

Subject: Grassy Mountain Coal Project

Submission to Joint Review Panel – Grassy Mountain Coal Project

By Fred Bradley

September 21, 2020

A. Introduction

Thank you for the opportunity to participate in the Grassy Mountain Coal Project Joint Review Panel public hearing on Benga Mining (Riversdale Resources) application to construct a metallurgical coal mine in the Crowsnest Pass.

a. Project Perspective:

I support responsible coal development in our province. And I support the Grassy Mountain Coal Project for the economic opportunities it brings to the region provided the appropriate environmental conditions, regulations, and mitigation strategies as outlined in the application and other conditions applied by the regulators are met in its construction, operation and reclamation.

B. Background

1. Witness Background and Experience

I was born and raised in the Crowsnest Pass. I have maintained a residence in the Crowsnest Pass all of my life.

Along with my brother and sister, I own our family home at <personal information removed>. It is the home in which I grew up. It is approximately one kilometer south east of the proposed rail load out facility for the proposed mine and approximately 8 km by road from the proposed surface mining operation and cleaning plant. I also have a residence on Tecumseh Road which is west of Coleman.

From March of 1975 to May of 1993, I served as the Member of the Legislative Assembly for Pincher Creek- Crowsnest, Minister of Environment for the Province of Alberta from 1982 to 1986, Chairman of the Alberta Research Council from 1986 to 1993, Board Member and latterly Chair of the Alberta Environmental Research Trust from 1975 to 1979. Currently I serve on the board of Community Futures Crowsnest Pass, which is an innovative financier of local business and involved extensively in community economic development. I also involved as a volunteer and board member on several heritage related organizations in the community.

2. Experience growing up in a coal mining community

I was born in Blairmore in 1949 and for the first ten years of my life the Greenhill Mine operated by West Canadian Collieries was an active coal mining operation which was located less than a mile from my familyhome. During its operation which included an underground mine, cleaning plant, and rail line to the CPR main line, it was the economic mainstay of our community, but also had obvious

environmental impact. When the cleaning plant was in operation the community experienced a great deal of coal dust, particularly from the west wind. Wash day on Monday's permitted the hanging of clothes to dry without the prospect of residue from the cleaning plant adorning the hanging clothes as the cleaning plant did not operate on that day.

Also, I worked during the summer of 1970 as a summer student for Coleman Collieries with a variety of job experiences at their coal processing plant and coal loadout facility. I experienced first-hand the level of coal dust created by those operations.

3.MLA Observations

During my tenure as MLA, the operation of the Coleman Collieries cleaning plant in Coleman was a continued cause of complaints from local residents due to the coal dust emanating from the operation of the coal processing plant and the rail load out. At my initiative a local Coleman Collieries Environment Advisory committee was struck to recommend to the provincial government options to reduce the environmental and health impacts on the local community. Although several mitigation strategies were employed, the location of the plant close to the townsite made it impossible to reduce the dust to manageable levels without considerable investment, including relocation of the cleaning plant and rail load out, which were prohibitive at the time and would have resulted in the closing of the operation. (Note: Coleman Collieries ceased active underground mining in 1989 and the coal processing facility closed in 1992.)

C.. Preliminary Disclosure approved for Grassy Mountain Project in 1976

In 1977, Consolidated Coal and Scurry Rainbow joint venture's preliminary disclosure was approved by the Alberta government to advance to the application stage under the then newly released Alberta Coal Policy (Appendix A PAA Accession PR1982.0165, item 399). It should be noted that the project lands were then under Category 4 which allowed for surface mining of the coal leases associated with the Consol/Scurry Rainbow Grassy Mountain Coal Project. At the time there was broad public support for this project to proceed. However, market economics and construction costs at the time resulted in the application not proceeding.

D Socio Economic Statistics

Following is a list of socio economic statistics which I believe are relevant to be considered by the hearing panel

1. Changes in Community Demographics

a. Population Decline

The population of the community has declined dramatically over the past 40 years.

The population of the newly amalgamated Municipality of Crowsnest Pass in 1979 was 7340. Today the population according to the 2016 census was 5589. That represents a decline in population of - 23.85% for that period. From 2001 to 2006 the population declined from 6262 to 5749 a decline of -8.19% over that five year period. (Appendix B – Demographic Profile – Population Decline.pdf)

b. Aging Community -one of Alberta and Canada's oldest communities

The Municipality of Crowsnest Pass has one of the oldest communities by age in the province. In 2016 Crowsnest Pass median age was 50 compared to a median age in Alberta of 36 and in Canada of 41.

According to the 2016 census 22.45% of the Crowsnest Pass population was over the age of 65 compared to 12.29% for Alberta and 16.88% for Canada (Appendix C – Demographics – Aging Population.pdf)

c. Assessment Base – currently dependent on residential assessment

In 2019, over 85% of the equalized assessment for the Municipality of Crowsnest Pass was residential according to Alberta Municipal Affairs profile for the community (\$819 million of a total assessment of \$962 million.) (Appendix D – Municipal Profile Index.pdf)

The Municipality is struggling to maintain services and needed improvements for water, sewer and road infrastructure. Without an increase in commercial and industrial assessment it will become extremely difficult for the municipality to maintain existing infrastructure solely from its municipal assessment base. Without major new investment and assessment base the community is on the verge of becoming unsustainable.

d. Vacant Storefronts in Blairmore

On Saturday, September 19, 2020 I counted 19 vacant commercial buildings on 20th Avenue in Blairmore which is the major shopping district of the Municipality of Crowsnest Pass. This is an indication of the toll that population decline, loss of major industrial employers and changing trade patterns have had on the community.

e. Approximate Industrial economic and employment activity decline by industry -1979-2012

Name of Industry	Closure Timeframe	Jobs Lost
Coleman Collieries (coal)	1979 underground 1982-tipple	600
Phillips Cable(telecommunication)s	1985	250
Atlas Lumber (Sawmill)	2002	100
Devon Gas Plant (gas processing)	2012	80
TOTAL		1030

Over 1030 jobs have been lost in the community from 1979 to 2012 from major resource extraction and manufacturing facilities closing. This does not include the multiplier effect of jobs lost in the service sector. This is a dramatic loss of jobs over this period of time.

f. Dormitory Community for South East BC Coal Industry

In 2016 according to the 2016 Census 19.2% of the workforce population (527 workers) was employed in mining, quarrying, and oil and gas extraction. (Appendix E Workforce, Mining Quarrying.pdf) As there are no such operations active within the confines of the Alberta side of the Crowsnest Pass, it is my conclusion that most of these individuals are employed in the coal mining industry in South Eastern British Columbia. That is approximately one in five of the working population commutes to work in jobs located outside of the community.

Without those jobs the community would have faced a more serious economic and population decline.

2. World Requirement for Coking Coal to Manufacture Steel

World demand for steel will continue into the foreseeable future. It is a fact that for every four tonnes of manufactured steel approximately three tonnes of coking coal is required. (“770 kg of coal are used to produce one tonne of steel” Appendix F <https://www.worldcoal.org/coal/uses-coal/how-steel-produced>)

a. Requirement for steel for manufacture of wind turbines

Also, it should be noted that steel is a major input in the manufacture of wind powered electrical generation. According to page 65 of Cost of Wind Energy Review” steel makes up”...”70% of the mass in a wind turbine.” <https://www.nrel.gov/docs/fy17osti/66861.pdf> (Appendix G pg. 65 2015 Cost of Wind Power.pdf)

For example one Vesta 1.65 Megawatt Wind turbine requires 181 tonnes of steel to fabricate its tower, nacelle, and rotor. The total weight of these components are 229.2 tonnes. For this wind turbine 80% of its main components are from steel. (Appendix H Pg. 16 Vesta 82-1.65 MW Turbine Life cycle assessment.pdf)

<https://www.vestas.com/~media/vestas/about/sustainability/pdfs/lca%20v82165%20mw%20onshore2007.pdf>

Wind powered turbines are one of the non-carbon powered electrical generation alternatives to the current reliance on hydrocarbon fuelled electrical generation. There is a strong relationship between the need for metallurgical coal to make steel and the manufacture of wind turbines.

E. Technical Aspects of Application

I do not have the technical expertise to comment on the specific topic areas of the application. I respect that there are many subject areas which require careful consideration by the Joint Review Panel and the technical advise of the appropriate regulatory bodies that require adjudication as to the specific strategies proposed by the proponent to meet regulatory requirements and mitigation required.

However, I do believe that this project can proceed provided that the appropriate conditions are applied to the approvals to ensure that all environmental and human health standards are met.

a. Water Quality and Habitat Impacts

Mitigation proposals and strategies by the proponent for major concerns about water quality (in particular selenium) and habitat mitigation for terrestrial and aquatic species seem reasonable in my opinion.

If the required monitoring of these effects cause concern during the operating period of the proposed coal mine then further regulatory measures should be entertained to ensure that the operation meets the environmental and human health standards required by the provincial and federal regulators.

b. Dust impact from operation of loadout

Concerns about dust and noise created by the proposed loadout facility are addressed by the applicant. From my experience the current locomotive and train traffic noise through Blairmore and noise from existing highway three traffic north of Blairmore currently exceed the noise level that would be generated by the operation of the rail line and loadout.

With the enclosed delivery conveyors, enclosed loadout, and coal car coating technologies employed on exiting coal cars for fugitive dust should mitigate against major dust emanating from the coal load out operation. Dust monitoring which is proposed should permit the gathering of the necessary information to require further measures if necessary.

c. Legacy Mining Impact

The proponent has outlined in their submission several of the legacy impacts that once this project is completed will be ameliorated.

When the Grassy Mountain mine was abandoned the reclamation requirements that are in today's regulatory regime were not in place.

It is my opinion, that upon completion of the site reclamation at the end of this project, better outcomes for water quality and other environmental impacts will result than from abandonment of the works with little or no reclamation by West Canadian Collieries when it ceased operations in 1959.

F. Conclusion

I respect all of those who have raised environmental and human health concern impacts about this project and the impact on asserted and historical traditional uses of the land by our indigenous peoples.

I believe that those concerns have been addressed by the applicant or can be mitigated by conditions placed in the appropriate approvals required by provincial and federal regulators.

Finally, it is my judgement that the jobs created and the economic activity which will be generated by the Grassy Mountain Coal Mining Project will provide needed long term stability to the economy of the Crowsnest Pass. These socio-economic impacts must receive due consideration and weighting by the Joint Review Panel in their decision and recommendation on this application.

Appendixes

Appendix A - PAA Accession PR1982.0165, item 399 Letter dated March 30, 1977 from Alberta Minister of Energy and Natural Resources to Consolidation Coal Company of Canada

Appendix B - Demographic Profile – Population Decline.pdf

Appendix C - Demographics – Aging Population.pdf

Appendix D – Municipal Profile Index.pdf

Appendix E – Workforce, Mining Quarrying.pdf

Appendix F [https://www.worldcoal.org/coal/uses-coal/how-steel-produced#:~:text=Around%200.6%20tonnes%20\(600%20kg,steel%20through%20this%20production%20route.\)](https://www.worldcoal.org/coal/uses-coal/how-steel-produced#:~:text=Around%200.6%20tonnes%20(600%20kg,steel%20through%20this%20production%20route.))

Appendix G pg.65 2015 Cost of Wind Power.pdf

Appendix H Pg. 16 Vesta 82-1.65 MW Turbine Life cycle assessment.pdf



ENERGY AND
NATURAL RESOURCES

OPP-P/A

Quick Memo to Mr. Getty

March 18, 1977.

Re: Preliminary Disclosures - Proposed Grassy Mountain
and Ram River Coal Mines

Enclosed are undated draft letters advising the company submitting the preliminary disclosures that the Government has no objection in principle to the proposed developments. This anticipates the Cabinet Committee's decisions on the two proposals. Should the decisions be negative, however, I will draft alternative responses to the companies.

AM

<Original signed by>

G. B. Mellon
G. B. Mellon
Deputy Minister
Energy Resources

b.c.c. Dr. Govier/ Dr. Mellon/Mr. Steele - Energy & Natural Resources
Hon. Al Adair/A. Drinkwater - Recreation, Parks & Wildlife
Hon. Dick Johnston/W.D. Isbister - Municipal Affairs
Hon. Bob Dowling/A.G. McDonald - Business Development & Tourism
Hon. Dr. H. Horner/R.G. McFarlane - Transportation
Hon. M. Moore/Dr. J. G. O'Donoghue - Agriculture <contact information removed>
Hon. Dave Russell/W. Solodzuk, - Environment
Hon. Dr. A. Warrack/J.W. Dodds - Utilities & Telephones

March 30, 1977

Mr. W. J. Dunn, Senior Engineer
Consolidation Coal Company of Canada
Western Division, Canadian Operatives
#300, 7330 Fisher Street S.E.
Calgary, Alberta. T2H 2H8

Dear Mr. Dunn,

Re: Preliminary Disclosure - Grassy Mountain Coal Mine

I wish to advise that Cabinet has no objections in principle to your company's proposal for development of the Grassy Mountain Mine as outlined in the preliminary disclosure document submitted to the Department in November, 1976. You should be aware, however, that some concerns have been expressed about the fact that the preliminary disclosure dealt only with the initial five-year phase of the proposed development, with no clear-cut indication of the company's longer-term plans for the mine. I presume this deficiency will be remedied in subsequent stages of the Government's review and approval procedure.

You should now proceed to arrange for a public disclosure meeting and to make the necessary applications under controlling legislation as summarized in the "Coal Development Policy for Alberta" document. The outcome of this procedure will determine whether the Government will grant a final development approval.

I have no objection if the company wishes to make this decision known to interested parties.

Yours sincerely,

<Original signed by>

Don R. Getty
Minister

c.c. Mr. F. D. Bradley, M.L.A.

DEMOGRAPHIC PROFILE

Population

In 2016, the total population in Crowsnest Pass was 5,590, a decrease of 2.8 percent from 2006. Overall, the population change in Crowsnest Pass was lower than the provincial growth rate.

In 2016, in Crowsnest Pass, 17.1% of the total population were children (0 to 17 years) and 22.5% were seniors (65 years and over). In contrast, 22.7% of the population in Alberta were children and 12.3% were seniors. For Canada, 20.0% were children and 16.9% were seniors.

Between 2006-2016, the senior population in Crowsnest Pass grew by 4.6%.

Table 1 Percent change and age distribution of the total population, 2006 and 2016 Censuses - 100% data

	Crowsnest Pass			Alberta			Canada		
	2006	2016	% Change	2006	2016	% Change	2006	2016	% Change
Total - Age group	5,750	5,590	-2.8	3,290,350	4,067,175	23.6	31,612,900	35,151,730	11.2
0 to 17 years	1,015	955	-5.9	775,175	923,180	19.1	6,893,280	7,029,315	2.0
18 to 29 years	525	485	-7.6	586,150	668,780	14.1	4,893,015	5,365,095	9.7
30 to 64 years	2,995	2,890	-3.5	1,575,610	1,975,000	25.3	15,491,350	16,821,690	8.6
65 years and over	1,205	1,260	4.6	353,410	500,220	41.5	4,335,250	5,935,635	36.9

Sources: Statistics Canada, Census of Population, 2006 and 2016.

-2.8%

POPULATION CHANGE FROM 2006 TO 2016 FOR CROWSNEST PASS

ALBERTA

23.6%

CANADA

11.2%

Rounded data

To prevent the possibility of associating statistical data with any identifiable individual, census data are randomly rounded. Under this method, all counts are randomly rounded up or down. As a result, counts end in either 0 or 5. This may lead to minor differences between the sum of a column of data and the sum that appears in the total. It can also result in a small difference (usually 5) in the counts between two data tables showing the same variable.

Percentages based on rounded data are shown extensively in this report and include category percentages of totals and percentage changes over time. Both of these types of percentages are calculated using rounded amounts.

In Crowsnest Pass in 2016, the population had a median age of 50 years. This was higher than the median age for Alberta (36 years) and Canada (41 years).

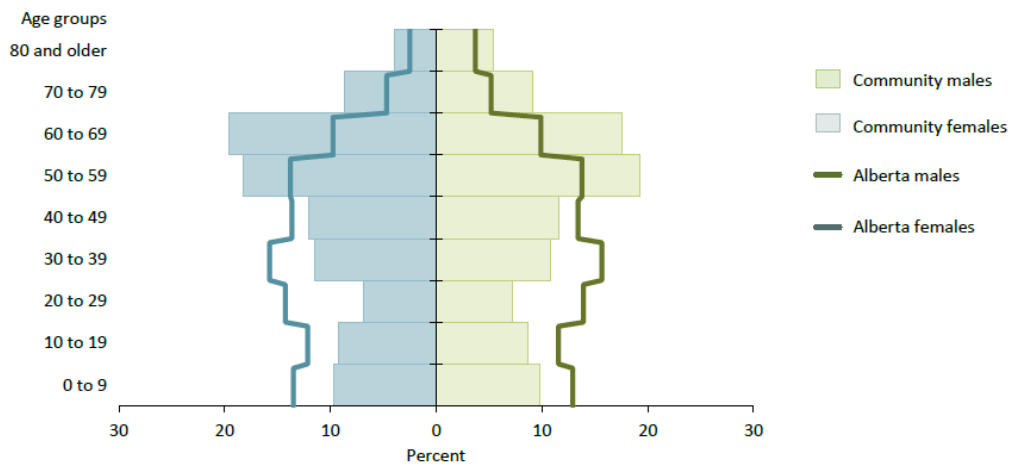
In 2016, Canada’s most prominent age group consisted of those who were 50 to 54 years, comprising of 2,678,070 (7.6%) individuals. Alberta’s most prominent age group was 30 to 34 years, consisting of 333,175 (8.2%) individuals. In Crowsnest Pass, the most prominent age group consisted of those who were between 55 to 59 years, comprising 575 (10.3%) individuals.

Table 2 Age and sex distribution of the total population, 2016 Census - 100% data

	Crowsnest Pass			Alberta			Canada		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
Total	5,590	2,825	2,760	4,067,175	2,039,410	2,027,765	35,151,730	17,264,200	17,887,530
0 to 4 years	255	120	135	266,520	136,520	129,995	1,898,790	973,035	925,755
5 to 9 years	290	155	135	270,710	138,990	131,725	2,018,130	1,034,685	983,445
10 to 14 years	240	130	110	241,920	124,060	117,865	1,922,645	985,200	937,445
15 to 19 years	260	130	130	240,030	123,625	116,415	2,026,160	1,039,215	986,945
20 to 24 years	180	95	85	261,830	133,990	127,840	2,242,690	1,144,495	1,098,200
25 to 29 years	210	100	115	310,940	156,715	154,225	2,285,995	1,144,475	1,141,515
30 to 34 years	320	155	160	333,175	167,550	165,620	2,329,395	1,148,290	1,181,110
35 to 39 years	310	170	140	305,505	153,655	151,855	2,288,370	1,118,635	1,169,730
40 to 44 years	320	165	150	281,210	142,550	138,660	2,255,135	1,104,440	1,150,690
45 to 49 years	350	175	170	269,035	135,855	133,180	2,359,965	1,157,755	1,202,205
50 to 54 years	475	220	255	284,305	142,205	142,105	2,678,070	1,318,750	1,359,320
55 to 59 years	575	295	275	275,540	138,570	136,970	2,620,240	1,285,190	1,335,055
60 to 64 years	550	285	265	226,230	113,440	112,790	2,290,510	1,114,885	1,175,630
65 to 69 years	485	270	220	173,680	85,505	88,180	1,972,480	953,075	1,019,405
70 to 74 years	315	160	145	117,035	56,425	60,610	1,420,875	677,970	742,900
75 to 79 years	190	85	105	83,955	39,110	44,845	1,021,850	469,545	552,305
80 to 84 years	135	55	75	62,160	27,590	34,575	749,645	325,765	423,880
85 years and over	130	55	75	63,385	23,065	40,320	770,785	268,790	501,990
Median	50	50	51	36	36	37	41	40	42

Source: Statistics Canada, Census of Population, 2016.

Chart 1 Total population by age and sex, 2016 Census, 100% data



Statistics Canada

8

Municipality of Crowsnest Pass

Municipal Code:0361

Membership in regional services commissions

Oldman River Regional Services Commission

	<u>2019</u>	<u>2018</u>	<u>2017</u>	<u>2016</u>	<u>2015</u>
Population	5,589	5,589	5,589	5,565	5,565
Total Full-Time Municipal Positions	60	57		58	60
Total Area of Municipality (Hectares)	37,949.0	38,039.0		38,039.0	38,039.0
Number of Hamlets (Specialized Municipalities & Municipal Districts Only)					
Length of all Open Roads Maintained (Kilometers)	184.50	184.50		184.50	184.50
Water Mains Length (Kilometers)	97.14	97.14		97.14	97.14
Wastewater Mains Length (Kilometers)	70.67	70.67		70.67	70.67
Storm Drainage Mains Length (Kilometers)	19.50	19.50		19.50	19.50
Number of Residences (Summer Villages Only)					
Number of Dwelling Units	3,367	3,883			3,322

The Municipal Profiles are a compilation of statistical, financial, and other information about municipalities in the Province of Alberta. The information is based on reports submitted and data made available to Alberta Municipal Affairs as of today. The Ministry is not responsible for the accuracy of the information. Users are encouraged to verify the accuracy of the information contained in the Municipal Profiles before relying on it.

Municipality of Crowsnest Pass

Municipal Code: 0361

Property Tax Rates (expressed in mills)

2019	<u>Residential/ Farmland</u>	<u>Non-Residential</u>
Municipal Tax Rate	7.4372	12.7535
Education - Alberta School Foundation Fund Tax Rate	2.6903	3.7103
Allowance For Non-Collection of Requisitioned Taxes	0	0
Seniors Lodge Accommodation Tax Rate	0	0
2018	<u>Residential/ Farmland</u>	<u>Non-Residential</u>
Municipal Tax Rate	6.8413	11.8867
Education - Alberta School Foundation Fund Tax Rate	2.6183	3.8124
Education Opted Out Tax Rate	0	0
Allowance For Non-Collection of Requisitioned Taxes	0	0
Seniors Lodge Accommodation Tax Rate	0.3944	0.3944
2017	<u>Residential/ Farmland</u>	<u>Non-Residential</u>
Municipal Tax Rate	6.5036	11.0904
Education - Alberta School Foundation Fund Tax Rate	2.5304	3.8988
Education Opted Out Tax Rate	0	0
Allowance For Non-Collection of Requisitioned Taxes	0.0746	0.2303
Seniors Lodge Accommodation Tax Rate	0.3566	0.3566

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Municipality of Crowsnest Pass

Municipal Code: 0361

	<u>2019</u>	<u>2018</u>	<u>2017</u>
Equalized Assessment			
Residential	\$819,337,112	\$829,399,613	\$833,158,956
Farmland	574,740	731,910	742,580
Non-residential	86,310,031	84,740,052	87,978,735
Non-residential linear	51,130,800	51,521,910	55,581,070
Non-residential railway	0	2,999,430	3,044,160
Non-res. co-generating M&E	0	0	0
Machinery and equipment	4,245,910	4,373,940	4,385,750
Total	<u>\$961,598,593</u>	<u>\$973,766,855</u>	<u>\$984,891,251</u>

Equalized municipal tax rates*	0.0078	0	0.0072
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* The formula is to divide prior year's Municipal Property Taxes by current year's Total Equalized Assessment

Assessment Statistics

Total assessment services cost	\$109,209	\$118,976	\$0
Number of Asst. Complaints Heard by Assessment Review Board	0	0	0

Industry

The top industry reported in 2016 by the labour force population aged 15 years and over in Crowsnest Pass was in Mining, quarrying, and oil and gas extraction (19.2%). In comparison, the top industry reported by the labour force population aged 15 years and over in Alberta was in Retail trade (11.0%).

Table 19 Top industries - North American Industry Classification System (NAICS) 2012 of the labour force aged 15 years and over in private households, 2016 Census - 25% sample data

	Crowsnest Pass		Alberta		Canada	
	Number	%	Number	%	Number	%
Total Industries - NAICS 2012	2,795	100.0	2,302,940	100.0	18,672,470	100.0
Industry - Not applicable	15	0.5	40,005	1.7	404,350	2.2
All industries	2,780	99.5	2,262,935	98.3	18,268,120	97.8
21 Mining, quarrying, and oil and gas extraction	535	19.2	142,485	6.3	271,300	1.5
62 Health care and social assistance	350	12.6	245,880	10.9	2,138,020	11.7
44-45 Retail trade	285	10.3	249,880	11.0	2,110,205	11.6
72 Accommodation and food services	260	9.4	153,795	6.8	1,283,725	7.0
23 Construction	240	8.6	236,370	10.4	1,365,010	7.5
81 Other services (except public administration)	160	5.8	105,865	4.7	814,700	4.5
91 Public administration	145	5.2	122,595	5.4	1,128,940	6.2
56 Administrative and support, waste management	130	4.7	87,350	3.9	802,415	4.4
54 Professional, scientific and technical services	115	4.1	167,800	7.4	1,335,120	7.3
61 Educational services	95	3.4	147,275	6.5	1,346,585	7.4
All other industries	465	16.7	603,640	26.7	5,672,100	31.0

Source: Statistics Canada, Census of Population, 2016.

TOP INDUSTRY FOR CROWSNEST PASS:



Appendix F [https://www.worldcoal.org/coal/uses-coal/how-steel-produced#:~:text=Around%200.6%20tonnes%20\(600%20kg,steel%20through%20this%20production%20route.](https://www.worldcoal.org/coal/uses-coal/how-steel-produced#:~:text=Around%200.6%20tonnes%20(600%20kg,steel%20through%20this%20production%20route.))

Extract from above website

“Around 0.6 tonnes (600 kg) of coke produces 1 tonne (1000 kg) of steel, which means that around 770 kg of coal are used to produce 1 tonne of steel through this production route”

(2011, 2012), we used the mass data from the Vestas V82 1.65 MW LCA to measure the effects of changes to raw materials prices. Although using any of the other turbines shown in Table 30 would likely yield similar results, the V82 falls roughly in the middle of the range of masses represented.

Table 30. Condensed Bill of Materials for Wind Turbines Used in Analysis

OEM							
Turbine make	Micon	Nordex	Micon	Vestas	Vestas	Vestas	Vestas
Turbine model	NM52	N-62	NM72	V82 1.65	V90 2.0	V100 2.0	V110 2.0
Nameplate capacity	0.9 MW	1.3 MW	1.5 MW	1.65 MW	2.0 MW	2.0 MW	2.0 MW
Hub height	60.7 m*	69 m	80 m	78 m	80 m	80 m	80 m
Rotor diameter	52.2 m	62 m	72 m	82 m	90 m	100 m	110 m
Mass (kg per kW)							
Steel	111.2	104.5	110.1	96.3	82.2	83.9	92.2
Fiberglass/resin/plastic	18.8	23.8	20.9	18.2	16.0	14.1	14.2
Iron/cast iron	7.2	17.3	8.7	17.8	20.5	13.3	13.3
Copper	1.6	1.5	1.2	1.8	0.9	0.6	0.7
Aluminum	N/A	N/A	N/A	1.9	2.1	1.7	1.9
Total	139.9	148.2	141.7	138.9	124.0	115.0	124.0
% of Total Turbine Mass							
Steel	79%	71%	78%	69%	66%	73%	74%
Fiberglass/resin/plastic	13%	16%	15%	13%	13%	12%	11%
Iron/cast iron	5%	12%	6%	13%	17%	12%	11%
Copper	1%	1%	1%	1%	1%	1%	1%
Aluminum	N/A	N/A	N/A	1%	2%	1%	2%
Total	99.2%	99.4%	99.4%	97.8%	98.0%	98.7%	98.5%

Sources: Liberman (2003); Vestas (2006); Garrett and Ronde (2011); Razdan and Garrett (2015a, 2015b)

Figure 29 shows the cumulative change in real prices for these five raw materials since 2001. Amidst quite a bit of volatility, prices generally rose through mid-2008 and have fallen since early 2011 (with a rapid plunge and recovery cycle in the interim). Given that steel makes up ~70% of the mass in a wind turbine, its price movement dominates the others; though not shown, a mass-weighted composite of these five materials very closely tracks the steel price change shown in Figure 29.

if we account for that margin separately, as we have tried to do in Section 7.2.3), then it is primarily the change in raw materials prices that are of concern when attempting to explain what has driven changes in wind turbine prices.

Inventory of onshore wind power plant

The onshore wind power plant in this LCA study is based on general project models used at Vestas.

The onshore wind power plant consists of 182 Vestas V82-1.65 MW turbines.

Main data for a V82-1.65 MW turbine can be seen in table 1.

Onshore turbine 78 meter hub height on concrete foundation	
Tower	136 ton
Steel	126.1 ton
Aluminium	2.6 ton
Electronics	2.2 ton
Plastic	2.0 ton
Copper	1.3 ton
Oil	1.0 ton
Nacelle	51 ton
Cast iron	18.0 ton
Steel, engineering	13.0 ton
Stainless steel	7.8 ton
Steel	6.3 ton
Fibreglass	1.8 ton
Copper	1.6 ton
Plastic	1.0 ton
Aluminium	0.5 ton
Electronics	0.3 ton
Oil	0.3 ton
Rotor	42.2 ton
Cast iron	11.3 ton
Steel	4.2 ton
steel, engineering	1.5 ton
Rest: Epoxy, fibre glass, birchwood, balsawood etc.	25.2 ton
Foundation	832 ton
Concrete	805 ton
Steel	27 ton

Table 1: Main data for V82-1.65MW turbines for onshore sited wind power plant.

At the onshore wind power plant, there is a total of 95 km of 32 kV cables for connecting all 182 turbines to a 32/150 kV transformer station. It is assumed that the wind power plant is placed in 50 km distance from the existing distribution grid. For the connection of the transformer station, the existing distribution grid two 150 kV cables are used. The distance to the existing grid varies a lot