CHALLENGES OF DIESEL GENERATION AND LOGISTICS IN THE NORTH

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1. Overview

In a resource hungry world, Canada's arctic frontier has seen a major increase in mineral exploration and mining development activity. With a near total lack of in-place infrastructure to support these activities, vast quantities of diesel fuel are being used to meet the electricity, process steam, and space heating requirements of these energy intensive operations. While this has proved to be a satisfactory solution in the past, the evolving dynamics of security of supply, fuel logistics, costs, and environmental concerns has cast serious doubt on the future viability of this energy source as the prime mover of large industrial projects in the north.

2. The present situation

2.1 Communities

Canada's three territories account for 40% of the land area of Canada yet are home to just 0.3% of its population. Communities are small, isolated, and, for the most part, have no interconnecting power grid. Each community must generate its own power and heat. Indigenous energy resources are scarce. There are a few hydro electric developments of approximately 10 to 15 MWe and two communities in the Northwest Territories have access to natural gas. Nunavut, the largest of the three territories, is home to the majority of mineral development and derives all of its energy resources from diesel. Fuel subsidies consume 20% of the territorial budget. Nunavut represents the greatest challenge in finding a solution to the evolving diesel dilemma.

> ***"One of the key objectives… is to find alternatives to diesel fuel for electricity generation"***
> ***Ikummatiit Report, Government of Nunavut energy strategy document***

2.2 Mining operations

Resource extraction and processing are the most important economic development activities taking place in the north. They are very energy intensive operations; a single large mine can consume more electricity than the entire territory of Nunavut. Unlike communities which are generally located in costal areas, mines are frequently located well inland, complicating fuel logistics and dramatically driving up the cost of energy. For example, the Diavik diamond mine in the NWT has 32 MWe of generation capacity and 108 million litres of on-site diesel fuel storage. All fuel and materiel must be brought in over a seasonal ice road, or flown in at great expense. This state of affairs often means that energy costs are the gatekeeper as to whether new mining projects go forward.

> ***"There are lots of resources up there, but a lot of those are not currently on mine plans because of operating costs. And that's mainly linked to energy cost. Once you've solved that, you've got diamond mines for the next 50 years easily"***
> Ricus Grimbeek, former president of Ekati diamond mine Globe and Mail, April 9, 2010, "The North Scrapes Bottom"

2.3 Military installations

A number of small military installations exist in the high arctic. They range from the very small and numerous 47 unmanned North Warning System radar sites to the larger and extremely remote CFS Alert which is the most northerly, permanently manned, outpost in the world. All military installations currently use JP-8 (a diesel facsimile) for power and heat. The remoteness of these military installations makes fuel supply extremely challenging and expensive. For example, CFS Alert, with no sea or land access, has all 1.7 million litres of its annual fuel supply airlifted in over a distance exceeding 4,300 km. The government of Canada is currently developing plans for a deep water port at Nanisivik, an arctic training centre at Resolute Bay and a high arctic research centre at Cambridge Bay. At present, each of these installations will be powered by JP-8/diesel. In keeping with federal and territorial policies on environmental emissions, sustainable development and government cost control, the Government of Canada is actively seeking alternatives to fossil fuels to provide power and heat to its federal and military installations in the arctic.

3. Diesel electricity generation at a glance

Diesel electricity generation is a mature, reliable, compact transportable system with relatively low capital costs. Its primary drawbacks are its high fuel consumption, the high and unpredictable cost of fuel, logistics of transporting and storing large quantities of fuel, environmental hazard of fuel spills, and emissions.

A modern diesel generator operating under ideal conditions will produce about 4 kWh per litre of fuel although under typical actual operating conditions this figure is closer to 3.8 kWh/litre. Each litre of fuel consumed produces quantities of SOx NOx VOCs and about 2.7 kg of CO_2. Like most heat engines, diesel gensets operate most efficiently at full power. Load following requirements will reduce the service life of the engine and increase fuel consumption. In a typical installation, the total generating capacity will be divided across 5 or more units. This redundancy allows for reserve capacity in the event of an unplanned outage, and/or regularly scheduled maintenance. Exhaust gas or water jacket heat recovery systems may be fitted to the diesel engine to supply space heating and raise the overall efficiency of the system.

4. Diesel Fuel

Arctic Diesel is diesel fuel that is specially formulated for operation in the extreme arctic cold. Recent changes to regulations require that it have ultra-low sulphur content (15 ppm) and a -40^{o} pour point. Ultra Low Sulphur Diesel (ULSD) requires more processing (higher costs), lower lubricity (engines require special oil), and slightly lower energy content than non ULSD. Brent Crude imported from the North Sea or Africa is the lighter grade feedstock that east coast refiners use to make most Arctic Diesel. Brent typically trades at a $15 to $20 per barrel premium over the more commonly quoted West Texas Intermediate. (Fig 1)

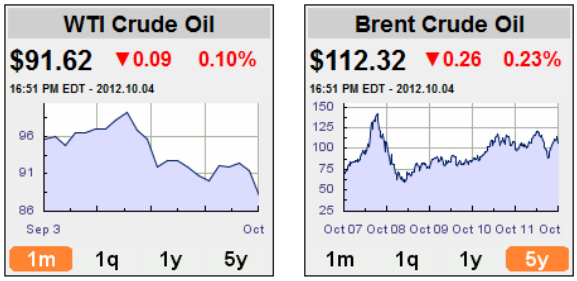

Figure 1

Many east coast refineries are old, operate on very thin profit margins and as a consequence, are being shut down. Some of the larger oil companies have advised northern miners that a reliable supply of Arctic Diesel cannot be assured in the future. One large mine in northern Quebec that consumes 50 million litres/yr has stated that they are down to a single supplier. The security of supply and cost of Arctic Diesel fuel can be expected to become increasingly unpredictable in future years. This situation is antithetical to the long term cost and logistical planning necessary for companies to commit to building multi-billion dollar mines.

5. Diesel fuel logistics

Compounding the problems of cost, scarcity, and greenhouse gas emissions are the increasing cost, complexity, and uncertainty of fuel logistics. A 2011 study of logistical requirements to northern Canada over the next 20 years was conducted by Prolog Canada and indicates that more than 52% of all materiel moving north will be fuel. This percentage is even higher if just the eastern arctic is considered. For costal communities, changing conditions in first year ice, and the southern migration of ship-wrecking multiyear ice chunks into seasonal arctic shipping lanes poses a major hazard to bulk fuel shipping in a fragile ecosystem that is intolerant of spills.

> ***"multiyear ice was to blame for 74 percent of the damage suffered by ships traveling in the Canadian Arctic between 1976 and 2007".***
> Will the Opening of the Northwest Passage Transform Global Shipping Anytime Soon? Anne Casselman, Scientific American, 10 Nov. 2008

Diesel fuel logistics are expensive, complex and not without risk

Tanker truck ice road accident

Fuel tanker grounded in Pangnirtung fjord

Figure 2

"There has been a significant number of fossil-fuel spills in Nunavut and these appear to be increasing with time"
Ikummatiit Report, Government of Nunavut energy strategy document

Seasonal Ice Roads are similarly being affected by the warming climate. Ice Roads seasons are becoming progressively shorter and the thinner ice will not support the heavy loads of fuel required by remote mine sites. As the ice continues to thin, loads will become progressively lighter (and therefore more costly) and more accidents are likely to occur.

6. Conclusion

Diesel fuelled heat and electricity have played an essential role in sustaining arctic communities and opening up the north for resource development. Current and long term trends in cost, security of supply, logistical effort and environmental hazard strongly indicate that continued reliance on diesel as the principal source of energy is unwise and unsustainable. This situation will only be exacerbated by the rapid resource development activities that are currently underway in the north. Action to develop long-term alternatives that can meet or exceed the reliability and performance of diesel must be initiated without delay or economic development will stall and social progress will be impaired.