MTHøjgaard Grønland

TANBREEZ
mining for greener technologies

TANBREEZ Project

Hydropower Plant
REP0029, rev. 3

TANBREEZ Project

Hydropower plant

FINAL

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1 Introduction

The Mineral Resources Act, §18 and §20, states that the licensee is obligated to use local companies and investigate alternative power sources.

In 2010, Rimbal Pty Ltd authorised MT Højgaard Grønland (MTH) to prepare the Definitive Feasibility Study (DFS) on behalf of TANBREEZ Mining Greenland A/S (TANBREEZ Mining).

At that time it was impossible to obtain information regarding the possibility of getting hydropower at the existing hydropower plant at Qorlortorsuaq because of an ongoing arbitration case between Nukissiorfiit and the contractor Energi-konsortiet I/S.

This arbitration case was settled in August 2012, making it possible for Nukissiorfiit to start up a dialogue with TANBREEZ Mining regarding delivery of hydropower to the TANBREEZ Project. This report covers the activities and findings as well as recommendations for future studies.

1.1 Background

Potential hydropower options have been investigated since the mid 1970's, and all options are mentioned in the report "Hydropower Resources in Greenland" from 2005, ref. /1/, no matter if the options are realistic or feasible. Data and information from this report form part of this study.

Nukissiorfiit has been very helpful regarding available information and assistance during the development of this report.

P. A. Pedersen A/S (PAP) is a Danish specialist consultant with knowhow and experience on electrical installations i.e. hydropower. They have been advisors on several Greenlandic hydropower plants and they have helped us develop this report.

1.2 Base case in the feasibility study

The base case for the power supply in the feasibility study is diesel generated power on site.

The basis for this solution was the availability of trustworthy data and information on which to build a reliable power supply. At the time, we were informed by the existing hydropower plant that we could only expect 1 MW in total for the TANBREEZ Project. The project requires 4.5 MW.

After settlement of the arbitration in August 2012, we entered into a positive dialogue with Nukissiorfiit to try to clarify the possibilities of the TANBREEZ Project being supplied locally and from the existing grid.

This report will go through the various scenarios.

1.3 Scope of work

This report is a preliminary study carried out to evaluate hydropower potential and other alternatives. The accuracy of the cost estimate is expected to range from -25% to +25%. The following scenarios are assessed:

- Potential hydropower and existing power supply in the area
- Extension of existing hydropower at Qorlortorsuaq
- Existing diesel generators in Narsaq and Qaqortoq
- New diesel generators on site

1.4 List of abbreviations

BMP	Bureau of Minerals and Petroleum
DFS	Definitive feasibility study
DGU	Diesel generator units
DKK	Danish kroner
M DKK	Million Danish kroner
GEUS	The Geological Survey of Denmark and Greenland
GWh	Gigawatt hours
km	Kilometre
KV	Kilovolt
kW	Kilowatt
kWh	Kilowatt hour
MTH	MT Højgaard A/S - MT Højgaard Grønland
MW	Megawatt
PAP	P. A. Pedersen
QOR	Qorlortorsuaq
Rev.	Revision

1.5 Hydropower in Greenland

For many years Greenland has received power from diesel generators located in the relevant towns. Increases in oil prices and focus on environment have shifted the focus to other and much greener energy sources like hydropower.

The first hydropower plant in Greenland was constructed in 1989-1993 in Buksefjorden near Nuuk, the capital of Greenland. Since then, a few other hydropower plants have been constructed or are under construction.

The other plants are located at Aammangaq near Tasiilaq on the east coast, Sisimiut on the west coast, Qorlortorsuaq in South Greenland and another one is under construction at Ilulissat on the west coast.

Hydropower is not a new energy source to Greenland and the power company, Nukissiorfiit, has experience in operation of such plants.

1.5.1 Hydropower

The principle of hydropower is to produce power by use of water. Water located at a high altitude is collected in a reservoir made of natural or dammed up lakes. From here the water is led by tunnels or through pipes to hydropower generators located at a lower altitude. These hydropower generators transform the energy from the falling water to electricity.

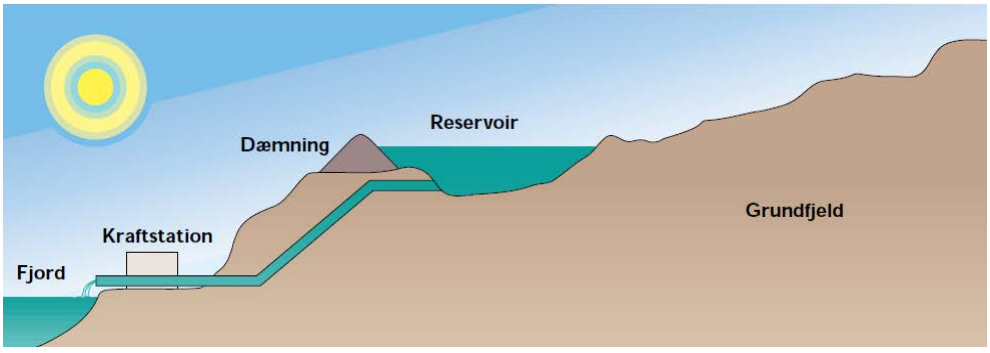

Figure 1 - Principle of hydropower (picture: ref. /2/)

One of the challenges when using hydropower in Greenland is that the inflow peeks during the thaw and summer season where demand for power and heating is low. The power demand increases during winter where the inflow is low, but the reservoir should, if possible, be designed to store the required amount of water. If, however, there is an insufficient amount of precipitation during the year, it will influence the ability of the plant to deliver the designed amount of energy.

1.6 Overview of the existing power in the area

In 2007 the hydropower plant at Qorlortorsuaq, located 53 km from Narsaq and 62 km from Qaqortoq, came into operation. The plant is situated beneath a natural lake with a small dam construction. The inflow to this lake (reservoir) is between 111 and 146 million m^3 per year according to a hydrological survey carried out in 2000, ref. /3/ - prior to the tender (2003) and the construction of the hydropower plant. All levels and quantities regarding the Qorlortorsuaq (QOR) hydropower plant mentioned in this report originate from this survey, which will be reviewed in 2013 as part of a new survey. This survey will include the quantity of water that will be available if the inflow of water is extended to include a nearby river (tunnelling distance 1.7 km).

The quantity difference, between 146 and 111 million m^3 of water per year, is usable as interruptible power for district heating only, since it is not certain that the inflow in any given year will amount to more than 111 million m^3.

The reservoir itself holds up to 126 million m^3 of water. Minimum water level is 90 m and maximum water level is 128 m.

The hydropower plant is equipped with two water turbines, capable of delivering 3.6 MW each at a water level of 114 m, and 2.65 MW at a water level of 95 m.

The minimum inflow of 111 million m^3 per year together with the reservoir and the installed water turbines are able to sustain an energy production of 32 GWh per year, which can be used as uninterruptible power for light, power and mining, since this amount of inflow can be expected every year.

The maximum inflow of 146 million m^3 per year together with the reservoir and the installed water turbines are able to sustain an energy production of 42 GWh per year. Since this amount of inflow cannot be expected regularly, the increase in energy production of 10 GWh is only usable as interruptible power, suitable for production of district heating backed up by conventional oil burning water boilers.

The energy production from the hydropower plant is thus being divided into uninterruptible power, used for lighting and power, and interruptible power, used to heat up water in electric boilers placed as pre-heaters to the oil burning boilers in the district heating systems in the two towns.

The power and energy production of the hydropower plant was designed so that the needs for light and power in the two towns could be met also in 2040. The intention is that the amount of energy used for interruptible district heating is decreased as the demand for lighting and power increases. The amount of interruptible power available is calculated on basis of the water level in the reservoir, that is the amount of water (and energy) left in the reservoir at any given point of time during the year.

The amount of interruptible power for use with the district heating installed in Qaqortoq is 1.2 MW, while the amount of interruptible power installed in Narsaq is 0.5 MW.

Before the plant was constructed, both towns, Narsaq and Qaqortoq, were supplied locally by diesel generated power.

Nukissiorfiit maintains the existing generators in Narsaq and Qaqortoq as backup supply in case the normal supply from the hydropower plant is interrupted or has to be interrupted due to maintenance or in extreme cases due to lack of water in the Qorlortorsuaq Reservoir.

In Qaqortoq the six existing diesel generators have a capacity of 2 x 1.69 MW and 4 x 0.92 MW, equalling a total of 7.06 MW in short term application (when used as backup power source) or 5.37 MW in long term application (when used as main power source – regardless of operation of the hydropower plant).

In Narsaq the three diesel generators installed have a capacity of 3 x 0.92 MW, equalling a total of 2.76 MW in short term application or 1.84 MW in long term application.

The backup supply is not and will not be used for supplying the interruptible power users (the district heating) because the price of energy produced on diesel engines is roughly twice the price of energy produced on boilers when using oil. Nor will the backup supply be used as long term power supply due to the production price and the decreased power output in long term operation.

Please notice that the backup power is placed where the energy is consumed (Qaqortoq end Narsaq) and is therefore able to cope with failures on the power transmission line.

An overview of the existing power in the TANBREEZ area is shown in Table 1 below.

Town / location	Energy source	GWh [2016]	GWh [2025]	Energy source	Long term MW	Diesel GWh	Short term MW
Narsaq, lighting and power	Hydro/ diesel	8	9	Diesel	1.84	8	2.76
Qaqortoq, lighting and power	Hydro/ diesel	13	14	Diesel	5.37	28	7.06
Uninterruptible	Hydro/ diesel	21	23	Diesel	7.21	36	9.82
Qorlortorsuaq	Hydro	32	32	Diesel	0	0	0
Available for mining	Hydro/ diesel	11	9	Diesel	7.21	36	9.82

Table 1 - Overview of existing power sources in the TANBREEZ area

The table indicates that available power for mining from Qorlortorsuaq is 11 GWh in 2016. If all the uninterruptible power can be used for mining, an additional 36 GWh will be available, totalling 47 GWh.

1.7 TANBREEZ power requirements

The mean power required for the TANBREEZ Project (mining and camp) is estimated at 3.7 MW, and the maximum required power is estimated at 4.5 MW.

The process requires reliable supply of electrical power at all time. However, a total of up to 47 days a year is estimated as "lost days" to cover harsh weather conditions, ice in the fjord, insufficient power supply etc. This means that full power backup at the mine is not necessary.

A small power backup supply, however, is necessary at TANBREEZ in order to maintain supply for anti freezing equipment, lighting and local heating installations, when the main power supply from the hydropower plant or diesel generators on site are down. This emergency power plant could be a single 300 kW high speed diesel generator in a canopy, possibly redundant.

If any process equipment requires a controlled shutdown, power of the backup generator(s) has to be increased accordingly.

If the downtime costs during blackouts are higher than the cost of a full power backup plant, this will have to be established as well. In case normal power supply can be established from the Qorlortorsuaq Hydropower Plant, a full power backup power plant can be established by use of high speed diesel generator sets in canopies placed on a slap of concrete instead of the estimated medium speed diesel generators; see more in section 5.2.

With a maximum required power of 4.5 MW and a mean power of 3.7 MW, mining operations will require 30 GWh of electricity per year - equalling a total of 300 GWh until operations stop in 2025.

The table below shows the expected power requirements in the towns of Narsaq and Qaqortoq based on numbers from Nukissiorfiit statistics.

Year	**Narsaq** [GWh]	**Qaqortoq** [GWh]	**TANBREEZ** [GWh]	**Total** [GWh]
2016	8	13	30	51
2025	9	14	30	53

Table 2 - Summarised power requirements

1.8 Sub-conclusion

If the long term diesel power in Qaqortoq and Narsaq is available for mining all year around, there is sufficient power for the TANBREEZ Project in the existing grid.

The cost per kWh is politically decided, and delivery of power based on the current cost structure will not be cost competitive since the kWh costs exceed the costs of producing power on site. See more in section 5, Table 6.

2 Small hydropower plant options

2.1 Available information

The study "Hydropower resources in Greenland" from August 2005, ref. /1/, summarises the different hydropower solutions available in Greenland. This study has been used to clarify the locations and the sizes of the different hydropower solutions available near the TANBREEZ Project.

2.2 Description

Several locations near the TANBREEZ Project are theoretically suited for producing hydropower. The study does not relate the suitable location to how realistic or feasible the location might or might not be.

The map below, Figure 2, is an extract from the abovementioned study.

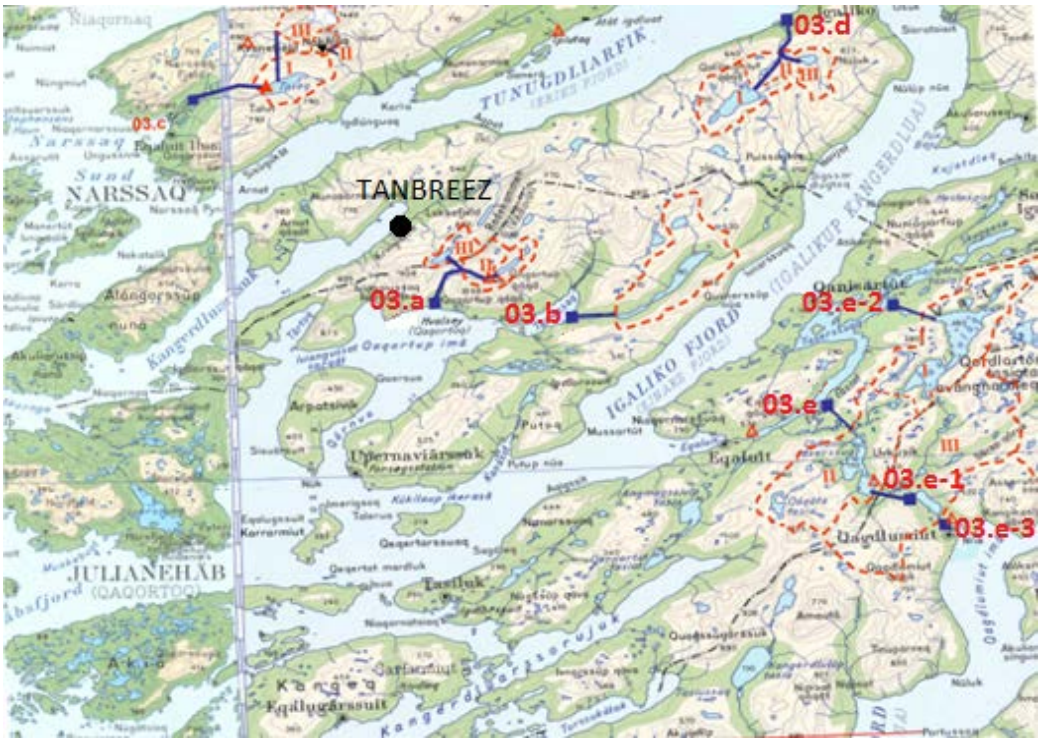

Figure 2 - Water resources in the area around TANBREEZ

In the study, seven locations are found in the vicinity of TANBREEZ and could be theoretically suitable for smaller hydropower plants; in Figure 2 described as 03.a, 03.b, 03.c, 03.d, 03.e, 03.e-1 and 03.e-2.

All of these locations have only been investigated as desktop studies with no or hardly any hydrological data, and therefore the estimated power output has to be used with great caution.

An overview of the estimated potential is shown in Table 3.

Number	Name	Status	Available power	
			[MW]	[GWh/year]
03.a*	Killavaat	III	1.1	8.8
03.b		I	0.5	2.5
03.c	Tasaq, stage 1 and 2	V	8.1	27.1
03.d	Igaliku	III	2.1	10.6
03.e		I	1.2	6
03.e-1		II	1.6	8
03.e-2		II	1.3	6.5

Table 3 - Potentially available power at the small hydropower locations
(*One of the lakes is allocated as tailings pond and therefore not available)

The column "status" indicates the planning level of each location. No geotechnical investigations have been made in status I to III. The level of status V is preliminary design.

2.3 Sub-conclusion

Option 03.c - situated only 5 km from Narsaq - could seem interesting. It consists, however, of two stages; the second of which is expected to collect twice the amount of water compared to the first stage and therefore necessary in order to supply the mine. Neither of these locations - on its own - will have enough water to generate the power required for the TANBREEZ Project.

Construction of several small hydropower plants including high voltage transmission lines for connection to the existing grid will not be a competitive solution compared to other scenarios discussed in this report. Furthermore, the basis for the data is uncertain and requires further field and site investigations followed by studies.

Therefore, these locations have not been investigated or evaluated further.

3 Extending the existing hydropower plant Qorlortorsuaq

3.1 Available information

Qorlortorsuaq has been in operation since 2007 and is - as mentioned (in section 1.6) - supplying the towns Narsaq and Qaqortoq with hydropower.

Figure 3 below shows the location of the existing hydropower plant and existing high voltage transmission lines.

The existing hydropower plant is reliable, with outages every 10 month lasting approx. 10 minutes. The latest power cut on 14 October 2012 lasted 20 minutes.

Figure 3 - Location of existing hydropower plant and cables

Nukissiorfiit has commenced an investigation in September 2012 regarding the possibilities of and power made available by extending the existing hydropower plant. This extension includes a reevaluation of the inflow to the existing reservoir as well as an evaluation of the inflow of water to a nearby lake (Ulvesøen). This inflow can be led to the existing reservoir. In 1995 GEUS estimated that the quantity of this inflow is roughly the same as the inflow to the existing reservoir, thus doubling the potential energy production. A major part of the investigations to be carried out in 2013 will be to establish just how much water can be led to and used at the hydropower plant at Qorlortorsuaq.

Currently and before these investigations are finalised, Nukissiorfiit has not been able to give any precise power or energy estimates.

The investigations are expected to be completed late 2013. TANBREEZ will commence discussions and negotiations with Nukissiorfiit as soon as the investigations are completed, if these show a possibility of supplying the TANBREEZ Project with hydropower.

If it is found profitable to the Greenlandic society to extend the hydropower plant, the extended plant is expected to be able to increase the energy deliveries around 2016/2017; that is more or less when mining operations in TANBREEZ are expected to start.

3.2 Description

The TANBREEZ Project has an estimated annual power requirement of 30 GWh per year.

Qorlortorsuaq is capable of producing 32 GWh per year covering the need for power and lighting in Narsaq and Qaqortoq and, to some extent, delivering power to electric boilers in the district heating systems in the two towns.

But more water-generated electricity could be used in order to displace oil used in the district heating systems where oil is still used for heating. Because of this, Nukissiorfiit has commenced the former mentioned investigations to assess the possibilities of extending the hydropower plant to be able to supply Narsaq and Qaqortoq with more hydropower or TANBREEZ with hydropower.

3.2.1 Existing grid

The existing 60 kV transmission line shown in Figure 3 is designed for a future increase in power transmission. The capacity of the transmission line is 20 MW. This capacity should be sufficient.

Approx. 7 km of new high voltage transmission line including a necessary transformer station (10 kV) will have to be constructed from the junction "Grenpunkt" to TANBREEZ.

This new transmission line has been estimated at DKK 17,550,000.

Transforming the power from 10 kV to 0.4 kV is not included in these costs.

3.2.2 Extension of Qorlortorsuaq

As mentioned, the inflow to the Qorlortorsuaq power plant can be increased. Furthermore, an extra turbine, expansion of the power plant building, electrical installation etc. can be constructed. The extra turbine has to be the same size and type as the existing ones, increasing the power output from the plant to 10.8 MW (at full load).

If an extension of the plant is carried out, it has previously been estimated - in 1995 and 2000 - that the plant will be able to produce 63 GWh per year; however, this will not be confirmed until late 2013. This extension should be sufficient to supply Qaqortoq, Narsaq and TANBREEZ (based on the current production of 500,000 TPA), with both the energy and the power needed.

Establishing the TANBREEZ mine before the extended hydropower plant is able to deliver the necessary power and energy makes it necessary to establish the power and energy production needed as diesel generated power either from extended diesel power plants in Qaqortoq and/or Narsaq - managed by Nukissiorfiit - or diesel generators on the TANBREEZ site - managed by the mining company. This solution of supplying the mine from Qaqortoq and/or Narsaq should only be used as a temporary and not a permanent solution.

The diesel power plant placed at the TANBREEZ site has one more generator (as redundant power) in order to maintain an uninterruptible power supply.

If the diesel power plant is placed in Qaqortoq and/or Narsaq, this redundancy is already there (the existing diesel power plants), and the extension of these might be reduced to establishing a simple high speed diesel power plant with 6 gen-sets in Qaqortoq and/or Narsaq. This configuration, however, still requires that two gen-sets are established at TANBREEZ in order to cope with failures on the transmission lines.

3.3 Timetable

The output of the investigations which are being prepared by Nukissiorfiit will be available in end 2013.

When these investigations are finalised and if a decision to extend the hydropower plant is taken, it takes approx. 2-4 years before Nukissiorfiit will be able to provide the TANBREEZ Project with hydro generated power.

This means that hydropower could be available to the project around 2016/2017, if feasible and if water is available around the existing hydropower plant.

3.4 Operating costs

The price of purchasing power from Nukissiorfiit has to be negotiated, preferably before any decision on the extension of the hydropower plant is taken. However, in order to be able to calculate the profitability for the Greenlandic society, Nukissiorfiit also needs to know the exact load that TANBREEZ will be purchasing.

Nukissiorfiit has informed us by e-mail on 19 September 2012, ref. /4/, about the present energy prices which will apply to a consumer type known as "Kundegruppe 1" (customer group 1). These prices, which are shown in Table 4, are a little lower than those which are found in their official prices[1] with their conditions of delivery[2].

The prices are calculated on basis of a certain set of rules which include a maximum price and a minimum price. The minimum and maximum prices as well as the energy prices are adjusted regularly every year, or if the fuel prices prompt a new price table. The calculation of minimum and maximum rates are based on Nukissiorfiit sales and delivery notes[3].

	Initial cost [DKK]	Yearly expenses [M DKK/year]	Cost per kWh [DKK/kWh]
Actual maximum price	Per bill*	97.2	3.24
Actual price sheet price	Per bill*	78	2.60
Actual minimum price	Per bill*	48	1.60

Table 4 - Yearly price for power received from Qorlortorsuaq for customer group 1
*** additional generators are required; costs are not estimated**

The above rates are effective from 1 January 2013 in South Greenland.

If an extended hydropower plant is capable of delivering the power needed, we have therefore assumed that the TANBREEZ Project will be charged the minimum price.

[1] http://www.nukissiorfiit.gl/dk/kundeservice/priser/

[2] http://www.nukissiorfiit.gl/fileadmin/user_upload/PDF_filer/Salgs_og_leveringsbetingelser/Salgsbetingelser_nr8_01-02-2009_dk.pdf

[3] http://www.nukissiorfiit.gl/fileadmin/user_upload/PDF_filer/Salgs_og_leveringsbetingelser/DK_Bilag_1_til_Salgs_og_leveringsbetingelserne.pdf

We also assume that the actual minimum price will most likely be charged until the extended hydropower plant is ready. If mining operations start in 2016, the energy may thus amount to DKK 97.2million in 2016, DKK 97.2 million in 2017 based on diesel generated power and 48 million in 2018 and the following years (2012 prices) based on the minimum rate from hydropower.

The cost of 17.5 M DKK for establishment of 7 km of new high voltage cables and transformer station at "Grenpunkt" is not part of the costs in Table 4. An estimated 0.08 DKK/kWh has to be added to the cost per kWh in order to cover these costs over a 10-year period.

Nukissiorfiit is only able to submit the list prices described above. The prices are politically decided, and Nukissiorfiit requires a new set of rules or a change to the existing code of practice from the Greenlandic Self-Government before Nukissiorfiit as a government company is able to change the price setting by themselves, ref. /5/.

3.5 Sub-conclusion

If the output of Nukissiorfiit's investigations shows that it is profitable to extend the hydropower plant, it seems to be sufficient in order to supply the two towns and the TANBREEZ Project (based on the current production of 500,000 TPA).

In case the study concludes that the amount of inflow usable is not sufficient in order to supply the two towns and TANBREEZ, diesel power will be needed to generate the amount of energy that cannot be delivered from the hydropower plant. As discussed in section 2, it is not feasible to construct several small hydropower plants. However, the case will have to be evaluated regarding costs etc.

4 Diesel power plant on site

4.1 Available information

Feasibility Study Report 0009 "Port and plant site infrastructure and ancillary facilities", ref. /6, describes the diesel power plant to be installed on site.

4.2 Description

The power supply will comprise three medium-speed 2,636 kW diesel generator units (DGUs) with an expected lifetime of 150,000 hours. The generators will be located in a separate building as close as possible to the main consumer, the process building. A tank farm also has to be established, capable of holding a sufficient volume of Arctic Gasoil, the oil consumption being 7,200 m^3 a year.

Such a plant uses more energy than 2,500 kW of fuel, and therefore has to achieve an environmental approval before any work is carried out. One of the most important issues of the application for this environmental approval is emissions and immissions, which will dictate the height of the smokestack needed. The height has to be calculated using a computer program called "OML-Point".

For more detailed information about the diesel power plant on site please see Feasibility Study Report 0009 "Port and plant site infrastructure and ancillary facilities", ref. /6/.

4.2.1 CO_2

The diesel power plant will have a CO_2 emission of 20,881 tons per year. In correlation with this - and according to "Statistics Greenland" - the total CO_2 emission of Greenland was 676,000 tons in 2011.

The TANBREEZ Project will thus increase the total CO_2 emission by 3.1%.

4.3 Timetable

Wärtsilä Power Plants is capable of delivering both the engineering and the mechanical and electrical equipment needed to establish the necessary diesel power plant at TANBREEZ. The required diesel generators (6L32) can be delivered six to nine months after placing of the order, and the plant can be commissioned and ready for use nine months after delivery of the diesel generators and other mechanical and electric components. Construction drawings of the power plant building can be expected six months after placing of the order.

4.4 Capital and operating costs

	Initial costs [M DKK]	Yearly expenses [M DKK/year]	Cost per kWh [DKK/kWh]
Capital costs			
Generators	56	5.6	0.187
Power plant building	11	1.1	0.037
Fuel tanks	6	0.6	0.020
Operating costs			
Fuel (6,776,000 l/year)		36.3	1.208
Lube		0.5	0.016
Maintenance parts		2.0	0.067
Manpower		0.8	0.027
Total		46.9	1.562

Table 5 - Yearly price for diesel generators located on site

The capital costs, yearly expenses, are calculated as shown above. A price on Arctic Gasoil of DKK 5.35 per litre is used in the calculations.

4.5 Sub-conclusion

The diesel power plant described in the feasibility study will be able to supply the project with power when starting up. If, at some point, an increase in production becomes relevant, it will be straight forward to install and commission the extra generators required.

5 Summary of capital and operating costs

A summarised cost benefit analysis is shown below.

	Yearly costs [M DKK/year]	Cost per kWh [DKK/kWh]
Qorlortorsuaq, hydropower, actual	78.0	2.60
Qorlortorsuaq, hydropower, expected	48.0	1.60
Diesel power plant on site	46.9	1.56

Table 6 - Summarised cost benefit analysis

It is cheaper for the TANBREEZ Project to establish and generate the required power on site by diesel generators. The power will also be available from day one when reaching the operations phase. Hydropower will be available around 2017 at the earliest.

The generators will also be available to generate power during the construction phase.

If there is political endorsement to support the TANBREEZ Project by hydro-power, and a new set of rules or a change to the existing code of practice from the Greenlandic Self-Government is implemented, and we assume that Nukis-siorfiit will be able to support the TANBREEZ Project as "Kundegruppe 2" (customer group 2) which is the same rate as the fish industry uses, the costs will be as listed in Table 7.

	Yearly costs [M DKK/year]	Cost per kWh [DKK/kWh]
Qorlortorsuaq, hydropower, fish industry rate	44.7	1.49

Table 7 - Summarised cost benefit analysis if the TANBREEZ Project is charged the same rate as the fish industry

The cost of 0.08 DKK/kWh for construction and depreciation of high voltage cables and transformer station will have to be added and will bring the costs to 1.56 DKK/kWh.

These costs are similar to the cost of producing diesel generated power on site. If the rate for the fish industry will be available to the TANBREEZ Project, hydro power will be competitive.

6 Sensitivity analysis

If the actual price of DKK 2.6 per kWh is maintained and all other expenses are kept fixed, the diesel price can increase by approx. 166% or DKK 1.04 per kWh before diesel generated power on site equals the same cost as purchasing power from Nukissiorfiit.

According to section 6.2 "Development in oil prices" in Feasibility Study Report REP0006 "Financial", ref. /8/, the following extrapolation is estimated.

Year	Oil price [DDK/l]	Cost per kWh [DKK/kWh]
2016	5.35	1.56
2017	5.62	1.62
2018	5.90	1.69
2019	6.19	1.75
2020	6.50	1.82
2021	6.83	1.90
2022	7.17	1.97
2023	7.53	2.05
2024	7.90	2.14
2025	7.98	2.16

Table 8 - Expected development in diesel prices

If the development in diesel prices behaves as expected, if high voltage cables and transformer stations are established and costs added to the minimum rate in Table 4, the costs per kWh is 1.68 DKK/kWh. It is expected that the cost of diesel generated power on site will reach a similar cost level after 3 years of production in year 2019.

If, however, the TANBREEZ Project is charged a rate similar to that of the fish industry, the cost of hydropower versus diesel generated power will more or less even out at the beginning of the project.

7 Discussions and conclusion

As a base case scenario TANBREEZ Mining Greenland A/S has found it necessary to budget and plan the project on the basis of a new installed diesel generator plant to be certain that the required power is available when starting up the mine.

It seems possible to use hydropower at the TANBREEZ Project; however, it depends on Nukissiorfiit's investigations; the results of which will be available late 2013.

This, together with the idea of a 'green' project, makes TANBREEZ Mining Greenland A/S very open to the idea of using hydropower as the primary power source.

As Table 1 shows, available power from Qorlortorsuaq is 11 GWh and the existing diesel generators in Narsaq and Qaqortoq are able to deliver 36 GWh in 2016. However, the prices are not cost-competitive as summarised in Table 6.

The cheapest reliable solution at this moment, however, is to use the suggested diesel power plant on site, as described in the DFS.

The main obstacle for using hydropower is the uncertainty regarding the amount of inflow as well as the energy price to be paid; the latter of which require a political change of the price structure.

TANBREEZ would prefer to buy power from Nukissiorfiit, but current official prices for diesel and hydro generated power from Nukissiorfiit are not cost-competitive. However, if Nukissiorfiit is able to enter into an agreement based on a similar price structure as that of the fish industry, the price will be cost-competitive as it is shown in this report.

TANBREEZ will commence discussions and negotiations with Nukissiorfiit in early 2013 to clarify the possibilities of being supplied by Nukissiorfiit.

7.1 Future expansion

The current study is looking at an annual production rate of 500,000 tons per year with a mine life time of 10 years.

When the mine is in operation and if the production continues after 10 years and maybe at a higher annual production rate than 500,000 tons per year, a larger supply of power will also be required.

A desktop study based on an annual production of 1,500,000 tons per year has indicated a power requirement of approx 75 GWh per year.

Considering a possible expansion, there might still not be sufficient power in the TANBREEZ area.

8 List of references

/1/ "Hydropower resources in Greenland, 19 August 2005"

/2/ "Geologi, Is og Energi (Geology, Ice and Energy), GEUS 5/96"

/3/ "Vandkraftværk Qorlortorsuaq, Beslutningsgrundlag, Maj 2000"

/4/ "TANBREEZ - power supply", e-mail of 19 September 2012 from Nukissiorfiit

/5/ The Greenlandic Finance act of 2012, page 69-72

/6/ REP0009 Port and Plant Site Infrastructure and Ancillary Facilities

/7/ REP0016 Operating Cost Estimate (OPEX)

/8/ REP0006 Financial