

TUTORIAL

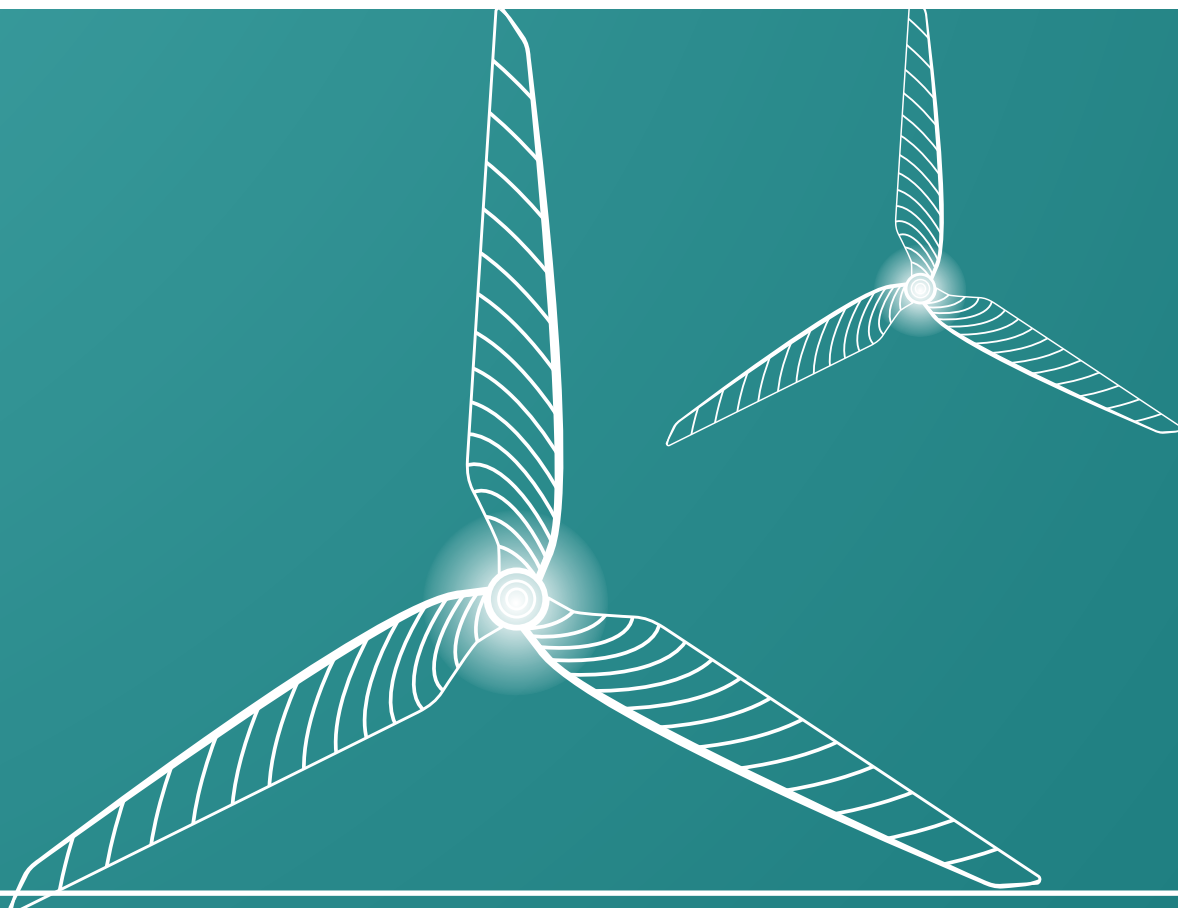
WINDFARMER

Visualisation Module

Version: 5.3

Date: April 2014

DNV GL - Energy



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Garrad Hassan & Partners Ltd., St. Vincent's Works, Silverthorne Lane, Bristol BS2 0QD
England

www.dnvgl.com
windfarmer@dnvgl.com

**None of the data contained in this tutorial have references
to existing or planned wind farms**

1. Introduction	1
2. Wireframes and rendered landscape visualisations	2
2.1 Setting up the workbook	2
2.2 Changing colours, textures and sunlight settings	7
2.3 Draping an aerial image	11
3. Production of Video (AVI) files	13
3.1 Creating an animated view	13
3.2 Creating a 360 degree pan	14
3.3 Creating a fly-through	14
4. Production of Photomontages	15
4.1 Creating a photomontage	15
5. Production of ZVI maps of turbine visibility	18
5.1 ZVI settings	18
5.2 ZVI calculation	20
6. Radar analysis	23
6.1 Radar station settings	23
6.2 Radar ZVI calculation	24
6.3 Radar visualisation	26
6.4 Using radar visibility as a constraint	27

1. INTRODUCTION

The aim of this tutorial is to gain familiarity with the applications provided with the Visualisation Module of WindFarmer. It can be run with the Demonstration version of the software. It can also be run with the full version of the software, provided the Visualisation Module is activated.

The main applications are:

- Wireframe and rendered landscape visualisations
- Photomontages
- Animations and flythroughs
- ZVI (Zone of Visual Influence) maps
- Radar station analysis

The family of tutorials are supplements to the User Manual and the Theory Manual of WindFarmer. The user should refer to these for more information. The documents can be accessed from the dropdown menu for WindFarmer found in the Start, Programs list of your computer. With WindFarmer software open, you can also access the Help files through the Help menu.

The exercises use sample files provided in a folder called 'Demodata', which can be found in Libraries\Documents\WindFarmer. Users of Windows XP can find this folder inside the WindFarmer installation directory, which is usually C:\Program Files\WindFarmer.

Throughout the tutorials, we recommend you save your work from time to time. However, note that Workbooks cannot be saved from the WindFarmer demonstration version.




2. WIREFRAMES AND RENDERED LANDSCAPE VISUALISATIONS

In this exercise, you will learn to build a Workbook for the production of simple wind farm visualisations.


Visualisations are independent of energy-related input data such as wind resource files. The minimum inputs for producing visualisations are digital terrain data, turbines located within a boundary and viewpoints. To build the Workbook it is recommended that the Wizard is cancelled and the Load File route is used.

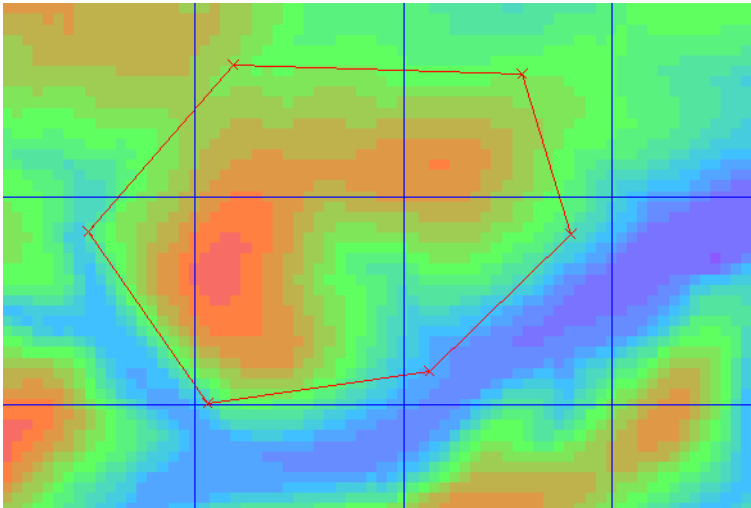
The following procedures can be carried out using files in the demo data provided.

2.1 Setting up the workbook

- Step 1.** Start GH WindFarmer using the shortcut icon on your desktop or from the Start Menu > Programs > WindFarmer >  WindFarmer . If WindFarmer is already open, click the New Workbook icon  or select File menu > New Workbook.
- Step 2.** Select “Cancel” in the Wizard Welcome panel to start with an empty Mapping window.
- Step 3.** Click the Load File icon  or select File menu > Load File....
- Step 4.** Go to the demodata directory in the WindFarmer library and load the file Demo.DTM.

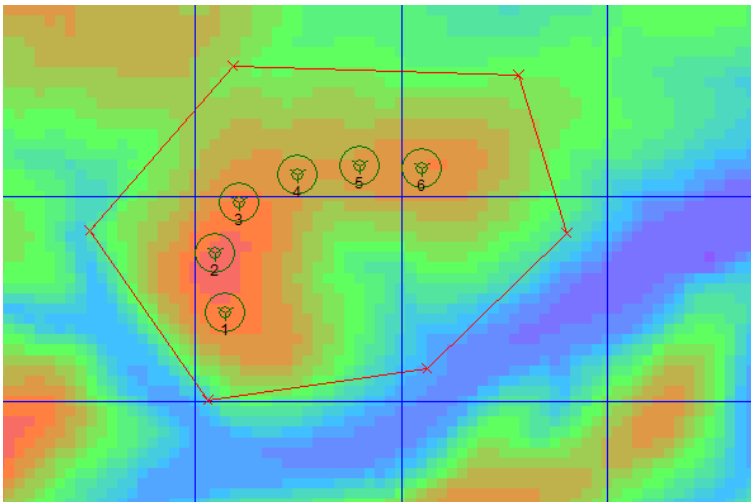
Demo.DTM is a digital terrain map containing height data at points in a regular grid. It displays as a colour height map. Note that if you have digital height data in contour format such as MAP, it can be converted to the required DTM format using “Map menu > MAP2DTM” on the taskbar and choosing the required resolution. The operation can take from a few seconds to a few minutes depending on the size of the area and resolution.

- Step 5.** Before turbines can be added, a boundary must be inserted. Click the New Boundary icon  on the Mapping toolbar or select Add menu > New Boundary from the taskbar.
- Step 6.** In the workspace, use the **Right Click** of the mouse to insert at least 4 boundary points. Left click inside the area to automatically complete the boundary.




Step 7. Now change to Turbine mode by clicking the icon  in the Mapping toolbar or by selecting Modes menu > Turbine.

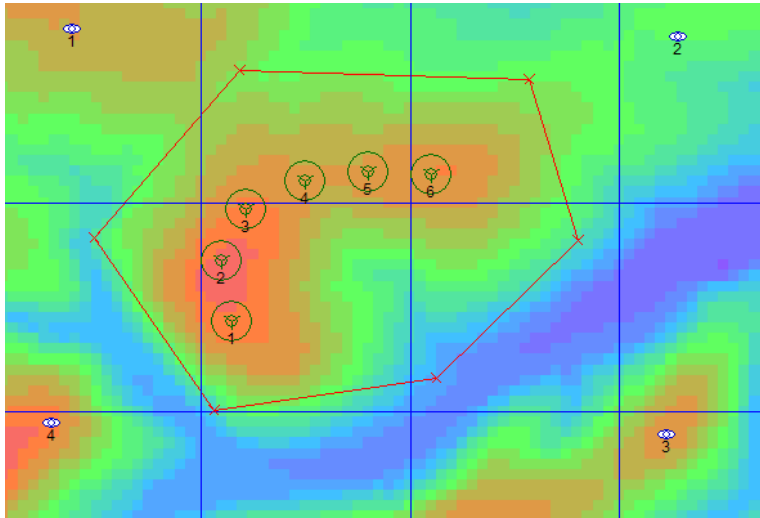
Step 8. Use Right Click to insert 6 wind turbines within the boundary.




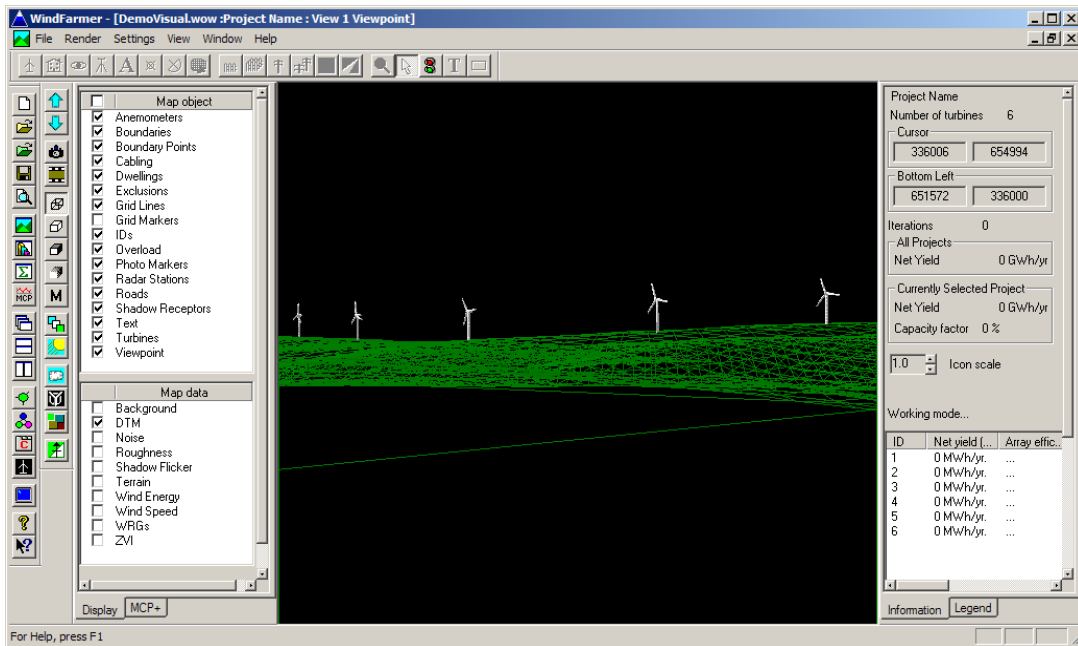
Step 9. Save the WindFarmer workbook using File menu > Save Workbook as.. and name it "Demovisual.wow".

Step 10. Now change to Viewpoint (or Camera) Mode by clicking on  in the Mapping toolbar, or selecting Modes menu > Viewpoint.

Step 11. Insert viewpoints around the site by right click, for example at the 4 locations shown below. The viewpoints must lie within the area of the DTM.






Step 12. To view wireframes and rendered landscapes, open a Visualisation Window by clicking on New Visualisation Window icon  on the Main toolbar or select Window menu > New Visualisation Window. The screen below appears.

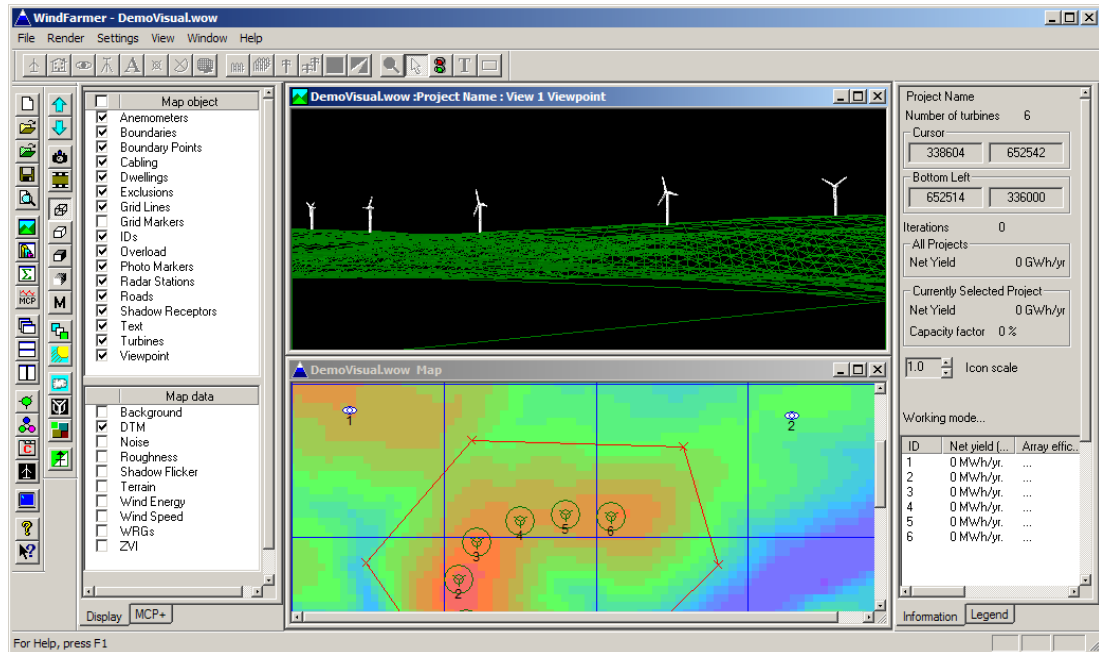



The image shows a transparent wireframe of the wind farm. The Viewpoint number is given in the top line of the window, and the Visualisation toolbar appears, probably down the side. Menus specific to the Visualisation Window are now present in this toolbar.

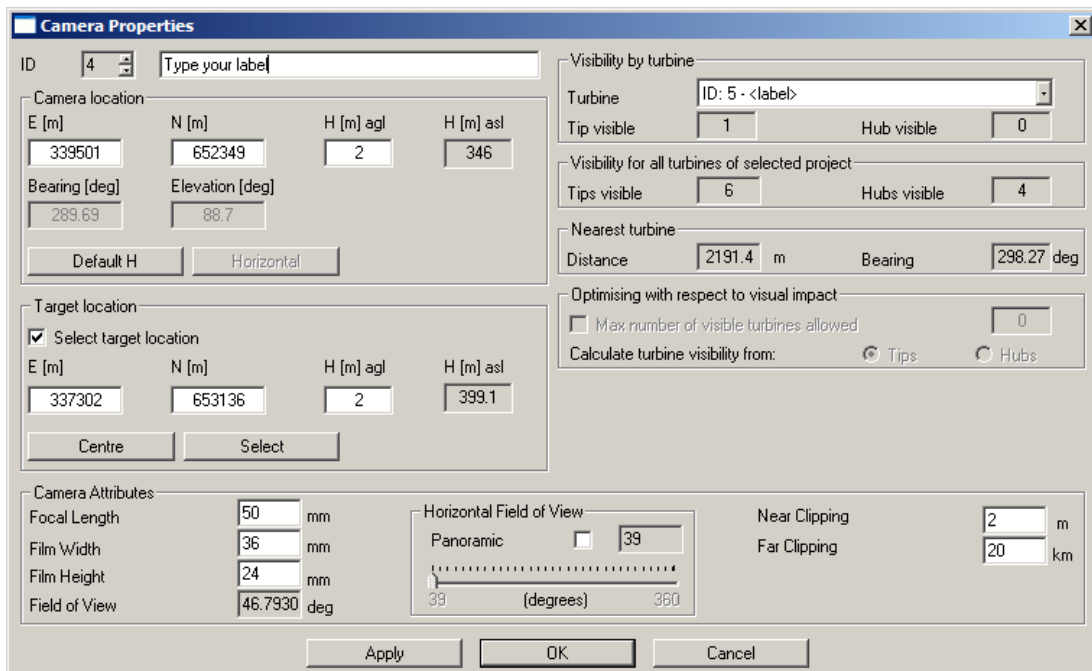


Step 13. Click  and  in the Visualisation toolbar to switch between the viewpoints in the project.


Step 14. Click one of the Tile Window buttons  or  to show the Mapping Window and Visualisation Window in the same view. Alternatively, select Window menu > Cascade / Tile horizontally / Tile vertically.




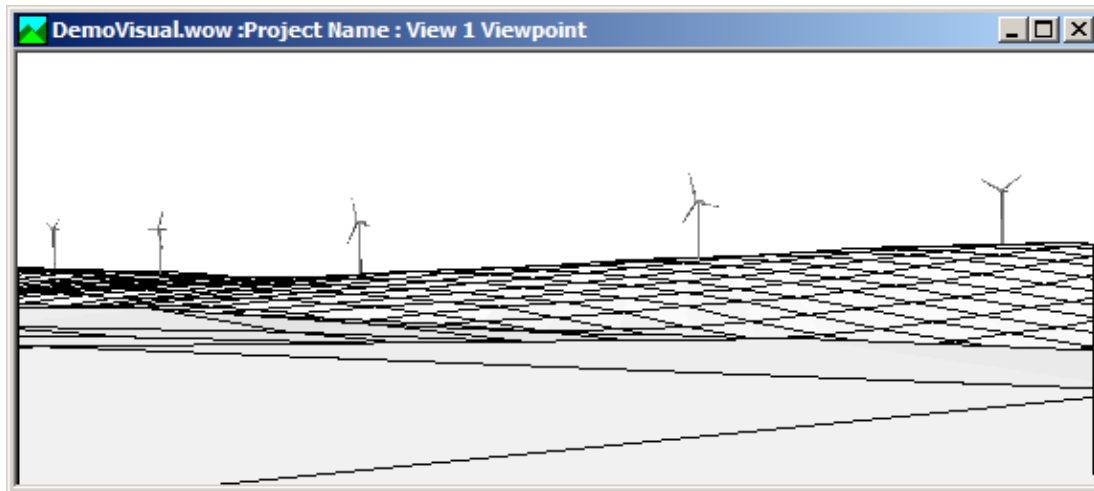
Step 15. Open a Camera Properties dialogue box by either clicking Camera Properties button  or by Right Click on Visualisation window.



About the “Camera Properties” dialog box

- It allows inputs for changing the camera location and target; camera attributes and mode of viewing.
- It provides information on which turbines are visible and the nearest turbine.
- It allows the setting of visual constraints, for the maximum number of hubs or tips that are allowed.
- Click the up/down arrows in the top left corner to change viewpoints. 
- See User Manual and online Help files for more detail

Step 16. Click Wireframe icon  to show the solid wireframe or select “Render menu > Wireframe”.

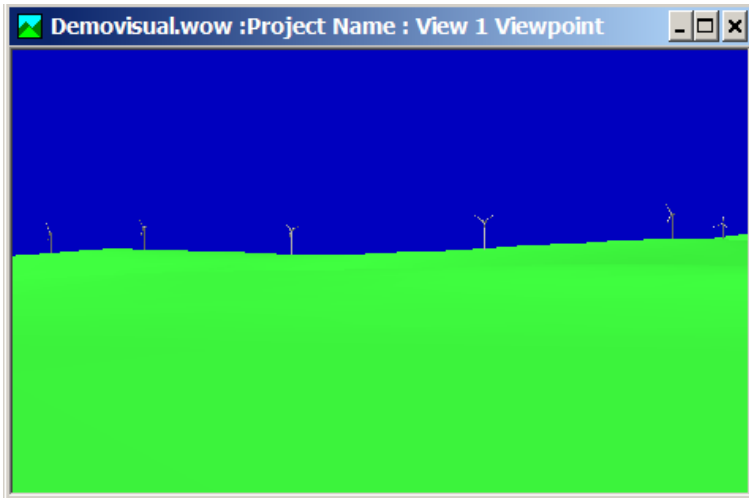
**Colouring turbines to help identification**

Turbines from different wind farms can be given different colours, to make them easier to identify.

Colours are chosen in the Display Options page of Project Properties, and the function is enabled in the Colours and Textures window – see Step 21.


For a more realistic visualisation, the image can be rendered with colours and image textures.

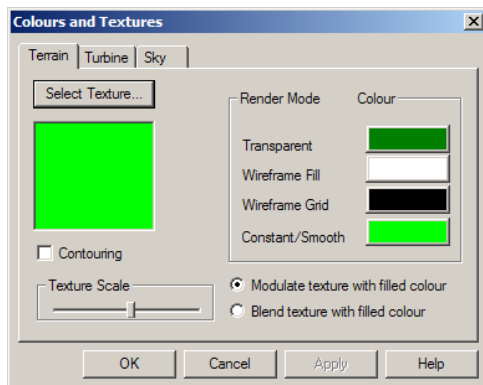
Step 17. Click the Smooth Shading icon  or select Render menu > Gouraud.



The initial colours are set by default. They can be easily changed and replaced by realistic textures as follows.

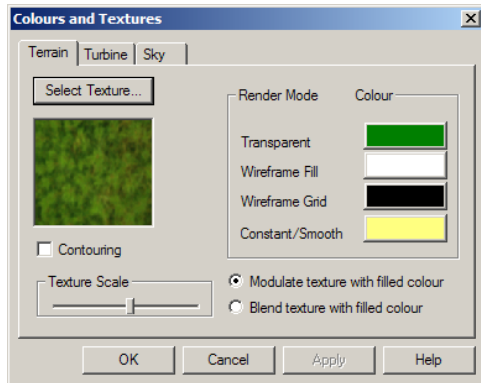
2.2 Changing colours, textures and sunlight settings

Step 18. Click the icon  or select Settings menu > Colours and Textures. In this exercise you will change the settings for the “Constant/Smooth” rendering which is used for the rendered visualisations.

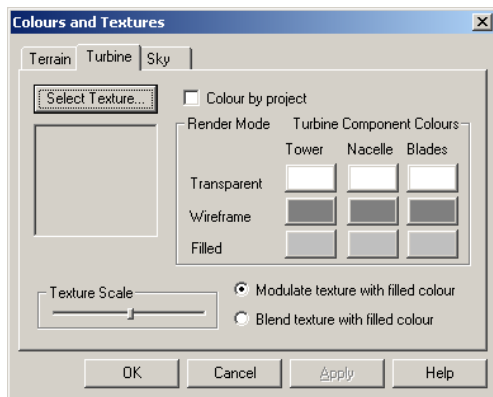


Step 19. In the Terrain page, click “Select Texture” and open the subfolder “Demodata > Textures > Terrain”. Load the file “Greenery.BMP”. The image will appear in the preview box.

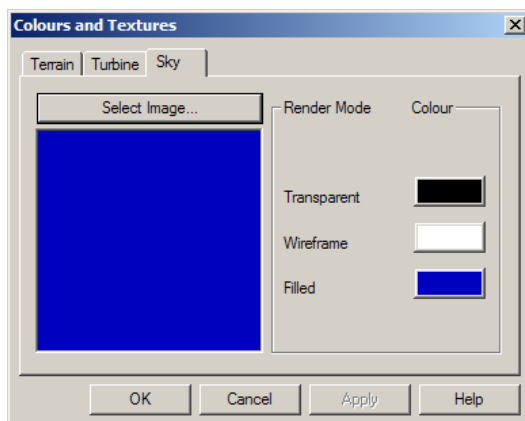
Step 20. On the right, click the Constant/Smooth colour box and select yellow in the palette. This colour will be used to modify the “Greenery” image. The Texture Scale slider can be used to modify the scale of the rendering in the Visualisation window.



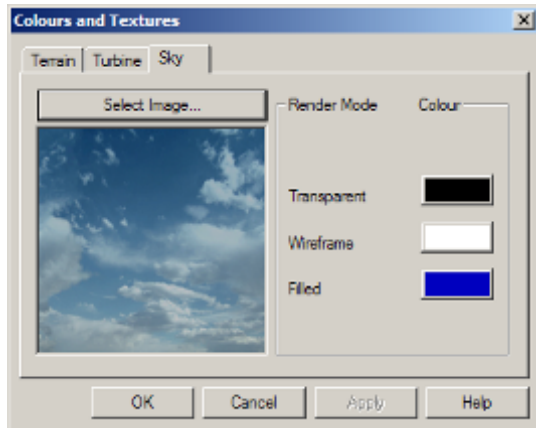
Step 21. Click on “Turbine” page in the same dialogue box. Select different colours for the tower, nacelle and blades for the “Filled” render mode. By default these are pale grey. If you select ‘Colour by project’, then turbines from different projects can be given different colours, as set in Project Properties.




Step 22. Click on “Sky” in the same dialog box to display the options below. Again select a colour for the third “Filled” render mode.






Step 23. To insert a realistic image of the sky click “Select image...” and go to “C > Program files > WindFarmer > Demodata > Textures > Sky and select Clouds.BMP. The image will appear in the preview box.



Step 24. Click OK to close the box.

Step 25. On the Visualisation toolbar, click  to display the loaded sky image in the view. This button will toggle the sky image on and off.

Step 26. Click  to display the texture of the terrain in the view. This button will toggle the rendered terrain on and off.

Step 27. Click on  and  to move from viewpoint to viewpoint. The colours and textures are applied for every viewpoint.


Step 28. Test some different colours and textures to gain familiarity with the available options.

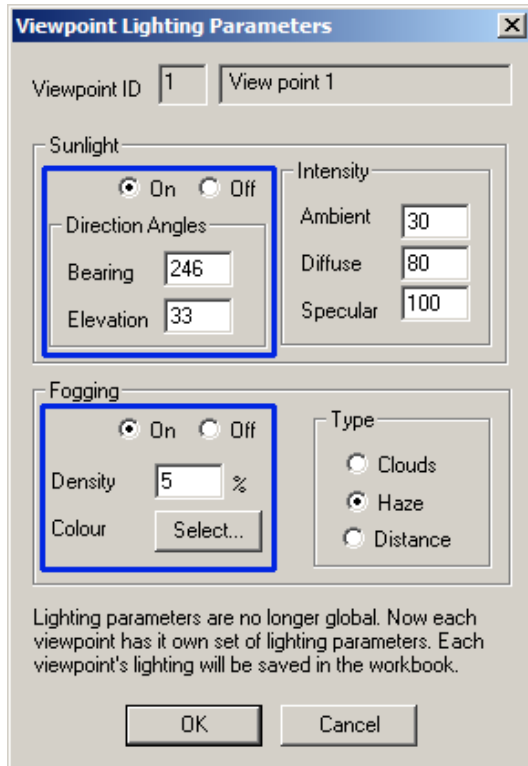
The following instructions do not follow a particular order. They allow the user to explore some of the tools available to enhance the visualisations. These settings are specific to each viewpoint. The user is referred to the User Manual for more information.

Step 29. Click anywhere on the Visualisation window, and then use the Insert/Delete keys to change turbine orientation. Alternatively, select Settings menu > Turbines > Yaw Turbines. Here the yaw can be changed by a chosen angle.

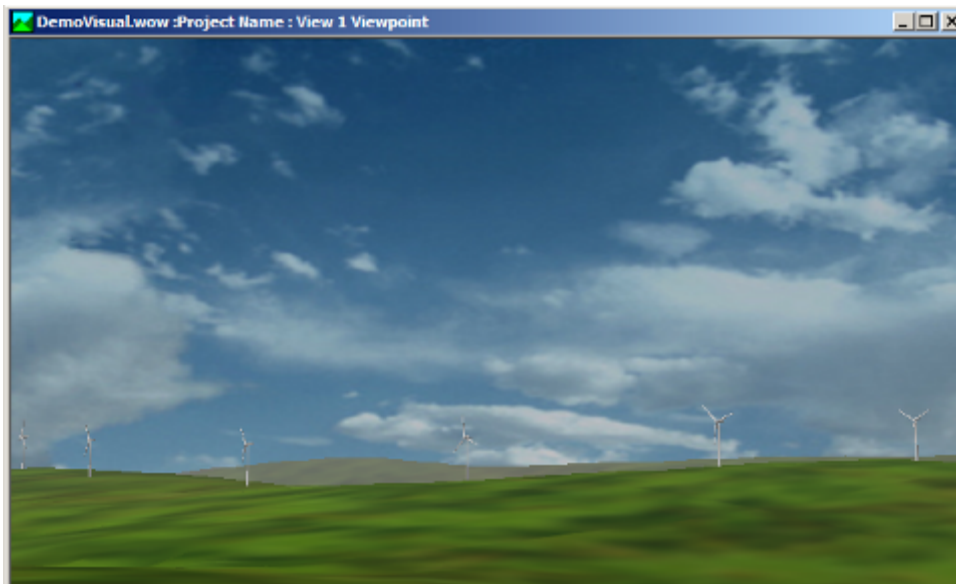
Step 30. Select Settings menu > Turbines > Animate Rotors to rotate the turbine blades. Alternatively press the Space bar on your keyboard to animate the visualisation. Press the space bar again to stop them.

Note: If rotor rotation does not start immediately, click anywhere on the Visualisation window and select Animate again.

Step 31. Click the icon  or select Settings menu > Sunlight to adjust the lighting (on/off and bearing) and the fogging (on/off, density and colour). Click OK to save.




Step 32. Use the keyboard up arrow and down arrow keys to change the elevation of the viewing direction.

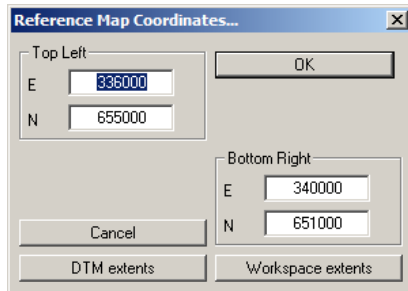


Step 33. Use either the keyboard left arrow or right arrow keys to generate a 360 degrees view around a specific viewpoint. This will take a few seconds. Once generated, use the same keys to scan around the view.

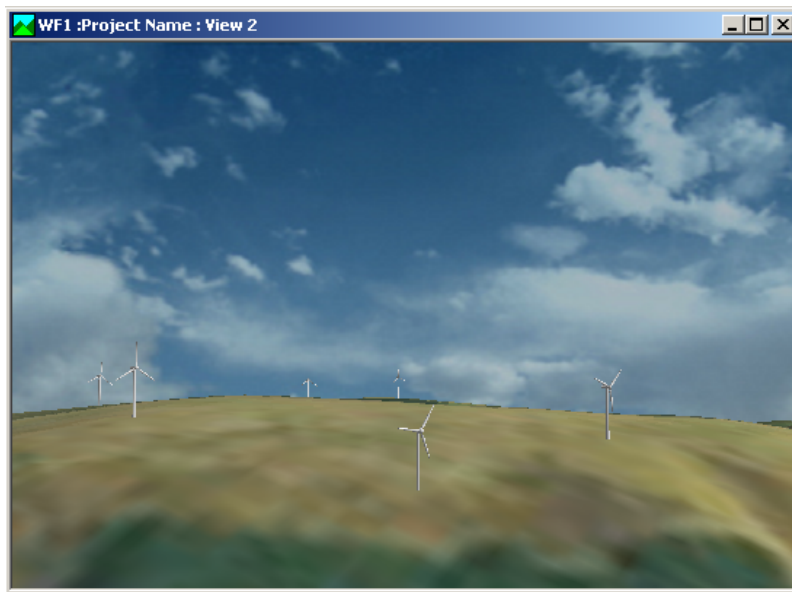
2.3 Draping an aerial image



To make a visualisation more realistic, a single image can be draped over the terrain. Typically this would be an aerial photograph or any scanned map over the matching area.



- Step 34.** Click the Drape icon  or select Settings menu > Terrain > Select Drape... WindFarmer requires a BMP image with known edge coordinates. In this exercise, open the subfolder in Demodata > Refmaps and load the file "DemoAerialPhoto.bmp". The dialog box below will appear.

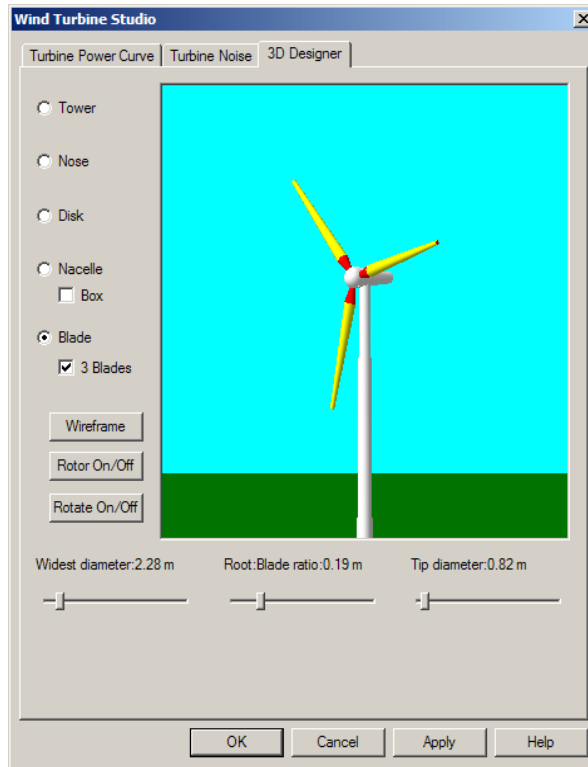


- Step 35.** The coordinates of the corners of the image must be set in this dialog box, or the predefined DTM or Workspace extents if it is the same. In this exercise, Click OK to use the default coordinates. In the view from Viewpoint 1, you will see the scanned map image draped over the DTM terrain shape.



- Step 36.** To see the draped image better, change the viewpoint settings: Click  or right click on the Visualisation window to display the Camera Properties dialog box.
- Step 37.** In "Camera Location" change, for this exercise, the camera height above ground level (H, agl) from 2 m to 500 m.
- Step 38.** Press APPLY and then OK. By raising the viewpoint, you are now looking down on the wind farm from above.
- Step 39.** To remove the scanned map, click  again or using Settings menu > Terrain > Select Drape. Select "None" button at the bottom of the box.

- Step 40.** Open Camera Properties dialog box by clicking  or right click on the Visualisation window. Reset the height of the camera to 2 m by clicking “Default H” in the “Camera Location” section, then Apply and OK.
- Step 41.** Change the geometry of the turbine in Turbine Studio . In 3D Designer page, select components in turn and use sliders to change the dimensions. Press Apply to save the settings. Hub height and rotor diameter are automatically read from the Turbine Power Curve page.

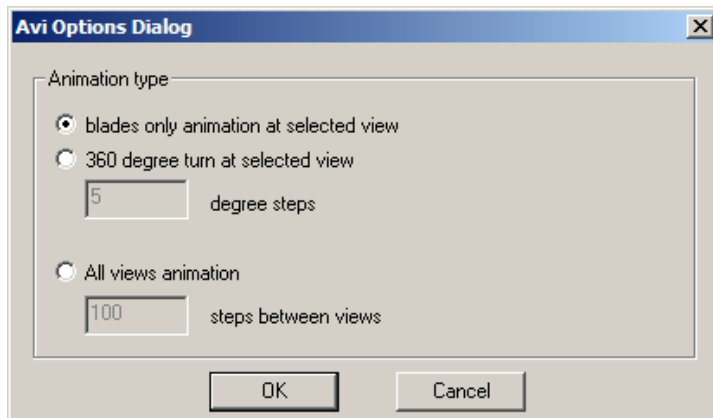


End of the exercise

3. PRODUCTION OF VIDEO (AVI) FILES

Video files in AVI (Audio Video Interleaved) format can be created for single views with rotating turbines, as a 360 degree pan from a given viewpoint or as flythroughs. Options allow the files to be compressed and to allow different speeds of movement.

The AVI Options Dialog appears by selecting Render menu > AVI when a Visualisation window is open and active.

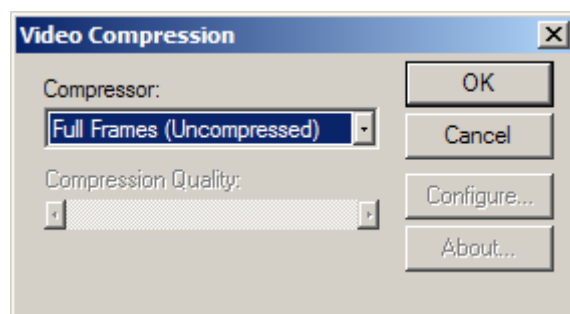


3.1 Creating an animated view

Continue from the previous exercise, or start with any workbook containing a simple wind farm in the Mapping window and a Visualisation window. First produce an AVI showing only the blade animation at the selected view

Step 42. With the Visualisation window open and active, go to Viewpoint 1 for this exercise, select Render menu > AVI, and Blades only Animation. Click OK.

Step 43. Assign a name to the file and click Save. Several options for compression are offered.



Step 44. Choose the type and quality of compression. Press OK to create the file.



The file can then be viewed outside WindFarmer by using standard movie players. You will probably need to try several types of compression and settings to get the best results for your system.


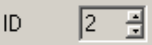
3.2 Creating a 360 degree pan

Step 45. Now create a 360 degree turn at the selected view. Try different sizes of steps. The best resolution is obtained with 5 degrees or less. Again the “Video Compression” dialog box allows the user to produce different sizes of the file.

3.3 Creating a fly-through

Flythroughs are created by the automatic collection of images as the camera flies between the viewpoints.

Step 46. Flythroughs are best produced by increasing the camera height at all the viewpoints. Inspect the viewpoints using  and  on the Visualisation toolbar.

Step 47. Click  at each viewpoint to change the camera height from 2 m to 500 m or use the scroll facility  in the top left of the Camera Properties box.

Note that to change the height of all viewpoints in one action, select Mapping window, Viewpoint Mode and keep the left mouse pressed and drag a box over all the viewpoints. Release the mouse button and the “Selected Viewpoint Properties” box appears. In the “Viewpoint Elevations” section change the Height above Terrain. A common target can also be set in this box.

Step 48. With the Visualisation window active, select Render > AVI, to open the “AVI Options Dialog” and select “All Views Animation”.

Step 49. Set the desired number of steps between viewpoints. The best resolution is obtained with a high number of steps. Press OK.

Step 50. Assign a name to the file and press “Save”.

Step 51. Choose a compression option and click OK



End of the exercise

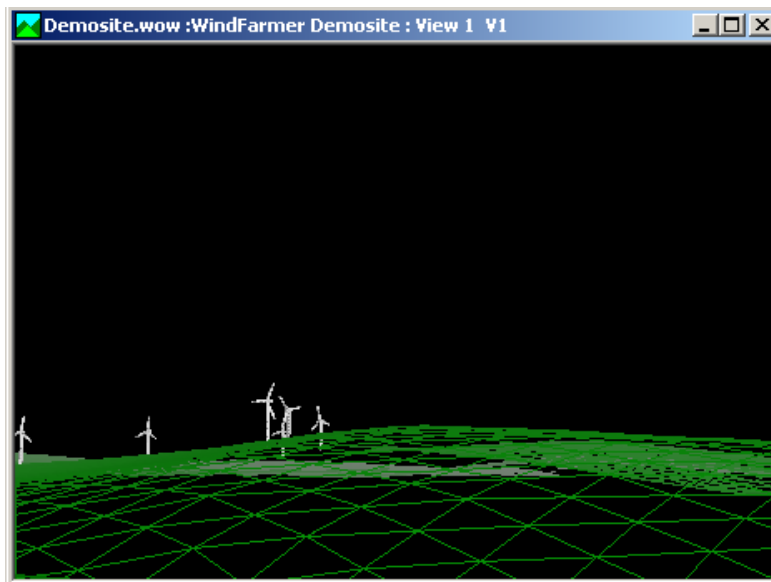
Note that by draping an aerial photo before producing the AVI file, the result is an AVI such as the “DemoFlyThrough.avi” in the Demodata directory.



4. PRODUCTION OF PHOTOMONTAGES

Comprehensive guidance is given in the Visualisation Chapter and Appendices of the User Manual: on taking photographs for photomontages; the editing of photographs; and the fitting of the model to match exactly the view of the photographs. In this exercise, the basic functions are described using the demo data which includes an example photograph.

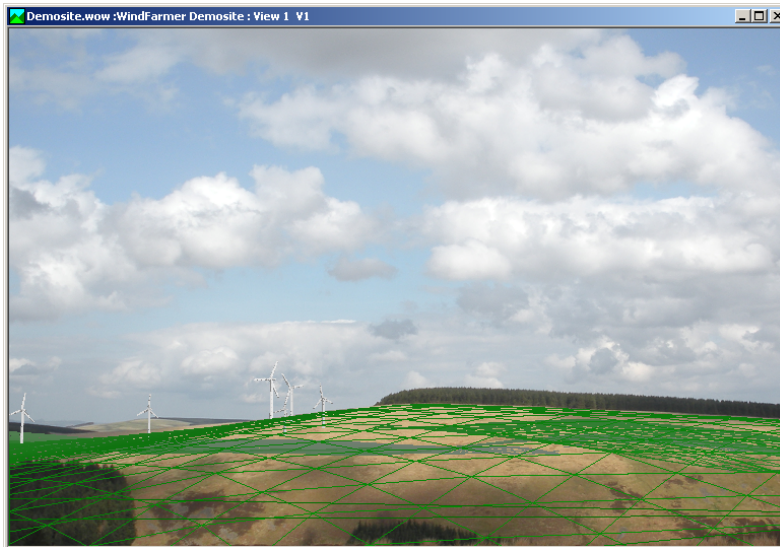
4.1 Creating a photomontage

- Step 1.** By selecting File menu > Open Workbook or , open the file “Demosite.wow” from the demodata section of the installation directory. In the Mapping View you will see viewpoints already in place. Viewpoint 1 in the lower left has been located at the same place as the photograph was taken from.
- Step 2.** Click  to open the Visualisation window. The transparent wireframe from the Viewpoint 1 appears.






- Step 3.** To load the BMP photograph, click  on the Visualisation toolbar or select Render menu > Photomontage and choose “Demo-View1 photo FL 50mm, Bearing 48deg.bmp”. The image will be loaded behind the transparent wireframe. If the image appears corrupted, you may need to disable hardware acceleration from your graphics card – see section **Error! Reference source not found.** for more information.
- Step 4.** In Camera Properties for the viewpoint, the exact settings of the camera must be set. Camera Properties is opened by right click on the Visualisation window, click icon  or Viewpoint Properties from the Mapping window. Set the following parameters:
- Camera location: Easting 336283; Northing 651953; Height above ground 2m
Bearing: 48deg
- Step 5.** To achieve exact superposition of the photo and wireframe, use the up/down and left/right arrow keys $\leftarrow/\rightarrow/\uparrow/\downarrow$ to adjust the vertical and horizontal direction of the

simulated view. To tilt the view, use the Page Up/Page Down keys. The horizon can be used to help the matching process.




Note that photomarkers can also be used in WindFarmer to help the user in this task, as described in the manual and help files.

- Step 6.** To hide the wire frame, click  or select Render menu > Constant or Gouraud on the taskbar. This displays only the photo with the turbines superimposed.
- Step 7.** Change the orientation of the turbines using Insert and Delete keys, or Settings menu > Turbines > Yaw Turbines.
- Step 8.** Change the sunlight direction and shade, and fog / haze settings using Lighting and Fog icon .
- Step 9.** Change the turbine geometry in Turbine Studio by clicking  and select the 3D Designer window.



- Step 10.** Animate the turbines by pressing the Space bar on your keyboard. You may need to click with the cursor on the image first. Press Space bar again to stop the animation.

- Step 11.** To save the photomontage image, select File menu > Export > Export View and save as a BMP file in an external directory.
- Step 12.** To save a video file of the animated photomontage, select Render menu > AVI.
- Step 13.** To return to standard operation of WindFarmer, unload the photo by clicking  and selecting the button "None" at the bottom.

End of the exercise

5. PRODUCTION OF ZVI MAPS OF TURBINE VISIBILITY

A ZVI (Zone of Visual Influence) map, sometimes called a ZTV (Zone of Theoretical Visibility), displays the visibility of a wind farm over the surrounding area. Planning guidelines may require the ZVI to be calculated out to distances of 15 km or more. Areas where turbines are visible are shaded or coloured according to the number of turbines that can be seen and the criterion for visibility that has been chosen.

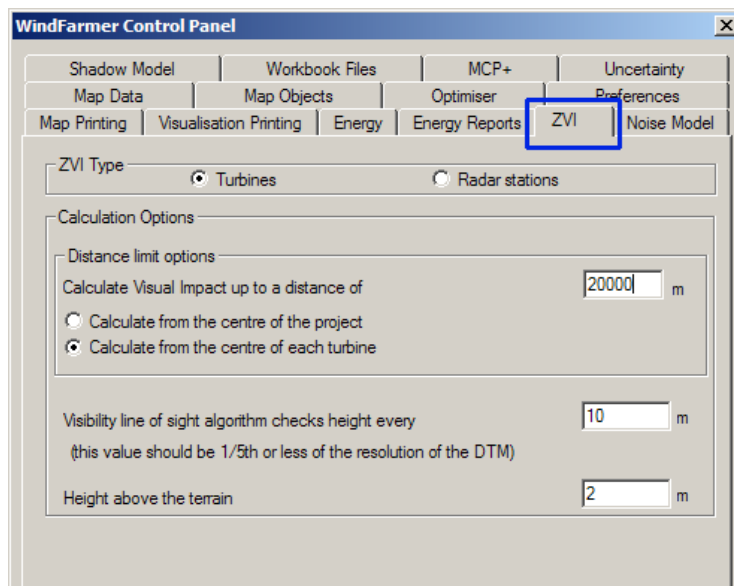
In this exercise, you will learn how to calculate a ZVI and customise the display. The exercise can be carried out using the Demo version of the software and files from the demo data supplied.

5.1 ZVI settings

Step 1. Open the pre-built workbook file “Demosite.wow” from the demo data section of WindFarmer.

Step 2. Click Control Panel icon  or select View > WF Control Panel.

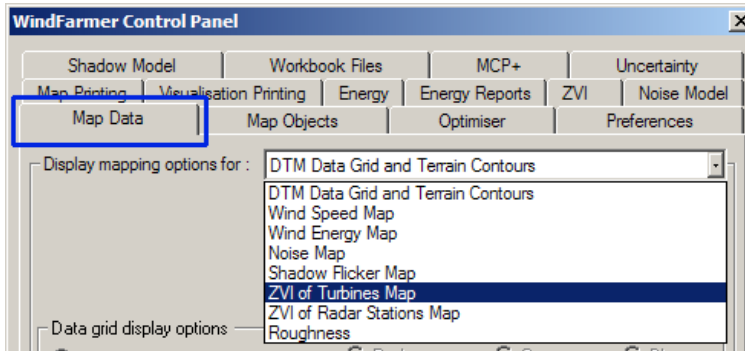
Step 3. Choose the ZVI page in the Control Panel. The window appears as shown below.



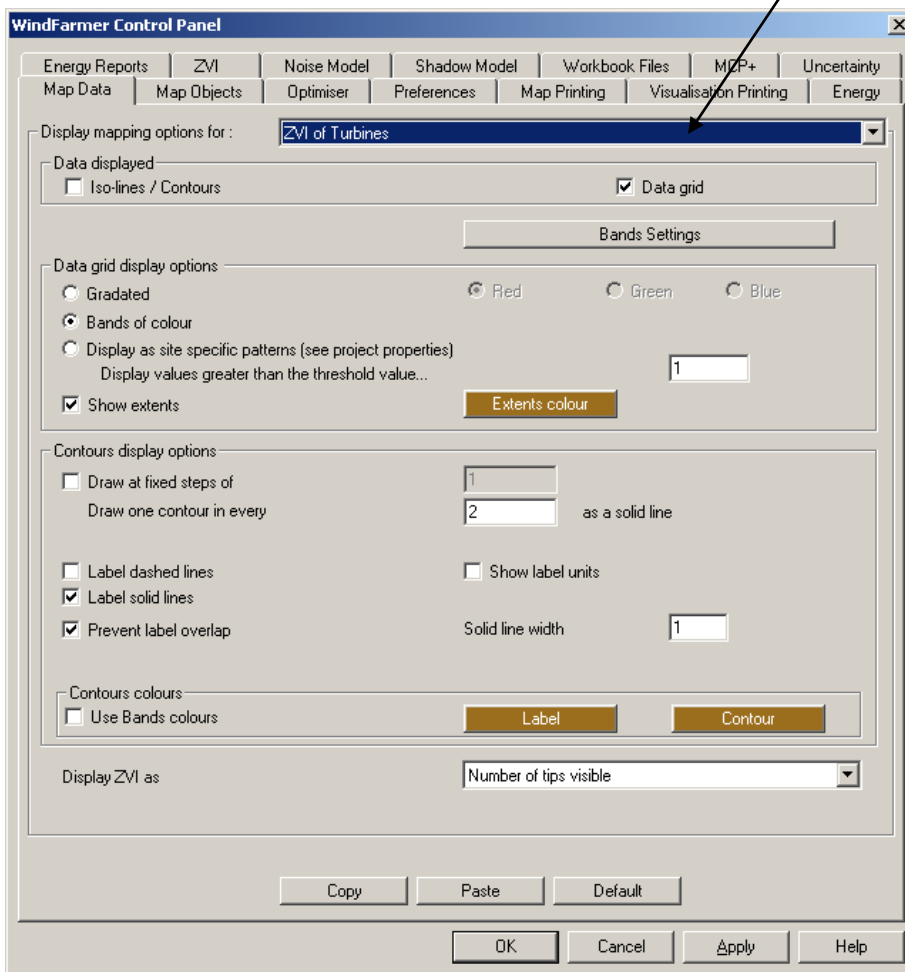
Note that here:

- in “ZVI type”, “Turbines” is selected. Analysis of radar stations is described later;
- in “Distance limit options” the user can set the maximum distance of the calculation;
- the “Height above the terrain” is 2 m, the assumed height of the observer’s eye;
- to register any changes in the ZVI model page, press APPLY then OK.

Step 4. Switch to “Map Data” within the Control Panel to choose how the ZVI will be displayed.

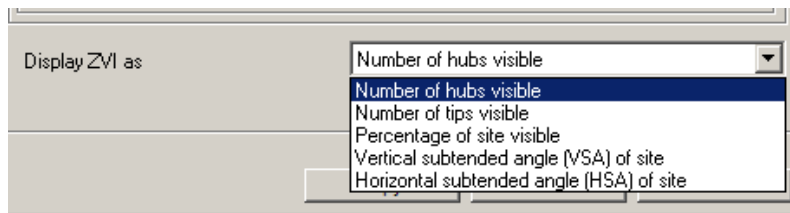


Step 5. Click the dropdown box shown above and switch to “ZVI of Turbines map”. The page below will appear.



Step 6. The map can be produced as “Iso lines” or “Data grid”. Options can be implemented in both cases. For this exercise, “Data Grid” must be active.

Step 7. At the bottom of the ZVI Map Data page, reveal the display options for the ZVI, as shown below.



Step 8. For this exercise select “Number of tips visible”, which means any part of the turbine, including just a blade tip, being visible by the observer. This is therefore the most sensitive criterion.

Step 9. In Map Data page, press APPLY to store the changes and OK to close the page.

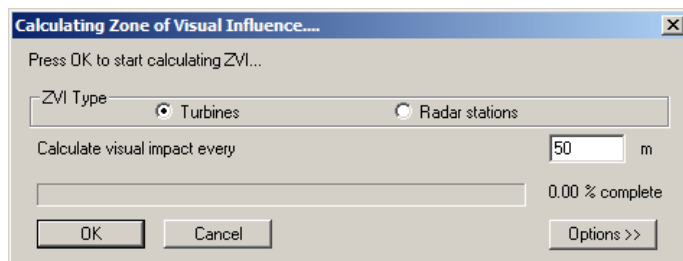
Step 10. Turn off the display of the DTM by un-ticking it in the Map Data section of the Display bar on the left hand side.

Note: Alternatively, the display settings can be altered after performing the ZVI calculation if required.

5.2 ZVI calculation

Step 11. Select “Calculate menu > ZVI” from the taskbar. Alternatively tick the ZVI box in the Map Data section of the Display Bar on the left. Windfarmer may ask you if you would like to assess the zones of visual impact – click ‘yes’. The box below will appear.

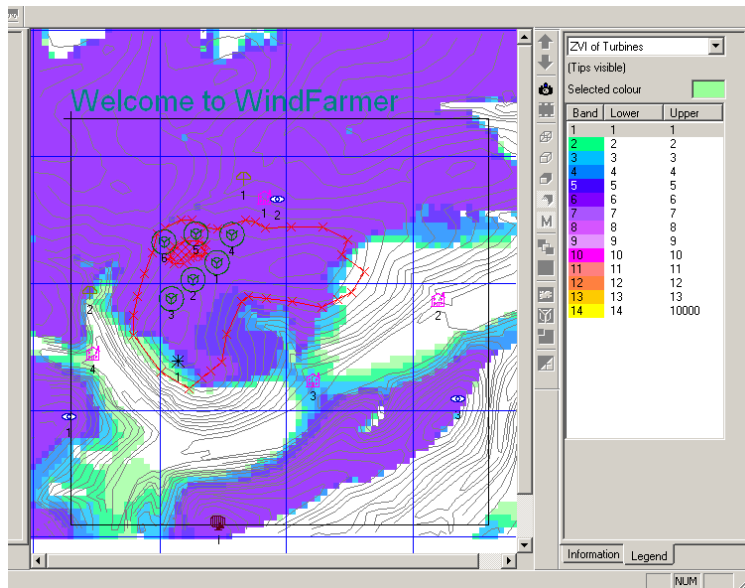
Note that clicking the button “Options >>”, gives access to the ZVI settings.




Step 12. Click OK to perform the ZVI calculation. The status bar shows the progress.

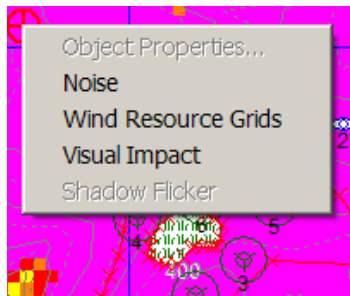
Step 13. When the calculation is complete, press OK. Even if the workbook is not saved, the calculation will be temporarily stored and the display can be adjusted. The ZVI display using the demo site and seven colour bands looks as shown below.

Step 14. Select the Legend tab on the right side to see the colour band ranges.



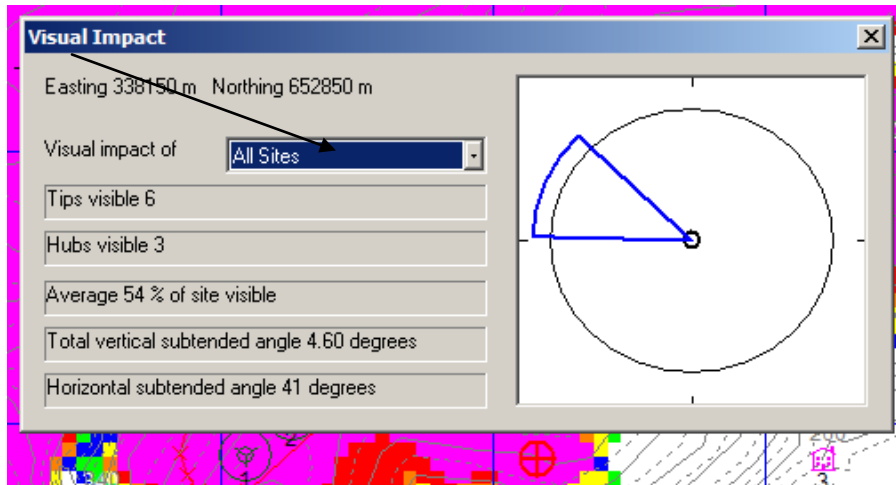
Step 15. Untick the ZVI box in the Display Bar on the left. The ZVI display will be hidden. Retick the ZVI box.

Step 16. When in Working Mode (select  from the toolbar), right click at a general point on the map to see a menu of available data:



Step 17. Select "Visual Impact". The Visual Impact box appears showing the visibility data at that point according to all the visibility criteria. The point is marked in the Mapping view with a red cross.

Note that if there are multiple projects, the visual impact due to specific projects or all projects can be selected using the dropdown.



Step 18. Close the box by clicking on  in its top corner.

Step 19. Explore the different types of ZVI display using the controls in the Map Data page of the Control Panel and Bands Settings, as described earlier in the exercise.


End of the exercise

6. RADAR ANALYSIS

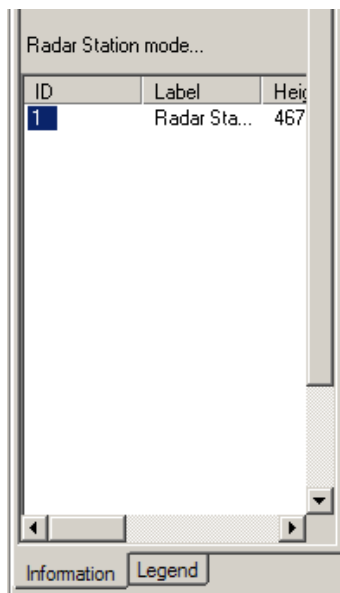
In general, radar stations may interrogate the whole sky or, in the case of weather radar systems, sweep the sky with a beam which is approximately horizontal and typically one degree deep. In WindFarmer, intervisibility with radar stations can be displayed as a type of ZVI according to height of turbine and it can be used as a constraint in layout optimisation. Using viewpoints incorporated into the radar station positions, visualisations can be created which include a superimposed sweep of the radar.

The procedure that follows can be carried out using the demo version of the software and the relevant demo data supplied.

6.1 Radar station settings

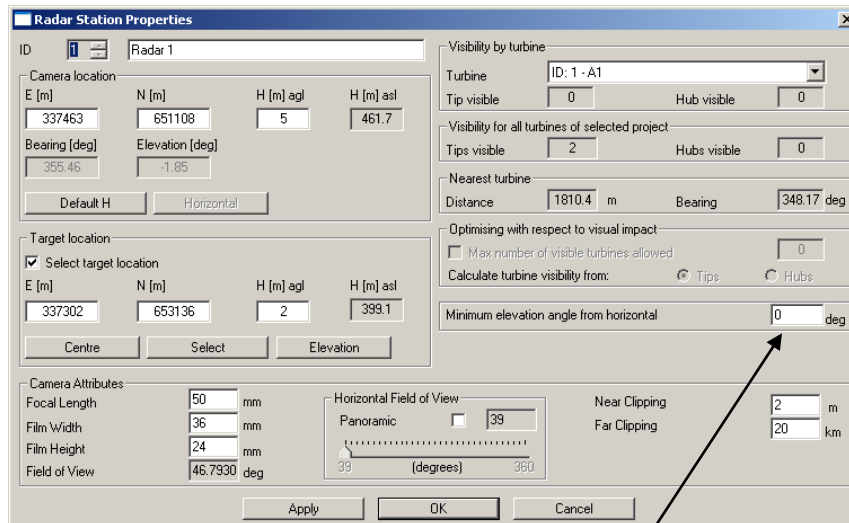
- Step 1.** Continue from the previous exercise about ZVI maps of turbine visibility; or open the pre-built workbook called Demosite.wow.
- Step 2.** Click on Radar Station icon  or select Modes menu > Radar Stations.
- Step 3.** Select the 'Information' tab in the Control Bar in the right bottom corner of the screen.

The Demosite workbook already contains one Radar Station in the centre-south of the site. For reference further radar stations can be added by right clicking in the map in Radar Station mode.



- Step 4.** Double click on the radar station ID to open the Radar Station Properties box for this radar. Alternatively, when in Working Mode, right click on the radar station in the Mapping window and choose "Radar Station properties".

A radar station has the properties of a viewpoint and additionally includes a "Minimum elevation angle from horizontal" to take weather station properties into account. -90 degrees is the default and is suitable for a whole-sky radar.

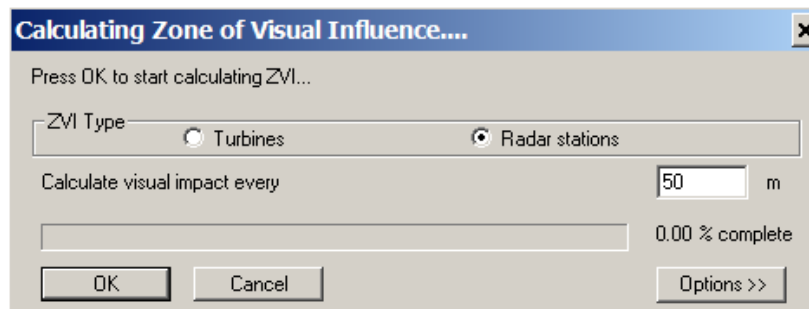


Step 5. Leave the Minimum Elevation Angle at 0 degree, which is typical for most weather radar stations. Press “Apply” to store any changes and OK to close the window.

6.2 Radar ZVI calculation

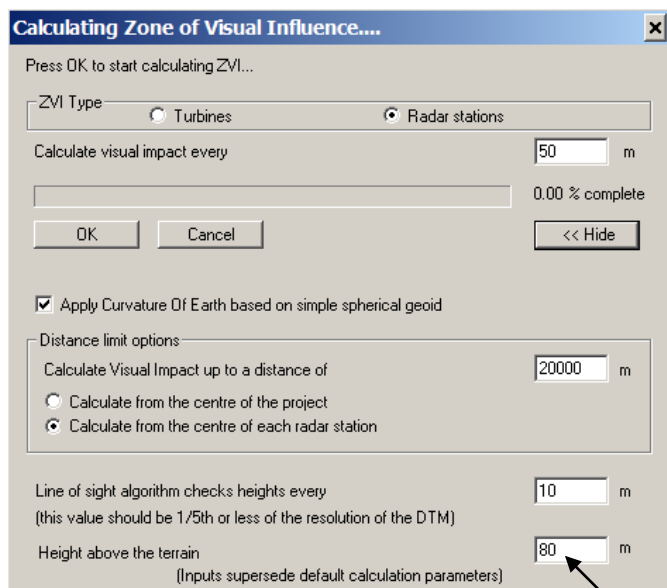
First, we can map the areas where there will be intervisibility between the radar station(s) and objects of a given height. The appropriate height is the tip height of the turbines. If there is intervisibility, then there is the potential for the turbines to interfere with the radar signals.

Step 6. Select “Calculate menu > ZVI”. The box below will appear.



Step 7. Switch to the option “Radar Station” as indicated above.

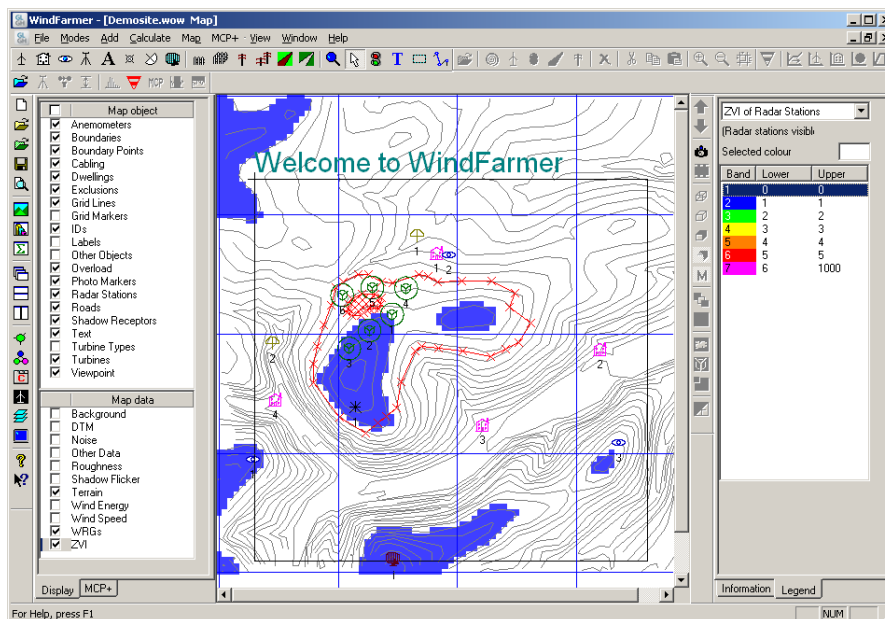
Step 8. Expand the dialog box by clicking the button Options>>. This shows the ZVI settings, which can also be accessed from the Control Panel.



Step 9. Change the “height above the terrain” to 70m, which is the tip height of the generic turbines.

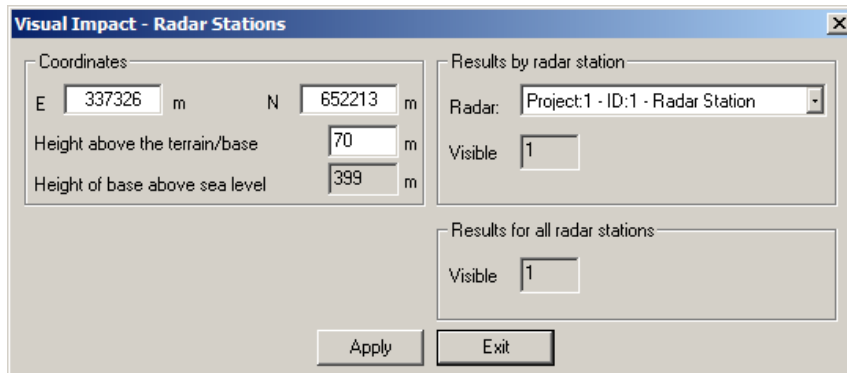
Step 10. Click OK to run the calculation with these settings.

Step 11. When the calculation is completed, press OK again. Even if the workbook is not saved, the calculation will be temporarily stored and the display can be adjusted.




Step 12. Select the Legend tab in the right bottom corner of the screen. The area in blue shows where turbines with maximum tip height of 70 m would be intervisible with the one radar station.



Step 13. Right click on any point of the map and select “visual impact”. The dialog box shows if this point (located, in this specific exercise, at a height above the terrain of 70 m) is visible by any radar station.

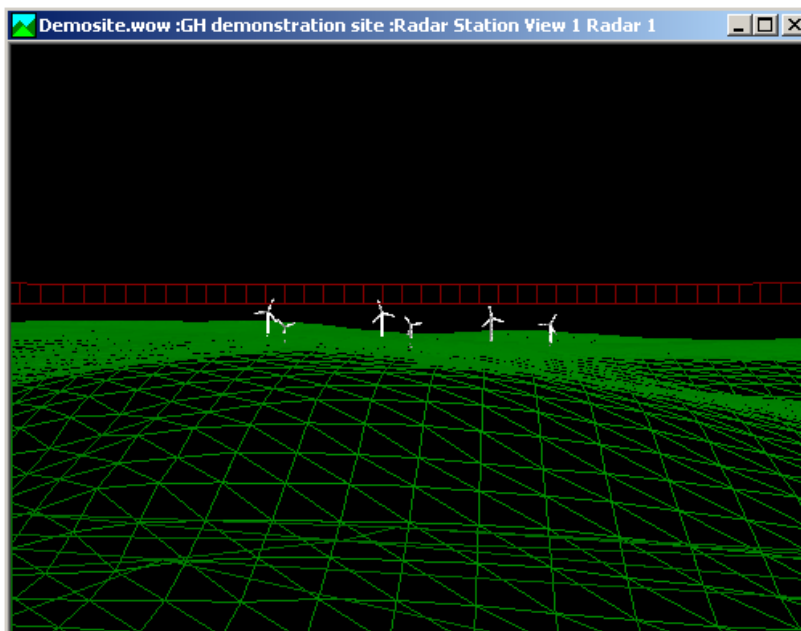



Step 14. Change the “Height above the terrain/base” in this box to 60m and press APPLY. The results on the right side may change to 0 if the 60m tip height is below the radar sweep. Change this height back to 70m and press APPY then Exit.

6.3 Radar visualisation

Step 15. Click Visualiation window icon  to open a Visualisation window.

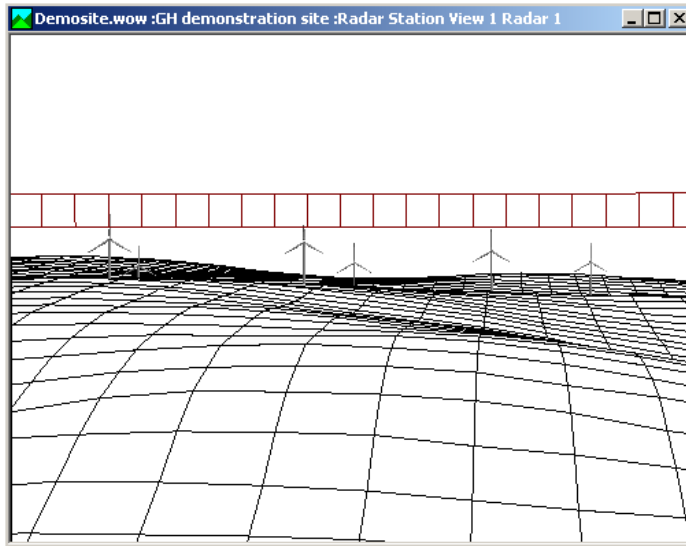
Step 16. Click  or  on the Visualisation toolbar to shift to the “Radar Station View 1” (since the window is also shared with general viewpoints). The sweep of the radar beam is indicated as a horizontal red “ladder”. The ladder represents the 1° vertical height and the 1° horizontal bins of a typical weather radar sweep.



Step 17. In Visualisation toolbar, change to solid wireframe view by selecting Wireframe icon .

Step 18. Right click on the visualisation window to open again the “Radar Station Properties” window.



- Step 19.** In the Camera Attributes area in the bottom left corner, increase the focal length to 100mm to zoom into the view. Press APPLY and OK to save the settings. You can click 'No' if WindFarmer asks if you would like to reassess the Radar Zones of Visual Impact.
- Step 20.** Select Settings menu > Turbines and untick "Random Turbines" so the turbine blades are vertical. This shows most clearly which turbines intersect the sweep of the radar to allow discussion between the developer and radar authorities.



- Step 21.** Explore the effect of changing the radar minimum elevation angle in Radar Station Properties window. To implement every change, press "Apply" and OK.

6.4 Using radar visibility as a constraint

To minimise intervisibility between turbines and radar stations, the Radar ZVI map shown above can be used as guidance. Alternatively, radar intervisibility can be included as a constraint during optimisation.

- Step 22.** Switch back to the Mapping window by selecting "Window menu > Demosite.wow Map near the bottom of the list.
- Step 23.** Open the Control Panel  (or select View menu > WF Control Panel)
- Step 24.** Choose the "Optimiser" page and in the Constraints area, select the option to Enable Optimising with respect to Radar Stations.
- Step 25.** Check that the correct Radar location, height above ground and minimum elevation angle are set in the Radar Station Properties box.
- Step 26.** Attempt to run an Energy Test  (or select Modes menu > Test). If there is intervisibility between radar and any turbine, this will be flagged. Similarly if the optimiser is run, the turbines will become located to avoid intervisibility.

End of the exercise