Integrated Resource Plan

Appendix 3A-24

2013 Resource Options Report Update

Resource Options Mapping (ROMAP) Report

Report Appendices: A and B
Appendix A

Density Analysis Using GIS
DENSITY ANALYSIS USING GIS

DENSITY ANALYSIS

The analysis converted the discrete energy resource data into a continuous surface. A variable of interest is the total energy resource available within a specified area. Overlaying a grid with the energy resources and running a GIS function known as “Kernel Density” was the method selected for estimating energy density.

A kernel function is a commonly-used means of distributing randomly occurring values over an area. The volume under the surface is equal to the sum of the values within the kernel area. The ArcGIS Kernel Density calculates the density of point values at each grid cell based on the quartic kernel function described in Silverman (1986, p. 76, equation 4.5):

\[ \frac{3}{\pi h^2} \left( 1 - \left( \frac{d}{h} \right)^2 \right)^\frac{3}{2} \]

for \( t = d/h \leq 1 \), where \( d = \) distance from analysis location to resource, \( h = \) bandwidth (radius from analysis point to edge of kernel area);

\[ 0 \]

for \( t > 1 \).

Figure C-1 illustrates how the kernel density works.
Due to confidentiality reasons, the locations of several resource options (biomass and natural gas) were represented with polygon features rather than point features. Because the kernel density function uses point features as input, these polygon areas were distributed into points for the purpose of the analysis. A grid of points was created at 1,000 m spacing within the polygon and the installed capacity, annual energy, firm energy, dependable capacity, and ELCC distributed over the points.

**KERNEL BANDWIDTH (RADIUS)**

The bandwidth of the kernel density analysis represents the maximum distance of an interconnecting transmission line from a potential generation site to either an existing or potential substation connecting to the bulk transmission system.

Bandwidth has been determined to be an independent variable for this analysis, but would generally represent the maximum distance for construction of a collector transmission line to a central substation servicing the cluster. The Western Regional Energy Zones project (WREZ) set a maximum distance of 100 miles (160 km), which roughly represents $10/MWh in additional costs to energy production\(^1\). This was the maximum bandwidth considered in this study.

Kernel densities were generated at 80 km and 160 km bandwidths. A larger bandwidth has the effect of ‘flattening’ the resulting density surface, but retains an accurate volume of energy beneath the surface. Comparing the results led to the selection of the 80 km bandwidth, as the 160 km bandwidth resulted in a small number of very large energy clusters, which was not as desirable as a larger number of smaller clusters for planning of potential new transmission in BC.

Appendix B

Roads & Power Lines Cost Estimation Using GIS

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ROAD & POWER LINE COST ESTIMATING USING GIS

Access road and power line costs were developed using GIS tools. The toolset identifies the least expensive route from power projects to existing roads or existing power systems.

These tools were used to develop unit cost surfaces of the entire province for road and power line construction.

The sources and processes for developing the road and power line costs are described in Table B-1.

Table B-1: Cost Surface Development Process

<table>
<thead>
<tr>
<th>Feature</th>
<th>Source/Author</th>
<th>Usage</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Roads</td>
<td>National Road Network (geobase.ca)</td>
<td>Roads</td>
<td>Used as sources for road cost routine.</td>
</tr>
<tr>
<td>Overhead Wires</td>
<td>BC Hydro and Fortis BC</td>
<td>Power Lines</td>
<td>Used as sources for power line cost routine.</td>
</tr>
<tr>
<td>Slope</td>
<td>Canadian Digital Elevation Data (CDED)</td>
<td>Roads &amp; Power Lines</td>
<td>Elevation data converted to slope, and categorized into cost classes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Slopes exceeding 30% and 75% were considered to be not feasible for</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>construction of roads and power lines, respectively.</td>
</tr>
<tr>
<td>Proximity to Major</td>
<td>Site classification (see Section 3.2.1)</td>
<td>Roads</td>
<td>Greater cost values were assigned to locations further away from city</td>
</tr>
<tr>
<td>Cities</td>
<td></td>
<td></td>
<td>centres.</td>
</tr>
<tr>
<td>Land Cover</td>
<td>AVHRR 1:2M Land Cover (geogratis.ca)</td>
<td>Roads &amp; Power Lines</td>
<td>Costs were adjusted based on land cover (i.e. forest, rock, croplands).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Permanent snow and ice were considered infeasible for construction.</td>
</tr>
<tr>
<td>Parks</td>
<td>BC Parks and Protected Areas (lrdw.ca)</td>
<td>Roads &amp; Power Lines</td>
<td>Parks were masked out so that no new roads or power lines can cross</td>
</tr>
<tr>
<td></td>
<td>Canada Lands Administrative Boundaries (geogratis.ca)</td>
<td></td>
<td>provincial and federal parks.</td>
</tr>
<tr>
<td>Water</td>
<td>Output from the Power calculation model Watershed</td>
<td>Roads &amp; Power Lines</td>
<td>Costs were assigned to small rivers that can be crossed with culverts</td>
</tr>
<tr>
<td></td>
<td>Atlas</td>
<td></td>
<td>or small bridges. Large rivers and lakes were not considered for</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>crossing.</td>
</tr>
<tr>
<td>Forest Roads</td>
<td>Forest Tenure Roads (lrdw.ca)</td>
<td>Roads &amp; Power Lines</td>
<td>Construction costs were discounted along existing forest roads.</td>
</tr>
</tbody>
</table>

The proposed project locations were overlaid with the resulting accumulated cost output and total road cost extracted. Some locations were found to be inaccessible as determined by the cost routine. These locations were reviewed and either assigned an approximate cost based on the output or assigned a $100 million cost for roads if the project is technically inaccessible:

Table B-2 lists the cost assigned for technically inaccessible projects for power lines.
Table B-2: Power Line Costs for Technically Inaccessible Projects

<table>
<thead>
<tr>
<th>New Power Line Voltage (kV)</th>
<th>Technically Inaccessible Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>50,000,000</td>
</tr>
<tr>
<td>69</td>
<td>120,000,000</td>
</tr>
<tr>
<td>138</td>
<td>300,000,000</td>
</tr>
<tr>
<td>230</td>
<td>1,000,000,000</td>
</tr>
<tr>
<td>500</td>
<td>3,000,000,000</td>
</tr>
</tbody>
</table>

The above costs are much higher than any of the cost output from the GIS routine and are intended to render a project economically infeasible due to inaccessibility to roads or power lines.

Clustering of projects to reduce costs through sharing of common infrastructure was outside of this assessment’s scope.

After the cost accumulation process, individual paths from sources to project locations were traced using the GIS tools. While this process identified common paths amongst adjacent projects, it was assumed that each project would be constructed independently. This is a key factor in the overall cost estimate as road and power line costs make up a significant portion of most projects, especially in remote areas.

ACCESS ROADS

Access roads were considered to begin at an existing, documented road and follow the least-cost path to the project location. The primary costs for roads were based on road gradient and distance to major centres. Adjustments to unit costs were made for crossing barren rocky areas, wetlands and agricultural areas. Nominal costs were assigned to existing forestry roads to account for maintenance and road upgrading. The forestry road costs were approximately an order of magnitude less than construction of new roads. This resulted in the least-cost path generally following these corridors until the vicinity of a proposed site was reached.

Roads were assumed not to traverse legally protected areas, large water bodies, glaciers or road grades exceeding 30%. If the site was in proximity to a large body of water, barge access was considered.

Development (engineering, environmental and other) and annual costs (O&M, land acquisition and property taxes, but not water rentals) were added on as a percentage of capital cost.

Road costs also included a 30% contingency.
Table B-3: Road Construction Unit Cost ($/m)

<table>
<thead>
<tr>
<th>Site Location Category</th>
<th>Slope</th>
<th>$/m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-5%</td>
<td>121</td>
</tr>
<tr>
<td></td>
<td>5-10%</td>
<td>153</td>
</tr>
<tr>
<td></td>
<td>10-15%</td>
<td>216</td>
</tr>
<tr>
<td></td>
<td>15-20%</td>
<td>278</td>
</tr>
<tr>
<td></td>
<td>20-30%</td>
<td>402</td>
</tr>
<tr>
<td>A</td>
<td>0-5%</td>
<td>209</td>
</tr>
<tr>
<td></td>
<td>5-10%</td>
<td>241</td>
</tr>
<tr>
<td></td>
<td>10-15%</td>
<td>303</td>
</tr>
<tr>
<td></td>
<td>15-20%</td>
<td>366</td>
</tr>
<tr>
<td></td>
<td>20-30%</td>
<td>490</td>
</tr>
<tr>
<td>B</td>
<td>0-5%</td>
<td>296</td>
</tr>
<tr>
<td></td>
<td>5-10%</td>
<td>328</td>
</tr>
<tr>
<td></td>
<td>10-15%</td>
<td>391</td>
</tr>
<tr>
<td></td>
<td>15-20%</td>
<td>453</td>
</tr>
<tr>
<td></td>
<td>20-30%</td>
<td>577</td>
</tr>
<tr>
<td>C &amp; D</td>
<td>0-5%</td>
<td>209</td>
</tr>
<tr>
<td></td>
<td>5-10%</td>
<td>241</td>
</tr>
<tr>
<td></td>
<td>10-15%</td>
<td>303</td>
</tr>
<tr>
<td></td>
<td>15-20%</td>
<td>366</td>
</tr>
<tr>
<td></td>
<td>20-30%</td>
<td>490</td>
</tr>
</tbody>
</table>

Four site categories were used to indicate remoteness of location. Category A sites were located within a 50 km radius of a major town or city centre (population of 25,000 or more). Category B and C sites were located within 200 and 400 km from a centre, respectively, and Category D sites were located anywhere outside a 400 km radius from a centre. Figure B-1 shows the site location categories.

**BARGE ACCESS**

Potential projects that were sited close to the shoreline of a large lake, the coast or a major inlet were given the opportunity to have barge access. In the case of lakes only large lakes (>50 km²) in close proximity to roads (<500 m) were allowed for barge access. A barge access cost allowance was included for projects based on the construction duration: $700,000 for 1 year, $1,000,000 for 2 years, and $1,300,000 for 3 years of construction.

Estimated costs for access can be found in Figure B-2.

**POWER LINE, INTERCONNECTION AND TRANSFORMATION COSTS**

As with access roads development (engineering, environmental and other) and annual costs (O&M, land acquisition and property taxes) were added on as a percentage of capital cost. The percentages used are noted in Section 3 of the report.

These costs also included a 30% contingency.

Estimated costs for power lines from 25 kV through 500 kV can be found in Figures B-3 through B-7.
ALLOWABLE INTERCONNECTION LOCATIONS

Independent power line (an unshared line that is used by one project to interconnect to the BC Hydro grid) interconnection occurred at either:

1. An existing power line (BC Hydro or Fortis BC grid) or the proposed 287 kV Northwest Transmission Line (NTL) from Skeena to Bob Quinn Lake substation (in-service December 2013); or

2. An existing substation (BC Hydro or Fortis BC grid) or the proposed 287 kV substation at Bob Quinn.

Interconnection to the existing system with independent power lines was not allowed at non-integrated substations or to power lines only connected to a non-integrated substation. This included the non-integrated existing Fort Nelson Substation (FNG) and line 1L359 from Alberta to FNG.

Table B-4 details the interconnection rules used to define whether a new power line can connect to an existing power line or to an existing substation. Table B-5 details the interconnection rules used to define whether a new power line can connect. Shaded grey cells indicate that interconnection is not allowed.

Table B-4: Interconnection Rules – New Power Line to Existing Power Line

<table>
<thead>
<tr>
<th>New Power Line Voltage (kV)</th>
<th>12.5, 25, &amp; 34.5</th>
<th>60, 63&lt;sup&gt;b&lt;/sup&gt; &amp; 69</th>
<th>138&lt;sup&gt;a&lt;/sup&gt;</th>
<th>230 &amp; 287</th>
<th>360 &amp; 500</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>D.I.&lt;sup&gt;c&lt;/sup&gt;</td>
<td>S.S.&lt;sup&gt;d&lt;/sup&gt;</td>
<td>S.S.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>69</td>
<td>X</td>
<td>S.S.</td>
<td>S.S.</td>
<td>S.S.</td>
<td>X</td>
</tr>
<tr>
<td>138</td>
<td>X</td>
<td>X</td>
<td>S.S.</td>
<td>S.S.</td>
<td>X</td>
</tr>
<tr>
<td>230</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>S.S.</td>
<td>X</td>
</tr>
<tr>
<td>500</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Notes:

a) If the voltage level of the new power line is not available at the existing substation, then a transformation cost will apply.
b) FortisBC System Voltage
c) D.I. = direct interconnection without a sectionalizing substation
d) S.S = interconnection only with a sectionalizing substation
e) 25 kV power lines were allowed to connect to 12.5 kV power lines in the BC Hydro system as it was assumed the system will eventually be upgraded to 25 kV. Either a 25 kV to 12.5 kV transformer would be required at the point of interconnection or the 12.5 kV power line would be upgraded to 25 kV. This transformation or upgrade cost was ignored.
Table B-5: Interconnection Rules – New Power Line to Existing Substation

<table>
<thead>
<tr>
<th>New Power Line Voltage (kV)</th>
<th>Lowest Voltage Available at Existing Substation (kV)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12.5, 25, &amp; 35</td>
</tr>
<tr>
<td>25&lt;sup&gt;c&lt;/sup&gt;</td>
<td>√</td>
</tr>
<tr>
<td>69</td>
<td>X</td>
</tr>
<tr>
<td>138</td>
<td>X</td>
</tr>
<tr>
<td>230</td>
<td>X</td>
</tr>
<tr>
<td>500</td>
<td>X</td>
</tr>
</tbody>
</table>

Notes:

a) If the voltage level of the new power line is not available at the existing substation, then a transformation cost will apply.

b) FortisBC system voltage

c) 25 kV power lines were allowed to connect to 12.5 kV substations in the BC Hydro system as the system will eventually be upgraded to 25 kV. A 25 kV to 12 kV transformer would be required at the point of interconnection. This transformation cost was ignored.

New power lines were only allowed to connect at specific points along an existing power line (be it a direct tap in the case of 25 kV or a sectionalizing substation in the case of 60, 69, 138, 230, or 287 kV). Allowable interconnection locations were positioned a minimum distance between each other and existing substations (Table B-6). The allowable interconnection locations also were placed in locations with lower terrain slope (i.e. at flatter locations not on the side of a hill).

Table B-6: Minimum Distance between Potential Interconnection Points

<table>
<thead>
<tr>
<th>Existing Power Line Voltage (kV)</th>
<th>Min. Distance (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.5, 25, &amp; 34.5</td>
<td>10</td>
</tr>
<tr>
<td>60, 63 &amp; 69</td>
<td>20</td>
</tr>
<tr>
<td>132, 138 &amp; 161</td>
<td>60</td>
</tr>
<tr>
<td>230, 238 &amp; 287</td>
<td>100</td>
</tr>
</tbody>
</table>

POWER LINE COSTS

The power line costs estimated for the 2007 Run-of-River (RoR) study by KWL were escalated to 2011 dollars using 2% per year (6% total). Costs vary with the slope in KWL’s least-cost routing method (see KWL’s Run-of-River Hydroelectric Resource Assessment for British Columbia 2007 study for discussion). The estimated 2011 powerline costs are presented in Table B-7.

Exclusion areas for power lines were legally protected areas, glaciers or topography with grades exceeding 75%.
Table B-7: Power Line Cost

<table>
<thead>
<tr>
<th>New Power Line Voltage (kV)</th>
<th>Avg. Slope (0-15%)</th>
<th>Avg. Slope (16-30%)</th>
<th>Avg. Slope (31 - 75%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>84,800</td>
<td>169,600</td>
<td>254,400</td>
</tr>
<tr>
<td>69</td>
<td>106,000</td>
<td>212,000</td>
<td>319,000</td>
</tr>
<tr>
<td>138</td>
<td>159,000</td>
<td>318,000</td>
<td>477,000</td>
</tr>
<tr>
<td>230</td>
<td>265,000</td>
<td>530,000</td>
<td>795,000</td>
</tr>
<tr>
<td>500</td>
<td>530,000</td>
<td>1,060,000</td>
<td>1,590,000</td>
</tr>
</tbody>
</table>

Table B-8: Transmission Voltages – Capacity and Distance

<table>
<thead>
<tr>
<th>Voltage Level (kV)</th>
<th>Capacity Range (MW)</th>
<th>Distance from Cluster’s Central Substation (Km)</th>
<th>75% of Distance x 75% of Capacity (MW x km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>0</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>69</td>
<td>20</td>
<td>60</td>
<td>20</td>
</tr>
<tr>
<td>138</td>
<td>60</td>
<td>150</td>
<td>60</td>
</tr>
<tr>
<td>230</td>
<td>150</td>
<td>500</td>
<td>N/A</td>
</tr>
<tr>
<td>500</td>
<td>500</td>
<td>1,500</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table B-9 provides estimated submarine cable costs.

Table B-9: Submarine Cable Cost

<table>
<thead>
<tr>
<th>New Submarine Cable Voltage (kV)</th>
<th>$M/km</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>0.5</td>
</tr>
<tr>
<td>69</td>
<td>1.0</td>
</tr>
<tr>
<td>138</td>
<td>3.6</td>
</tr>
<tr>
<td>230</td>
<td>5.3</td>
</tr>
<tr>
<td>500</td>
<td>7.1</td>
</tr>
</tbody>
</table>

INTERCONNECTION & TRANSFORMATION COSTS

Tables B-10 & B-11 provide estimates for the unit interconnecting station cost and transformation costs.

Table B-10: Interconnection Cost to Existing Power Lines

<table>
<thead>
<tr>
<th>New Power Line Voltage (kV)</th>
<th>Interconnecting Station Cost or Sectionalizing Substations (required to connect to 69kV, 138kV and 230kV, and 287 kV)</th>
<th>Interconnection Costs to an Existing Power Line – Without a Sectionalizing Substation Required (only 25kV to 25kV, 12 kV and 35kV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>$1.5M</td>
<td>$400k</td>
</tr>
<tr>
<td>69</td>
<td>$7.5M</td>
<td></td>
</tr>
<tr>
<td>138</td>
<td>$9.5M</td>
<td></td>
</tr>
<tr>
<td>230</td>
<td>$10.5M</td>
<td></td>
</tr>
</tbody>
</table>
Table B-11: Transformation Cost

<table>
<thead>
<tr>
<th>New Generation Power Line Voltage (kV)</th>
<th>Lowest Voltage Available Existing Substation (kV)</th>
<th>25 &amp; 34.5</th>
<th>69</th>
<th>138</th>
<th>230</th>
<th>287</th>
<th>360</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Only apply if there is not a voltage level available at the substation)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 a</td>
<td></td>
<td>$0</td>
<td>$1.5M</td>
<td>$1.5M</td>
<td>$1.5M</td>
<td>$1.5M</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>69 a</td>
<td></td>
<td>X</td>
<td>$0</td>
<td>$7.5M</td>
<td>$7.5M</td>
<td>$7.5M</td>
<td>$7.5M</td>
<td></td>
</tr>
<tr>
<td>138</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>$12M</td>
<td>$12M</td>
<td>$15M</td>
</tr>
<tr>
<td>230</td>
<td></td>
<td>X</td>
<td>X</td>
<td>$0</td>
<td>$0 b</td>
<td>$13.5M</td>
<td>$16.5M</td>
<td></td>
</tr>
<tr>
<td>500</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>$0</td>
</tr>
</tbody>
</table>

Notes:

a) In absence of information, the sectionalizing substation cost was used.
b) There was no transformation cost assumed since the power line would likely be built at 287, which would be a similar cost to a 230 kV.

TOTAL POWER LINE AND INTERCONNECTION COSTS

The total cost was calculated as follows for the two scenarios:

1. New power line and interconnection to an existing power line was calculated as follows:

   \[
   \text{Total cost} = \text{C}_{\text{PL}} \times \text{L}_{\text{PL}} + (\text{C}_{\text{Int,PL Direct}} \text{ or } \text{C}_{\text{Int,PL SS}}) + \text{C}_{\text{Tran}}
   \]

   Where:
   - \( \text{C}_{\text{PL}} \) = power line cost per length (varies with slope and kV)
   - \( \text{L}_{\text{PL}} \) = power line length
   - \( \text{C}_{\text{Int,PL Direct}} \) = cost of direct tap interconnection to an existing power line only applies to 25kV to 25kV (and also for 25 kV to 12.5 kV or 35kV in the BC Hydro system)
   - \( \text{C}_{\text{Int,PL SS}} \) = cost of interconnection using a sectionalizing substation to connect to an existing power line. (Not required for 25kV to 25kV, 12.5 kV, or 34.5 kV power lines.)
   - \( \text{C}_{\text{Tran}} \) = cost of transformation (based on kV of the new power line and kV of the power line), only applies if the kV of the new power line is lower than the kV of the existing power line.

2. New power line and interconnection to an existing substation would include:

   \[
   \text{Total cost} = \text{C}_{\text{PL}} \times \text{L}_{\text{PL}} + \text{C}_{\text{Tran}}
   \]

   Where:
   - \( \text{C}_{\text{PL}} \) = power line cost per length (varies with slope and kV)
   - \( \text{L}_{\text{PL}} \) = power line length
   - \( \text{C}_{\text{Tran}} \) = cost of transformation (based on kV of the new power line and kV of the substation if the voltage of the new power line is not available at the substation) = $0 if the voltage of the power line is available at the existing substation
Legend

- Existing Road
- Legally Protected Areas and Glaciers

Accumulated Cost for Access ($ Millions)

- < 0.25
- 0.25 - 1
- 1 - 2.5
- 2.5 - 10
- > 10

Note:
1) Areas with dense existing road networks (purple) generally correspond to cheaper road costs.
Legend

- Substation
- Non-integrated Substation
- Proposed Substation
- Distribution Line
- Non-integrated Distribution Line
- Transmission Line
- Non-integrated Transmission Line
- Fortis BC Transmission Line
- Proposed Transmission Line
- Legally Protected Areas and Glaciers

Accumulated Cost for Power Line ($ Millions)

- $<1
- $1-5
- $5-10
- $10-15
- $>15

Notes:
- Non-integrated substations and power lines were not included in the costing process.
- Cost does not include interconnection costs.

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Estimated Cost for 25 kV Power Lines

Figure B-3
Legend

- Substation
- Non integrated Substation
- Proposed Substation

- Distribution Line
- Non Integrated Distribution Line
- Transmission Line
- Non integrated Transmission Line
- Fortis BC Transmission Line
- Proposed Transmission Line

Legally Protected Areas and Glaciers

Accumulated Cost for Power Line ($ Millions)

- < 1
- 1 - 5
- 5 - 10
- 10 - 15
- > 15

Notes:
* Non-integrated substations and power lines were not included in the costing process.
* Cost does not include interconnection costs.

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100 0 100 Kilometers

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Estimated Cost for 69 kV Power Lines Figure B-4

Integrated Resource Plan Appendix 3A-24
2013 Resource Options Report Update Appendix 5-A18
Legend

- Substation
- Non-integrated Substation
- Proposed Substation
- Distribution Line
- Non-integrated Distribution Line
- Proposed Distribution Line
- Transmission Line
- Non-integrated Transmission Line
- Fortis BC Transmission Line
- Proposed Transmission Line

Accumulated Cost for Power Line ($ Millions)

- < 1
- 1 - 5
- 5 - 10
- 10 - 15
- > 15

Notes:
- Non-integrated substations and power lines were not included in the costing process.
- Cost does not include interconnection costs.

Estimated Cost for 138 kV Power Lines

Figure B-5
Legend

- Substation
- Non integrated Substation
- Proposed Substation
- Distribution Line
- Non integrated Distribution Line
- Transmission Line
- Non integrated Transmission Line
- Fortis BC Transmission Line
- Proposed Transmission Line
- Legally Protected Areas and Glaciers

Accumulated Cost for Power Line ($ Millions)
- ≤ 5
- 5 - 25
- 25 - 50
- 50 - 75
- > 75

Notes:
- Non-integrated substations and power lines were not included in the costing process.
- Cost does not include interconnection costs.

Estimated Cost for 230 kV Power Lines

Figure B-6
Legend
- Substation
- Non Integrated Substation
- Proposed Substation
- Distribution Line
- Non Integrated Distribution Line
- Transmission Line
- Non Integrated Transmission Line
- Fortis BC Transmission Line
- Proposed Transmission Line

Legally Protected Areas and Glaciers
Accumulated Cost for Power Line ($ Millions)
- < 9
- 9 - 45
- 45 - 90
- 90 - 135
- > 135

Notes:
* Non-integrated substations and power lines were not included in the costing process.
* Cost does not include interconnection costs.

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Estimated Cost
for 500 kV Power Lines
Figure B-7