Finnish Transport and Communications Agency

The impact of wind farms on radio systems and the reduction of adverse effects

Effects on radar systems

Microwave radar sensor systems bear the brunt of the impact of wind farms. In Finland, radar systems are employed in marine traffic and aviation traffic control and meteorology (by the Finnish Meteorological Institute) as well as by the Finnish Border Guard and in area surveillance carried out by the Finnish Defence Forces.

The radar's sensitivity to disturbances caused by wind power is mainly due to two factors:

- The relatively high frequencies used by the radar are dampened considerably as the signal passes through a wind farm, effectively shortening the range of the radar.
- The operation of radar is based on identifying weak targets (echoes) that are often in motion. The moving rotors of wind power plants generate false echoes to the receivers, causing the radar to misinterpret them.

If an assessment by the Defence Forces finds that a planned wind farm may affect its radar systems, the wind farm contractor must commission a report on the impact of the project from VTT Technical Research Centre of Finland.

Impact on other radio systems

The most important public radio transmissions and services are digital television, which uses the ultrahigh frequency band, and frequency-modulated sound radio (FM radio), which uses the frequency range 87.5–108 MHz. Mobile communications networks operate on several frequency bands, whose geographical usage varies slightly by operator. The following bands are used: 700; 800; 900; 1,800; 2,000; 2,600 MHz; 3,600 MHz and 26 GHz. Microwave links operate using their own frequency bands: 6.2; 6.8; 7.3; 7.6; 8.0; 13; 15; 18.7; 23; 28; 32; 42 and 80 GHz. In sea transport, the effects target mobile and fixed service VHFs.

The effects of wind power may be divided into three primary categories:

1. Dampening of signals travelling through the wind farm
2. Reflections off power plant structures
3. Reflections off rotor blades

Dampening of signals travelling through the wind farm

When a radio transmitter and receiver are located on opposing sides of a wind farm so that the radio signal, which travels rectilineally, must pass through the farm, the farm will dampen the signal. The significance of the dampening is greatest near the edges of the reception and visibility line, in which case even a small additional damper may deteriorate or sever the signal.

Measurements carried out by the Finnish Transport and Communications Agency have shown that TV signals may be significantly dampened when there are several wind farms back to back between the transmitting and receiving points.

In terms of mobile communications and radio link frequencies, the location of the transmission and reception points is crucial. In these cases, wind farms may completely sever the visual and radio connection.

Reflections off power plant structures

The dampening effects discussed in the previous chapter concern the signal travelling directly from the transmitter to the receiver in the direction of the line of sight. The strength of the signal may, however, vary due to the effects of the wind farm, even if the farm was slightly to the side of the direct line of sight. This is due to the radio wave moving and reflecting from wind power plants outside the line of sight.

Based on reports, reflections from power plant structures are not a significant disruptive influence even to analog FM radio.
However, the reports also show that reflections may affect radio links considerably.

Reflections off rotor blades

The measurements also show that wind power plant rotors cause frequency changes and frequency-dependent dampening in the signal, which is evident in the constant fluctuation of wide band signals. This may lead to short disruptions in television transmissions or pixelation of the image when a wind power plant rotor blade is located in a certain position between the transmitter and receiver.

Summary of wind power effects on other radio systems

Based on the material reviewed and measurements carried out by the Finnish Transport and Communications Agency, the radio technical effects of wind farms can be summarised as follows:

Radio system	**Dampening of signals travelling through the wind farm**	**Reflections off wind farm towers**	**Reflections off rotor blades**
FM radio	Small	Minor, but signal fluctuation may occur	
TV (digital)	The effect of a single factor is quite small. If all three factors affect the signal simultaneously, their impact is considerable. If the quality of the TV signal is good in the receiver, a wind farm is unlikely to affect reception, but new blind spots may occur at the edges of the coverage area.		
Mobile communications networks	There is no research data concerning the impact on mobile communications networks, but the impact is likely to be similar in TV reception and fixed mobile communications networks using directive antennas, albeit lesser in mobile networks due to their cellular structure. Mobile reception occurs in a fluctuating radio channel, meaning that the impact of wind farms is likely to be drowned out by other fluctuation within the channel.		

Microwave links	Great, may even sever the connection	May be significant in higher modulations and deteriorate the quality of transmission	May deteriorate the quality of transmission

Decreasing adverse effects

The adverse effects of wind power on radars cannot be eliminated using radio engineering means. Blind spots may only be removed by improving radar coverage, e.g. by building a new radar.

Blind spots caused in terrestrial television networks by wind farms may be eliminated by optimising the transmission network or by adding a new gapfiller. Satellite reception may be considered in individual cases.

A wind power plant will sever a radio link connection if it hits the line of sight. The only option is to move the radio link. This is normal practice if a large obstacle, such as a building or forest, severs the connection.