

# CBC TECHNOLOGY REVIEW

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## EFFECTS OF WINDMILLS ON TELEVISION RECEPTION

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### INTRODUCTION

This article describes the signal degradation that wind turbines can cause to our existing transmission systems, as well as any off-air TV reception, including satellite pick-up. The interference from wind turbines can manifest itself in two ways: a static ghost caused by the wind turbines support tower, and/or a dynamic pulsing of the picture's brightness and/or colour, caused by the rotating blades. To quantify and qualify this degradation, signal quality measurements were taken before and after the construction of a wind farm near Murdochville, Quebec.

### BACKGROUND

Four years ago, the Quebec Ministry of Environment notified the CBC that they were about to approve the development of a wind farm consisting of approximately 70 wind turbines, on the mountains around Murdochville, a small town two hours east of Matane on the Gaspé Bay peninsula. For several years, the CBC has operated two television stations in Murdochville: CBGAT-2, part of our French TV network; and CBMMT, part of our English TV network. Both stations are located on Mount Miller, on the outskirts of Murdochville.



WINDMILLS AND OUR TELEVISION TRANSMITTER SITE NEAR  
MURDOCHVILLE

As plans for the wind farm called for the placement of wind turbines within a few hundred meters of CBC's TV transmitters, the Strategy and Planning department performed signal quality measurements in Murdochville, prior to the installation of the wind turbines. A second set of measurements, taken at the same locations, was made last spring after the wind farm had been completed. The measurements were then compared to determine any effects caused by the wind turbines on the over-the-air reception of our signals, as well as the cable TV head-end pick-up and our transmitter's off-air pickup from CBGAT-10, Mont-Louis on channel 19.

During the two measurement campaigns, the following quantitative and qualitative measurements were collected in Murdochville: signal levels, waveform measurements, tape recordings and subjective signal quality evaluations.

## THE WINDMILLS

The wind turbines are manufactured by Vestas and are each capable of producing 1.8 megawatts. Their towers are 90 meters tall at the hub and each of their three non-metallic blades is 40 meters long. Their nominal rotational speed is 18 revolutions per minute. The wind turbines that most affect our TV signals in Murdochville are on Miller Mountain and have been placed on the mountain's ridge, north to south, in line with the CBC's transmission tower.

## ASSOCIATED B-TAC WORK

In parallel with these measurements, Strategy and Planning has been working through the Broadcasting Technical Advisory Committee (B-TAC) to develop a technical paper defining the potential radio communication signal degradation in and around a wind turbine farm. The B-TAC Wind Turbine subcommittee (subcommittee 18), comprised of private broadcast consultants, Industry Canada and the CBC, recently completed its work and presented the paper to the main B-TAC committee in early October. This document will soon be available on the Industry Canada Web site and is intended to act as an aid to wind farm promoters, allowing them to quickly and easily assess if their proposed wind farms have the potential of degrading the quality of local over-the-air-signals. It also provides them with a number of possible mitigation measures that may help reduce or eliminate any detrimental effects their wind farm could have on local over-the-air transmission and reception.



MEASUREMENT TRUCK AND THE WINDMILLS

## HOW WINDMILLS AFFECT THE TELEVISION SIGNAL

### Static Interference

Static interference or “ghosting” occurs when the receiver picks up more than one continuous incoming signal from the same transmission source. These sources include the direct signal from the transmitter and one or more reflected signals delayed in time as a result of being reflected off a stationary solid surface such as a building or, as is the case in Murdochville, the support towers of the wind turbines.

Static ghosting was originally measured at 14 different locations in and around Murdochville in 2004, prior to the building of the wind turbines. These measurements were repeated at the same 14 sites in 2005 after construction of the wind turbines was completed. An example of the static ghosting caused by these windmills can be found at the end of this article. Results of the ghosting comparison, before and after windmill construction, are summarized below.

#### **Channel 10 (FTV)**

An increase in the level of ghosting or an increase in the number or severity of the ghosts was seen at 11 of the 14 locations.

#### **Channel 21 (ETV)**

When compared to the 2004 measurements, an increase in the level of ghosting or an increase in the number of ghosts was seen at three of the 14 locations.

The difference in the results between channels 10 and 21 can be explained in part by the difference in their antenna patterns. Channel 21 has a much more directional pattern towards Murdochville that does not encompass the wind turbines to the same extent as channel 10's antenna pattern. A graphic comparison of the two patterns is shown in the “Antenna Patterns Relative to the Wind Turbines” figure

### Dynamic Interference

Dynamic interference occurs when the receiver picks up, in addition to the direct signal, an interference signal that has been reflected off of the rotating blades of one or more of the wind turbines. This interference manifests itself as a periodic variation in the picture's brightness and/or colour occurring in time with the rotation of the blades. In Murdochville, these pulses occurred approximately once per second (18 revolutions per minute X 3 blades = 54 pulses per minute).

As a result of the pulsating nature of dynamic interference it is difficult to empirically measure the level of interference. So, to illustrate the effect of this degradation on a TV picture, the channels were recorded onto a VHS tape using a Sony VCR<sup>1</sup>.

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<sup>1</sup> A copy of this video can be obtained by contacting the authors.

As previously mentioned, the original sets of signal quality measurements were taken in 2004 prior to the wind turbines being constructed; obviously no dynamic interference was observed at that time. However, during the 2005 measurements, after the construction of the wind turbines, dynamic interference was observed as following:

#### **Channel 10 (FTV)**

Dynamic interference was noticeable at four of the 14 original locations in town and six of the 10 new measurement locations situated within the wind farms.

#### **Channel 21 (ETV)**

No dynamic interference was visible at any of the 14 original locations but was noticeable at four of the 10 new measurement locations situated within the wind farms.

As with the static interference, the difference in the results between channels 10 and 21 can be explained in part by the difference in their antenna patterns. See the “Antenna Patterns Relative to the Wind Turbines” figure for a comparison.

### **WHAT CAN BE DONE**

#### **Mitigation Measures**

There are a number of means of mitigation that can be used to reduce or even eliminate the degradation caused by the windmills. These measures can be separated into two groups: preventive and corrective.

Preventive measures are taken during the planning phase of the proposed wind turbine project. If, when defining where the individual wind turbines are to be placed, the wind farm promoters factor in the location of all local radio communication towers, over-the-air RF links and areas of served population, degradation can be minimized or even eliminated.

Corrective measures are used after the construction of the wind turbines to minimize the impact of any resulting degradation to the TV signal. The following are examples of mitigation methods that can be used individually or in combination to reduce or even eliminate the degradation of the TV signal:

- Improve the directivity of the receiving antenna
- Replace the off-air reception with an alternative such as satellite, cable, etc.
- Relocate the receiving antenna
- Relocate the transmitter site
- Relocate the problematic wind turbines

Results from these corrective measures will vary depending upon the circumstances. Preventive measures are much more likely to reduce the effect of the wind turbines on radio communication systems.

## **Murdochville Case**

In the case of Murdochville, no preventive measures appear to have been considered. The wind turbines were built within a few hundred meters of the transmitter and directly between the transmitter and the served population. As a result, only limited means of mitigation are available. The small angle the receive antennas “sees” between the main signal and the signals reflected off the wind turbines (both static and dynamic) makes directional antennas ineffective in improving the picture quality. Relocating either the offending wind turbines or our transmitter site is cost prohibitive, so the only remaining corrective measure is to convert any off-air pick-ups to cable TV or satellite.

This also pertains to the feed signal to CBC’s TV transmitter and to the cable TV head end. In Murdochville, the input signals to CBC’s transmitters have recently been changed from off-air feeds to satellite feeds so that no interference is seen. If there are problems with the cable TV feed (no problems were detected during a site visit) it will be necessary to switch to a satellite feed.

The wind turbines can also affect any of CBC’s transmitters that receive their feed off-air from Murdochville. CBGAT-3 Grande-Vallée may be affected and so may any of its downstream stations.

In its final report on the windmill project in Murdochville, the Quebec “Bureau d’audiences publiques sur l’environnement” (BAPE) has recommended that the promoters follow the methodology presented in the B-TAC Wind Turbine subcommittee document. In the same report, BAPE asked the promoters to correct, at their own expense, any reception problems caused by the windmills around Murdochville.

## **WILL HDTV BE AFFECTED?**

So what happens when we switch from NTSC to HDTV over-the-air transmission? Will the potential for interference from wind turbines still exist?

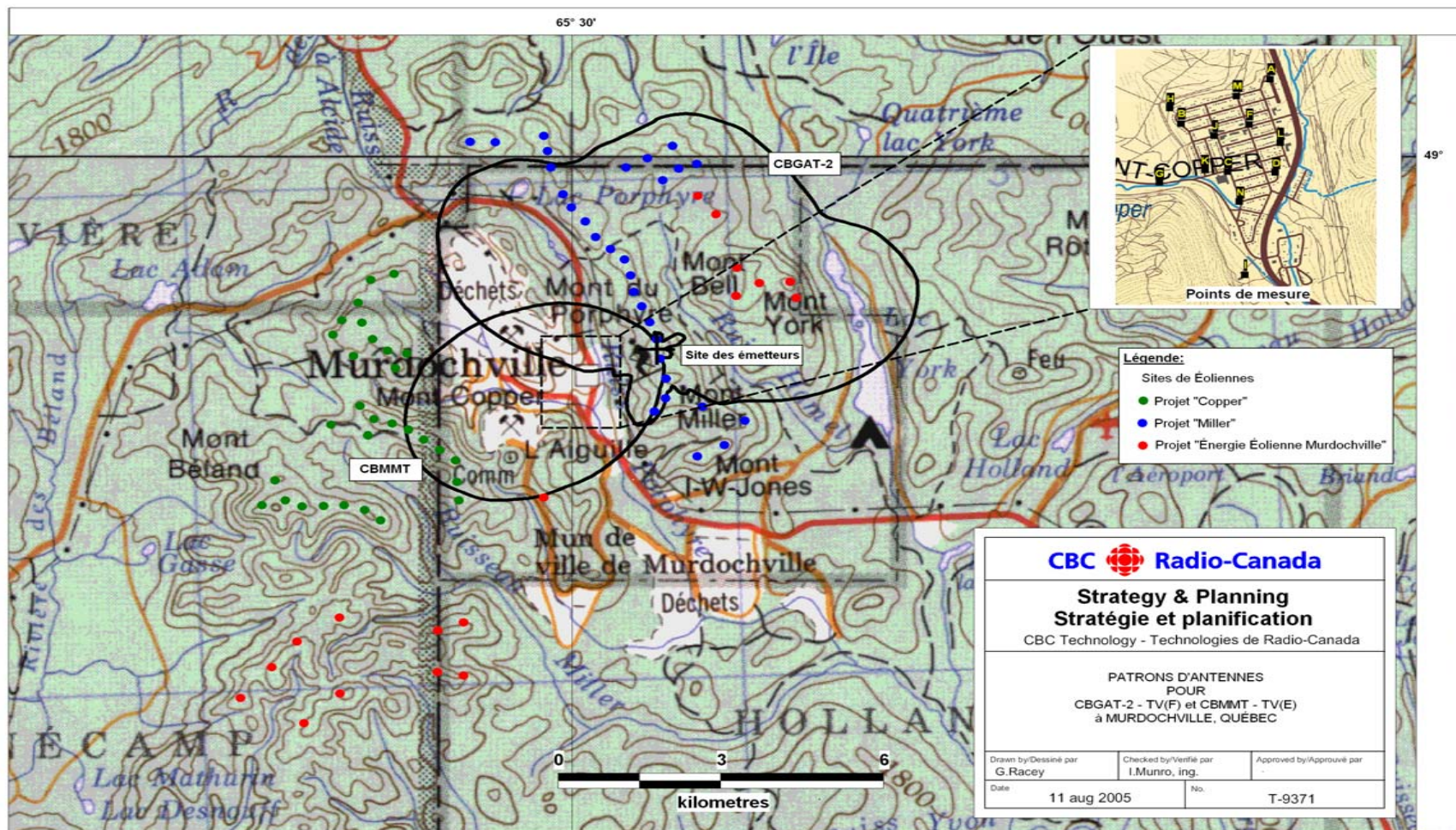
To date, no signal quality tests have been conducted to determine the impact from wind turbines on HDTV signals because currently, there are no large-scale wind farms in proximity to any of CBC’s existing HDTV transmitters. However, based on previous work with NTSC signals, it can be theorized that interference may occur.

HDTV receivers have built-in ghost-cancelling circuits not found in NTSC receivers. These circuits should greatly reduce or even eliminate the static interference created by large structures such as wind turbines. Therefore, it is expected that HDTV will be more immune to the static effects from the wind turbines.

Dynamic interference, however, is a different story. As noted earlier, dynamic interference results when the receiver sees not only the main signal but also one or more additional signals reflected off the rotating blades of the wind turbines. As the signal is only reflected when the blades are at a particular point in their rotation, the reflected signal causes a sudden increase or decrease in the amplitude of the received signal, in sync with the rotation of the blades. HDTV, like NTSC, uses amplitude modulation and so it is possible that HDTV signals may experience dynamic interference. Unlike NTSC, though, this interference may show up as pixelisation, blocking, frozen frames or the complete failure to decode.

It is likely that the degree of impact caused by any dynamic interference to HDTV signals will be related to the quality of the ghost-cancelling and Automatic Gain Control (AGC) circuits in the receiver. These may vary from one receiver to the next as the performance of the ghost-cancellation circuits is a Consumer Electronics manufacturer proprietary issue. However, the actual degree of interference to our HDTV signals will not be truly known until field measurements are completed. Although the CBC fully expects to undertake these measurements when an HDTV transmitter is installed near a wind farm, this will likely not occur for a few years yet, and it is acknowledged that advances in receiver technology and design may overcome these issues before any measurements are taken.





ANTENNA PATTERNS RELATIVE TO THE WIND TURBINES

The following pictures represent a comparison between video stills and the 2T pulses at one of the Murdochville locations. The left picture was taken before the wind turbines were constructed while the right pictures are after construction. The difference in ghosting can most easily be seen on the pictures to the right of the logo and any lettering. On the 2T pulses (shown below the pictures) an increase in ghosting shows up as an increase in the height and distance from the 2T pulse of the humps to the left and right of the pulse.

