Policy Statement on Wind Turbine Clearance

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EirGrid

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Contents

1. Background

Commercial wind turbines absorb energy from the wind, and this has the effect of reducing the wind speed in their wake. Conductors on overhead transmission lines are susceptible to damage from vibration initiated by wind, particularly at low wind speeds. EirGrid's policy reduces the likelihood of premature wear on conductors and fittings because of this arrangement which, if uncontrolled may lead to a significant reduction in asset life, increased maintenance, unplanned outages or ultimately conductor failure.

2. Policy

EirGrid's current policy, based on international experience, is that the distance between an overhead transmission line (110 kV, 220 kV or 400 kV) and a commercial wind turbine should not be less than three and a half rotor diameters unless EirGrid have risk assessed and approved a reduction in clearance.

Minimum clearance for all turbines and overhead transmission lines shall be falling distance plus flashover distance for the relevant voltage. Falling distance shall be measured from turbine foundation edge.

Flashover distance at 110kV = 1.1m
Flashover distance at 220kV = 2.4m
Flashover distance at 400kV = 4.1m

The distance between a wind turbine and an overhead transmission line shall be measured horizontally from closest point on the centreline of the overhead transmission line (not the tower locations) to the centreline of the turbine body.

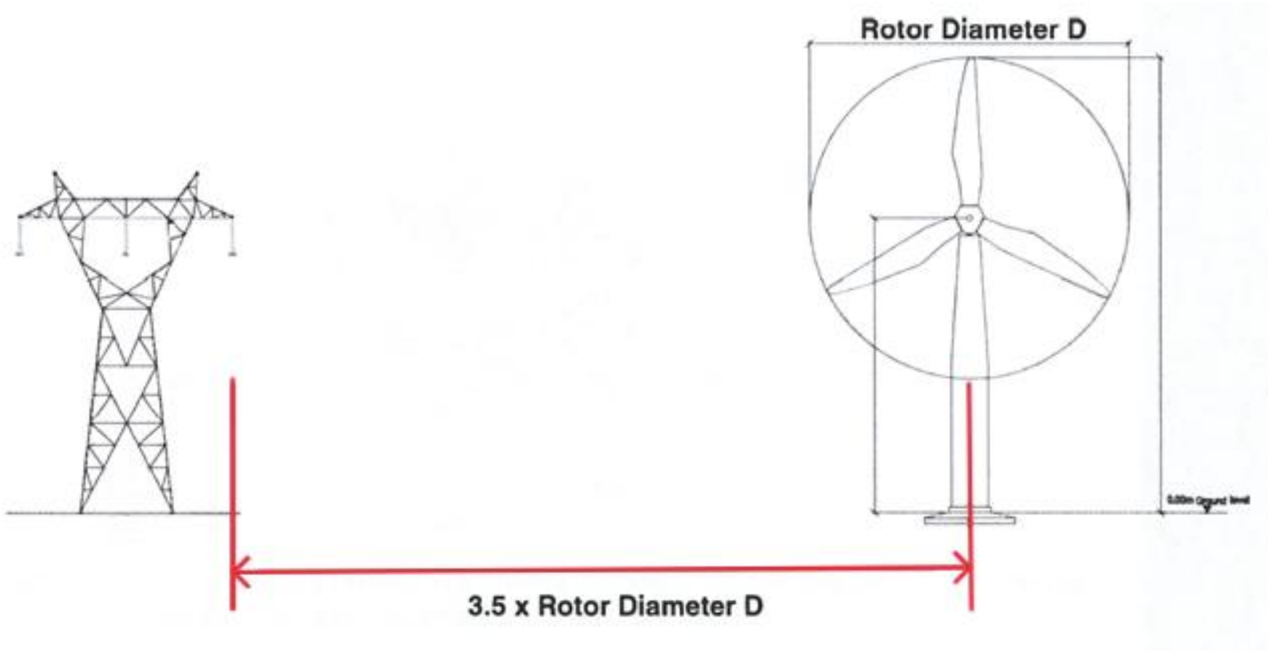

Figure 1 Minimum distance from line to turbine.

Small and Micro Wind Turbines are covered in the Planning and Development Regulations 2008[1]

[1] https://www.irishstatutebook.ie/eli/2008/si/235/made/en/pdf

3. Risk Assessments

The risk of damage to overhead transmission lines depends on the line/turbines relationship with the wind rose from each site and so a full assessment should be made on the impact of turbine wakes on nearby overhead transmission lines. Developers proposing turbines within 3.5 x D of an overhead transmission line should submit the following information as a minimum to EirGrid for proposed turbine locations so a risk assessment can be performed:

- turbine coordinates, dimensions, tip height, rotor diameter, foundation dimensions and associated drawings;
- the relevant overhead line details and measured separation distances;
- wind roses based on a minimum of 12 months measured data;
- sectional elevations and relevant drawings where turbines are within the assessment zone;

4. Application

All projects proposing turbines within 3.5 x D of an existing or proposed overhead transmission line should engage with EirGrid at the earliest available stage.

5. Derogation

Derogation requests from this policy will be by exception and will follow the Derogation Policy.

6. Assessment Criteria

If the falling distance of the turbine is less than the required clearance (including flashover, etc) from the line, the turbine cannot be installed in this position, and turbine location must be changed.

a) If more than 25% of the prevailing wind is perpendicular to the OHL the full distance of 3.5 x D is required in order to prevent damage to the OHL.

b) If between 10% and 25% of the prevailing wind is perpendicular to the OHL a minimum distance of 3.25 x D is required in order to prevent damage to the OHL.

c) If less than 10% of the prevailing wind is perpendicular to the OHL a minimum distance of 3.0 x D is required in order to prevent damage to the OHL.

7. Worked Example

7.1. Theory

There are two main factors in determining the minimum distance between wind turbines and overhead power lines, both involving the effect of the wind turbine on the line:

1. Falling distance including electrical and mechanical clearances.

2. Wake effects on the dynamics of the OHL conductors.

7.2. Falling Distance

The mechanical clearance is essentially the furthest point that a turbine could reach on falling about it's turning point. The turning point is not the turbine structure but the edge of the foundation nearest to the OHL. Commonly, turbines have a wide, relatively shallow, foundation structure and in the case of failure, the whole unit is likely to rotate as one from this foundation edge (Figure 2).

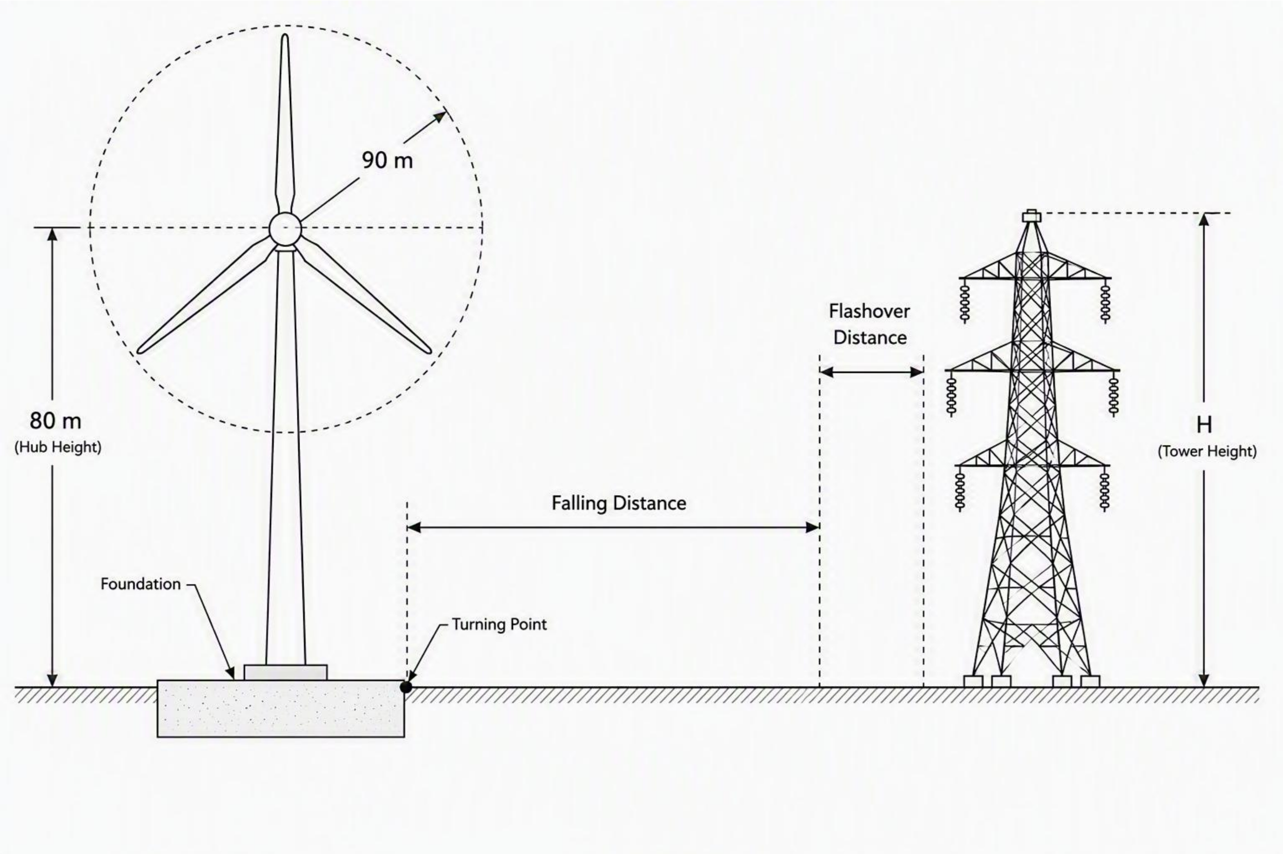

Figure 2 Falling distance

Figure 3 Fallen turbine

This falling distance must not enter the flashover distance of the OHL conductors.

As the turbine will be much higher than the conductors, the distance will be to the furthest horizontal position of the conductors. Consideration must be given to the maximum deviation of the conductor from the normal position in environmental extremes such as maximum sag during summer and peak galloping in wet snow and rime ice conditions in winter. Typically for Ireland the worst-case scenario to be considered is peak galloping in wet snow.

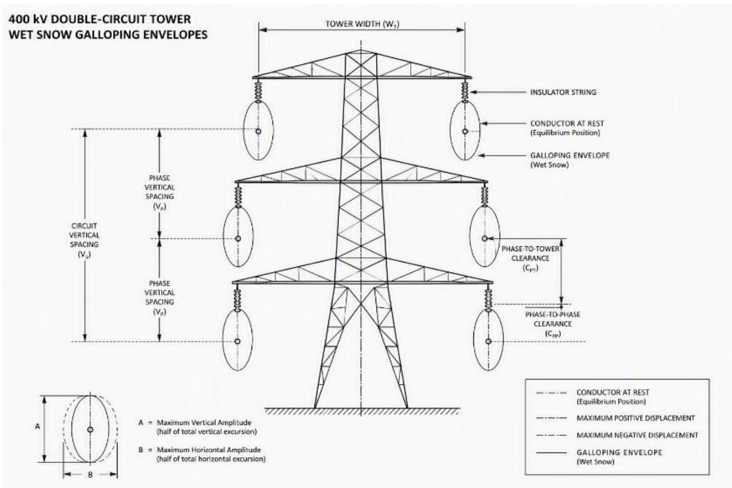

Figure 4 Envelopes for wet snow galloping

The centre of the circular envelope in Figure 4 will be the conductor position at worst case scenario (45° angle swing) from the crossarm support i.e. the typical 12m sag plus 4.1m insulator length for a 400 kV line. This gives a horizontal distance from the crossarm support position of 16.1m x (sin 45°) plus the envelope radius of 6m plus a 4.1m flashover distance. This totals 11.4+6+4.1=21.5m. The centre phase crossarm length of an Irish 400 kV intermediate tower is typically 10.5m, so the closest approach of a falling wind turbine to the line of the 400 kV tower route would be 32m.

In other words, the furthest horizontal position of the conductor on a typical Irish 400 kV line measured from the centreline of the tower shall be calculated by summing:

- Centre phase crossarm length (10.5m)
- Flashover distance (4.1m)
- Envelope radius (6m)
- Horizontal clearance from crossarm support (11.4m)
  Total = 32m

Line Voltage (kV)	Sag (m)	Envelope Radius (m)	Flashover Distance (m)	Insulator Length (m)	Crossarm Length (m)	Conductor Displacement (m)
400	12	6	4.1	4.1	10.5	32
220	10	5	2.4	3	8	24.6
110	8	4	1.1	1.7	4.5	16.5

Table 1 Typical values for 110, 220, 400 kV tower lines

Note that the above values are typical, i.e. indicative only and the actual tower structure and line characteristic data need to be obtained and presented in the assessment report.

7.3. Wake Effects

Vibrations can be set up in overhead line conductors because of interactions between the wind turbine and air flow upstream of the overhead lines. These vibrations can significantly reduce the lifetime of the conductors due to metal fatigue. It has been determined that these wake effects become significant once the turbines are within 3.5 x 'D' measured perpendicularly from the line, where 'D' is the rotor diameter of the wind turbine. Once the distance is less than 3.5 x D a risk assessment based on wind rose data must be conducted to determine if the wake effect and subsequent line fatigue can be sufficiently mitigated due to the nature of the local wind conditions.

The criteria set out by EirGrid for this assessment are as follows:

a. If more than 25% of the prevailing wind is perpendicular to the OHL, the full distance of 3.5 x D is required to prevent damage to the OHL.
b. If between 10% and 25% of the prevailing wind is perpendicular to the OHL, a minimum distance of 3.25 x D is required to prevent damage to the OHL.
c. If less than 10% of the prevailing wind is perpendicular to the OHL a minimum distance of 3.0 x D is required to prevent damage to the OHL.

7.3.1. Worked Example 1:

Turbine Data:

Rotor Diameter (D) = 150m

Tip Height = 190m

Foundation Diameter = 30m

Tower Line Data:

Line Voltage = 400 kV

a. Falling Distance

i) Mechanical Clearance = Tip Height + (0.5 x Foundation Diameter)

= 190m +15m

= 205m

ii) Flashover Distance = 4.1m

iii) Conductor Displacement = 32m

Falling Distance = i) + ii) + iii)

= 205m + 4.1m + 32m

= **241.1m**

Therefore, the nearside edge of the turbine foundation can be no closer than 241.1m from the centre of the tower line route to meet the falling distance requirement.

b. Wake Effect

The wind rose data for the turbine location shall be analysed to determine the prevailing wind characteristics.

i) If more than **25%** of the prevailing wind is perpendicular to the OHL, a minimum of **3.5 x D** = 3.5 x 150m = **525m** distance between turbine and tower line route is required.

ii) If **between 10% and 25%** of the prevailing wind is perpendicular to the OHL, a minimum of **3.25 x D** = 3.25 x 150m = **487.5m** distance between turbine and tower line route is required.

iii) If **less than 10%** of the prevailing wind is perpendicular to the OHL, a minimum of **3.0 x D** = 3.0 x 150m = **450m** distance between turbine and tower line route is required.

Note: Wind speeds less than $10ms^{-1}$ have significantly more fatigue potential, so prevailing winds perpendicular to the OHL at these speeds may increase the minimum distance requirement.