to encourage the development of clean and renewable projects and technologies more efficiently than a suite of policies (Fischer and Newell, 2008). However, no single policy was identified as being able to address all of the other market failures that exist in the energy sector, such as those related to the nature of knowledge creation (Philibert, 2011). In addition, interviewees and the literature recognized that a GHG emissions price high enough and/or applied over a sufficiently large geographic area was not currently politically credible and was unlikely to happen in the near future (Heiman and Solomon, 2004; Mitchell, 2008). The policies discussed below include: the carbon tax, cap-and-trade schemes, the Calls for Power and Standing Offer Program (SOP), granting programs, loan guarantees, and feed-in tariffs. The technology development section also includes a section on picking winners and strategic choices for funding direction. These policies were the most widely discussed by interview participants, had general support in the energy literature, and are the most relevant to the current BC context.

6.1.1. GHG Emissions Pricing

There was agreement between interview participants and the literature that placing a price on carbon, through either a carbon tax or cap-and-trade scheme, was an important part of any long-term energy transition towards more clean and renewable resources and technologies (Fischer and Newell, 2008; Sovacool, 2011; Mitchell, 2008). While there was no consensus in either the literature or among participants regarding a preference for either carbon taxes or cap-and-trade systems although there was greater general support for carbon taxes (Sovacool, 2011; Mitchell, 2008; Hammar and Sjöström, 2011; Fischer and Newell, 2008). This preference stemmed from concerns with regard to the main weaknesses associated with tradable permits systems, such as increased transaction costs, susceptibility to political lobbying, and permit price volatility (Sovacool, 2011; Campoccia, Dusonchet, Telaretti, and Zizzo, 2009; Yin and Powers, 2010). These issues have been challenges for the EU's Emissions Trading Scheme (ETS) and have undermined the efficiency of the program (Sovacool, 2011). BC is a signatory to the Western Climate Initiative, which has committed to establish a cap-and-trade system to cover the emissions from numerous US states and Canadian provinces. While tradable permit based mechanisms have theoretical appeal, they are also subject to significant implementation difficulties. These problems should function as a warning to BC during the implementation phase of the Western Climate Initiative (WCI). BC has the opportunity to provide leadership to ensure it does not fall victim to the same systematic issues experienced in the EU's ETS.

Carbon taxes also have drawbacks however, as the actual quantum of emissions reductions under a carbon tax scheme remains uncertain (Mitchell, 2008). Yet the simplicity of the carbon tax and the price certainty that it affords makes the carbon tax the preferable mechanism for GHG emissions pricing and stimulating the development of clean and renewable energy options. BC already has a broad based carbon tax operating within the province. While interview participants were supportive of the tax, there was agreement that the tax was not yet at the level necessary to have a significant impact on investment decisions or behaviour. In addition, interviewees expressed uncertainty regarding the future of the carbon tax after its final scheduled increased in July 2012. This uncertainty undermines the main benefits of the carbon tax as individuals and companies are no longer certain that their future operating costs will increase through the tax, which threatens to derail investments into lower GHG emission options including clean and renewable energy investments.

6.1.2. Electricity Acquisition

BC is in the fortunate situation of having more than 93% of the province's existing electricity generation coming from clean and renewable resources. There is pressure to add additional clean and renewable supply to support population growth, additional economic development, and the clean energy export agenda, but this pressure is generally less than in other jurisdictions. This is one of the main reasons why BC has chosen not to use its proposed feed-in tariff policy as its general energy acquisition strategy. This is unlike other jurisdictions, such as Ontario and Germany, which have wanted to add significant new clean and renewable supply to their existing generation mixes. To accomplish such an aim, these jurisdictions were required to offer subsidies to various types of clean and renewable supply technologies, at considerable cost. BC still has large amounts of potential clean and renewable supply from lower cost resource areas and therefore does not need to rely on less economical options to supply its main load centres for the near future.

To encourage the further development of already commercialized and economical projects, a commonly discussed measure in the literature is the renewable portfolio standard (RPS) (Sovacool, 2011; Yin and Powers, 2010; Heiman and Solomon, 2004). BC does not have an RPS policy, but it does have a similar quota-type policy requiring 93% of the province's generation mix to be from clean or renewable sources (BC Government, 2010a). This percentage is much higher most other jurisdictions' RPS requirements and appears to be a progressive and powerful policy. However, as the policy allows all existing clean and renewable capacity to count, and as BC already produces 93% of its electricity from clean or renewable sources, it represents a status-quo approach. The *Clean Energy Act* also requires that all additional electricity projects must be from clean or renewable sources. The combination of these policies does provide some certainty to the clean and renewable energy sector but does not give an incentive to decarbonize the remaining 7% of the generation mix.

Given BC's favourable position with regard to potential new cost-effective renewable supply, interview participants generally felt that the current electricity acquisition policies (i.e. Net Metering, Standing Offer Program (SOP), and the Calls for Power) are serving the supply needs of the province well. This does not mean that there is no room for improvement, however. While it appears it was the intention to construct these policies as technology agnostic, several interviewees felt that some design characteristics may have inadvertently disqualified certain technologies. For example, it was suggested by participants that geothermal was essentially eliminated from consideration under both the SOP, due to size restrictions, and the Clean Power Calls, due to long project lead times and uncertainties with regard to the provision of transmission infrastructure.

Interview participants also identified the boom and bust nature of the Clean Power Calls as an impediment to certainty for the energy industry and as disadvantaging small companies in particular, as small companies were less able to survive the long periods between major calls. Conducting more regular and predictable calls may offer a solution to this problem, as it would provide improved stability and allow industry to undertake greater long-term planning. Other interview results suggested possible significant risks associated with conducting more regular calls including BC Hydro's possible lack of capacity to effectively conduct calls that would overlap at various stages of the process. It is not clear from this research whether or not the risks of conducting more regular calls would outweigh the benefits, or vice versa.

Interview participants also suggested that the uncertainties regarding what BC Hydro will and will not undertake with regard to the provision of transmission infrastructure to new projects was an issue for the development of new projects. Jurisdictions such as Texas and California have been successful in working around this uncertainty through the establishment of competitive renewable energy zones (CREZs) (Puga and Lesser, 2009; Schumacher, Fink, and Porter, 2009; Hurlbut, 2008). The CREZs identify areas that have the greatest potential clean and renewable resources, the most acceptable environmental footprint, and ensure that projects approved for development within the boundaries of the CREZ will be provided transmission infrastructure (Schumacher, Fink, and Porter, 2009; Hurlbut, 2008). The zones provided greater certainty and focused industry's attention on particular geographic areas, which allowed for a planning environment with reduced risk (Alagappan, Orans, and Woo, 2011; Hurlbut, 2008).

BC is in a somewhat similar situation in that some of the best potential areas for resources such as wind and geothermal are not necessarily close to existing transmission infrastructure. Although development of all the rich clean and renewable resource areas will not be undertaken due to both environmental and economic considerations, the province may wish to look more seriously to these other resources in the long-term to diversify the generation mix. It was also suggested by one interviewee that the potentially lengthy transmission negotiations that a developer must engage in with BC Hydro further increases the risks of projects. The provision, for example, of a CREZ for geothermal resources, could significantly reduce project risks and increase the likelihood of a geothermal project being among the selected projects during a call for power. This would also increase BC Hydro's experience with the resource and potentially pave the way for further geothermal development, as was seen with wind energy deployment in Texas

(Barradale, 2010). Guarantees regarding the provision transmission infrastructure can be expensive, however, and should be undertaken with care.

6.1.3. Technology Development

There was no agreement in either the literature or among interviewees as to whether support policies should be tailored to specific technology streams or offered at a flat rate across all technologies (Goodward et al., 2011; Philibert, 2011; Frondel et al., 2009). Proponents of flat rate incentives argue that these will result in efficient development of projects and technologies as each technology competes to become competitive at the level of the subsidy. Differentiation lessens the impetus for technological innovation as the technology no longer needs to compete against other potentially lower cost options in order to gain market share. Therefore, according to these observers, policy makers should avoid choosing technology winners, and develop technology agnostic support policies to meet particular desirable design characteristics (Frondel et al, 2009; Holburn, Lui, and Morand, 2010).

However, flat rate subsidies have only been shown to support those technologies that are already the most cost competitive (Goodward et al., 2011; Philibert, 2011; Sovacool, 2011). This has been the case for electricity programs that might have theoretically supported multiple technologies. In practice, the vast majority of projects built through these programs have been for wind converters or hydro installations. If goals include areas such as technological development to take advantage of specific resource areas (e.g. biomass, wave, tidal, geothermal etc.) or the differentiation of its electricity generation mix, then incentives and measures tailored to specific technology areas are likely justified.

Strategic Choices and Picking Winners

While literature and interviewee support for the idea of picking winners was varied, both sources suggested that focusing on particular areas where a jurisdiction has competitive advantages can pay dividends, such as in the case of Denmark and wind turbines (Heiman and Solomon, 2004; Kerr, 2010; Nemet, 2010). Governments have traditionally needed to provide substantial portions of the initial investments in energy technology development, due to the high upfront capital costs and uncertainty regarding potential returns on investment (Kerr, 2010; Goodward et al., 2011). Given the investments required and the current tight budget realities, there is a strong argument to be made for pooling available resources into particular areas, rather than spreading the investment out and reducing the overall impact.

Interview participants felt that BC's programs and policies, and Canada's more generally, spread investments too thin to make a significant impact in moving technologies from concept to market deployment. BC has already identified bioenergy as a priority for investment though the BC Bioenergy Strategy and supporting measures such as the bioenergy calls for power and the BCBN. However, several interviewees felt that BC could further this type of "picking winning areas" approach in order to increase the probability of a return on investment into technology development. Investing in the development of resource areas that the province already has significant resources in also has a strategic advantage. These areas are more likely to play a role in the future energy mix of the province itself as opposed to being a technology that is primarily developed for export. Ocean energy was identified as fitting these criteria and was suggested by several interview participants as a potential area that the province could focus further investment into.

In addition, it was also identified by interviewees that if BC were to focus on particular areas for investment, it would make sense to focus on areas that require significant future investment and innovation. For example, the probability of BC becoming a major player in the advancement or manufacturing of an area such as solar photovoltaic (SPV) panels is quite limited, given the level of development of the industry internationally and the larger historical and ongoing investments that other jurisdictions have put into the SPV space. On the other hand, ocean energy technology has been identified as underfunded and underdeveloped, but also as having a high potential for additional innovations and output capacity (Kerr, 2010; IEA, 2011).

A Continuum of Support

There is a growing recognition that supports and incentives for the development of new clean and renewable energy technologies need to be matched to the level of development of the particular technology under consideration (Goodward at al. 2011; Philibert, 2011). This is largely to do with the fact that technologies at certain stages of development have particular risks and needs associated with them, and that different tools and measures have particular strengths and weaknesses for addressing these various risks and needs, both from the government and technology developer perspectives (Goodward et al., 2011). In this way, an ideal energy technology strategy would have separate instruments that would carry the technology through the different stages of the development continuum until it reached market deployment or was determined to not be feasible at this time. Some overlap between the support provided from the different instruments should also be considered normal, as technology development stages are not as discrete and identifiable in practice. This last point also emphasizes the need to be flexible in the approaches applied to support different development projects. This type of approach would create increased certainty and help technologies move past the funding “valley of death” that often occurs between the proof of concept stage and full-scale demonstration (OECD, 2011, p. 57; Goodward et al., 2011; p. 3).

One essential yet simple tool identified in the literature and by interview participants for the development of projects between the pilot and commercial demonstration stage is the direct application of partial funding, or grants. Projects at this stage have proof of concept, but have difficulty attracting investors due to the uncertain nature of the technology at various scales and uncertainties with regard to its performance under real life conditions (Goodward et al., 2011). Grants help buy down the risk of a project and decrease the remaining investment required. A successful public sector grant can also help leverage further investment from the private sector. This model is already applied in BC through the granting programs of the Innovative Clean Energy (ICE) fund and the industry led BC Bioenergy Network (BCBN). However, according to interviewees, BC has a tendency to want to allocate money in granting programs to as many projects as possible, which potentially undermines the benefits of providing the grant in the first place. Several interviewees also noted that some projects funded through the ICE fund were only given 10% or less of the total project value. This amount did not underwrite much of the projects’ risks and did not solve the issue of project financing. For partial funding to be effective, grants need to be large enough to draw in the additional investment required, balanced with the potential benefits of financing additional projects.

At the later demonstration and early commercialization stages of development, loan guarantees are an effective and efficient way to mobilize the required investment according to the literature and a number of interview participants. The capital requirements in these stages are significantly increased from the earlier stages, and there are still development uncertainties and a lack of familiarity with the technology by financial institutions. This makes obtaining financing difficult (Goodward et al., 2011). Underwriting part or a developer's entire loan will also allow the project to receive longer-term financing than would otherwise be possible, which reduces capital financing costs (Goodward et al., 2011). While the prospect of project failure opens up the government to increased risk under a loan guarantee program, it is nevertheless one of the most certain ways to ensure the development of commercial demonstration scale projects of promising new technologies (Goodward et al., 2011; OECD, 2011).

With respect to later commercialization and market deployment stages, the literature and interview participants both emphasize that the technology push can only take the development of new technologies so far, and that this approach must be matched with a market opportunity or market pull (Philibert, 2011; IEA, 2011). To address this need for a market pull to complement the technology push, a popular instrument many jurisdictions have implemented for electricity projects is the feed-in tariff (FIT) (Mendonoça, Jacobs, and Sovacool, 2010). A key feature of most FIT policies is the establishment of a mass market to deliver learning-by-doing effects that result in subsequently lower generation costs, as shown by the progress ratio (Philibert, 2011). Almost all jurisdictions that have implemented FIT policies have had less than 10% of their existing generation mix come from clean and renewable energy. In these jurisdictions, the FIT was seen as a key policy instrument to drive the transition towards alternative generation methods and add significant amounts of new capacity as well as to deliver the technology improvements and stimulate economic activity (Mendonoça, Jacobs, and Sovacool, 2010). Some observers have argued that in order for FIT policies to be effective and provide the desired investment certainty, they must be free from capacity caps to allow for a strong market pull (Mendonoça, Jacobs, and Sovacool, 2010).

BC has already stated that there is no intention to use the proposed FIT policy as a general electricity acquisition tool and has instead designed what interviewees described as a "modest" program with a $25 million cap. There was agreement amongst interview participants that there was no need for BC to implement a general FIT, as Ontario and Germany have done, as BC still had significant amounts of lower cost supply to develop before it would be required to exploit less economical clean and renewable options. Interview participants felt that the small market pull provided by the proposed FIT would be unlikely to allow for sufficient deployment to see the intended technology advancements or to attract the additional green jobs that are often a major motivational factor behind FIT policies. The scale of the market required to derive many of the benefits from the FIT mechanism does not appear to be present in BC.

Despite these potential drawbacks to implementing a more limited FIT, several interview participants suggested that the provision of at least some form of market pull was important. New technologies' operations and maintenance (O&M) costs are often higher than the prevailing market price for the energy they produce. Once a new facility is built, it is often unable to remain in operation without the input of additional funds, and thus cannot capture the learning and increased profile related to its operation. Despite a potential lack of a large market for additional capacity in BC, there may still be the need for an instrument to add a market pull when technologies hit a certain point in the technology development continuum. Interview participant suggested that the above considerations are partly what drove the design of BC's proposed limited FIT. The proposed policy is missing many of the core features FIT policies usually possess, such as long-term contracts and no capacity caps. It could be argued that the SOP looks more like a FIT with a flat tariff rate than the proposed FIT design. Interviewees also suggested that policy options to meet the desired objectives of the proposed FIT were also constrained by the fact that the creation of a FIT was specifically mandated through the *Clean Energy Act.* As the FIT policy has not been used in such a specific or constrained way in any other jurisdiction, it is difficult to examine how it will perform in BC, but interviewees felt the program as currently defined would face considerable challenges meeting its goals.

6.2. Operational Environment Considerations

While this paper's primary focus and purpose has been to examine supports and incentives for the development of clean and renewable energy, the findings have also suggested that the environments in which these instruments operate have implications for their efficiency and effectiveness. This section examines the main considerations that arose from the literature and participant interviews, with particular attention to areas that are of potential significance for BC. The discussion focuses on considerations for energy policy and program administration including its placement, the relationship between energy impacts and access to export markets, and the impact that long-term vision and goals have on certainty and the clean and renewable energy sector.

6.2.1. Policy and Program Administration

Decisions regarding the type of organizational body responsible for the administration of energy policies and programs have the potential to significantly impact their success. While a program such a FIT logically resides with the electricity purchaser (i.e. the utility), the ideal body for the administration of other programs is less clear-cut. Administration of programs through a government department carries risks with regard to instability of funding during times of economic downturn, and the increased potential, both real and perceived, for political interference in decision making and project selection (Kerr, 2010; Dinica; 2006). These risks decrease certainty for technology investors and developers, which will reduce investment and program uptake. To overcome these challenges, several informants suggested that the use of the arms-length model for granting programs, such as with Sustainable Development Technology Canada (SDTC), would provide greater certainty to technology developers.

An arms-length organization would also be able to provide increased coherence for funding decisions and function as a repository and coordinator for knowledge generated through successful and unsuccessful projects (IEA, 2010). Interviewees also suggested that an arms-length organization would be less constrained as to the types of conversations it would be able to engage in. Such an organization would be also be better placed to act as a relationship intermediary between industry and academia, and between smaller companies with technology aspirations and larger companies with greater resources to help realize those objectives. The increased distance from potential political interference also decreases the likelihood that technologies or projects will continue to receive support once it is determined that the project is a failure (IEA, 2010). Interviewees suggested that recognizing failure early was essential to be able to save resources and to help capture the knowledge that the failed undertaking generated, which can aid future projects and funding decisions.

Regardless of whether or not technology supports and incentives are administered by a government department or an arms-length organization, there are processes that are common to successful utilization of these types of instruments. Interviewees emphasized that peer review of applications was important as it increased the likelihood of supporting successful projects. Participants also noted that peer review decreased the potential for information asymmetries between decision makers and program applicants, as decision-makers do not necessarily have the technical knowledge required for evaluating new technology prospects and risks. Successful programs have also tended to have simple and clear procedures, and competitive public requests for proposal (RFP) mechanisms with well-communicated timelines (Goodward et al. 2011).

6.2.2. Impacts and Exports

The *Clean Energy Act* has established the export of energy as one of BC's energy goals. There has been a significant export component of the province's energy policy since the early 1960's (Froschauer, 1999). Froschauer argues that much of the construction of the large hydroelectric facilities in the 1960's and 70's, such as Revelstoke and Shrum, was meant to position the province as a supply source California's "power hunger" and other US markets (1999, p. 200). Access to the California market became restricted by the US federal Bonneville Power Authority (BPA), however, which left BC with a significant surplus electricity generation capacity in the 1980's (Froschauer, 1999).

Now, as then, there are still significant risks regarding the development of energy capacity for export outside the province. Once the additional capacity is constructed for export purposes, there is no guarantee that the energy will be accepted by the desired market or for the price envisioned. For example, if California Senate Bill X1 2 passes in its current wording, it would establish a renewable portfolio standard (RPS) for the state's utilities, but would disqualify the majority of BC's electricity supply from its definition of renewable energy (Simitian, Kehoe, and Steinberg, 2011). Similar events have recently occurred in the biofuels sector, where changes to the definitions of what was acceptable under the US' blending standards have essentially stopped exports from Canada to the US (S&T^{2}and Cheminfo, 2011). This point was also articulated by interviewees who suggested that a similar situation was equally likely with regard to an exclusion for both electricity and fuels produced from pine beetle wood, which would significantly diminish BC's bioenergy export prospects to the US and/or EU.

If a more widespread carbon economy develops in North America, BC may be in a favourable export position given its abundance of clean and renewable energy options and existing hydroelectric storage and generating capacity. This prospect is not yet certain, however, and there would still be no guarantee that BC's energy products would meet the increasingly stringent regulations and standards in US states. These issues highlight the need to continue to build relationships between jurisdictions and work to ensure coordination of regulations and standards over as wide an area as possible (OECD, 2011; IEA, 2011). Interviewees suggested that attending to the impacts of various types of energy sources up front is important for building the industry's social license to operate, and to avoid potential future public backlashes against particular energy projects. This backlash has been observed in BC for particular hydro projects, and in Ontario for many of the province's new wind installations (Hume and Hunter, 2010; Blackwell, 2012). Holding new technology projects to high environmental standards was identified by participants as having the potential to slow down the technology's development, but was suggested to pay dividends for the environment and for the technology itself. This was due to the fact that, if the increased scrutiny enhances the possibility that the technology would meet other jurisdictions' regulations, then there would be a greater chance that either energy produced using that technology or the technology itself would be viable for export. Participants additionally emphasized that identifying impacts as a concern at the front end of a technology's development allows for these concerns to be better integrated into innovation processes throughout the development continuum.

6.2.3. Long-term Vision, Goals, and Certainty

A consistent theme in the literature and the interview findings was that due to the high capital costs and long time frames involved in the development of energy projects and technologies, stability and increased certainty were important components of successful energy governance regimes (Goodward et al., 2011; Philibert, 2011; Sovacool, 2011; Fischer and Newell, 2008; Holburn, Lui, and Morand, 2010: Parkus and Barth, 2011; Nemet, 2010). Achieving this desired certainty has proved a difficult objective for many jurisdictions. Uncertainty regarding broader future economic conditions and the short political lifecycles that exist in most jurisdictions create barriers and challenges to providing certainty through programs and policies (Philibert, 2011; Fischer and Newell, 2008).

This problem is particularly pronounced in areas of energy programming where the sector may be fundamentally reliant upon government funding for the development of projects. Uncertainty regarding a program's future will reduce the number of projects being developed for application, as there is no guarantee to industry that a particular program will exist when they have completed the project proposal. While there continues to be some degree of uncertainty in the development of energy projects and technologies, uncertainty can be reduced through programs and policies that provide stability, and by supporting these tools with high-level political commitment and vision (OECD, 2011; Fisher and Newell, 2008).

Furthermore, for any vision to be credible, it must also have as broad support as possible. Without such support or a sustainable source of funding for the supporting measures, any stability that was intended by the creation of an energy vision would be lost, as there is no guarantee that the plan would survive the next election cycle or economic downturn. In addition, interview participants felt that incremental support and programming changes that can be believed to have sustainability are preferable to large-scale programming and huge injections of funds at one time or another, despite generally large capital demands for energy projects.

Building support for energy development policies can also be more difficult compared to other program areas. As a result of the long time frames generally associated with the development of energy projects or technologies, it can be easy to be cynical regarding the projected long-term benefits that public investments into these areas will produce. There is also the risk of "issue fatigue," the loss of interest or support associated with continually portraying long-term energy issues as crises, which has the tendency to overemphasize the benefits associated with particular investments (Nemet, 2010, p. 7223). Interview participants felt that to be effective at innovation, there needs to be a greater general acceptance and recognition of failure. This was viewed as an important consideration, as failure was an essential part of the innovation process and inevitable when dealing with new technologies.

These considerations were part of the motivation for the BC government to initiate the Clean Energy Advisory Task Force in 2009, so the province could build on the direction set out in the 2007 Energy Plan. While the task force included a wide array of representatives from across the province, and provided an opportunity for the public to make submissions, it was criticized for being rushed and lacking transparency. Such issues undermined the very objectives of greater certainty and trust that the task force had set out address (Heap, 2010; Burrows, 2009). In this particular instance, there was also skepticism regarding the appointed members of the task force since many were shown to have provided financial support to the governing Liberal Party of BC (Burrows, 2009). These types of criticisms feed into what observers have described as a more general "crisis of trust in politicians, professionals and public institutions", which does not help the credibility of policies and programs (Belfiore, 2009, p. 346).

The interview data presented above suggests that despite the appropriate sentiments being expressed, the BC government still lacks a credible plan on how it is going to fully implement its long-term energy vision for the province. There is, however, an opportunity to build on the previous work undertaken by refining and establishing a coordinated constellation of clearly articulated policies that are connected to particular provincial objectives. There is also the opportunity to add specificity to broad policy objectives, and provide a clearer vision of what the province's energy supply mix will look like by particular target dates. To build broad support for the policy and program developments contemplated under a long-tern strategy, the developments should be undertaken in a transparent fashion, and include a considerable public, industry, and First Nations consultation component.

6.3. Summary

This chapter has discussed the key findings from the literature review and participant interviews in relation to the BC context. Key considerations with relation to the main themes from this research were discussed, including those related to the acquisition of electricity, technology development, and operational considerations for the efficient and effective development of clean and renewable energy resources and technologies. These ideas are further distilled in the following chapter which provides recommendations to the BC government.

7. RECOMMENDATIONS

This chapter explores the author's recommendations to the BC Government to answer the project's research question:

What supply side policies and measures would best incentivize and accelerate the development of clean and renewable energy projects and technologies in BC?

Seven recommendations were developed through careful consideration of the information collected through the literature review and participant interviews. The recommendations are ranked according to a proposed implementation order and contain specific suggestions for implementation including timelines.

1. *Commit to the Carbon Tax*

The BC Government could commit to making the carbon tax a permanent fixture of the province's fiscal framework and continue increasing the tax rate by $5 per tonne of CO_2 equivalent emissions per year as previously undertaken since 2008. Announcement of the continuation of the carbon tax would happen as far in advance of July 2012 as possible to provide increased certainty for investments.

In 2016, the government could consider moving away from the strict revenue neutrality of the carbon tax. Revenues could be funneled back into areas such as the development of clean and renewable energy projects and technologies.

In 2018, when the tax has reached $60 per tonne of CO_2 equivalent emissions and depending on the development of emissions pricing regimes in other jurisdictions, the province could decide to reduce the rate of tax increase for important energy intensive industrial sectors.

2. *Develop a loan guarantee program for commercial demonstration projects*

The province could develop a loan guarantee program to support the development of commercial scale demonstration projects of promising new clean and renewable energy technologies.

The program would offer to guarantee a loan of 50% of total project costs. No cap on total loan size would be established as the costs of commercial scale installations for different technologies can vary significantly. Projects would be selected by way of a public and competitive request for proposals (RFP) mechanism and no more than two projects would be selected per RFP process. Application expectations would be communicated at least six months in advance of the RFP process.

Transparency would be created by establishing an independent expert panel to make public recommendations on the selection of projects and by providing program applicants with explanations why their project was not selected.

Predictability would be created by conducting RFP processes in a standardized bi-annual fashion and by having specific timelines for the selection or rejection of projects. Initiation of this program could be targeted for the spring of 2014.

3. Do not proceed with the proposed Feed-in Tariff (FIT) program

The BC government would inform industry stakeholders that the program will not proceed. Key messages would include:

- The government is reconsidering its position on the FIT program and have delayed implementation indefinitely.
- The BC government remains strongly committed to the responsible development of clean and renewable energy projects and technologies in the province.

To demonstrate the government's ongoing commitment, the announcement could potentially be paired with the announcement of the province's intention to develop the loan guarantee program for commercial demonstration scale projects.

4. Conduct more regular Calls for Power

The BC government could request BC Hydro to conduct more regular and predictable Calls for Power. The calls would occur no longer than three years apart and take place at a well-communicated and standardized time. The province could commit to a standardized minimum amount of electricity for each call, such as 250 megawatts. This amount could be expanded upon depending on circumstances and need. The implementation of more regular Calls for Power could start in the fall of 2014.

5. Develop a BC Ocean Energy Technology Strategy

The BC government could develop a strategy to specifically foster the development of ocean energy technology in BC.

The strategy would operate in tandem with the current BC Bioenergy Strategy to identify these two resource areas as specific focuses of the BC Government. In addition, the strategy would build upon the existing technology development programming in the province. For instance, committing a percentage of the Innovative Clean Energy fund's resources towards ocean projects in selected years.

The strategy would also contain elements to encourage further linkages and partnerships between industry and academia, and between industry within the province and larger international companies with greater capacity and financial resources. This would include support for multidisciplinary conferences and symposiums on ocean energy.

The development of the strategy's details would include a transparent consultation process involving the public, industry, First Nations and universities that would take a minimum of six months. Implementation of the strategy could be targeted for the fall of 2014.

6. Renew the BC Energy Plan to deliver a long-term energy vision

The BC government could update the *BC Energy Plan* to deliver a stable long-term energy vision for the province. The plan would be updated to include greater specificity regarding provincial goals and targets as well as clarification of the policies and actions that would be used to reach those goals. This would include identifying the future characteristics of the energy mix that would be achieved by particular target dates, such as the percentages of supply from base load and intermittent sources, and the percentage supply of alternative transportation fuels in the province.

The updated plan would be identified as a high level priority for the province. The process of updating the plan would include broad and transparent consultations with the public, First Nations, not for profit organizations and industry. The consultation period would take place over the course of a year to allow for a broad range of submissions from each of these groups. Completion of the renewed plan could be targeted for release by the summer of 2015.

7. Establish a provincial equivalent of Sustainable Development Technology Canada (SDTC)

The BC Government could consider the development of a provincial equivalent of the federal SDTC to oversee the province's energy, and possibly other, technology granting operations. Development of the agency would occur in close consultation with SDTC to help ensure strong ties and coordination between federal and provincial funding decisions.

Resources dedicated to the ICE fund would be collapsed into the new organization as well as the administration of project selection for the new loan guarantee program. The external panel developed for the administration of the new loan guarantee program could also be utilized for the selection of projects though the new organization.

The programs administered by the external agency would remain as public and competitive RFP processes. The RFP would occur annually at a set time and have clearly established and administered timelines for project acceptance or rejection.

Application procedures and reporting requirements would also be standardized between SDTC and the new agency. The external agency would act as a repository and coordinator of knowledge gained through successful and unsuccessful projects.

The organization would be independent but accountable through BC Ministry of Energy and Mines and report to the Legislature on its activities through annual reports and budget statements tabled by the Minister of Energy and Mines. The implementation of this new provincial agency could be scheduled for 2016.

8. CONCLUSION

This report was undertaken for the BC Ministry of Energy and Mines' Renewable Energy Development Branch in support of the province's energy objectives. Specifically, the report sought to investigate what types of supply side policies and measures would best incentivize and accelerate the development of clean and renewable energy projects and technologies in BC. To answer this question, a review of the academic and professional literature pertaining to the key supports and incentives was undertaken. In addition, interviews were conducted with clean and renewable energy experts and practitioners. These individuals were from government departments, crown corporations, not-for-profit organizations, universities, industry associations, and within the energy industry itself, and represented a broad range or energy sector involvement.

While implementing energy supply side policies and measures are important for addressing future energy demands and generating economic activity, demand side instruments also form an important part of a comprehensive clean and renewable energy transition strategy. It is important to ensure that investments into energy supply does not crowd out investments in energy efficiency improvements that may also have considerable benefit for the province. Further research could focus into the area of energy demand management practices to allow for a coordinated policy strategy that addresses both the demand and supply sides of the equation.

The materials considered for this report emphasized the need for predictability and stability for all policies and programs that pertain to energy due to the long time frames and large sums of money associated with energy developments. The report also suggests that energy programming should be tailored to match specific stages on the technology development continuum. Finally, this report emphasizes the need for a widely supported, stable long-term energy vision. BC has the opportunity to build on its solid foundation and further develop a coherent constellation of programs and policies to support the development of the projects and technologies that will deliver economic benefits and power the province for the coming century.

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APPENDIXES

Appendix I- British Columbia Legislation Partially or Wholly Administered by the MOEM

- *BC Hydro Public Power Legacy and Heritage Contract Act*
- *Clean Energy Act*
- *Coalbed Gas Act*
- *Energy Efficiency Act*
- *Gas Utility Act*
- *Geothermal Resources Act*
- *Greenhouse Gas Reduction (Renewable and Low Carbon Fuel Requirements) Act*
- *Hydro and Power Authority Act*
- *Hydro Power Measures Act*
- *Ministry of Energy and Mines Act*
- *Natural Gas Price Act*
- *Petroleum and Natural Gas Act*
- *Petroleum and Natural Gas (Vancouver Island Railway Lands) Act*
- *Power for Jobs Development Act*
- *Special Accounts Appropriation and Control Act, s. 9.5*
- *Vancouver Island Natural Gas Pipeline Act*
- *West Kootenay Power and Light Company Act, 1897 (Private Act)*

Appendix II- BC Government Energy Objectives as in the Clean Energy Act (2010)

a) to achieve electricity self-sufficiency;

b) to take demand-side measures and to conserve energy, including the objective of the authority reducing its expected increase in demand for electricity by the year 2020 by at least 66%;

c) to generate at least 93% of the electricity in British Columbia from clean or renewable resources and to build the infrastructure necessary to transmit that electricity;

d) to use and foster the development in British Columbia of innovative technologies that support energy conservation and efficiency and the use of clean or renewable resources;

e) to ensure the authority's ratepayers receive the benefits of the heritage assets and to ensure the benefits of the heritage contract under the *BC Hydro Public Power Legacy and Heritage Contract Act* continue to accrue to the authority's ratepayers;

f) to ensure the authority's rates remain among the most competitive of rates charged by public utilities in North America;

g) to reduce BC greenhouse gas emissions
   i. by 2012 and for each subsequent calendar year to at least 6% less than the level of those emissions in 2007,
   ii. by 2016 and for each subsequent calendar year to at least 18% less than the level of those emissions in 2007,
   iii. by 2020 and for each subsequent calendar year to at least 33% less than the level of those emissions in 2007,
   iv. by 2050 and for each subsequent calendar year to at least 80% less than the level of those emissions in 2007, and
   v. by such other amounts as determined under the *Greenhouse Gas Reduction Targets Act*;

h) to encourage the switching from one kind of energy source or use to another that decreases greenhouse gas emissions in British Columbia;

i) to encourage communities to reduce greenhouse gas emissions and use energy efficiently;

j) to reduce waste by encouraging the use of waste heat, biogas and biomass;

k) to encourage economic development and the creation and retention of jobs;

l) to foster the development of first nation and rural communities through the use and development of clean or renewable resources;

m) to maximize the value, including the incremental value of the resources being clean or renewable resources, of British Columbia's generation and transmission assets for the benefit of British Columbia;

n) to be a net exporter of electricity from clean or renewable resources with the intention of benefiting all British Columbians and reducing greenhouse gas emissions in regions in which British Columbia trades electricity while protecting the interests of persons who receive or may receive service in British Columbia;

o) to achieve British Columbia's energy objectives without the use of nuclear power;

p) to ensure the commission, under the *Utilities Commission Act*, continues to regulate the authority with respect to domestic rates but not with respect to expenditures for export, except as provided by this Act.

Appendix III- Terminology

There are many terms used to describe energy production and use, which can be confusing and frustrating. This section contains brief definitions of energy related terms one is likely to come across while investigating the topic. While not all of the terms are used in this report it may be helpful to understand how the terms relate to one another, as many authors will use their own selection of terms and even switch between the use of the metric and imperial systems in the same publication.

Many of the different units used to describe energy outputs or consumption are determined by the relative physical differences of the primary fuel. For example, coal is often described in terms of weight whereas oil and gas are generally described in terms of volume. It is also therefore helpful for comparison and discussion purposes to have a general sense of the energy content contained in the various different sources. Figures provided below are estimates, as the exact energy content of different sources will depend on factors such as the quality of the resource (e.g. the sulfur content of coal), and the efficiency of the energy conversion process used.

Joule

The joule is the international metric measurement of energy. It is equivalent to the energy produced by the power of one watt flowing for one second (Canadian Electricity Association (CEA), nd). A joule is a very small measure of energy it is commonly expressed with metric system prefixes in front as indicated in Table 3. For example, the average total energy consumed by households in BC in 2007 was 98 gigajoules (GJ) (Statistics Canada, 2010).

Table 3. Common Metric Prefixes for Energy

Prefix		Equivalent
k	kilo	1 thousand or 10^3
M	mega	1 million or 10^6
G	giga	1 billion or 10^9
T	tera	1 trillion or 10^{12}
P	peta	1 quadrillion or 10^{15}
E	exa	1 quintillion or 10^{18}

(National Energy Board (NEB), 2010)

Calorie

The calorie was traditionally defined as the amount of energy required to heat one gram of water by 1 degree Celsius (°C) from 14.5 to 15.5 °C. This is often referred to as the 15 °C calorie, and is equivalent to 4.1858 joules.

British Thermal Unit (Btu)

Described as the English system analog for the calorie "1 Btu is the amount of heat energy used to raise the temperature of one pound of water by 1 degree Fahrenheit (°F)", and is equivalent to 1,055 joules (American Physical Society (APS), 2011; Dukert, 2009).

Quad

A measurement of energy commonly used in the US to describe aggregate energy production and consumption. For example, the total energy consumption in the US in 2007 was approximately 99.8 Quads. The unit is equivalent to one quadrillion Btu or 10^{15} Btu, and is equal to 1.055 exajoules (10^{18} joules)(Dukert, 2009).

Watt

A watt is a unit of electric power and is a rate defined as "doing work at a rate of one joule per second" (CEA, nd.):

1 kilowatt (kW) = 1,000 watts; 1megawatt (MW) = 1,000 kW; 1 gigawatt (GW) = 1,000 MW and so forth (Dukert, 2009).

Kilowatt-hour

The kilowatt-hour (kW.h) is a commonly used unit of electricity production and consumption. The unit "can best be visualized as the amount of electricity consumed by ten 100-watt light bulbs burning for an hour" (CEA, nd). Electricity is also commonly displayed in bulk units such as megawatt hours (MW.h), gigawatt hours (GW.h) and terawatt hours (TW.h):

1 kW.h = 3,413 Btu = 3.6 megajoules

Barrel of Oil

As a crude mineral, crude oil barrels are not uniform in chemical or energy content. However, a barrel is considered to be roughly equivalent to 6 million Btu or 6.33 gigajoules (Dukert, 2009). Oil is no longer handled in barrels, but the measurement has persisted in many jurisdictions. Production of oil is often reported in millions of barrels per day (mmbd), or millions of barrels per day of oil equivalent (mmbdoe) (Dukert, 2009). Many European jurisdictions report oil production in millions of metric tons:

7.14 barrels = 1 metric tonne.

1 barrel = 42 US gallons= 34.97 Imperial gallons= 158.99 litres

1 mmbd = 2.12 Quad per year = 2.24 exajoules per year

Ton(ne) of Oil Equivalent (toe)

Tons and tonnes are often used to describe oil and coal production. The toe can be a confusing measurement because some publications will use "short" or US tons (2,000 pounds), some will use "long" tons (2,240 pounds), and others will use metric tonnes (2,200 pounds or 1,000 kilograms (kg)) (Dukert, 2009). If one is uncertain which measure an author is using, it is most likely short tons. Crude oil and equivalent production includes light and medium crude oil, condensate, and pentanes plus (Statistics Canada, 2011)

Table 4. Ton(ne)s of Coal and Oil Energy Conversion Summary

Unit	Equivalent GJ
1 toe (metric)	46.06
1 toe (short)	41.87
1 tonne coal (anthracite)	27.70
1 tonne coal (bituminous)	27.60
1 tonne coal (lignite)	14.40

Unit	Equivalent GJ
1 tonne coal (subbituminous)	18.80

(APS, 2011; NEB, 2010)

Cubic Metres and Cubic Feet

In Canada, oil, gas, and coal production is often reported in thousands cubic metres (Mm^3). Many US publications will describe outputs in barrels or tons, except for natural gas, which is most often reported in terms of millions, billions, or trillions of cubic feet (cf).

1 m^3 = 35.3cf

Table 5. Cubic Metres and Cubic Feet Energy Conversion Summary

Unit	Equivalent GJ
1 m^3 Pentanes plus	35.17
1 m^3 Light oil	38.51
1 m^3 Heavy oil	40.90
1 m^3 Diesel	38.68
1 m^3 Ethanol	23.60
1 m^3 Hydrogen	0.012
1 m^3 Motor gasoline	34.66
1 m^3 Aviation turbo fuel	35.93
1 m^3 Kerosene	37.68
1 m^3 Ethane	18.36
1 m^3 Propane	25.53
1 m^3 Butane	28.62
Mcf natural gas	1.05

(NEB, 2010)

Primary and Secondary Energy

Primary energy is the energy that is contained in raw fuels (e.g. oil, coal, biomass, natural gas, wind) before it is converted to the secondary energy of electricity or heat (Schellnhuber et al., 2010). Total energy consumption for a region or individual should be discussed in terms of the combined primary and secondary energy consumption, as this gives the most complete view of resource demands and potential impacts.

Capacity vs. Generation Output

The capacity of an electricity power system is most often referring to the maximum output that a generating unit (e.g. a wind turbine) can deliver at any given moment. The generation output, on the other hand, is the amount of electricity the unit reliably delivers over a large period of time (seasonally or annually) (Dukert, 2009).

Greenhouse Gas Emissions and Carbon Dioxide Equivalent

There are numerous naturally occurring and artificially created greenhouse gasses (GHGs) present in the Earth's atmosphere including water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), ozone (O_3), sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). CO_2 is by far the most prevalent of these gasses, but all have different relative global warming potentials for given volumes. Carbon dioxide equivalent (CO_2eq) is the amount of CO_2 necessary to produce a similar warming effect by the release of a given quantity of a different GHG (Environment Canada (EC), 2010a).

Clean **and** ***Renewable Energy***

For the purposes of this report, clean and renewable energy is energy derived from clean or renewable resources as defined in BC's *Clean Energy Act* as "biomass, biogas, geothermal heat, hydro, solar, ocean, wind or any other prescribed resource" (Government of BC, 2010a).

Appendix IV- BC GHG Emission Summary

Table 6. BC GHG Emissions Summary 2000-2009 (kilotonnes CO_2eq)

GHG Source Categories	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
TOTAL Emissions	**66,241**	**67,826**	**64,938**	**66,081**	**68,157**	**65,682**	**64,835**	**68,019**	**68,719**	**68,719**
ENERGY	**51,365**	**53,739**	**51,224**	**52,061**	**54,247**	**51,833**	**51,280**	**54,651**	**55,256**	**55,256**
Stationary Combustion Sources	**22,387**	**24,681**	**22,439**	**22,001**	**23,186**	**21,639**	**21,643**	**24,222**	**23,523**	**23,523**
Electricity and Heat Generation	2,513	3,106	1,199	1,349	1,871	1,485	1,539	1,461	1,520	1,520
Fossil Fuel Industries	3,767	5,382	5,583	6,003	6,521	5,768	5,780	6,220	6,238	6,238
Mining & Oil and Gas Extraction	318	233	273	155	494	299	1,000	1,309	1,348	1,348
Manufacturing Industries	7,336	7,540	6,665	6,753	6,614	6,189	5,362	7,364	6,537	6,537
Construction	76	71	74	82	101	107	111	117	100	100
Commercial & Institutional	3,423	3,474	4,166	3,457	3,522	3,399	3,362	3,326	3,374	3,374
Residential	4,638	4,519	4,356	4,120	3,995	4,325	4,424	4,361	4,349	4,349
Agriculture & Forestry	315	356	124	80	68	66	66	64	56	56
Transportation	**23,705**	**23,503**	**23,561**	**24,895**	**25,934**	**24,953**	**24,314**	**24,917**	**25,529**	**25,529**
Domestic Aviation	1,414	1,106	1,367	1,341	1,505	1,489	1,479	1,425	1,504	1,504
Road Transportation	14,677	14,473	14,561	14,819	15,733	15,334	15,284	15,574	15,371	15,371
Railways	1,268	1,045	849	558	388	414	400	402	626	626
Domestic Marine	1,235	1,574	1,884	3,001	2,656	2,544	2,461	2,566	2,510	2,510
Other Transportation	5,111	5,305	4,900	5,176	5,652	5,173	4,690	4,949	5,519	5,519
Fugitive Sources	**5,273**	**5,555**	**5,224**	**5,165**	**5,127**	**5,241**	**5,323**	**5,512**	**6,204**	**6,204**
Coal Mining	478	522	477	431	504	543	469	521	507	507
Oil and Natural Gas	4,794	5,033	4,747	4,733	4,623	4,699	4,854	4,991	5,697	5,697
INDUSTRIAL PROCESSES	**4,776**	**3,996**	**3,674**	**4,059**	**4,083**	**4,139**	**3,957**	**3,950**	**4,059**	**4,059**

GHG Source Categories	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Mineral Products	1,348	1,273	1,309	1,288	1,407	1,376	1,397	1,411	1,281	1,281
Chemical Industry	0	0	-	-	-	-	-	-	-	-
Metal Production	1,820	1,272	1,062	1,232	1,357	1,131	1,015	1,101	1,150	1,150
SOLVENT & OTHER PRODUCT USE	**32**	**28**	**22**	**29**	**27**	**23**	**42**	**42**	**43**	**43**
AGRICULTURE	**2,432**	**2,523**	**2,531**	**2,625**	**2,686**	**2,639**	**2,397**	**2,409**	**2,394**	**2,394**
Enteric Fermentation	1,187	1,199	1,241	1,283	1,333	1,298	1,199	1,149	1,157	1,157
Manure Management	377	384	392	398	404	396	377	368	368	368
Agriculture Soils	867	940	899	944	949	945	821	892	869	869
Direct Sources	316	359	325	344	339	346	286	343	338	338
Pasture, Range and Paddock Manure	260	264	273	285	292	285	261	251	239	239
Indirect Sources	291	316	301	315	317	315	273	298	292	292
WASTE	**3,863**	**3,909**	**3,882**	**3,859**	**3,788**	**3,714**	**3,790**	**3,806**	**3,803**	**3,803**
Solid Waste Disposal on Land	3,688	3,735	3,706	3,685	3,612	3,540	3,615	3,629	3,626	3,626
Wastewater Handling	105	107	107	106	107	106	107	109	109	109
Waste Incineration	70	67	69	69	69	69	68	68	68	68
AFFORESTATION AND DEFORESTATION	**3,770**	**3,625**	**3,600**	**3,444**	**3,322**	**3,335**	**3,374**	**3,162**	**3,164**	**3,164**
Afforestation	-14	-14	-14	-15	-15	-16	-15	-16	-14	-14
Deforestation	3,784	3,639	3,614	3,459	3,337	3,351	3,390	3,178	3,178	3,178

(MOE, 2010)

Appendix V- Prepared Questions for Semi-Structured Interviews

- Tell me a bit about your position and interest in energy and energy policy?
- What do you consider the main barriers to clean and renewable energy development in BC?
    - By sector?
    - Different development sizes?
- Do you consider the size of BC's economy as a barrier to its energy goals? What is your opinion of the province's engagement with other jurisdictions over energy issues?
- The literature puts significant importance on creating stable environments for investment. What do you think of BC's current approach to this and how could the province possibly improve stability?
    - Conflicting priorities? Oil and gas investment/administrative resources, loss of tax credits for solar hot water etc. How much do optics matter?
    - Ongoing First Nation treaty processes?
- The literature also puts considerable emphasis on streamlining administrative processes for energy development. What could be improved in this regard in BC?
- In you opinion, is one major overarching policy program (such as a sufficiently high carbon tax) more effective or less effective than a suite of programs for supporting clean and renewable energy development?
    - What are the drawbacks to both approaches?
    - Knowledge spillover market failure?
    - Do you think the number of funding options from various different sources in BC creates burdensome transaction costs on businesses, communities, and individuals?
    - What types of programs or policies do you feel give the most efficient results?
        - For RD&D?
        - For project development?
- Could you comment on the major successes or challenges of some of the existing policies or programs in BC to support clean or renewable energy in BC?
    - Bioenergy Strategy- (Bioenergy Calls, Bioenergy Network, Renewable and Low carbon Fuel requirements)
    - Carbon Tax
    - Clean Power Calls
    - Hydrogen initiatives- (Hydrogen Highway, Vancouver Fuel Cell Vehicle Program)
    - ICE Fund

  - Information and education campaigns and services- (Live Smart etc)
  - Pacific Carbon Trust
  - Proposed FIT
    - People generally supported of it being a more focused technology development tool but:
    - Will the $25 million cap just be eaten up quickly by a few organized firms with the closest to commercialization technologies filling the void?
    - 5 Year contracts- too short a period to ensure payback? Or will create too much required to ensure payback which will eat up the $25 million too quickly
  - Remote and Community initiatives- (Remote Community Electification, Remote Community Clean Energy, Remote Community Energy Network, Remote Community Implementation, Towns for Tomorrow, First Nations Clean Energy Business Fund etc)
    - Conflicting programs? AANDC diesel incentives versus some of the other clean energy programs?
  - Solar BC
    - Funding ending and there is a potential for a loss of momentum and capacity behind this movement. Does this not send mixed messages to consumers?
  - Standing Offer Program
- Do government run programs not offer the same kind of stability for investors as utility or arms length organizations' programs?
- Are current electricity programs weighted in favour of hydro projects?
  - Is this problematic given the potential impacts of climate change on the timing, distribution, and amount of precipitation in the province?
- In your opinion what fuel will play a greater role in transportation in the future in BC?
  - Some argue that hydrogen for transportation is a dead technology. What do you think about this contention?
  - What are the prospects of developing Second Generation (lingocelluosic) commercial Biofuel production in BC?
- Technology forcing approach as in California?
  - Is there appetite for that in Canada?

Appendix VI- List of Short Forms and Acronyms Used

°C- Degree Celsius

°F- Degree Fahrenheit

AANDC- Aboriginal Affairs and Northern Development Canada

APS- American Physical Society

BC Hydro- BC Hydro and Power Authority

BC- British Columbia

BCBN- BC Bioenergy Network

BCOGC- BC Oil and Gas Commission

BCSEA- BC Sustainable Energy Association

BCTC- BC Transmission Corporation

BCUC- BC Utilities Commission

BMU- German Federal Ministry of Environment

BTU- British Thermal Unit

CAP- Climate Action Plan

CBPTC- Cellulosic Biofuel Producer Tax Credit

CEA- Canadian Electricity Association

cf- cubic feet

CH_4- Methane

CHFCA- Canadian Hydrogen and Fuel Cell Association

CO_2- Carbon Dioxide

CO_2eq- Carbon dioxide equivalent

COD- Commercial Operation Date

CPC- Clean Power Call

CREZ- Competitive Renewable Energy Zones

DOE- Department of Energy

EC- Environment Canada

EIA- US Energy Information Administration

EPA- Electricity Purchase Agreement

EU- European Union

FBC- Fraser Basin Council

FIT- Feed-In Tariff

GDP- Gross Domestic Product

GHG- Greenhouse Gases

GJ- gigajoules

GW- Gigawatt

GW.h- Gigawatt hour

H_2O- Water

HFCs- Hydrofluorocarbons

HST- Harmonized Sales Tax

ICE- Innovative Clean Energy

IEA- International Energy Agency

IPP- Independent Power Producer

ITC- Investment Tax Credit

kW- Kilowatt

kW.h- Kilowatt hour

LCFS- Low Carbon Fuel Standard

MFLNRO- BC Ministry of Forests, Lands and Natural Resource Operations

MIT- Massachusetts Institute Technology

Mm^3- Thousands cubic metres

mmbd- millions of barrels today

mmbdoe- millions of barrels of oil equivalent

MOE- BC Ministry of Environment

MOEM- Ministry of Energy and Mines

MOF- BC Ministry of Finance

MOU- Memorandum of Understanding

MW- Megawatt

MW.h- Megawatt hour

N_2O- Nitrous Oxide

NEB- National Energy Board

NIMBY- not in my back yard

NRC- Natural Resources Canada

O_3- Ozone

OECD- Organization for Economic Cooperation and Development

O&M- operations and maintenance

PCT- Pacific Carbon Trust

PFCs- Perfluorocarbons

PST- Provincial Sales Tax

PTC- Production Tax Credit

R&D- Research and Development

RCCE- Remote Community Clean Energy

RCE- Remote Community Electrification

RCEN- Remote Community Energy Network

RCI- Remote Community Implementation

RD&D- Research, Development, and Demonstration

REC- Renewable Energy Certificate

RETI- Renewable Energy Transmission Initiative

RFP- Request for Proposals

RPS- Renewable Portfolio Standard

SDTC- Sustainable Development Technology Canada

SF_6- Sulphur Hexafluoride

SHW- Solar Hot Water

SOP- Standing Offer Program

SPV- Solar Photovoltaic

TGC- Tradable Green Certificate

toe- Ton of Oil Equivalent

TW.h- Terawatt hour

UK- United Kingdom

UN- United Nations

US- Unites States

VEETC- Volumetric Ethanol Excise Tax Credit

VFCVP- Vancouver Fuel Cell Vehicle Program

VOIP- Voice Over Internet Protocol

WCI- Western Climate Initiative