

RESOURCE OPTIONS UPDATE

RESULTS SUMMARY

October 2016



FOR GENERATIONS

BACKGROUND & OBJECTIVES

This slide deck summarizes the process and results of the Resource Options Update that BC Hydro undertook in 2014–2015. The update focused on generation options.

In the course of planning, we monitor and periodically update the inventory of B.C. resource options to capture advances in technology, resource potential estimates, cost evolution and other aspects relevant to planning activities.

Through 2014 and 2015, BC Hydro and FortisBC collaborated on a shared set of resource options which each utility can draw from, to produce separate integrated resource plans.

Objectives for this update:

- Update resource options information for select resources contained in BC Hydro's 2013 Resource Options Report
- To work with those in the industry to ensure that resource options information is kept relevant and up-to-date

SCOPE OF WORK

A update of resource options was undertaken based on assessments of recent advances in technology and costs. Independent Power Producer association members helped inform the work plan through upfront scoping of technical issues.

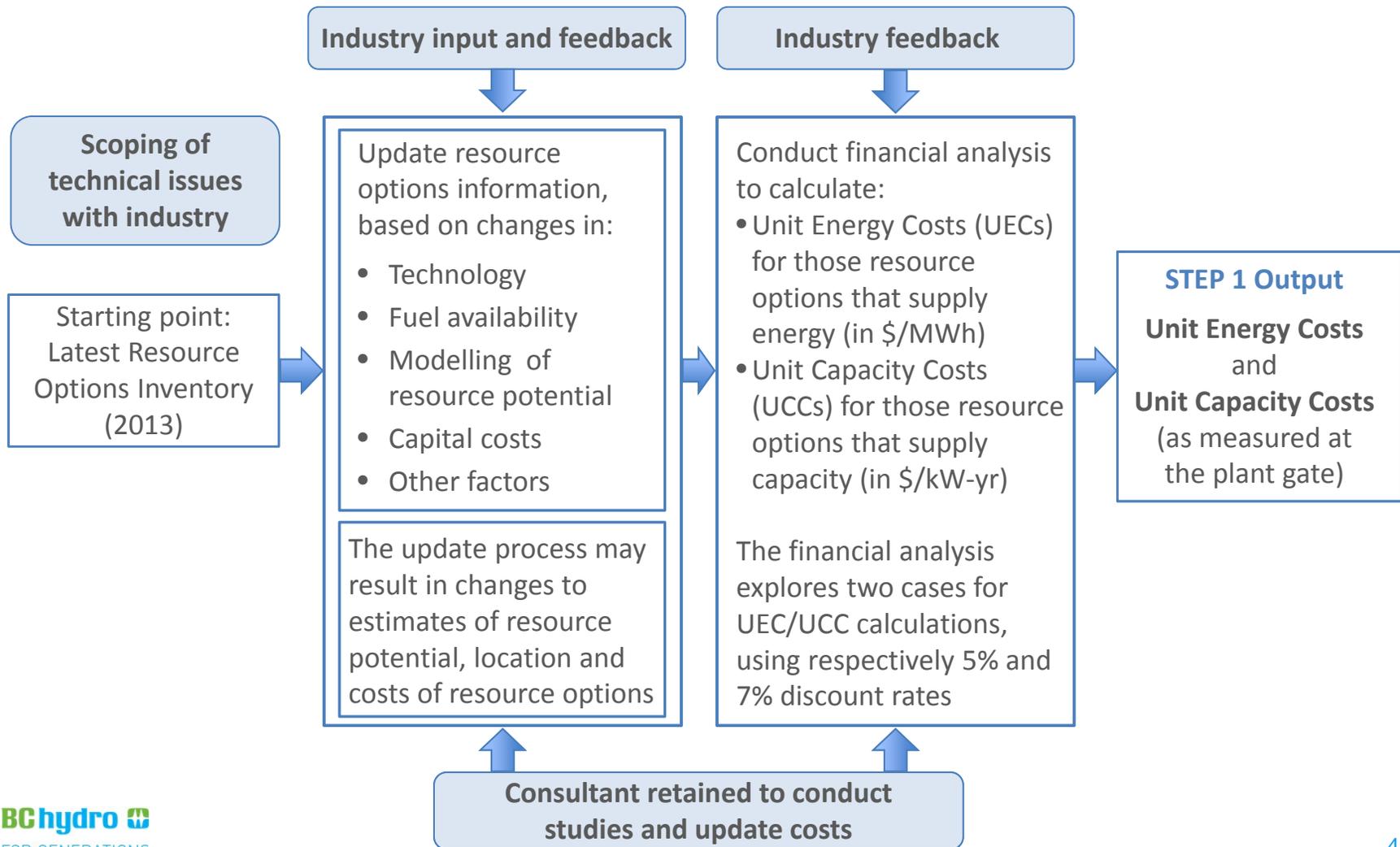
For a number of resource options, the update process included retaining consultants to renew resource characterization information and involved input and feedback from industry stakeholders. These included: *wood-based biomass, onshore wind, run-of-river, geothermal, solar and natural gas-fired generation.*

For other resource options, the update process included discussions with industry experts and literature reviews. These included: municipal solid waste, tidal and wave.

For *biogas, coal with carbon capture and storage, offshore wind and pumped storage* resource options, the in-house analysis included adjusting previously estimated costs for inflation. Some adjustments from the onshore wind resource update (e.g., project life) were extended to the offshore wind resources for consistency.

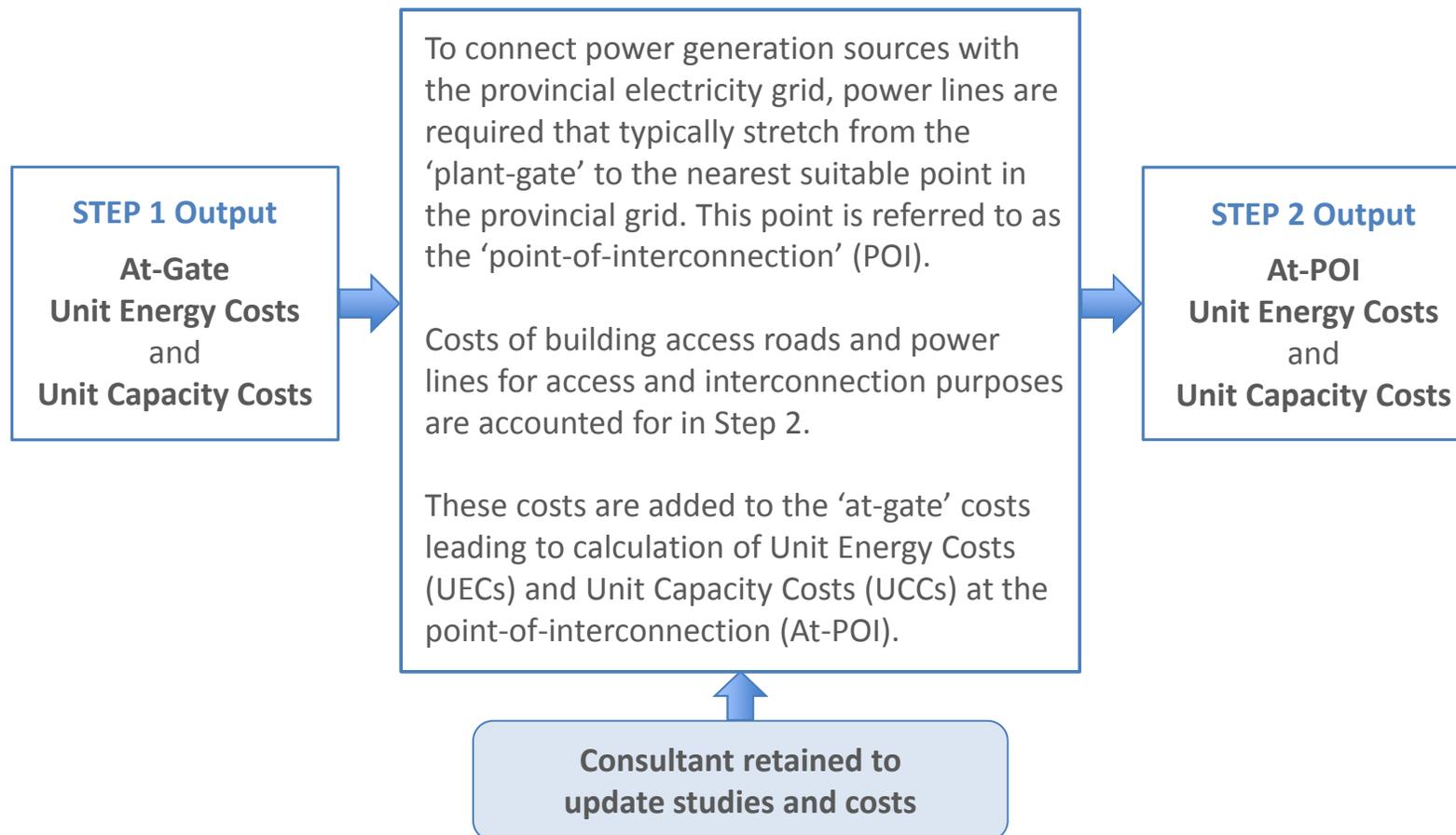
OVERVIEW OF RESOURCE OPTIONS UPDATE PROCESS

STEP 1 – ESTIMATE COSTS AT THE ‘PLANT GATE’



OVERVIEW OF RESOURCE OPTIONS UPDATE PROCESS

STEP 2: ESTIMATE COSTS AT ‘POINT-OF-INTERCONNECTION’



RESULTS

UNIT ENERGY COSTS / UNIT CAPACITY COSTS

- The resulting **Unit Energy Costs (UECs)** and **Unit Capacity Costs (UCCs)** for resource options are shown at the Point-of-Interconnection
- UECs and UCCs were estimated and are presented using two different discount rate scenarios: 5% and 7%. Typically, the higher the discount rate used, the higher the resulting UECs and UCCs (everything else equal)
- The costs are presented in \$2015 Canadian dollars

UPDATE DETAILS

Resource Option	Consultant (retained or not)	Description of Update
Wood-based biomass	✓	Cost and potential review due to changes in industry and fiber availability, technology scan
Onshore Wind	✓	Turbine size and costs, power curves and energy profiles
Run-of-river	✓	Additional screening of existing hydrology data, at-gate cost components
Geothermal	✓	Site-specific data compilation, cost and potential review for select sites
Solar	✓	Technology, cost and potential review
Natural gas-fired generation	✓	Turbine technology and cost review
Municipal Solid Waste		Review select attributes and update costs
Tidal		Review technology development and update costs
Wave		Review technology development, revise resource assessment, and update costs

WOOD-BASED BIOMASS UPDATE SUMMARY



FOR GENERATIONS

SCOPE

- Update wood-based biomass (fiber) potential
- Review technologies for biomass electricity generation
- Update cost information and associated unit energy costs

METHODOLOGY

- Retained two consultants: Industrial Forestry Service Ltd (IFS) and AMEC Foster Wheeler (AMEC FW)
- IFS used BC Fiber Model to estimate fiber potential for 13 fiber regions
 - Proprietary model well known in the forest industry
 - Annual Allowable Cut (AAC) modeled vetted with Ministry of Forests, Lands and Natural Resource Operations
- Worked with Metro Vancouver to estimate additional fiber potential from landfills and recycled facilities
- Cost information updated based on input from IFS, AMEC FW, stakeholders and project information available to BC Hydro

KEY ASSUMPTIONS – FIBER

- Fiber potential after existing and proposed industry demand is accounted for is assumed available for electricity generation
- Delivered fiber cost estimated for 4 different fiber categories (listed in the order of increasing costs):
 - Sawmill woodwaste
 - Roadside residues
 - Pulp logs
 - Standing timber
- Delivered fiber cost reflects cost of transportation and market competition.
- 2.45 cubic metres of wood = 1 oven dry tonnes at 0% moisture

KEY ASSUMPTIONS – PROJECT ECONOMICS

- A few different technologies are available for generating electricity with biomass. Given a range of costs associated with different setups, the following generic assumptions have been made:
- Capital cost: \$5.0 million/ MW gross
- Project lead time: 4 years with spending profile as (2.5%, 2.5%, 45%, 50%)
- Project life: 20 years
- For a 40 MW gross typical plant size:
 - Capacity = 36.8 MW (8% internal use)
 - Capacity factor = 91% (as a factor of net installed capacity)
 - Annual energy = 290 GWh (36.8 MW x 8760 hrs x 0.91)
- Annual O&M cost : \$120/kW-yr and \$7/MWh (roughly \$7 million for a 40 MW gross plant)

ENGAGEMENT SUMMARY

- Two engagement sessions – March 31, 2015 and July 2, 2015
- Email and phone correspondence

RESOURCE OPTION UNCERTAINTY

- The potential for wood fiber biomass is uncertain as the availability of biomass fiber is subject to both consumption from existing industries as well as other potentially higher value future uses for the fiber

WOOD-BASED BIOMASS RESULTS AVAILABLE FIBER

Region	Estimated Biomass Available Annually (cubic metres/year) by Period and Region							
	2016 - 2025				2026 - 2040			
	Sawmill hog fuel	Roadside logging residues	Pulp logs	Standing timber	Sawmill hog fuel	Roadside logging residues	Pulp logs	Standing timber
Coast	231,000	904,000		265,000	290,000	959,000		
East Kootenay		171,000				171,000		
West Kootenay	370,000	330,000			384,000	334,000		
Kamloops/Okanagan			281,000	43,000			283,000	
Cariboo		126,000		331,000		126,000		
Prince George		97,000	209,000	1,376,000		164,000		
Mackenzie		67,000	75,000	504,000		65,000		
South Peace		264,000	168,000	106,000		264,000	168,000	109,000
North-east				1,625,000				1,625,000
East Prince Rupert			458,000	550,000			254,000	11,000
West Prince Rupert	17,000	17,000	67,000	3,054,000	17,000	17,000	67,000	3,037,000
North-west				305,000				305,000

WOOD-BASED BIOMASS RESULTS DELIVERED FIBER COSTS



\$/OVEN DRY TONNE (INCLUDING AVERAGE TRANSPORTATION COST)

Region Name	Standing Green Timber	Standing Pulplogs	Roadside Wood Waste	Sawmill Hog Fuel
West Prince Rupert	\$174	\$134	\$65	\$25
East Prince Rupert	\$150	\$116	\$67	\$23
North-West	\$187	\$144	\$75	\$25
Prince George	\$162	\$125	\$67	\$29
South Peace	\$150	\$116	\$75	\$40
North East	\$187	\$144	\$67	\$5
Cariboo	\$162	\$125	\$62	\$27
E. Kootenay	\$162	\$125	\$70	\$25
W. Kootenay	\$174	\$134	\$80	\$35
Kamloops/Okanagan	\$162	\$125	\$73	\$37
Mackenzie	\$150	\$116	\$67	\$10
Coast - Island	\$199	\$134	\$67	\$23
Coast - Mainland	\$199	\$134	\$67	\$30

WOOD-BASED BIOMASS RESULTS FIBER FROM LANDFILLS

- Additional 139 GWh equivalent of **clean wood** could be sourced from landfill, at market price of hog fuel/sawmill waste (~\$25/MWh delivered).
- Energy Supply could increase to 479 GWh, the difference comes with uncertainty associated with emission permitting as well as clean energy qualification.
- Waste wood is expected to increase over time. Current use limited to heat or power generation, higher value use is an active research area.

Sources of waste wood	Annual volume as of 2013 in Metro Van (metric tonnes, wet weight about 25% moisture content)	GWh/year	Considerations
Clean wood from Landfill	133,700	139	can be used without a special permit
Treated, painted & composite woods from Landfill	188,200	196	requires special air emission permit
Recycled mixed wood from recycling facilities	434,300 less 250,000* less 46,075** net: 138,225	net: 144	some types require a special permit but the split between different types is not known***
* refuse derived fuel accounted for in IFS's model			
** 25% of the remaining is sourced from industrial facilities like lumber mills and plywood manufacturers			
*** wood recycled from mixed loads requires a permit; other types of clean recycled wood can be used without a permit if it was separated at the source and delivered to a recycling facility or user (e.g. clean construction waste and clean dimensional lumber from deconstruction/selective disassembly)			

WOOD-BASED BIOMASS RESULTS UNIT ENERGY COSTS

Resource Option	Resource Options: Representative Aggregate Projects (By Location and Fiber Category)	Installed Capacity (MW)	Dependable Generating Capacity (MW)	Annual Average Energy (GWh/yr)	Annual Firm Energy (GWh/yr)	UEC at POI - \$/MWh (5% Discount Rate)	UEC at POI - \$/MWh (7% Discount Rate)
WBBio_LM_SR	Coast: Sawmill Waste & Roadside Residue	63	63	503	503	\$137	\$148
WBBio_EK_RR	East Kootenay: Roadside Residue	12	12	97	97	\$140	\$152
WBBio_WK_SW	West Kootenay: Sawmill Waste	26	26	211	211	\$110	\$121
WBBio_WK_RR	West Kootenay: Roadside Residue	23	23	184	184	\$143	\$154
WBBio_CB_RR	Cariboo: Roadside Residue	2	2	17	17	\$150	\$163
WBBio_MAC	Mackenzie: Roadside Residue	4	4	29	29	\$151	\$163
WBBio_SP_SR	South Peace: Sawmill Waste & Roadside Residue	22	22	172	172	\$134	\$145
WBBio_SP_PL	South Peace: Pulp Logs	12	12	99	99	\$166	\$178
WBBio_NE_ST_1	North-East: Standing Timber	116	116	921	921	\$221	\$233
WBBio_EPR_SRP	East Prince Rupert: Sawmill Waste & Roadside Residue & Pulp Logs	26	26	208	208	\$170	\$182
WBBio_EPR_ST	East Prince Rupert: Standing Timber	6	6	49	49	\$194	\$205
WBBio_WPR_SW	West Prince Rupert: Sawmill Waste	3	3	21	21	\$112	\$124
WBBio_WPR_RR	West Prince Rupert: Roadside Residue	2	2	17	17	\$151	\$164
WBBio_WPR_PL	West Prince Rupert: Pulp Logs	8	8	65	65	\$181	\$192
WBBio_WPR_ST_1	West Prince Rupert: Standing Timber	216	216	1718	1718	\$208	\$219
WBBio_NW_ST	North-West: Standing Timber	11	11	86	86	\$284	\$306

ONSHORE WIND UPDATE SUMMARY



FOR GENERATIONS

SCOPE

- Update turbine and cost assumptions
- Recalculate unit energy costs based on updated information

METHODOLOGY & KEY ASSUMPTIONS

- Analysis based on potential projects identified in the 2009 BC Hydro Wind Data Study and the 2009 BC Hydro Wind Data Study Update
- Installed capacity for each project was left unchanged, but average annual energy (and net Capacity Factor) for each site was updated by applying updated turbine characteristics and loss assumptions to the wind speed time series from the 2009 studies
- Updated assumptions:
 - 3 MW turbine size
 - 100 m hub height (previously 80 m)

METHODOLOGY & KEY ASSUMPTIONS (CONTINUED)

- Total losses of 20.4% (previously 18.6%)
- 25 year project life (previously 20 years)
- Developed generic power curves for each IEC turbine class, based on current information obtained from 5 original equipment manufacturers (OEMs)
- Capital and O&M cost information obtained through:
 - Wind project cost review by Hatch
 - Survey of developers active in BC (conducted by GE Power & Water)
 - EPC cost review for Canadian wind projects by Borea Construction (confidential report)

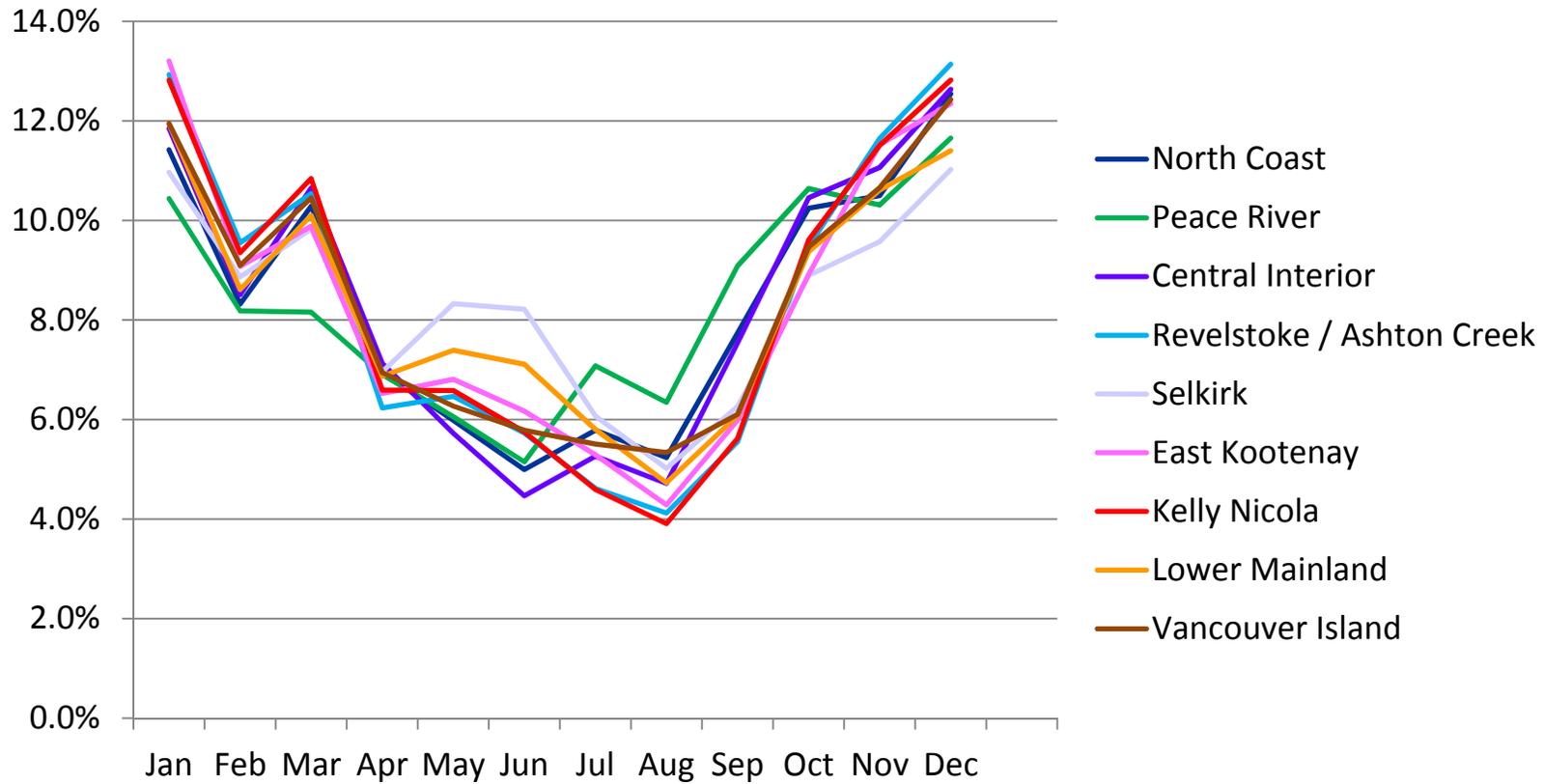
ENGAGEMENT SUMMARY

- Four engagement meetings were held – September 12, 2014; December 15, 2014; May 5, 2015 and June 3, 2015
- Stakeholders reviewed and provided input on assumptions, methodology and results
- Numerous communications with OEMs

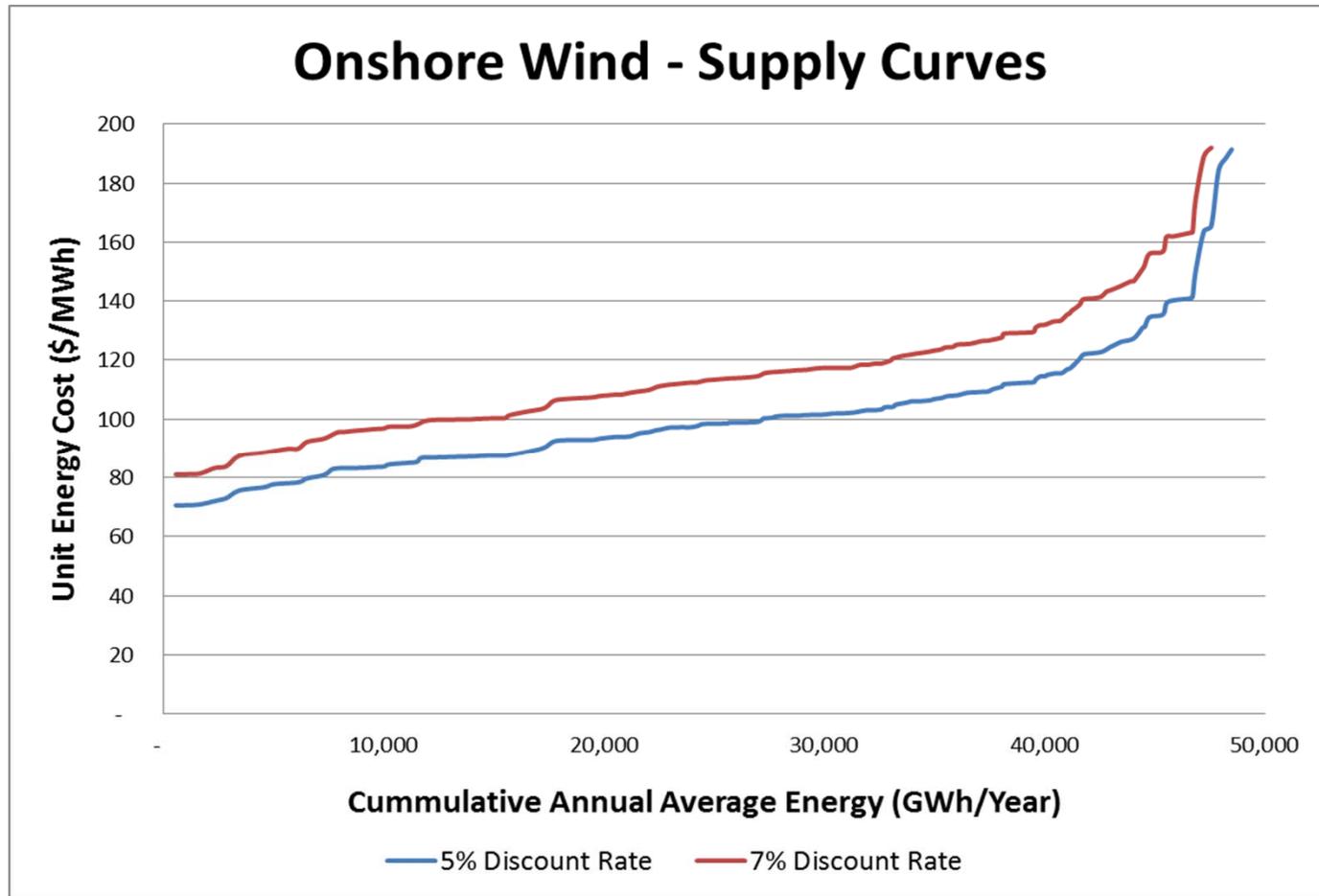
ONSHORE WIND RESULTS SUMMARY BY REGION

Transmission Region	Number of Resource Options	Total Installed Capacity (MW)	Effective Load Carrying Capacity ELCC (MW)	Total Annual Average Energy (GWh/year)	Annual Firm Energy (GWh/yr)	Range of Unit Energy Costs (\$/MWh) - 5% Discount Rate	Range of Unit Energy Costs (\$/MWh) - 7% Discount Rate
Central Interior	9	1,038	270	2,832	2,832	96-142	111 - 164
East Kootenay	2	135	35	344	344	112-116	129 - 133
Kelly Nicola	22	3,264	849	8,970	8,970	85-124	98 - 144
Lower Mainland	1	87	23	263	263	117	136
Revelstoke / Ashton Creek	4	567	147	1,614	1,614	83-103	96 - 118
North Coast	24	3,867	1,005	11,654	11,654	78-243	90 - 282
Peace River	47	6,057	1,575	20,114	20,114	71-260	81 - 301
Selkirk	2	81	21	204	204	122-131	141 - 152
Vancouver Island	13	1,071	278	3,368	3,368	87-122	100 - 140
Total	124	16,167	4,203	49,362	49,362		

ONSHORE WIND RESULTS MONTHLY ENERGY PROFILES BY REGION



ONSHORE WIND RESULTS UNIT ENERGY COSTS



RUN-OF-RIVER

UPDATE SUMMARY



FOR GENERATIONS

SCOPE

- Additional screening of existing resources
- At-gate cost estimate improvements

METHODOLOGY & ASSUMPTIONS

- Kerr Wood Leidal (KWL) retained to update 2010 Run-of-River Hydroelectric Resource Assessment for British Columbia
- Potential sites identified in 2010 report screened using GIS data for parks/protected areas, glaciers, salmon observations/reaches, and new Electricity Purchase Agreements
- Capital cost estimates include: intake, penstock, powerhouse, turbine, generator, electric balance of plant, mobilization and transport (including camp), engineering, bonding and insurance, environmental and social mitigation allowance, and interest during construction
- Annual cost estimates include: O&M, water rental fees, taxes, and land usage fees

METHODOLOGY & ASSUMPTIONS (CONTINUED)

- Assessed over 7,000 potential sites for installed capacity, annual energy, and cost and determined unit energy cost (UEC) for each location
- Project life and lead time assessed for each potential resource individually

ENGAGEMENT SUMMARY

- Methodology and results reviewed by run-of-river industry engagement group
- Two meetings held – March 2 and July 6, 2015

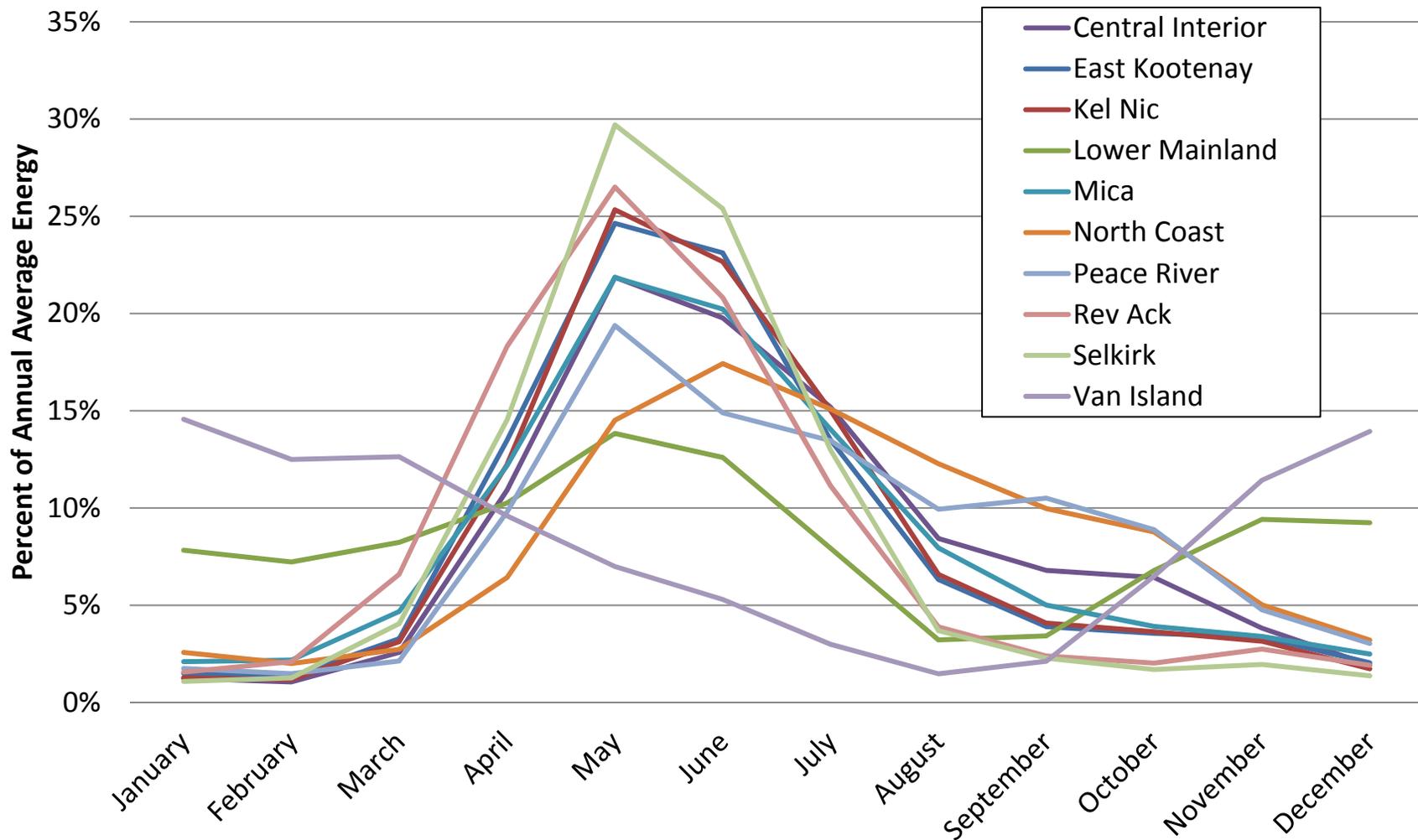
RUN-OF-RIVER RESULTS SUMMARY BY REGION

Transmission Region	Installed Capacity (MW)	Effective Load-Carrying Capability ELCC (MW)	Average Annual Energy (GWh/yr)	Annual Firm Energy (GWh/yr)
Central Interior	1,320	49	3,974	2,782
East Kootenay	736	34	2,260	1,679
Kelly Nicola	800	35	2,255	1,645
Lower Mainland	3,574	705	12,785	9,882
Mica	1,150	54	3,564	2,720
North Coast	5,558	611	19,195	15,118
Peace River	707	64	2,297	988
Revelstoke / Ashton Creek	1,247	45	3,587	2,507
Selkirk	578	19	1,550	1,006
Vancouver Island	633	220	1,665	1,073
Total (All Resource Options)	16,303	1,836	53,134	39,401

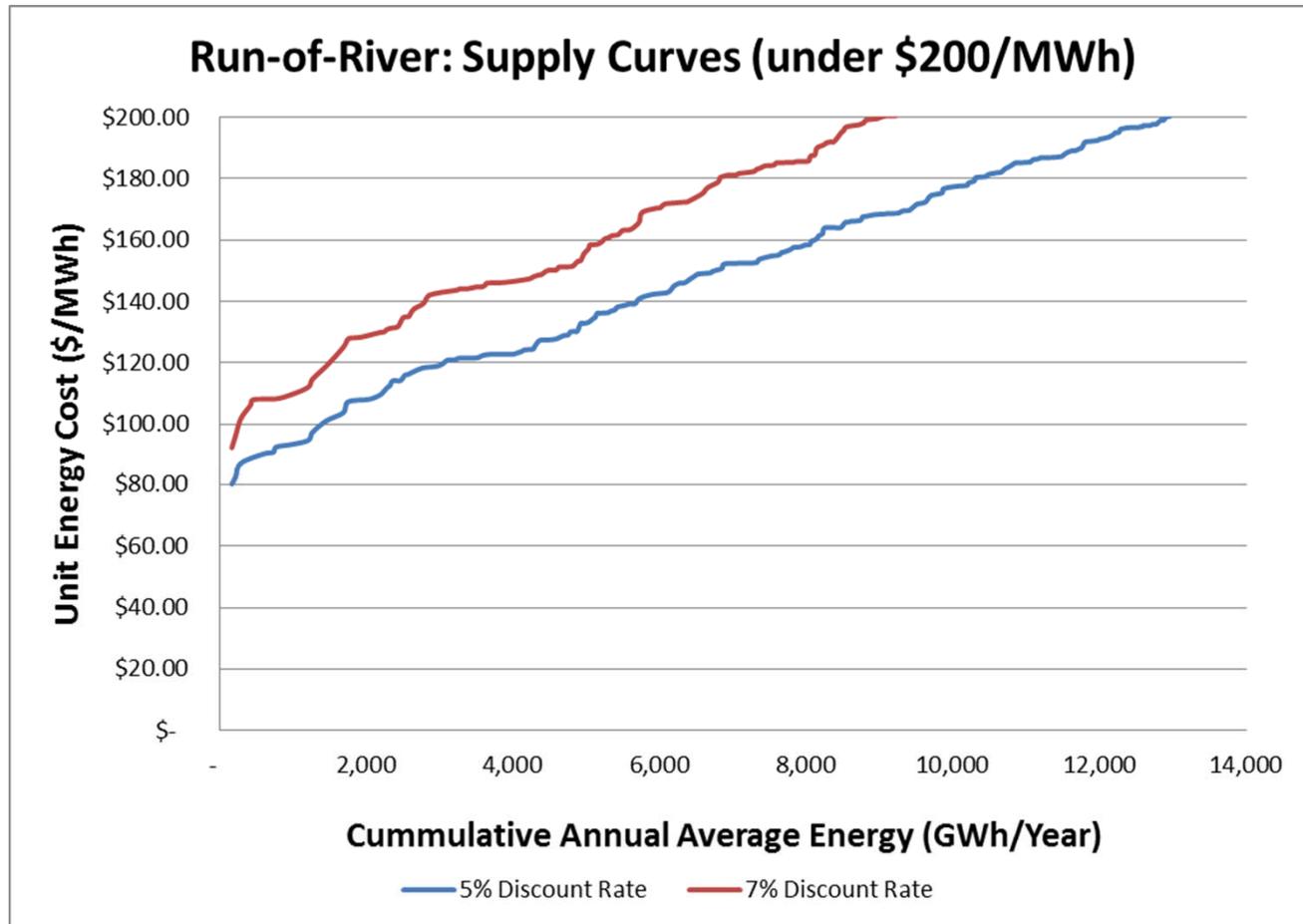
RUN-OF-RIVER RESULTS SUMMARY BY REGION

Transmission Region	Installed Capacity (MW)	Effective Load-Carrying Capability ELCC (MW)	Average Annual Energy (GWh/yr)	Annual Firm Energy (GWh/yr)	Range of UEC at POI (\$/MWh) - 5% Discount Rate	Range of UEC at POI (\$/MWh) - 7% Discount Rate
Central Interior	18	0	49	47	\$155	\$181
East Kootenay	165	3	522	430	\$91-\$169	\$106-\$197
Kelly / Nicola	261	14	799	618	\$93-\$161	\$110-\$188
Lower Mainland	1,275	234	4,842	3,737	\$83-\$169	\$96-\$199
Mica	143	6	494	412	\$80-\$156	\$92-\$182
North Coast	259	27	933	751	\$97-\$168	\$114-\$199
Revelstoke / Ashton Creek	307	8	956	754	\$112-\$170	\$131-\$198
Selkirk	106	4	332	240	\$138-\$172	\$161-\$200
Vancouver Island	11	3	33	27	\$156	\$180
Total (Resource Options within \$200/MWh Cut-Off)	2,545	300	8,961	7,016		

RUN-OF-RIVER RESULTS MONTHLY ENERGY PROFILES BY REGION



RUN-OF-RIVER RESULTS UNIT ENERGY COSTS



GEOHERMAL UPDATE SUMMARY



FOR GENERATIONS

SCOPE

- Screening of existing data to identify most favourable resources
- Update of resource potential and costs

METHODOLOGY & ASSUMPTIONS

- Collaborated with GeoscienceBC to retain Kerr Wood Leidal (KWL) to produce “An Assessment of the Economic Viability of Selected Geothermal Resources in British Columbia”:
 - Collect and review all existing public data at known geothermal sites;
 - Screen potential sites and identify most favourable sites;
 - Produce a volumetric assessment of the potential geothermal resource at each favourable site;
 - Use a transparent economic analysis to estimate project costs and unit energy costs
- Produced sensitivity analysis on the project economics to create a range of UECs at each site, recognizing the high uncertainty of geothermal development costs in B.C.

ENGAGEMENT SUMMARY

- Methodology and preliminary consultant results reviewed with geothermal industry group in July 2105
- Written feedback on methodology and preliminary results received from industry group.
 - General acceptance of methodology and high-level volumetric assessment in the context of large geological data gaps.
 - Some stakeholders questioned the accuracy of the economic assumptions, and suggested a sensitivity analysis of some of the economic assumptions would be warranted
- Sensitivity analysis of project costs was conducted to incorporate the stakeholder feedback

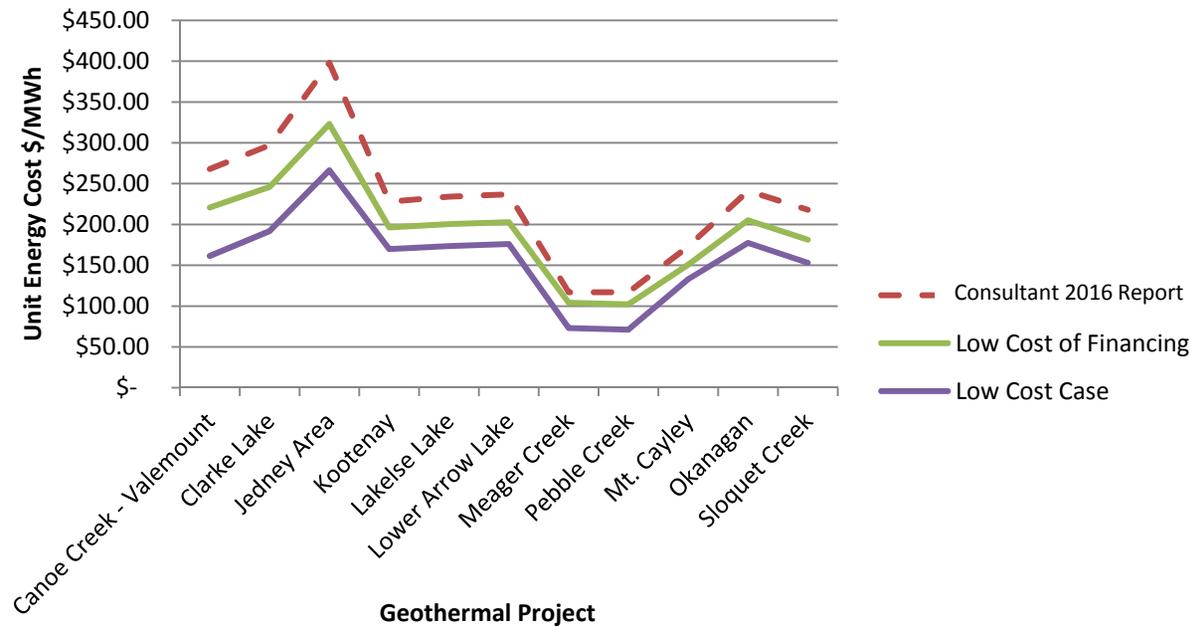
GEOHERMAL RESULTS

VOLUMETRIC ASSESSMENT OF FAVOURABLE SITES

Project Name	Region	Installed Capacity (MW)	Dependable Capacity (MW)	Annual Average Energy (GWh)	Annual Firm Energy (GWh/yr)
Canoe Creek - Valemount	Kelly Nicola	14.3	12.9	95	95
Clarke Lake	Peace River	18.4	13.8	104	104
Jedney Area	Peace River	12.2	9.2	69	69
Kootenay	Selkirk	19.9	14.9	112	112
Lakelse Lake	North Coast	19.6	14.7	111	111
Lower Arrow Lake	Revelstoke / Ashton Creek	19.6	14.7	111	111
Meager Creek	Lower Mainland	99.0	89.1	657	657
Pebble Creek	Lower Mainland	99.0	89.1	657	657
Mt. Cayley	Lower Mainland	40.7	30.5	232	232
Okanagan	Selkirk	18.3	13.7	103	103
Sloquet Creek	Lower Mainland	10.0	7.5	57	57

GEOHERMAL RESULTS UNIT ENERGY COST SENSITIVITY ANALYSIS

Assumptions	Drilling Cost	Financing Cost	Drilling Success Rate
Consultant 2016 Report	“High” costs of drilling as per GETEM	30% for early stages of development, declining to 7% at plant start up	60% for confirmation stage; 80% for well field development
Low Cost of Financing Case	Same as Consultant 2016 Report	5% flat financing rate	Same as Consultant 2016 Report
Low Cost Case	“Low” costs of drilling as per GETEM	5% flat financing rate	90% for confirmation stage; 90% for well field development



SOLAR

UPDATE SUMMARY



FOR GENERATIONS

SCOPE

- Focus on utility-scale Photovoltaics (PV)
- Update technology characterization and annual energy output estimates
- Update unit energy costs

METHODOLOGY

- Used 13 generic locations, 10 identified in the 2010 Resource Options Report and added 3 incremental sites near or within the FortisBC service territory
- Retained Consultant (Compass Renewable Energy Consulting Inc.) to update technology and cost features
- Estimated annual average energy and cost of a hypothetical 5 MW solar PV project at each location
- Estimated the unit energy cost (UEC) for each site

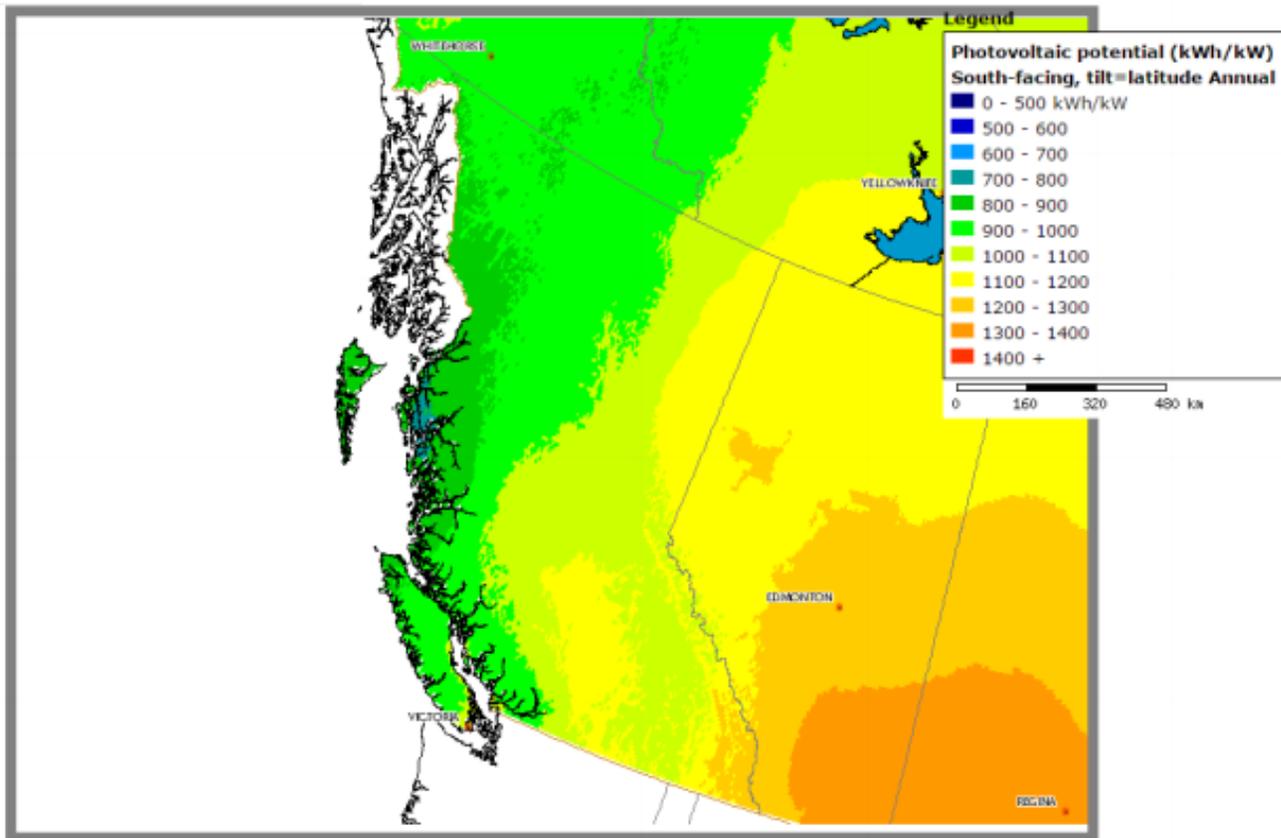
ASSUMPTIONS

- Project life of 25 years, with a 4 year lead time
- PV build assumed to be single axis tracking
- Capacity factor range: 17%-20% (as a factor of net installed capacity)
- Cost inputs: \$1.88 US Dollar per watt installed (as per consultant), 5% soft cost adder (related to site development), and O&M costs (as per estimates from EIA based on US experience)

ENGAGEMENT SUMMARY

- Methodology and results reviewed by solar industry engagement group
- Two meetings held – March 25, 2015 and June 29, 2015

SOLAR IRRADIATION MAP FOR B.C (NRCAN)



Note: NRCan's Cartes PV Map was used as basis for estimating the solar potential; however, adjustments were made to convert from fixed tilt to single axis tracking.

SOLAR RESULTS

All Representative Sites have an installed capacity of 5 MW each:

Transmission Region	Site Location	Solar Potential (kWh/kW/yr) - Adjusted for Single Axis Tracking	Effective Load Carrying Capability ELCC (MW)	Annual Average Energy (GWh/year)	Annual Firm energy (GWh/year)	UEC at POI (\$/MWh) - 5% Discount Rate	UEC at POI (\$/MWh) - 7% Discount Rate
Central Interior	Horsefly	1,370	0	6.9	6.9	\$179	\$211
East Kootenay	Elkford	1,522	0	7.6	7.6	\$168	\$197
East Kootenay	Cranbrook	1,510	0	7.6	7.6	\$145	\$171
Kelly Nicola	Kamloops	1,428	0	7.1	7.1	\$179	\$210
Lower Mainland	Powell River	1,254	0	6.3	6.3	\$197	\$232
Mica	Chase	1,393	0	7.0	7.0	\$196	\$230
North Coast	Vanderhoof	1,279	0	6.4	6.4	\$192	\$226
Peace River	Fort St. John	1,430	0	7.0	7.0	\$178	\$209
Revelstoke	Vernon	1,392	0	7.0	7.0	\$197	\$232
Selkirk	Osoyoos	1,396	0	7.0	7.0	\$216	\$253
Selkirk	Kelowna	1,395	0	7.0	7.0	\$152	\$180
Selkirk	Trail	1,379	0	6.9	6.9	\$157	\$185
Vancouver Island	Victoria	1,343	0	6.7	6.7	\$185	\$218

NATURAL GAS-FIRED GENERATION UPDATE SUMMARY



FOR GENERATIONS

SCOPE

- Retained AMEC Foster Wheeler to develop capital costs and performance characteristics of 3 combined cycle gas turbine facilities and 3 simple cycle gas turbine facilities
- Recalculate unit energy costs (UEC's) and unit capacity costs (UCC's) based on the updated characteristics

METHODOLOGY & KEY ASSUMPTIONS

- For combined cycle facilities, the consultant was requested to study GE LM6000, GE 6FA, and GE 7FA gas turbines. These units were chosen to obtain cost and performance characteristics over a range of unit sizes.
- For simple cycle facilities, the consultant was requested to study GE LM6000, GE LMS100, and GE 7FA gas turbines. These units were chosen to obtain cost and performance characteristics over a range of unit sizes.

METHODOLOGY & KEY ASSUMPTIONS (CONTINUED)

- The cost of natural gas fuel was derived using the ABB Spring 2016 (Mid) gas price scenario
- Fixed and Variable Operations and Maintenance costs were not updated
- The carbon tax was assumed to increase at the rate of inflation from its current value of \$30/tonne

ENGAGEMENT SUMMARY

- A number of gas turbine developers and original equipment manufacturers (OEMs) were engaged through e-mail communications
- Comments on the draft report were incorporated into the final report prepared by the consultant

NATURAL GAS-FIRED GENERATION RESULTS

Resource Option	Installed Capacity (MW)	Dependable Generating Capacity DGC (MW)	Average Annual Energy (GWh/yr)	Annual Firm Energy (GWh)	UEC at POI (\$/MWh) - 5% Discount Rate	UEC at POI (\$/MWh) - 7% Discount Rate
67 MW Combined Cycle Facility	67	67	411	528	\$92	\$97
119 MW Combined Cycle Facility	119	119	730	938	\$85	\$89
279 MW Combined Cycle Facility	279	279	1712	2201	\$74	\$77

In addition to capital costs, the above UECs include the following ongoing costs:

- Fuel gas cost at \$5.47/GJ
- Motor fuel tax (7% of fuel cost)
- Fixed O&M
- Variable O&M
- Carbon Tax (\$30/tonne of CO2 equivalent)

NATURAL GAS-FIRED GENERATION RESULTS

Resource Option	Installed Capacity (MW)	Dependable Generating Capacity DGC (MW)	Average Annual Energy (GWh/year)	Annual Firm Energy (GWh/year)	UCC at POI (\$/KW-Yr) - 5% Discount Rate	UCC at POI (\$/kW-Yr) - 7% Discount Rate
50 MW Simple Cycle Gas turbine	48	48	75	75	\$130	\$159
100 MW Simple Cycle Gas turbine	100	100	158	158	\$115	\$142
190 MW Simple Cycle Gas turbine	192	192	303	303	\$64	\$79

In addition to capital costs, the above UCCs include the following ongoing costs:

- Fixed O&M

MUNICIPAL SOLID WASTE UPDATE SUMMARY



FOR GENERATIONS

SCOPE

- Review select attributes and update cost estimates

METHODOLOGY & KEY ASSUMPTIONS

- MSW potential carried forward from 2010 ROU - assumes conservative estimate for fuel source availability so as to not interfere with waste avoidance and diversion strategies
- Analysis considers 3 waste-to-energy facilities which collect waste from several regional districts
- Updated capital and O&M costs based on ICF International 2014 report (Economic Analysis of New Waste-to-Energy Facility in Metro Vancouver)
- Project life increased from 25 to 35 years

ENGAGEMENT SUMMARY

- Reviewed modelling approach with Metro Vancouver staff on April 23, 2015. Approach was considered sound.

MUNICIPAL SOLID WASTE RESULTS

Project Name	Transmission Region	Installed Capacity (MW)	Dependable Generating Capacity (MW)	Average Annual Energy (GWh/yr)	Annual Firm Energy (GWh/yr)	UEC at POI (\$/MWh) - 5% Discount Rate	UEC at POI (\$/MWh) - 7% Discount Rate
MSW 1	Vancouver Island	12	12	101	101	\$179	\$238
MSW 2	Lower Mainland	25	25	211	211	\$92	\$132
MSW 3	Selkirk	14	13	112	112	\$226	\$282

TIDAL

UPDATE SUMMARY



FOR GENERATIONS

SCOPE

- Technology status and industry monitoring
- At Gate cost estimate improvements

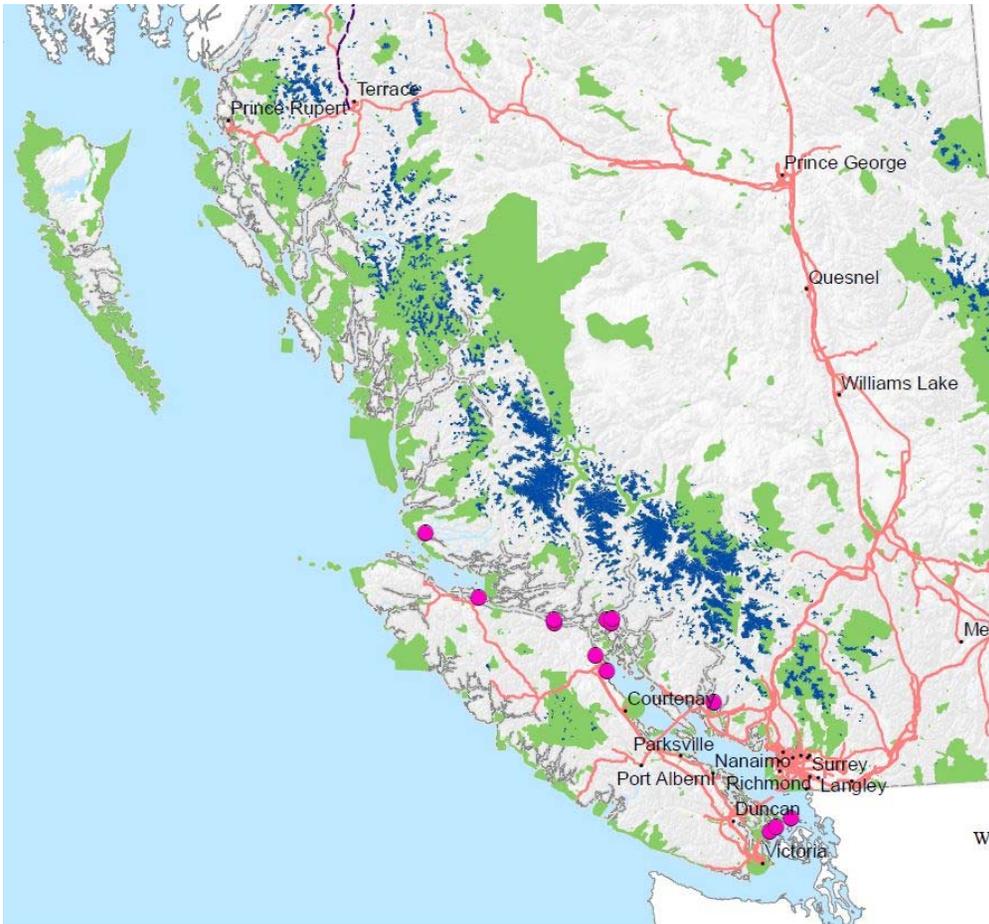
METHODOLOGY & ASSUMPTIONS

- Potential sites same as those described in 2010 BCH Resource Options Report
 - Identified from 2006 study by NRC Canadian Hydraulic Centre, Inventory of Canada's Marine Renewable Energy Resources
- Capital cost and O&M estimates updated as per World Energy Council/Bloomberg New Energy Finance 2013 report, World Energy Perspective, Cost of Energy Technologies
- Environmental/Social consultation and permitting as well as land use costs added to annual cost

ENGAGEMENT SUMMARY

- Methodology and results reviewed by academic experts (University of Victoria)
- Meeting held March 26, 2015

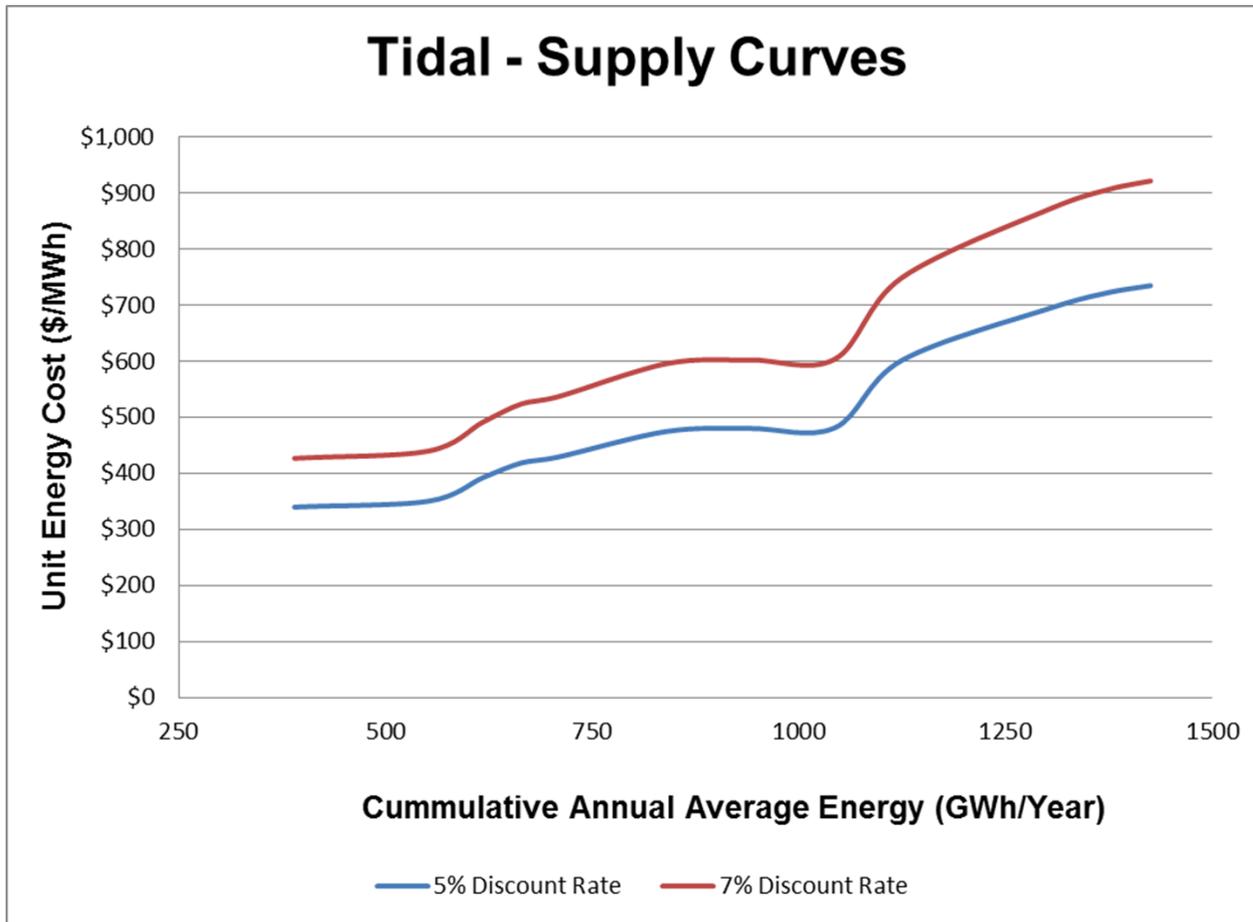
TIDAL RESULTS – RESOURCE LOCATIONS



TIDAL RESULTS – SUMMARY BY REGION

Transmission Region	Number of Resource Options	Installed Capacity (MW)	Effective Load-Carrying Capability ELCC (MW)	Annual Average Energy (GWh/yr)	Annual Firm Energy (GWh/yr)	Range of UEC at POI (\$/MWh) - 5% Discount Rate	Range of UEC at POI (\$/MWh) - 7% Discount Rate
Lower Mainland	1	15	6	44	44	\$430	\$537
Vancouver Island	11	602	241	1381	1381	\$340-\$735	\$427-\$922

TIDAL RESULTS – UNIT ENERGY COSTS



WAVE

UPDATE SUMMARY



FOR GENERATIONS

SCOPE

- Technology status and industry monitoring
- Resource assessment updated to most recent research
- At Gate cost estimate improvements

METHODOLOGY & ASSUMPTIONS

- Resource potential informed through recent research by West Coast Wave Initiative (WCWI) at the University of Victoria
 - 10 sites identified on west coast of Vancouver Island through detailed nearshore wave modelling
 - Generic wave energy converter power matrix used to determine energy output
- Capital cost and O&M estimates updated as per World Energy Council/Bloomberg New Energy Finance 2013 report, World Energy Perspective, Cost of Energy Technologies
- Environmental/Social consultation and permitting costs added to annual cost

ENGAGEMENT SUMMARY

- Methodology and results reviewed by academic experts (University of Victoria)
- Meeting held March 27, 2015

WAVE RESULTS – RESOURCE LOCATIONS

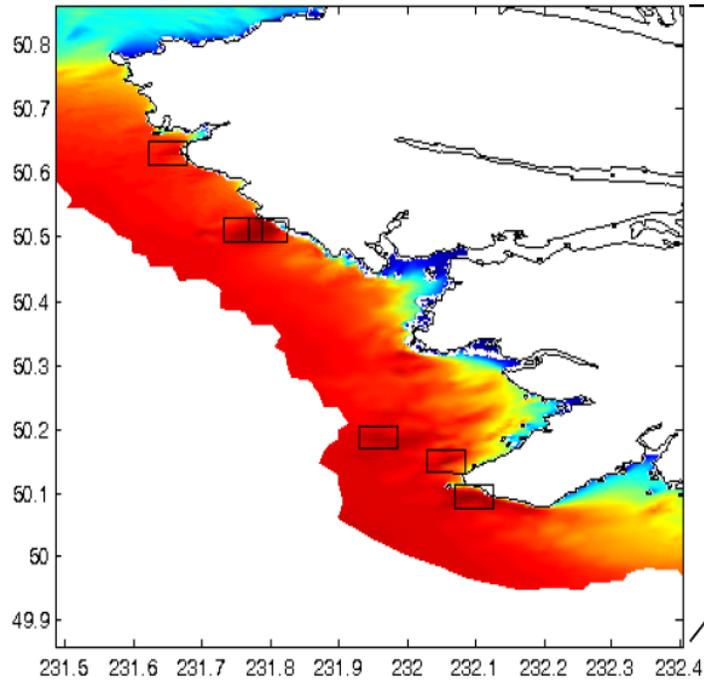


Figure 9: Potential Wave Farm Locations – Northern Vancouver Island

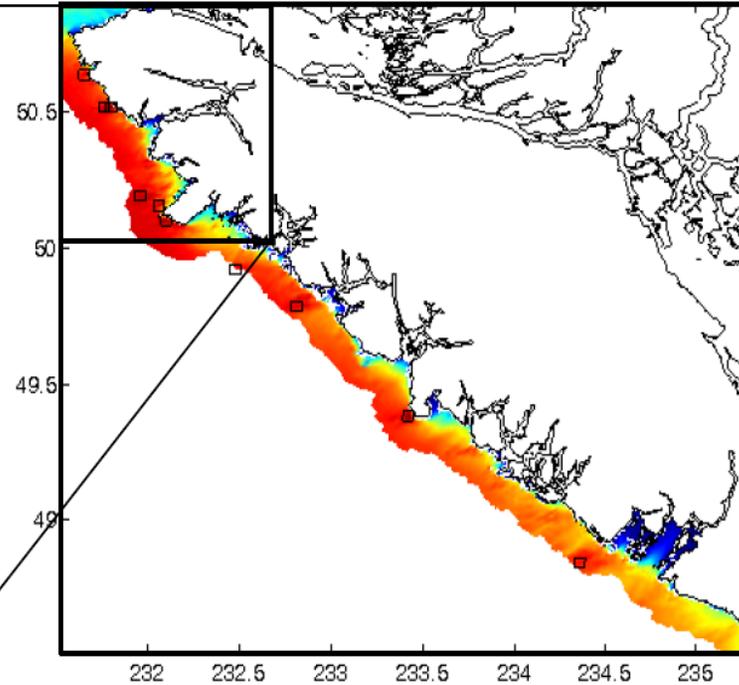


Figure 10: Potential Wave Farm Locations

Source: Robertson, B., Hiles, C., Luzko, E., Buckham, B., *Quantifying Wave Power Production Opportunities for Western Canada*. *Journal of Renewable Energy*, in review.

WAVE RESULTS – RESOURCE POTENTIAL

All sites have an installed capacity of 50 MW each:

Transmission Region	Number of Resource Options	Installed Capacity (MW)	Effective Load-Carrying Capability ELCC (MW)	Annual Average Energy (GWh/Year)	Annual Firm Energy (GWh/yr)	Range of UEC at POI (\$/MWh) - 5% Discount Rate	Range of UEC at POI (\$/MWh) - 7% Discount Rate
Vancouver Island	10	500	120	1163	1163	\$448-\$569	\$558-\$708

WAVE RESULTS – UNIT ENERGY COSTS

