WINDVISION 2025

A STRATEGY FOR BRITISH COLUMBIA

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CANADIAN WIND ENERGY ASSOCIATION | ASSOCIATION CANADIENNE DE L'ÉNERGIE ÉOLIENNE

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WIND ENERGY: A CLEAN AND AFFORDABLE CHOICE FOR BC

Wind energy has grown rapidly as an energy generation technology around the world and within Canada. First installed at scale in Denmark and California barely 30 years ago[1], 13,600 MW of modern wind turbines were in operation worldwide by 2000[2], generating twice as much electricity annually as BC's huge W.A.C. Bennett dam[3]. Since then, wind energy has continued to grow rapidly – at the start of 2011, there was fully 197,000 MW of installed wind energy capacity around the world, supplying two per cent of the world's total electricity demand[4]. In 2009, more wind power was built in Europe than any other electricity generation technology, and during 2005-2009 US installations of wind power were second only to natural gas generation[5]. This year, wind turbines globally are expected to produce as much as all of Canada's hydroelectric and nuclear generation plants combined[6].

The Global Wind Energy Council notes that:

> *Commercial wind farms now operate in close to 80 countries, and present many benefits for both developed and developing countries: increased energy security; stable power prices; economic development which both attracts investment and creates jobs; reduced dependence on imported fuels; improved air quality; and, of course, CO_2 emissions reductions. Each of these factors is a driver in different measure in different locations, but in an increasing number of countries they combine to make wind power the generation technology of choice*[7].

Wind energy has grown by leaps and bounds in Canada as well. From less than 200 MW installed at the end of 2001, Canada had over 4,600 MW of installed wind energy capacity in operation by the end of 2010. CanWEA expects that by the close of 2011 approximately 5,300 MW of wind energy capacity will be installed in Canada – enough to power more than 1.5 million Canadian homes[8].

Wind energy has had a slow start in British Columbia. In November 2009, with the opening of the 102 MW Bear Mountain Wind Park (near Dawson Creek), BC became the last province in Canada to see the construction of a utility-scale wind energy project. As of 2011, BC has almost 250 MW of installed capacity in the province, producing just over one per cent of the province's electricity requirements[9]. This ranks British Columbia sixth in Canada, behind Ontario, Quebec, Alberta, New Brunswick and Nova Scotia.

Fortunately, there is more wind power to come. Wind energy captured almost half of the total gigawatt-hours (GWh) contracted in BC Hydro's competitive 2008 Call For Power process. Six wind power projects totaling 534 MW of installed capacity are now under active development for completion by 2014. Beyond this, 156 MW of expansion capacity could be added to existing wind energy projects. In total, wind energy from these projects could supply over 2,300 GWh of electricity into the grid by 2015, providing almost five per cent of BC Hydro's present-day electricity demand[10].

But this current development barely hints at the potential for wind energy in British Columbia. CanWEA's *WindVision for BC* identifies a 5,250 MW wind energy opportunity by 2025 that arises from British Columbia's extensive wind resources, the flexibility of its existing electricity system, and the tremendous new demand for electricity that comes about as the province works to reduce its greenhouse gas emissions.

SPLENDOUR WITHOUT DIMINISHMENT[11]

British Columbia is a land rich in natural resources – resources that the people of BC have always depended upon for prosperity. Citizens want the development of shared resources to benefit communities, and for the province's economy to be founded on sustainable industries that provide these benefits over the long term.

British Columbians have a proud entrepreneurial spirit and a willingness to pioneer new approaches to established problems. The people of the province support innovative approaches, hard work, and perseverance.

British Columbians have benefited greatly from the forward-looking infrastructure investments of previous generations, and desire an energy system that is low-impact, high benefit, and as low-cost as possible.

Finally, British Columbians desire energy security. The province needs a resilient energy system that protects against the energy shortages that could arise from the vagaries of fossil fuel supply, weather and climate, and the cost spikes that occur in the market when these shortages occur. Having a reliable and affordable supply of electricity in times of regional scarcity is critical to BC's economic health.

CanWEA's WindVision for BC reflects and advances these values.

Our current age faces not only the challenge of a rapidly rising demand for energy, but the imperative to slash greenhouse gas emissions, even while keeping costs as low as possible. But BC has the great fortune of excellent and extensive wind resources, and a priceless inheritance in its hydroelectric grid, capable of integrating many thousands of megawatts of wind power. Because of wind power's unmatched ability to meet the multiple challenges now facing BC, **CanWEA calls for 5,250 MW of renewable, cost-competitive and low-impact wind energy capacity to be installed in British Columbia by 2025**. This homegrown wind energy will generate jobs and economic benefits for British Columbians, greatly lower the greenhouse gas emissions of the province's expanding economy, and provide reliable power for over 17 per cent of BC's total electricity requirements[12].

Bear Mountain Wind Park, Dawson Creek, BC

BC's Current Energy System: Increasing Demands

British Columbians have an extraordinary hydroelectric-based electricity grid that they can be justly proud of, but the province's overall energy system has room for improvement.

BC's electricity generation system is based almost entirely on hydroelectricity, and has remarkably low emissions of greenhouse gases (GHGs). While the provincial government requires that BC Hydro produce at least 93 per cent of its electricity from clean or renewable sources – a benchmark almost three times higher than California's celebrated renewable portfolio standard for 2020[13] – BC's policy merely prevents any reduction in the proportion of zero-emission electricity already on the grid. The current system faces challenges, primarily that British Columbia's existing infrastructure is now aging and requires significant reinvestment. Moreover, too much of the province remains beyond the BC grid, including Fort Nelson, where BC's biggest resource industry boom in decades is now underway.

BC is quite ordinary in terms of its other energy use, and provincial greenhouse gas emissions have continued to increase as the population and economy has grown. The province's aggressive legislated greenhouse-gas emissions targets[14] will not be achieved without taking additional action to reduce emissions from energy use in BC.

Addressing BC's Cost Challenge

British Columbia's heritage large hydroelectric dams have served BC well over the past decades, but the decades-long period in which BC's electricity prices were extremely inexpensive is now at an end. In the 25 years since the completion of the last dam in the "Two Rivers" strategy, BC's population and energy use have continued to grow steadily so that BC no longer has an electricity surplus[15].

The cost of new electricity supply will be substantially higher than the prices British Columbians have been used to paying for their heritage supply, regardless of what technology is employed. Power from the proposed Site C hydroelectric project will be generated at a cost of $87-$95/ MWh, almost twice the cost of power produced today from BC Hydro's existing dams[16]. The cost of electricity from existing heritage generation and transmission resources will also become more expensive in future, as they require maintenance and reinvestment. (Indeed, BC's heritage generation has always been more costly than usually acknowledged, once the damage to downstream habitat, and the flooded forests, farmlands and communities that their construction entailed is accounted for.[17])

Efficient use of energy resources makes "new" electricity available for other uses, and BC's Clean Energy Act calls on BC Hydro to reduce expected new electricity demand to 2020 by at least 66 per cent[18]. However, even if BC Hydro meets its upper-end target of 79 per cent[19], efficiency and conservation will not do away with the need for new generation.

Wind Power and BC's Off-Grid Communities

Many of BC's small off-grid communities depend entirely on expensive and polluting diesel generators to meet their electricity needs. While electricity is provided at on-grid rates, the cost of production in some First Nations communities can be as high as 50 cents per kWh, while reliability can be very poor[20]. In locations with good wind resources, wind turbines integrated with the diesel generator using a hybrid control system can meet 30 per cent or more of the community's electricity demand at substantially lower cost[21].

LOOKING FORWARD

Taken on its own, the demand forecast that BC Hydro prepared in 2010 indicates that the overall increase in electricity demand to 2025 will be a modest 4,400 GWh, if the utility is successful in meeting its demand-side management targets[22]. However, a remarkable surge in new industrial activity is coming to BC over the next 15 years, most conspicuously in increased production of natural gas from shale deposits in Northeastern BC, the export of liquefied natural gas, new mining activity, and the development of alternative transportation fuel synthesis plants. This new industrial demand – which must be electrified to the fullest extent possible if we are to have any hope of achieving BC's legislated greenhouse gas reduction targets – is conservatively projected by CanWEA to total 17,300 GWh by 2025[23]. In addition to this, electrification in the transport and space heating sectors is reasonably projected to add a further 1,900 GWh to this total[24]. Adding these sums to BC Hydro's own baseline projection of demand growth, we find that **BC will need an additional 23,600 GWh of electricity production to meet domestic demand for electricity in 2025**. This active approach to electrification is projected to reduce the province's greenhouse gas emissions by millions of tonnes each year relative to a business-as-usual future.

PROJECTION OF BC'S ELECTRICITY SHORTFALL BY 2025

		Additional GWh in 2025
Factors that will increase demand	New Consumer Demand *projected by BC Hydro*	16,400
	Decrease in Generation Supply (Firm Supply) *projected by BC Hydro*	1,000
	Other projected industrial demand increases	19,200
	Shale gas extraction 5,400 Liquefied Natural Gas Infrastructure 6,500 Additional mining activity 1,200 Alternative transportation fuels 4,200 Electrification of transportation and space heating 1,900	
Factors that will decrease demand	Demand decrease due to demand-side management (efficiency and conservation) *projected by BC Hydro*	-13,000
Total Projected Electricity Supply Gap (Shortfall)		**23,600**

Beyond this, an additional 6,600 GWh of clean, firmed and shaped zero-emission wind energy could be profitably exported to California and Alberta[25], raising the potential new generation total to 30,200 GWh in 2025.

In sum, BC is going to need much more electricity in the future, and far sooner than expected. A lot of this new electricity can – and should – be powered by the wind.

THE ADVANTAGES OF WIND ENERGY

Wind energy can provide significant local and province-wide social and economic benefits to British Columbians, all while generating electricity with lower overall impacts than any other cost-competitive technology.

COST-COMPETITIVE GENERATION

Wind energy is now one of the world's most cost-effective means of generating new electricity. The cost of wind turbines has come down dramatically over the past 30 years as the technology has matured, even as the cost of building new coal, hydro and nuclear plants has steadily increased. For a number of years now, wind energy projects at good sites have proven themselves to be cost-competitive with conventional generation. Once a wind energy project is built, the cost of generating power stays pretty much fixed over the life of the project; there are never any fuel costs to worry about because there is an infinite supply of wind that is absolutely free. Global wind energy production now provides two per cent of the world's electricity – equivalent to the total demand for electricity in Canada – and is forecasted to meet as much as one-tenth of the world's total electricity demand in 2020.

COMMUNITY BENEFITS

Wind energy projects are a cost-competitive source of new power generation that also offer substantial benefits to the communities where they are constructed. Wind energy development can help benefit communities in BC by diversifying rural and First Nation economies and providing new sources of revenue to boost local business and provide community services.

Effective and meaningful community and stakeholder engagement is fundamental to the success of a wind energy project. CanWEA's *Best Practices in Community Engagement and Public Consultation* guides the industry in its continued effort to improve and strengthen practices as interest in wind energy development grows across Canada.

LOW ENVIRONMENTAL IMPACTS

The environmental footprint of a wind energy project is extremely modest, particularly when compared to conventional electricity sources. The production of wind energy does not require the consumption or diversion of water. Wind turbines emit no common air contaminants, and produce zero toxic wastes. The energy it takes to mine, manufacture, erect, operate and eventually decommission a wind turbine is recouped in clean electricity within the first 9 to 15 months of its 20 to 25 years of productive life[26]. 95-98 per cent of the area within a wind energy project can be used as it was before the development of the wind energy project – for grazing, for growing crops, or as natural habitat[27].

When new wind energy projects are proposed, issues are sometimes raised over potential impacts on wildlife, visual impact, or noise pollution. These concerns are thoroughly evaluated and addressed through an extensive environmental assessment process. In many cases, potential impacts can be prevented from occurring through careful siting of the wind energy project and its wind turbines, or through adaptive management practices[28]. Not all sites are suitable for wind development: in those locations where impacts cannot be substantially mitigated at affordable cost, project developers usually abandon the project rather than proceed in the face of rejection by regulatory agencies.

BENEFITS TO OFF-GRID COMMUNITIES

Hybrid wind-diesel systems can provide multiple benefits to off-grid communities beyond reduced costs, including reliability, a reduced risk of local pollution risks from diesel spills, and improved air quality. The new generation system can provide local job opportunities. Moreover, the use of local resources is a tangible means by which communities can begin to determine their own future and move towards self-sufficiency.

BC'S WIND ENERGY ADVANTAGE

British Columbia is better suited than most places on Earth for the large-scale development of wind energy. The province has extensive cost-competitive wind resources, as well as the ability to use its large hydro reservoirs to easily and inexpensively integrate many thousands of megawatts of new wind energy capacity. Best of all, by actively working towards a hybrid large hydro and wind energy future, BC can create a system that is more resilient and better matched to future electricity demands than the current system.

BC HAS EXTENSIVE WIND RESOURCES

Wind project developers in BC have discovered high quality wind resources in many different regions of BC[29]. In 2010, a BC Hydro study estimated that there is 16,425 MW of onshore wind energy potential in the province, capable of generating almost 39,000 GWh of electricity annually[30]. Because the study focused only on onshore areas currently under active development by wind companies, the real onshore potential for BC is likely to be even higher than this. The study also estimated total offshore wind energy resources to be 59,000 GWh[31]. By comparison, BC Hydro's own large hydro facilities generate between 42,000 and 52,000 GWh per year[32].

BC WIND IS COST-COMPETITIVE

Wind energy projects captured 47 per cent of the total amount of contracts awarded (by GWh) in BC Hydro's competitive Call for Power process in 2008-2010[37]. BC Hydro's 2010 Resource Options Report found that 5,000 GWh of potential wind energy developments in the province could be produced at an average sale price of less than $105 per MW, 10,000 GWh for less than $114, 20,000 GWh for less than $130 and 30,000 GWh for less than $142[38]. Remarkably, this assessment appears to significantly overestimate the average cost of these resources in 2011:

- The study modeled the production at each site with the same turbine. In reality developers assess a wide range of turbines and install the machine best able to capture the energy from the specific wind conditions at their project site, Within BC, this choice has been found to affect electricity production levels by as much as 20 per cent[39].

BC'S OFFSHORE WIND RESOURCES

In addition to its onshore wind, BC has tremendous offshore wind resources. Offshore wind production is already underway in Europe, where almost 3,000 MW were in operation at the start of 2011[33]. China also has offshore wind energy production – the country's first project began generating power in 2010[34]. Within BC itself, there has been extensive work to develop a very large wind energy project in Hecate Strait in partnership with the Haida First Nation[35]. While BC Hydro's Resource Options Report indicates that offshore wind resources are not yet competitive with onshore sites, and no electricity purchase agreement (EPA) has yet been issued for an offshore wind energy project in BC, the cost of offshore wind generation is expected to fall sharply in the future as this technology matures[36].

- Since the data for BC Hydro's assessment was obtained, new wind turbine technology has further increased productivity. Taller towers now help capture stronger wind flows higher in the atmosphere. Larger rotors and improved blade control technology are improving energy capture at lower wind speed sites, while the use of direct drive and permanent magnet technology is also improving overall turbine efficiency[40].

- The cost of turbines in 2011 has fallen an estimated 20 per cent since 2009[41]. While turbine prices can be expected to fluctuate in reaction to short-term supply and demand drivers, prices are widely expected to continue to slowly decline over the long term.

- BC Hydro's cost calculations assume that the Renewable Energy Credits (or RECs), which represent the environmental attributes generated by wind turbines, have zero value. In reality, these RECs have significant value which should be subtracted from the average cost of the bundled resources[42].

WIND ENERGY INCREASES RESILIENCY

BC is dependent on hydroelectric generation – perhaps too dependent. The late spring and summer freshet combined with must-run requirements at other facilities obliges BC Hydro to generate large amounts of electricity when domestic demand is at its lowest, and to hoard water in many other months in order to meet winter peak demands. This raises concerns when there is real uncertainty about next year's weather patterns – and the impacts that climate change will have on long-term trends. Pursuing the development of BC's wind potential, while also reinvesting in the province's existing hydroelectric resources to ensure their continued performance, is a crucial means of diversifying British Columbia's electricity production portfolio.

WIND MATCHES BC'S ELECTRICITY DEMAND

Installing wind doesn't just diversify BC's hydro system – it almost perfectly complements it. Demand for electricity in BC peaks during the winter, when there is strong heating and lighting load, and tapers off in the spring and summer[43]. BC gets its strongest winds in the winter months, peaking in the freezing months of December and January, just when streamflows are at their lowest. Conversely, winds blow least powerfully in the late spring and early summer when hydroelectric production is at its peak[44]. Wind energy generation will greatly reduce the drain from BC Hydro's fixed reservoir capacity during the winter and spring months, and enable existing facilities to serve a large and growing population well into the future.

Eye of the Wind Turbine, Vancouver, BC
Courtesy of Grouse Mountain Resorts Ltd.

BC HYDRO CAN INTEGRATE 6,000 MW OF WIND BY 2025

A recent BC Hydro study found that the province's electricity grid could integrate 3,000 MW of wind energy in 2007 at zero risk for a single hour of wind power curtailment[45]. Boosting the amount of wind capacity to 4,000 MW would only add a slight risk of curtailment[46], one that wind projects could accommodate provided that clear market rules for this situation were developed in advance, and factored into electricity purchase agreements. By 2025, existing plans to install additional capacity-only units at existing dams and to build the new Site C dam should enable over 6,000 MW of wind to be added to the BC Hydro grid ***with no additional backup generation required***[47]. This 6,000 MW total is sufficient to cover CanWEA's projected build-out of wind to meet British Columbia's domestic electricity demand to 2025.

Assuming that there is 23,600 GWh of new electricity demand in BC to 2025, that Site C is built, and that wind energy captures 70 per cent of the remaining demand (in line with BC Hydro's own findings), CanWEA's **WindVision for BC has 5,250 MW of wind energy installed capacity by 2025**, providing 17 per cent of BC's total demand for electricity[48], while reducing the province's GHG emissions by millions of tonnes.

If we additionally choose to pursue profitable export opportunities in Alberta and California, the market in BC could support a total installed wind energy capacity of 7,450 MW[49] – although more wind integration capacity would be required to achieve this total.

The result will be a hybrid wind-hydro electrical system better suited to the needs of the province than the one in place today, capable of generating large amounts of reliable, cost-competitive, low-impact power for British Columbians for many decades to come.

The WindVision respects the long-standing energy objectives of British Columbians: to ensure access to adequate supplies of reliable energy at the lowest achievable cost, to build a strong economy through vision and initiative, to support our communities and to protect our environment.

ECONOMIC BENEFITS OF THE WINDVISION FOR BC

In addition to cost-competitive, low-impact renewable energy, implementation of the WindVision for BC will also generate jobs, investment and revenues for British Columbia.

JOBS AND INVESTMENT

Wind energy development provides direct employment benefits from start to finish. Project development work creates long-term technical and professional jobs for British Columbians. The construction phase brings large numbers of direct and indirect jobs to nearby communities. After completion, operational wind energy projects require on-site operations and maintenance staff, generating high-value long-term jobs.

The fulfillment of the WindVision for BC is estimated to result in $16 billion dollars of investment, and over $3.7 billion dollars of direct benefits to BC during the construction phase alone[50]. Implementing the WindVision would generate an estimated 22,500 person-years of employment during construction, and 7,500 person-years of employment over the 20 to 25 year operations and maintenance phase of the resulting wind energy projects[51]. If these wind energy projects were repowered with new turbines at the end of their operational lifetime, additional construction and operations jobs would result from this reinvestment of capital.

Many First Nations, with aboriginal rights and title to the Crown Lands where almost all wind energy development in BC takes place, are strongly supportive of wind energy project development, and see these partnerships as an important mechanism by which the local communities can share the benefits of wind energy development[52].

"WIND INTEGRATION" PROFITS

BC Hydro levies a $10 per MWh charge on wind energy, the proceeds of which go to BC Hydro and the provincial government[53]. Assuming that actual wind integration costs consume as much as half of this revenue[54], implementation of the BC WindVision would generate almost $73 million in income for BC Hydro each year[55].

These figures for jobs, investment and revenues to government are intentionally conservative, since they exclude the economic and employment benefits that could accompany the manufacturing of wind turbines or the 8,000 components within. At present, BC's wind industry is too small to capture these economic benefits. However, the size of the WindVision target is more than sufficient to support the development of wind-related manufacturing capacity within BC itself. If the provincial government uses implementation of the BC WindVision as a basis from which to aggressively pursue the opportunity to establish wind energy manufacturing within British Columbia, the direct economic benefits of wind project development noted above could increase by over 50 per cent, while employment benefits might double[56].

BC'S SMALL WIND MANUFACTURING AND SALES SECTOR

BC is home to Endurance Wind Power, which manufactures 5kW and 50kW small wind turbines at its factory in Surrey, BC. TWN Wind Power Inc. – a company owned and operated by the Tseil Waututh First Nation of North Vancouver – distributes Endurance turbines to aboriginal communities throughout North America[57].

BUILDING BC'S ELECTRICITY FUTURE

The scale of wind development coming to BC provides government with a great opportunity to optimize the economic benefits of wind energy for the province. Long-term commitments to the province's existing clean energy policies, acknowledgement of the big increase in energy demand now facing BC, and a recognition of wind's critical role in meeting the province's growing energy gap are key means by which government can encourage the development of wind energy manufacturing within British Columbia and support the development of a highly-skilled wind sector construction workforce based in BC. To make this WindVision for BC a reality, CanWEA recommends that the provincial government act decisively to:

MAINTAIN BC'S LEADERSHIP ON CLIMATE AND CLEAN ENERGY

Now is the time to strengthen BC's extraordinary hydro-based power system with greater amounts of wind energy. With more wind energy, BC can take stronger action against greenhouse gas emissions and demonstrate to the world that the province is a leader in sustainable energy production. To achieve this, electricity prices need to reflect the environmental and health impacts associated with the different ways of producing power. This should be accomplished by:

- Maintaining BC's 93 per cent clean or renewable requirement;
- Ensuring BC generates sufficient electricity to meet domestic demand; and
- Continuing to increase the cost of carbon after 2012.

MAXIMIZE ELECTRIFICATION

Increased electrification of the economy is already starting to happen. Electrification is the most efficient choice for the province's new industrial loads because of its low impacts, its superior energy efficiency and because of the long term cost savings to energy users that electrification will provide. The BC Government must accelerate the existing trend to electrification, particularly with regard to large new industrial facilities where business-as-usual practice will produce large increases in the province's greenhouse gas emissions. Wind energy will be essential to keeping electric supply growth in step with demand.

BUILD TRANSMISSION PRO-ACTIVELY TO BC'S WIND RESOURCE REGIONS

CanWEA calls on the provincial government and BC Hydro to prioritize the development of transmission infrastructure that supports the electrification of new industrial loads, accesses low-impact high-energy wind resources, and helps integrate this wind power into the provincial grid. Accelerated development of the proposed Northeast Transmission Line to Fort Nelson and the Horn River Basin, which can pass through some of the province's best wind energy resources, would create large benefits on all of these counts. Government should also encourage wind-diesel hybrid systems where appropriate in BC's remaining small off-grid communities.

EXPAND BC HYDRO'S WIND INTEGRATION LIMIT

As BC Hydro continues to expand its hydro generating facilities, the amount of wind power that can be immediately integrated into the system will also rise. Today, BC Hydro could integrate 4,500 MW of wind power with zero risk, and this limit will grow to 6,000 MW by 2025. The government and BC Hydro should start assessing additional opportunities now in order to integrate additional wind capacity in the long-term future.

EXPAND INTERCONNECTIONS TO BC'S EXPORT MARKETS

There are long-term opportunities for British Columbia to expand profitable exports of wind power and hydro electricity to Alberta and California, resulting in substantial economic benefits for British Columbians – but this potential will only be realized through sustained effort by the provincial government.

IMPLEMENT TRANSPARENT, FREQUENT AND REGULAR PROCUREMENT PROCESSES

One of the strengths of wind energy is that it can be deployed at varying scales by a great variety of potential project developers. Competitive tendering processes are technically challenging and expensive for bidders. Tenders processes that lack transparency on evaluation criteria as well as timing and frequency unnecessarily increase costs and attrition rates, while undermining public trust. CanWEA calls on BC Hydro to hold regular calls for power that are timely and have clear evaluation criterion. Additionally, the Standing Offer Program should be reformed to be viable for wind projects.

OPTIMIZE PERMITTING AND APPROVAL PROCESSES TO ENSURE LOW-IMPACT DEVELOPMENT AT LOW COST

While current permitting processes help ensure the low-impact development of wind projects, they can also be needlessly complex and uncertain. There is often significant duplication and overlap between processes, and requirements and timelines are often unclear. These problems are compounded by a lack of dedicated government resources: there simply aren't enough people working on approvals and permits to handle the interest in new wind energy development in BC. CanWEA calls on the provincial government to ensure that efficient and effective review, permitting and approval of new wind power and renewable energy projects is a priority at all levels.

Bear Mountain Wind Park, Dawson Creek, BC
© Don Pettit photo, Peace photoGraphics

CONCLUSION

While the development of wind power in BC has only just begun, the province has a remarkable set of advantages in its resources, its heritage hydroelectric assets, and not least, its people: British Columbians have long placed a high value on clean, low-impact – and low cost – electricity.

CanWEA's WindVision for BC recognizes these goals, while responding to the huge increase in electricity demand that is coming. Wind energy is abundant, cost-competitive and provides benefits to the economy, local communities and the environment. CanWEA's WindVision for BC to have 5,250 MW of wind energy generation by 2025 is not only practical but will result in an electricity system even more suited to the needs and aspirations of a growing modern and responsible society.

ENDNOTES

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39. Based on modeling of alternate turbines for a BC wind farm in development.

40. Fletcher, Holly. "Wind turbine glut, greater efficiency drive prices down." *Power Finance and Risk.* September 2, 2011. Also: Wiser, Ryan and Mark Bolinger. *2010 wind technologies market report.* US Department of Energy. June 2011. http://www.iipower.com Accessed September 6, 2011, and: Salo, Jussi. "The attraction of simplicity: permanent magnet machines are here to stay." ABB Review, 2/2009. pp.29-34

41. Wiser, Ryan and Mark Bolinger. *2010 wind technologies market report.* US Department of Energy. June 2011. p.vii

42. See Chapter 6, *WindVision 2025 – a strategy for British Columbia:* long report.

43. BC Hydro. "BC Hydro system needs: operational considerations." PowerPoint deck presented by Renata Kurschner, June 6, 2007. Slide 39.

44. "Figure 13 – Normalized monthly onshore wind energy" in: BC Hydro. *Draft 2010 resource options report (2010 ROR).* 2011 Integrated Resource Plan (2011 IRP). December 8, 2010. p.61

45. BC Hydro. *Integrated Resource Plan Technical Advisory Committee meeting #4.* PowerPoint deck. April 5-6, 2011. Slides 100-102

46. BC Hydro. *Integrated Resource Plan Technical Advisory Committee meeting #2 – Day 2.* PowerPoint deck. January 28, 2011. Slide 104

47. Op cit. This total adds the 1,000 MW of low-risk curtailment noted above to the "wind integration limit" indicated on Slide 103.

48. Assumes a average capacity factor of 32 per cent. Refer to Chapter 6, *WindVision 2025 – a strategy for British Columbia:* long report.

49. Ibid.

50. The economic benefits for BC have been calculated by CanWEA based on similar calculations for the Ontario market by ClearSky Advisors. Although ClearSky Advisors has not had the same opportunity to explore the specific economic benefits for BC as it has for Ontario, ClearSky Advisors has reviewed CanWEA's BC calculations and found them to be a reasonable and conservative estimate for the likely economic benefits to BC. Fitzpatrick, Michael and Tim Wohlgemut. Review of *CanWEA's WindVision estimate of economic benefits for BC.* ClearSky Advisors Inc.2011.

51. Ibid.

52. First Nations Leadership Council. *BC First Nations energy action plan.* Produced by the BC Assembly of First Nations, the First Nations Summit, the Union of BC Indian Chiefs and the BC Assembly of First Nations. 2007. For specific examples, see: McKay, Joel. "Finavera Wind lands partnership with B.C. First Nation" August 23, 2011. *Business In Vancouver* website. www.bivinteractive.com/index.php?option=com_content&view=article&id=4671:finavera-wind-lands-partnership-with-bc-first-nation&catid=14:daily-news&Itemid=46 Accessed September 6, 2011.

53. BC Hydro. *Wind integration cost and limit.* 2011 IRP Technical Advisory Committee summary brief. Meeting #2, January 27 & 28, 2011. p.1

54. "Fluctuations in the net load (load minus wind) caused by greater variability and uncertainty introduced by wind plants have been shown to increase system operating costs by up to about $5/MWH at wind penetration levels up to 20 per cent." Note that this assumption is conservative: the cost of integrating wind using hydroelectric resources is widely acknowledged to be much less costly than integration using fossil fuel generators because of the avoided cost of fuel. UWIG. *Utility wind integration state of the art.* Prepared by Utility Wind Integration Group in cooperation with American Public Power Association (APPA), Edison Electric Institute (EEI) and National Rural Electric Cooperative Association (NRECA). May 2006.

55. $5.00 per MWh x 14,567,000 MWh = $72.825 million.

56. Doing so would result in economic benefits comparable to those found in Ontario in 2011. Source: ClearSky Advisors. *The economic impacts of the wind energy sector in Ontario 2011-2018.* 2011.

57. www.endurancewindpower.com and www.twnwindpower.com

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