

Appendix 4.4

Industrial Energy and Peak Demand Forecast 2016-2035



**YUKON
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1.1 Introduction

The industrial load forecast includes all customers in the industrial rate class. At this time, the only large industrial customers in the territory are mines. All other industries of the territorial economy (e.g., agriculture, construction and forestry) are captured in the commercial forecast.

The industrial load and peak demand forecast considers the electricity requirements for mines connected to the grid. Historically, the alternative for industrial customers was to operate and meet power requirements with on-site thermal generation from imported fossil fuels (e.g., diesel). Recently, mining companies have relied on other resource options such as liquefied natural gas (e.g., Stornoway's Renard diamond mine), wind (e.g., Glencore's Raglan mine and Rio Tinto's Diavik mine) or solar photovoltaic (e.g., Sandfire Resources' DeGrussa Copper-Gold Mine) to meet industrial projects energy requirements.

1.2 Background

The Yukon Territory economy is sensitive to fluctuation in commodity prices which impacts the global mineral resource industry. From 2012 to 2014, the contribution of the Mining and Oil and Gas Extraction industry to the territorial GDP has averaged just over 21%.

Prior to the Faro Mine closure in 1988, industrial power requirement amounted to 43% of the energy and 30% of the total demand on the system (Whitehorse-Aishihik-Faro and Mayo-Dawson grids; 1996/97 Cost of Service Study).

The years following the closure at Faro saw substantial capacity and energy surplus hydro generation when compared to the load. The connection of new industrial customers (i.e., Minto mine and the Bellekeno silver mine) to the grid in 2008 and 2010 eroded the surplus. During the same period, commercial and residential electricity requirements have increased significantly. Recent residential and commercial developments increased pressure on existing generating assets due to the high penetration of electrical heating (over 90% for both commercial and residential classes).

In 2013, the Bellekeno silver mine ceased operations, decreasing industrial demand by about 32%. In 2016, Capstone Mining announced it would cease operations at Minto mine in the near future unless commodity prices would increase.

Since 2011, several projects such as Wellgreen (Wellgreen Platinum Corp.), Eagle Gold (Victoria Gold Corp.), and the Coffee Gold Project (Goldcorp, formerly Kaminak Gold Corp.), have continued exploration activities, feasibility work or sought permitting.

1.3 Source of Information

The industrial load and peak demand forecast uses data from proxy mines to estimate electricity needs from mines connected to the grid. Information used to generate the industrial peak and load forecast includes:

- information provided on specific projects in operation or planning phase via direct communication with mining companies

- historical demand and sales data
- information included in past YEC regulatory applications
- information from YEC 2011 Resource Plan

In many instances, the information is preliminary and will be subject to changes as the mining companies advance the engineering and definition of their respective project. To that effect, Yukon Energy will adjust the energy and peak demand forecast should material change occur in the future.

1.4 Industrial Projects Requirements

Due to the significant cost of the transmission lines required to connect some industrial projects to the Yukon Power System (YPS), only a subset projects closer to the grid were considered to be connected to the grid for the industrial load and peak demand forecast. The projects retained were as follow:

- Potential Industrial Developments
 - Victoria Gold Eagle Gold Project
 - Copper North's Carmacks Copper Project
 - Golder Predator's Brewery Creek Project
- Existing Industrial Developments
 - Capstone Mining's Minto mine
 - Alexco Resources' Bellekeno mine

It should be noted that the availability of details relating to the various phases of an industrial project is not consistent amongst projects. A project like Victoria Gold's Eagle Gold project has more information on energy and peak demand requirements through all phases of its project life than a project such Golder Predator's Brewery Creek Project.

Unless specified, Yukon Energy assumed the entirety of the energy and peak demand requirements would have to be met using the utility's assets and thus, did not include any contribution by generating assets located at the project site.

It is generally recognized that load profile of industrial projects across the calendar year is constant; therefore, not as sensitive to fluctuations in weather conditions as non-industrial loads are. Unless otherwise stated within the information available, monthly industrial energy and peak demand requirements were assumed constant throughout the year.

The following subsections present the energy and peak demand requirements at the point of delivery (i.e., exempt of losses) assumed for each of the industrial projects. The forecast of the total energy and peak demand requirements, including the losses, is presented in the last section of this report. The losses include transmission and distribution line losses, transformer losses and station service loads. A review of actual sales and generation data indicates overall losses on the Yukon Power System for the

2012-2015 period is 8.8%. This represents an increase of 0.1% from the 8.7% reported in the 2012 GRA¹ and LNG Part III application².

1.4.1 Potential Industrial Developments

This section describes power requirements for potential industrial developments that have gone through permitting or are going through the environmental and socio-economic review.

1.4.1.1 Eagle Gold Project

The property is located 45 km from the grid and 45 km north of the Town of Mayo. The project has all the necessary permits to move the project forward to construction and later, production. The project can be divided between the following four stages with associated duration:

- Construction: 1.5 years
- Production: 10 years
- Post-Production
 - Rinsing: 2 years after end of production
- Closure: 3 years after end of rinsing

Power requirement during the construction phase is estimated at less than 1 GWh/month. For the purposes of the industrial load forecast, 1 GWh/month or 12 GWh/year is assumed (Table B-1). Assuming an 85% load factor, the anticipated peak demand at the site is 1.6 MW (Table B-1).

During the production phase, Victoria Gold is also looking at implementing a summer and winter schedule whereby peak demand would decreased between the months of December until the mid-March (Table B-1). The load would then ramp up for the remainder of the year.

Energy requirement during the rinsing and closer phases are similar and estimated at 4 GWh/month or 48 GWh/year (Table B-1). Assuming a load factor of 85%, peak demand, net of losses, is estimated at 6.5 MW (Table B-1).

¹ Yukon Energy Corporation, 2012. 2012/2013 General Rate Application, application submitted to the Yukon Utilities Board, April 2012.

² Yukon Energy Corporation, 2013. *Application for an Energy Project Certificate and an Energy Operation Certificate Regarding the Proposed Whitehorse Diesel-Natural Gas Conversion Project*, application submitted to the Yukon Utilities Board, December 2013.

Table B-1: Eagle Gold Project Power Requirements over Project Life

Phase	Duration	Peak Demand	Load Factor	Annual Energy Requirement
	(Years)	(MW)	(%)	(GWh)
Construction	1.5	1.6	85%	12.0
Production	10	18.2 (Summer)	85%	114.8
		8.0 (Winter)	85%	
Post-Production	2	6.5	85%	48.0
Closure	3	6.5	85%	48.0

Notes:

- Numbers rounded to nearest digit after the decimal point
- Excludes losses
- Does not assume any on-site generation
- Summer season extends from the start of December to mid-March
- Winter season is defined as Mid-March to end of November
- Victoria Gold Corporation is updating its feasibility study in 2016
- Numbers presented in the table are subject to changes in the future
- Includes 10% contingency

1.4.2 Carmacks Copper Project

The property is located 12 km from grid and 38 km northwest of Carmacks. The forecast peak demand during the production phase is estimated at 14 MW (Table B-2). Connection of the project to the Yukon Power System is expected to occur during the construction phase. Before the interconnection to the YPS is completed, Copper North would rely on on-site thermal power to meet immediate needs. Once connected, the energy need is expected to last for about 8 months at 0.2 GWh/month or 1.6 GWh for the entire period (Table B-2). Peak demand during construction is expected to be 0.5 MW (Table B-2).

Total anticipated energy requirement during production phase is estimated at 6 GWh/month or 72 GWh/year (Table B-2). Mine life included in the YESAB project proposal is 7 years but current resources indicate mine life could be extended to 10+ years. For the 20-year energy and peak demand forecast, the mine life was assumed to be 10 years (Table B-2).

Energy and peak demand requirements during reclamation and closure are estimated at 200 MWh/month or 2.4 GWh/year and 0.5 MW, respectively, for a duration of 2 years after end of production. The project needs to complete the YESAB review process before moving forward.

Table B-2: Carmacks Copper Project Power Requirements over Project Life

Phase	Duration	Peak Demand	Load Factor	Annual Energy Requirement
	(Years)	(MW)	(%)	(GWh)
Construction	0.75	0.5	60%	1.6
Production	10	14	60%	72.0
Post-Production	N/A	N/A	N/A	N/A
Closure	2	0.5	60%	2.4

Notes:

- Numbers rounded to nearest digit after the decimal point
- Excludes losses
- Initial construction loads met with onsite thermal generation
- Does not assume any more contribution from on-site generation
- Load assumed constant throughout the year
- Preliminary data for reclamation and closure period, may be subject to change in the future

1.4.3 Brewery Creek Project

The property is located 55 km southeast of Dawson City and 27 km from the 69 kV Mayo-Dawson transmission line. At this time, there is limited information available that would suggest this is a firm load for resource planning purposes (i.e., no recent regulatory filings or publically available information defining potential load requirements).

Energy and peak demand information from the 2014 Preliminary Economic Assessment³ were considered for the industrial load forecast. Power requirement during construction are expected to be met with the existing on-site thermal assets.

During the production phases, winter peak demand is expected to reach 1.8 MW for a 9-year production period (Table B-3). Energy requirements are estimated at 23.5 GWh/year (Table B-3) broken down as follow:

- 5 GWh/year or 1.1 GWh/month during the winter period
- 18.6 GWh/year or 2.4 GWh/month during the operating period

The information on closure and reclamation suggest Golden Predator will implement a passive solution that will not result in material power requirement over a 15-year period. As such, neither energy nor peak demand requirements were considered in the industrial forecast for this project.

³ EBA, A Tetra Tech Company, 2014. 2012 Preliminary Economic Assessment for the Brewery Creek Property Yukon Territory, Canada National Instrument 43-101 Technical Report, report submitted to Golden Predator Exploration Ltd. November 2014.

Table B-3: Brewery Creek Project Power Requirements over Project Life

Phase	Duration	Peak Demand	Load Factor	Annual Energy Requirement
	(Years)	(MW)	(%)	(GWh)
Construction	1	N/A	N/A	N/A
Production	9	1.8 (Winter)	32%	23.5
		3.9 (Operating)	54%	
Post-Production	N/A	N/A	N/A	N/A
Closure	N/A	N/A	N/A	N/A

Notes:

- Numbers rounded to nearest digit after the decimal point
- Excludes losses
- Power requirements during construction assumed to be provided by on-site thermal generation
- Operating season defined as start of March until late October
- Winter season is defined as late October to end of February
- Does not assume any more contribution from on-site generation
- Load assumed constant throughout the year
- No major loads expected during closure period
- Includes 19% contingency

1.4.4 Existing Industrial Developments

This section describes power requirements for existing industrial developments. Of the two properties, only the Minto mine is still operating. Alexco’s Bellekeno mine was considered as a potential project should commodity prices increase in the near-future.

1.4.4.1 Minto Mine

The Minto Mine is located 27 km west of Minto Landing. The Copper-Gold mine started production in 2007. In 2008, the mine was connected to the newly built spur line between the mine site and Minto Landing as part of the Phase 1 of the Carmacks-Stewart Transmission Line project.

Historical data indicate the mine has an operating winter peak load of 6 MW (assuming a power factor of 0.95). Actual annual energy requirements have averaged 36.7 GWh for the 2014-2015 period. Pursuant to the power purchase agreement (PPA) between Yukon energy and Capstone Mining Corporation (formerly Minto Exploration Ltd.), the company could elect to increase its annual energy requirements to 42 GWh/year at a peak load of 6 MW (assuming power factor of 0.95). The maximum energy and peak demand requirements outlined in the PPA were used for the purposes of estimating the industrial electrical requirements (Table B-4). The mine is assumed to operate until mid-2022⁴.

⁴ Minto Explorations Ltd., 2012. *Minto Phase VI Preliminary Feasibility Study Technical Report Minto Mine Yukon, Canada*, report prepared by Minto Explorations Ltd., December 2012.

Table B-4: Minto Project Power Requirements over Project Life

Phase	Duration	Peak Demand	Load Factor	Annual Energy Requirement
	(Years)	(MW)	(%)	(GWh)
Construction	N/A	N/A	N/A	N/A
Production	6.5	6.0	80%	42.0
Post-Production	N/A	N/A	N/A	N/A
Closure	N/A	N/A	N/A	N/A

Notes:

- Numbers rounded to nearest digit after the decimal point
- Excludes losses
- Does not assume any more contribution from on-site generation
- Load assumed constant throughout the year
- Last year of production period is expected to last 6 months

1.4.4.2 Bellekeno mine

Alexco’s Bellekeno mine is located in the Keno region. Alexco is also operating a mill in the Keno region and plans to develop other silver deposits in the vicinity to use this mill in the near-term. The project started production in 2010 and operated until its temporary closure in 2013. The mine life was initially estimated to be 10 years. Based on the duration of historical mining activities, it is estimated that the projects has a remaining life of 7 years (Table B-5).

Table B-5: Bellekeno Project Power Requirements over Project Life

Phase	Duration	Peak Demand	Load Factor	Annual Energy Requirement
	(Years)	(MW)	(%)	(GWh)
Construction	N/A	N/A	N/A	N/A
Production	3	3.5	65%	20.0
	4	2.6	66%	15.0
Post-Production	N/A	N/A	N/A	N/A
Closure	N/A	N/A	N/A	N/A

Notes:

- Numbers rounded to nearest digit after the decimal point
- Excludes losses
- Load assumed constant throughout the year

Actual energy sales averaged 12 GWh/year for the 2011-2012 period. Peak load is estimated at about 3.5 MW based on actual demand data. At the time of the closure, information provided by Alexco suggested the project had three additional years of production with an energy requirement of 20 GWh/year and peak load of 3.5 MW. This period would be followed by four years of production with a lower energy requirement estimated at 15 GWh/year and peak load of 2.6 MW. The remaining life of the Bellekeno mine was assumed for the purposes of estimating the industrial electrical requirements (Table B-5).

1.5 Industrial Activity Scenarios

Four major scenarios and a set of sensitivity scenarios were defined on the basis of the intensity of industrial activity. The following subsections describe the assumptions relating to the timing and life of the existing and planned industrial projects. Industrial projects assumed to connect to the Yukon Power System are also presented below.

1.5.1 Very Low Industrial Activity

The Very Low Industrial Activity scenario assumes the following:

- Minto Mine remains the only mine connected to the grid with mine closure at the end of 2017.

For the purposes of estimating energy and peak demand requirements over the planning period (2016-2035), no new mines are assumed to connect to the grid.

1.5.2 Low Industrial Activity

The Low Industrial Activity scenario assumes the following:

- Minto Mine remains the only mine connected to the grid with mine closure in mid-2022.

For the purposes of estimating energy and peak demand requirements over the planning period (2016-2035), no new mines are assumed to connect to the grid.

1.5.3 Medium Industrial Activity

The Medium Industrial Activity (Base Case) scenario assumes the following:

- Minto Mine remains in operation and connected until mine closure at the end of 2022.
- Eagle Gold (Victoria Gold) connects to the grid with construction starting in 2019, production starting in mid-2020 and mine closure activities starting in 2030.

1.5.4 High Industrial Activity

For the High Industrial Activity scenario, the following was assumed:

- Minto Mine remains in operation and connected until closure in 2022
- Alexco Mine coming back online in 2020 until 2026
- Three medium mine connecting to the Yukon Power System as follow:
 - Victoria Gold's Eagle Gold from 2017 to 2034
 - Copper North's Carmacks Copper from 2020 until the end of 2031

- Golden Predator’s Brewery Creek from 2020 until the end of 2030

1.5.5 Sensitivity Scenarios

A total of 11 sensitivity scenarios were defined to quantify the impact of climate change, other industries and sectors of the Yukon economy. These scenarios focus on variations on mining starts and impacts on the territorial economy. The sensitivity scenarios considered the following:

- Impact of mining boom and bust cycle
- Early and late mining starts
- Potential oil and gas development
- Changes in government spending as a proxy to variations in federal transfer payments
- Increase in activity of Yukon’s smaller economic sectors including tourism, forestry, agriculture, and fishery.

For each of the sensitivity scenario, timing of the project start was consistent with the econometric scenario description presented in the appendix on Yukon Macroeconomic Model 2016-2035 (Appendix B). For instance, under the impact of Boom and Bust cycle scenario (Scenario 10), construction of the Eagle Gold project is assumed to start in 2028 as opposed to 2019 for the Base Case (Scenario 3)

Because the sensitivity scenarios are variations on the four major industrial activity scenarios, only energy and peak demand data for those four scenarios are discussed and presented in this document. Detailed numerical data on industrial energy and peak demand requirements for the sensitivity scenarios can be found in the Energy and Peak Demand Forecast Data 2016-2035 appendix (Appendix A).

1.6 Industrial Energy and Peak Demand Forecast

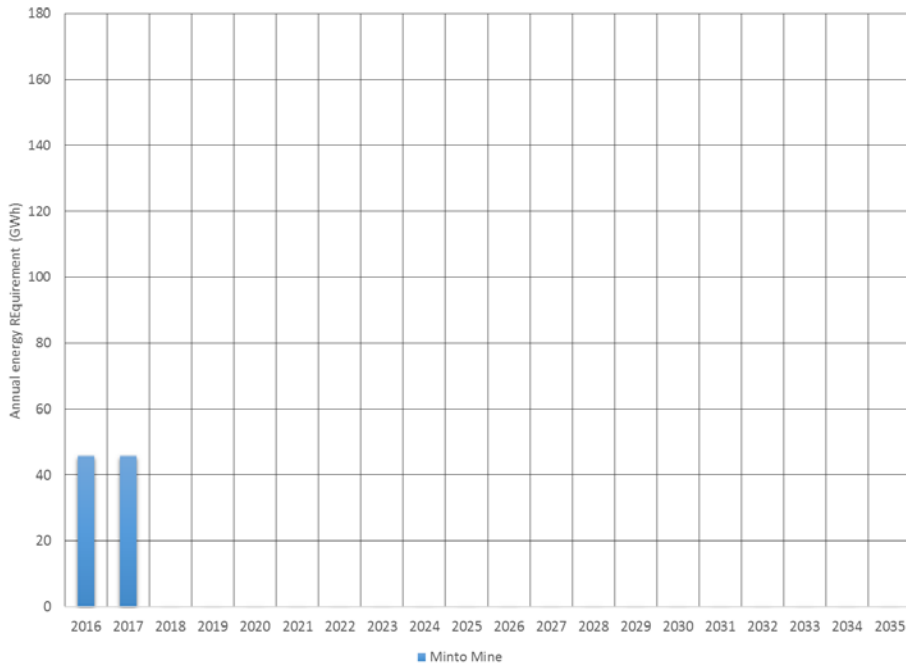
The industrial energy and peak demand forecast considered the same mines and timing described in the appendix on Yukon Macroeconomic Model 2016 – 2035 (Appendix B). Only the forecast for the four major scenarios are presented below. Results for the sensitivity scenarios are effectively variations of the four major scenarios. Industrial forecasts for all scenarios are included in Appendix A. All the forecast values presented in this section are inclusive of losses and represent the energy and peak demand YEC needs to meet at the generating stations.

1.6.1 Industrial Energy Forecast

The Very Low Industrial Activity shows a constant energy requirement for 2016 and 2017 at 45.7 GWh/yr (Figure 1). After 2017, Minto mine is assumed closed for the remaining of the forecast period (Figure 1). No other industrial projects are assumed for this scenario

The Low Industrial Activity shows a constant energy requirement between 2016 and 2021 at 45.7 GWh/yr (Figure 2). In 2022, Minto mine is expected to operate for 6 months and therefore, decrease its energy requirement by half (Figure 2). After 2022, this scenario assumes one industrial project would start operation but would not connect to the Yukon Power System.

Figure 1: Very Low Industrial Activity Energy Forecast



Similar the Low Industrial Activity scenario, the Medium Industrial Activity (Base Case) scenario assumes the Minto mine is in operation through mid-2022 (Figure 3). A peak energy requirement of 170.6 GWh/year is estimated to occur in 2021 and is due to the first full year of production at Eagle Gold and the last full production year at Minto mine (Figure 3). Energy requirements decrease over the following two years as a result of the Minto mine closure and level off at 124.9 GWh/year for the 2023-2029 period (Figure 3). Starting in 2030, energy requirements materially decrease due to the end of the production period at Eagle Gold and the start of the post-production and closure activities until 2035 (Figure 3).

Figure 2: Low Industrial Activity Energy Forecast

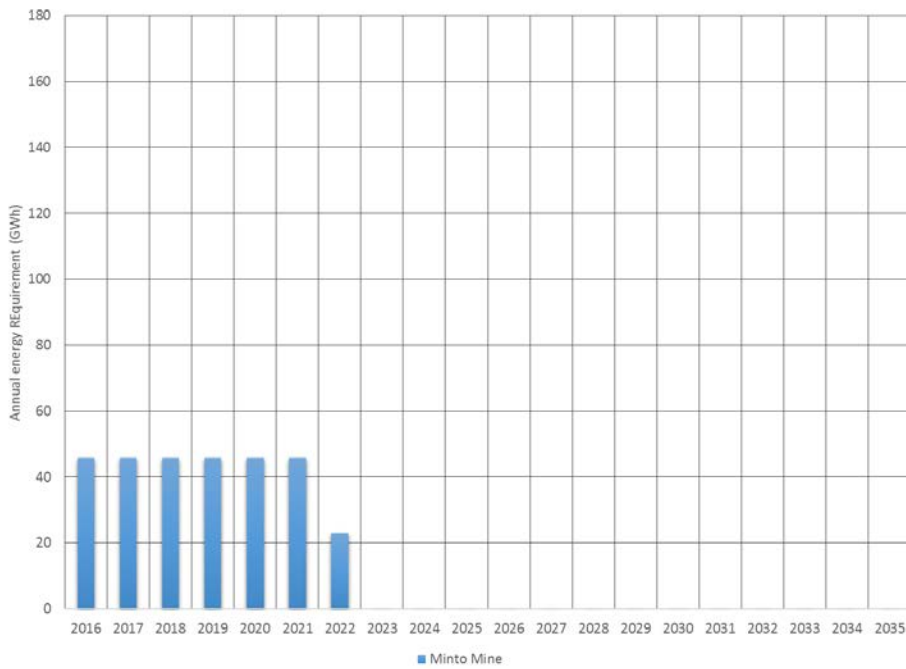
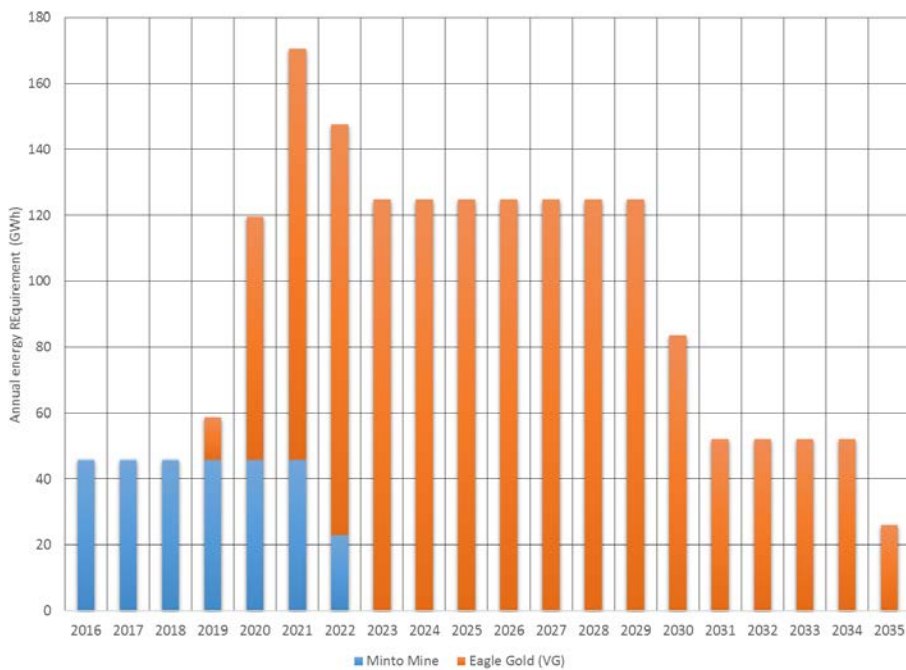


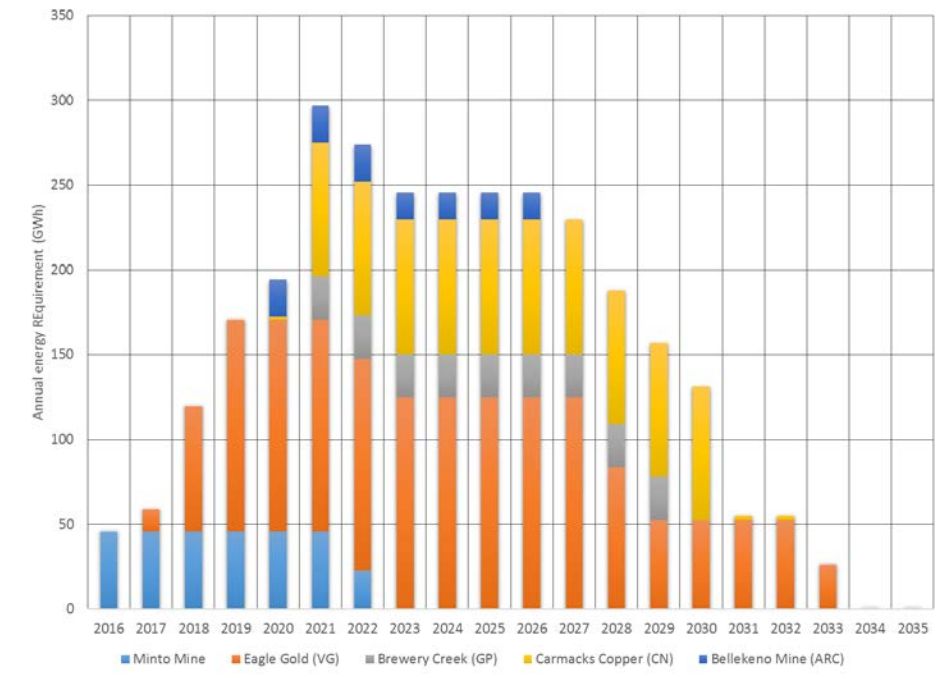
Figure 3: Medium Industrial Activity (Base Case) Energy Forecast



For the High Industrial Activity, Minto mine is still assumed to operate at 45.7 GWh/year until 2022 where its energy requirement decreases to 22.8 GWh (Figure 4). Industrial energy requirements start ramping up in 2019 to culminate at 296.9 GWh/year in 2022 (Figure 4). The material increase is in part

due to the start of construction and later, production at the Eagle Gold property (Figure 4). Compounding the effect of the Eagle Gold project is the start of construction and production activities at the Carmacks Copper, Brewery Creek and Bellekeno mine in 2020. Subsequent to 2021, energy requirements decrease by 22.9 GWh and 28.3 GWh for 2022 and 2023, respectively. This reduction is due to the closures of the Minto mine. Beyond 2023, industrial energy needs remains constant at 245.7 GWh/year until 2026. After 2026, the Bellekeno mine is assumed to shut down. Forecast energy requirement begins to ramp down in 2027 until 2030. Several factors explain this decrease, notably the transition from production to post-production and closure at Eagle Gold project and the expected closure of the Brewery Creek project. From 2031 to 2033, energy requirements are intended to support closure activities at Carmacks Copper and Eagle Gold projects. The industrial energy forecast decrease to 0 GWh/year for the last two years of the forecast period.

Figure 4: High Industrial Activity Energy Forecast



1.6.2 Industrial Peak Demand Forecast

The contribution of the industrial projects to the overall system peak for the Very Low Industrial Activity and Low Industrial Activity scenarios are closely related to the production activities at the Minto mine. A contribution to the peak of 6.5 MW is expected until 2017 and 2022 for Very Low Industrial Activity (Figure 5) and Low Industrial Activity (Figure 6) scenarios, respectively. Subsequent to the Minto mine closure, the industrial demand contributing to the overall system peak is expected to drop off to 0 MW.

Figure 5: Very Low Industrial Activity Peak Demand Forecast

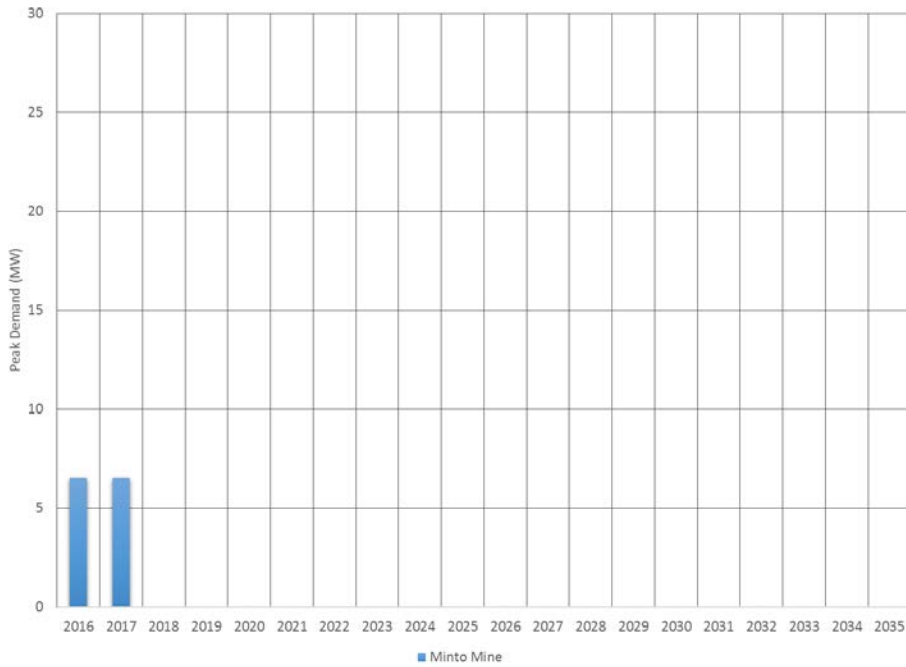
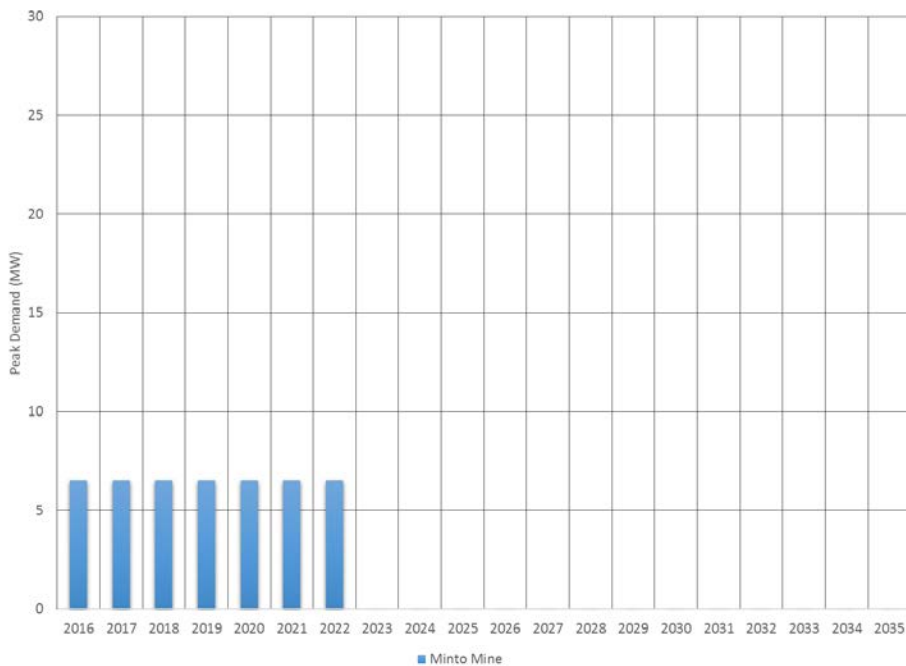


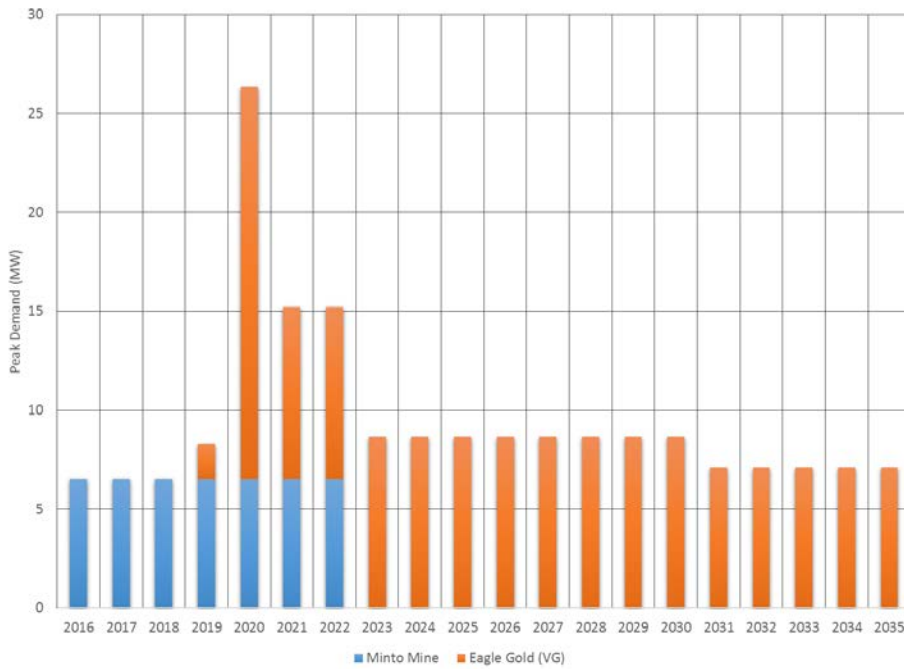
Figure 6: Low Industrial Activity Peak Demand Forecast



The forecast peak demand for the Medium Industrial Activity scenario shows an increase of 26.4 MW as the connected mine, Victoria Gold’s Eagle Gold project, starts its production phase in 2020 (Figure 7). For the remainder of its operation phase, the contribution of the Eagle Gold project to the peak demand is estimated at approximately 8.7 MW (Figure 7); this corresponds to the peak demand during the

winter period (November to January). Summer peak demand (February to October) for the project at the point of delivery is just over 19.8 MW. Although greater than the winter peak demand, the summer peak demand is non-coincident to the non-industrial peak demand forecasted to occur in January of each forecasted year. Only one year (2020) shows a contribution of the project of 19.8 MW to the system peak demand attributable to the transition from construction to production.

Figure 7: Medium Industrial Activity (Base Case) Peak Demand Forecast



For the High Industrial Activity scenario, the contribution to the overall system peak of the industrial peak demand is estimated to reach 36.2 MW in 2021 (Figure 8).

Prior to 2021, industrial peak demand is expected to contribute 26.3 MW to the system peak in 2018 (Figure 8). This elevated demand is associated with the transition between construction phase and the production phase at the Eagle Gold project. This is similar to what is expected in 2020 under the Base Case scenario (Figure 7).

After 2021, peak demand is expected to gradually decrease until 2030 where it is expected to reach 22.3 MW. After 2030, the peak industrial demand decreases to 7.7 MW and stay relatively constant until 2034 where it drops to zero (Figure 8). The drop occurring in 2031 is associated with the end of the production period and start of the closure activities at the Eagle Gold Project and end of production at Golden Predator’s Brewery Creek project (Figure 8).

Figure 8: High Industrial Activity Peak Demand Forecast

