5. WindPRO Visual

5.0 VISUAL – Introduction and step-by-step guide

5.0.1 Introduction to visualizations

The WindPRO turbine visualization modules are tools for the documentation of the visual impact from turbines sitting in the landscape when negotiating with planning authorities about the turbine sizes, the number of turbines and the layout of wind farms.

There will always be different opinions on the visual impact of a turbine project in the landscape, but visualizations can often settle the difference of opinion, and it will thus be possible to ensure the widest possible support for the best project alternatives before the project is implemented.

In WindPRO we have attempted to simplify the visualization process. This is why information on most of the turbines on the market has been entered in the turbine catalogue (as described in chapter 2, BASIS). This way, one only has to place the turbines on a map and select the turbine type. The program will then render the turbines taking into consideration such factors as lighting conditions, position of the sun, wind direction, etc. The turbines are placed in a landscape photo or in a digital landscape model.

Beside turbines, WindPRO can visualize almost everything via the 3D object, which can be linked to a .DXF file or a bitmap file - with certain limitations. Also the line- and area object, WAsP obstacle and METEO-object can be used in visualizations, which makes it powerful also for the control of the data used in energy calculations.

Visualizations can roughly be divided into the following types:

A photomontage in which turbines are placed in a landscape photo.
A landscape analysis where turbines are placed in an artificial landscape calculated via digital height contour lines in order to evaluate a project from any position contrary to the above module where the positions are "locked" by the specific points from which photos are available
A "fixed position" animation (2D animation), which makes the turbines rotate on a photomontage, which e.g. can be published on the Internet
A 3D-Animation, which is a landscape analysis where it is possible to move around in the landscape (via the creation of a digital landscape model), and thus evaluate the turbine project from various angles, and even create a "movie" where a prearranged route is followed in the landscape. The 3D-Animation can also be e-mailed or burned on a CD to be played from a remote computer.

5.0.2 Step by step guide performing photomontage

- ❑ Establish map and proposed turbine project (se basis 2.0.5)
- ❑ If available, load height contour lines into line object or elevation grid object. Use the "Automatic Z value from DHM" for all turbines and cameras (can be applied from the MultiEdit function)
- ❑ Establish a camera object. Pick red camera object from right menu bar, place cursor where the photo is taken, click once, and click again near the turbine site. Load photo (or switch on "Artificial landscape"), set date, time and focal length if available. (if EXIF data in Photo, these are auto loaded)
- ❑ Click OK to launch the photomontage window. Insert control points on the map as reference objects which are visible on the photo.
- ❑ Calibrate camera model – best by using reference marks – Adjust Pan, Tilt, Rotation and focal length in menu left bar of photo as needed. Remember to adjust z-values to reasonable ones (especially if you don't use height contours) in order to get your sketch turbines inside your photo.
- ❑ If digital height contours lines are available, the horizon line (yellow) is very handy to check the camera model. The yellow line must follow the landscape on photo (if elevation data are available far enough out in the landscape).
- ❑ Click the render button in the menu bar on the top of the photo. NOTE: Default all turbines in visible layers are rendered, so use the layer structure (see Chapter 2.11 Basis) to select which turbines to render.
- ❑ Rub out turbine parts that should be behind trees etc.

❑ Export the photomontage as an image or from calculation menu, run Photomontage to generate report and printout.

5.0.3 Step by step guide performing 2D-animation

❑ Continue from 5.0.2 If rotor parts will be behind trees etc. during rotation, rub these parts (no turbine part visible, but rub anyhow – render eventually turbine on top of the part to be rubbed in order to make sure, that the right pixels will be removed.
❑ Click at the red button in the photomontage ("Create animation") in the top toolbar.
❑ Apply information on the animation.
❑ Save the animated "movie" in WindPRO format or other and start animation.
❑ When finished, the EMDplayer automatically starts showing the animation.
❑ You can now send the animation file together with the EMDplayer.exe to any PC to be run. Or you can integrate the animation on a web site by using the flash format.

5.0.4 Step by step guide performing 3Danimation

❑ Establish map and proposed turbine project (se basis 2.0.5)
❑ If e.g. aerial photo shall be used as surface, it will be a large advantage to attach it as a map (georeference it with 3 coordinate points or insert as a geo file)
❑ Load height contour lines into line object. Make sure that height contour lines cover the whole region that shall be rendered – extend eventually with an additional line around the project region (often relevant for off shore projects).
❑ Establish a VR object. Pick VR object from right toolbar; place the object in the middle of the region to be rendered. Set size (start eventually with a smaller region max. 1000 x 1000 m to test that everything is working as expected) – reduce eventually the number of triangles from height contour lines by choosing "grid", if there are many points in height contour lines. Select the texture of the ground.
❑ Click at the video camera symbol at the left menu bar. Click the green arrow that appear in the new window to start rendering the landscape.
❑ Move around with the mouse or the arrow keypads(Move up/down with Page Up / Page Down, look up/down (tilt) with mouse click at top/bottom of render window (alternative u/d keypads can be used). A joystick can also be used.
❑ A 3D standalone animation is automatically created in an independent folder for each VR object and can be e-mailed or burned on a CD so that it can be played by any external viewer via the viewer shareware program.
❑ In the render window you find different toolbars and controls that can change the different settings on-line. e.g. the "track" toolbar makes it possible to record a track and replay it. The "run time data" option deals with the 3D alone settings.
❑ Finally you can put in all details describing the landscape as precise as you wish by putting in objects and link those to bitmaps, bitmap objects or 3DA-collections. All 3 types are maintained and access via the 3DA-editor. Turbines, METEO objects, Text objects and 3D objects can be inserted "on-line", while obstacles, line and area objects need a "rebuild" before changes are shown in the 3Danimation window.

5.1. VISUAL - Photomontage

5.1.0 Introduction to photomontage

A photomontage means to take a photo and then superimpose the proposed changes (the new turbines) on top of this photo. The method has been used for many years to document the visual impact of a planned project of many different kinds, e.g. bridges, power plants, new roads etc.

Another use of the photomontage is to measure or check different elements in the landscape, e.g. local obstacles or positions of measure masts. With good photos and digital height contour lines, it is possible to measure positions with accuracy of around 1 meter, which is far more accurate than GPS loggings with standard GPS equipment. As an extra advantage, the positions relative to the height contour lines and the precision of the height contour lines can be checked, which for measure masts are extremely important.

5.1.1 Calculation methods in VISUAL Photomontage

The technique behind a photomontage is to establish a camera model that can transform any point with known elevation and coordinates from a map to a 2-dimensional photo. Once the camera model is established, the camera model can position a 3-dimensional model of a turbine into the image with the correct proportions. The surface of the turbine is controlled by various parameters. Some of these parameters are linked to the turbine (colour, reflection, etc.), and others are linked to the weather conditions at the time when the photo was taken (sun position, brightness, haziness, etc.). We have tried hard to simplify the set-up of these parameters: The sun position is calculated by the program based on time of day, date, time zone, latitude/longitude and camera pointing direction. The weather is described through simple choices such as: "clear sky", "light overcast", "heavily overcast", etc.

5.1.2 Photographing

When you take a photo you only catch a "part" of the landscape with the camera - thus, make sure to take photos of the adjacent landscape on both sides.

The camera reduces the image quality, so be sure to use a camera with a good quality lens, preferably a single lens reflex camera that generally brings less distortion through the lens. A large format camera gives you a better quality, but it is not crucial for making good visualizations.

The focal length of the camera lens should be between 35 and 70mm. The standard focal length, which preserves the proportions of the photo as close to what the eye sees as possible, is defined as the diagonal on the 36x24mm format which corresponds to approx. 43mm. If possible, use a lens with a fixed focal lens, i.e. not a zoom lens, to make the calibration of the camera model easier. Most of modern digital cameras provide with the information about the focal length. Please refer to the corresponding section thereafter.

To keep the camera in a horizontal position (for a good presentation purpose), you can use a tripod and a level.

The photo should to be taken in "landscape" format, although the software also work with "portrait" format, which sometimes can be useful, e.g. when checking the measurement heights of a met mast.

If you plan to make a photomontage on a stitched photo (panorama), it is important to ensure a prefect stitching of the individual photos. Make sure that all images should be taken from exactly the same viewpoint (centre of the sensor) using at least a tripod. More in particular: the camera should be rotated around the 'no parallax point' (sometimes referred to as the 'nodal point') of the lens. For most lenses this point is located near the front element; since it does not coincide with the tripod screw of the camera, you will need to use a so called panorama head on top of your tripod if very high accuracy is important. If the camera is not rotated exactly around this point, parallax errors will occur, preventing a perfect stitch. Check for the horizontality of each photo. Make sure that the images have an overlap of about 1/3 of the width of the photo.

While taking the photo it is recommended to ensure that the elements in the landscape that will be used to calibrate the photomontage are available on the photo. It is recommended to have a good calibration point both on the left and right in the photo and at least 500 m from the camera.

When and where to take the photo:
-Good weather with the sun in the back makes for high photo quality.
-The best distance is within 500 to 5000 m from the planned WTGs.
-Find points the local people are familiar with (roads, viewpoints etc.).

Last but not least, be sure of the exact position at which the photo has been taken. You can use an external GPS or a camera with GPS.

5.1.3 Example of making a Photomontage

In the following, a typical procedure for the photomontage work will be outlined from the point where the photo is stored on the hard disk. Some examples can also be found on the DEMO projects, included in the WindPRO installation. (In folder WindPRO Data\Samples\)

The first step is to establish the necessary project information including links to bitmap maps. Although the visualization can be made without the use of a digital map these should be used whenever possible, as you will benefit from the significant time saving facilities and other advantages, which are linked to the use of maps.

Details concerning input of project information and linking of maps are described in chapter 2, BASIS.

5.1.3.1 Time zone

The program converts the local time into Global Standard Time, e.g. GMT, using the time zone and the local time, which is linked to the photo in question and defined in the project properties. The global standard time, the date and geographical position (latitude/longitude which the program calculates from the map used) are used to calculate the sun position for correct light settings.

5.1.3.2 Entering maps, turbines, areas and 3D objects

Click on the map icon to load the background bitmap map. You can then enter turbines and other objects directly on-screen. See chapter 2.5 BASIS.
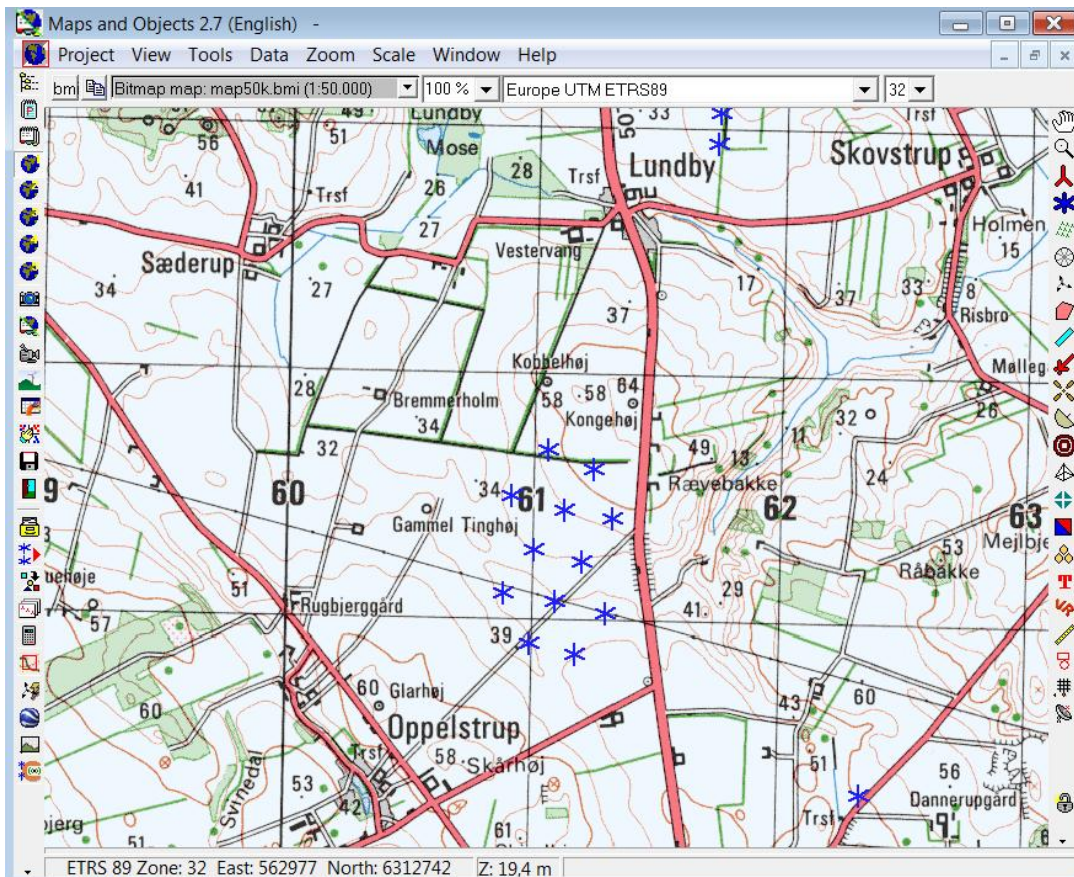
You will find a detailed description of how to enter turbines in Chapter 2.5. Lattice towers must be added to the turbine Catalogue as .DXF files before you can incorporate them in the photomontage (see part 6 in Chapter 2. BASIS).


You enter 3D Objects via the same procedure as you enter turbines.

5.1.3.3 Camera Object

The Camera Object plays a central role in the Photomontage. This object holds most of the information needed for the visualization work. The object is created by clicking on the Camera Object on the tool bar and inserting it on the map by clicking on the map at the position from where the photo in question was taken (the Camera Point). Drag the camera line to the target point of the photo and click again to position the object. The properties of the camera object will pop up automatically. You can edit the position of the object at any time by dragging the camera point and/or the target point or manually from the project properties. The contents of the object will be described below.

Camera object – tab sheet Camera
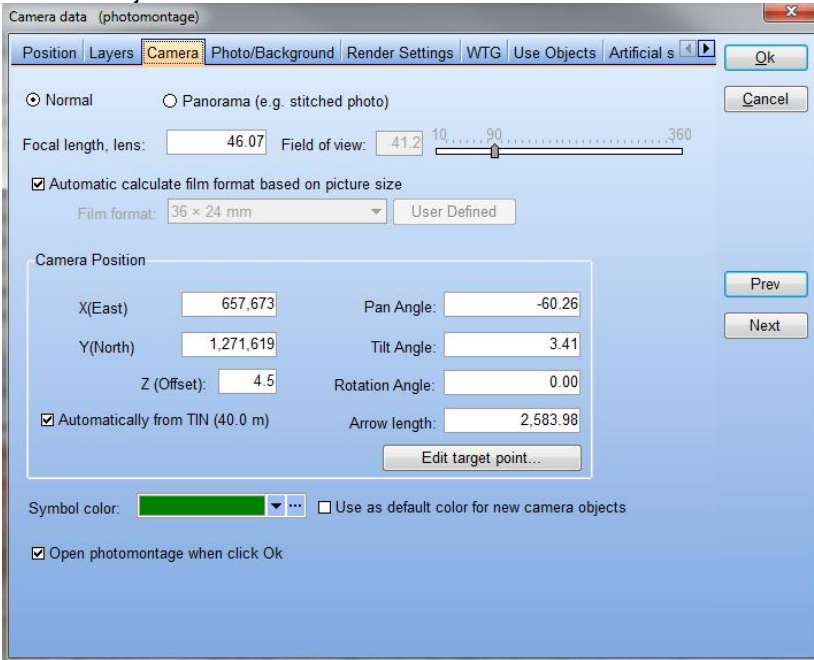
Normal

Normal is to be selected for a photomontage based on a single photo. The film format associated to the focal length will then decide the size of the turbines. WindPRO can automatically calculate the film format width and height corresponding to a 36 x 24 mm film format as the default option "Automatic calculates film format based on picture size" is checked. The focal length of the lens will normally be indicated on the lens or it can be found in the technical manual for the camera (or lens). Very small deviation on the focal length can be necessary to compensate the light distortion that can be due to the transfer or the variation of the temperature. If you use a variable zoom lens it might be necessary to establish the focal length used by the aid of control points (see a later description of this).

General information about focal lengths (36x24mm film format):

- Normal lens, focal length 40-50mm
- Tele lens, focal length>50mm
- Wide angle lens, focal length<40mm

The above formats change for other film formats. If, for example, the film format is 6 x 6 (60x60mm), the normal lens will have a focal length of 80mm
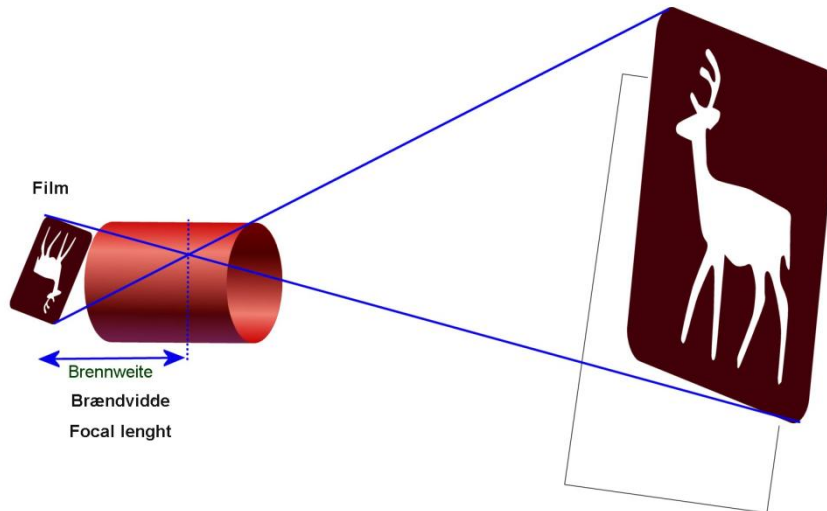
Figure 1 The illustration above shows how the motive will be mirrored through the lens. The focal length is the distance in mm between the negative and the crossover point. This shows that another negative format, will give another focal length for catching the same motive.

The focal length given by a digital camera has to be corrected to the equivalent focal of the traditional 36x24mm film format. The correction factor (typically from 1 to 2.5) can be found in the technical specification of the digital camera. The focal length and sometimes also the corrected focal length can be read automatically by WindPRO from the EXIF properties of the picture file (see Photo/Background tab).

For digital cameras WindPRO can calculate the film format width and height corresponding to a 36 x 24 mm film format. For this, check the "Automatic calculate film format based on picture size" option. You can also add your own definitions in the following form, which appear by unchecking "Automatic calculate film format based on picture size" and by selecting "User defined" in film format:

By typing the pixel width and height of the digital photo, the software calculates the film format width and height corresponding to a 36 x 24 mm film format. The important thing is that the diagonal is the same, as the diagonal in 24 x 36 mm film format – then the focal length corresponding to this film format shall be used. This is normally found in the technical description of the camera. Note: If the camera has a zoom lens, only the outer positions will be known, e.g. 35 mm – 70 mm. If by photographing none of the outer positions has been used, the only way to find the focal length normally is to calibrate the picture with control points. Anyhow, use of control points will be recommended in all cases, while even the focal length of a zoom camera in outer position can change e.g. by temperature.

Scanned images (including professionally scanned photo images on a photo CD) often get the edge of the actual image cut away during the scanning process to avoid possible black edges on the image, e.g. due to misalignment of the photo in the scanner. To compensate for this "cutting", you either have to change the film format or the focal length. It is usually more convenient to change the focal length, which should normally be

increased by 2-5% for photos on a photo CD. Use the control points (which will be discussed later) to establish the precise focal length.
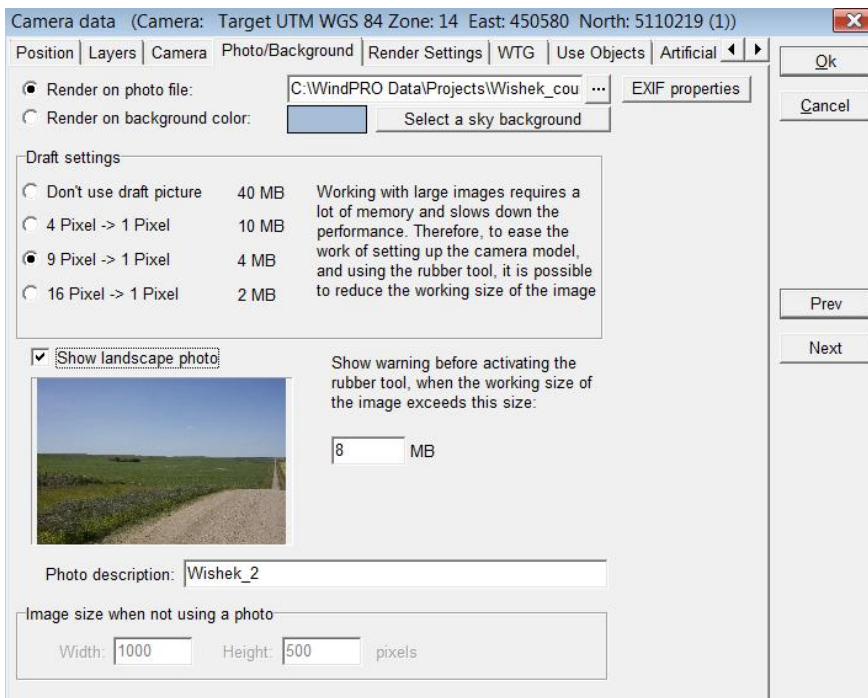
Panorama
Panorama is to be selected for a photomontage based on stitched pictures. The field of view (FOV) is the main parameters. The dimensions of the photo (number of pixels) associated to the field of view will then decide the size of the turbines. The field of view is the angle formed by the two rays encompassing the horizontal view that can be seen on the photo. The FOV is defined in degrees.

Camera position
The 3-dimensional coordinates for the camera point and the target point (the centre of the photo - can be any point on the line of photographing) ends the definition of the camera model. In most cases, you will have to know the exact Camera Position, which help much in the camera model calibration process. It is always a good idea to log the photo positions with a GPS.

The camera model defines how each point in the map is transferred to the image, and thereby also controls the proportions of the turbine you enter. A correct camera model is therefore a basic requirement for a correct photomontage.

Camera object – tab sheet Photo/Background

Select the file with the photo or panorama to be used by clicking on the three points next to "Render on photo file". If the photo file includes EXIF properties (such as the date and time, the focal, length, coordinates, etc), the EXIF Form window will pop up automatically so you can decide which properties to "Import to camera". From the form you can for example input the conversion factor to convert of the focal length to the equivalent 35mm focal length. The conversion factor can usually be found in the technical specifications of the digital camera. The conversion factor is saved for the type of Camera if the option "Save conversion data for this camera model" is selected. The conversion data are saved in this folder: C:\WindPRO Data\Standards\CameraDB.

Note that working with large photos slow down the performance. So especially in the rough trimming of the camera model using draft mode is recommended. Especially when working with the rubber tool memory consumption becomes very large. You can set a limit in MB photo size, where the software shall warn you before starting using the memory demanding tools. This limit should be set relative to the hardware you are working on. 5-10 MB seems reasonable for today's standard PC. Because the photo might be too large the screen it is recommended to start the calibration of the photo on a draft picture which will reduce the size on the screen and allow to see both sides of the photo (important for the calibration of horizontality). It is then possible to fine tune the calibration using the normal size of the photo.

A short description of the photo can be added, which will then be included on printouts later on.

If you do not have any photo from the site, the tool can be used with a background and render artificial landscape based on height contour lines (TIN model). In this case select "Render on background colour", select a colour and alternately a sky background and go the "Artificial surface" tab. In following it is assumed that a photo or panorama is available. You can increase the number of pixel (and thus the quality of the picture) by increasing the **Image size** (at the bottom).

Camera object – tab sheet Render settings

The render settings control different details on how the photomontage will look.

Date and time control the angle of the direct light together with the geographic position and time zone.
Weather type controls the light settings when the turbines are rendered into the image. You can also choose to generate only the wireframes of the turbines, e.g. if you wish to emphasize that the image is a photo montage where you want to focus on the proportions only, or if you want to clearly distinguish between existing and planned turbines.
Antialiasing enlarge the photo in order to smoothen the edges between the rendered turbines and the background photo. This can consume plenty of memory, but also improve the result much for a final presentation. So in the "experimental phase" this should be kept low and put on maximum at rendering the final result.

Camera object – tab sheet WTG
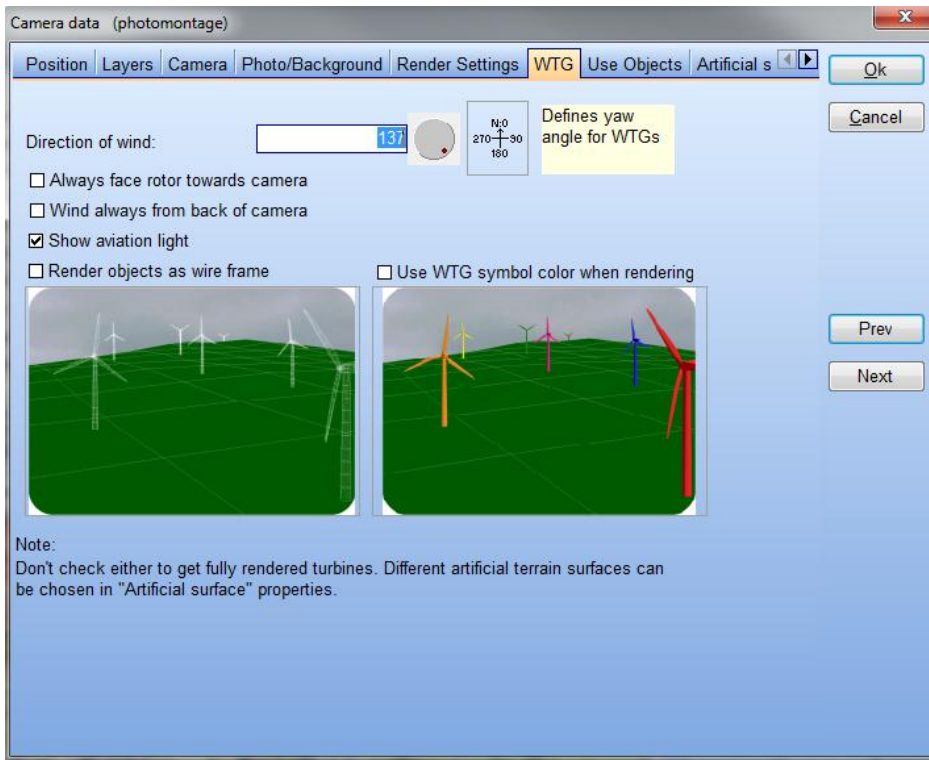
Direction of wind controls the yaw angle of the turbine nacelle. If the photo includes existing turbines or other objects, which indicate the wind direction, e.g. flags, then the actual wind direction should be entered. Otherwise, use the predominant wind direction to make the image as realistic as possible.

It is also possible to select "Always face rotor towards camera" so that all the turbines will be facing the observer. Although this does not happen in reality, the purpose of this option is to make a photomontage with a maximum visual impact.

With "Wind always from back of the camera" the direction of the wind is the same than the Camera is point at. This gives the realistic maximum visual impact.

The "Show aviation light" option enables to include aviation light(s) as long as they have been defined for each turbines (cf. section 5.1.3.17). This option can also be selected on the top bar of the photomontage window. WTG objects can for special purposes be rendered as wireframe models or as colour turbines. If e.g. more different wind farms clearly should be identified on a photo, the turbines can be given different symbol colours which will be transferred to the photomontage by checking this option.

"Render objects as wireframe": the wind turbine is simulated as a white wireframe.

"Use WTG symbol color when rendering": the virtual wind turbine is colored accordingly to the symbol color.

Camera object – tab sheet Use Objects
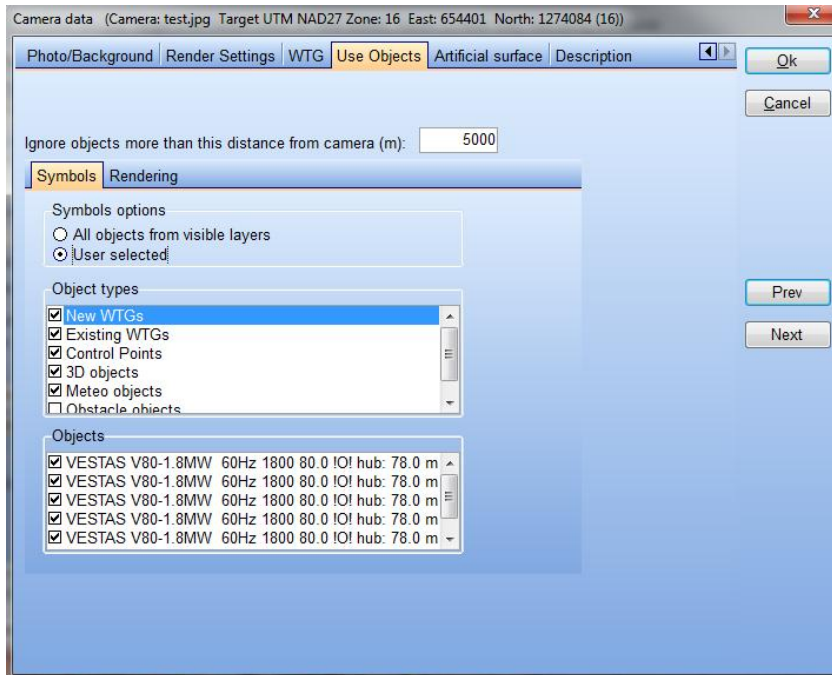
This tab decides which wind turbine, 3D object or area object will be simulated on the photomontage.

Beyond the default distance of 5000m, the objects will be ignored, saving some rendering time.

Some objects you might only use as control points, not for rendering (e.g. existing turbines), while other might be used for both (e.g. new turbines). With this menu it is possible to select freely. Default setting is "all from visible layers", so by using the layer structure it is very efficient to take in/out objects.

Following objects can be used in photomontage:

Existing and new turbines
Control points (only as control points)
3D Objects
Meteo objects
Obstacle objects
Area objects (only for rendering)

A wind turbine can be excluded from the symbol and/or render layer of a photomontage by selecting" User selected" and unchecking "Render WTG" and/or "Show as WTG symbol" in the Visual properties of the wind turbine (See Chapter 2).
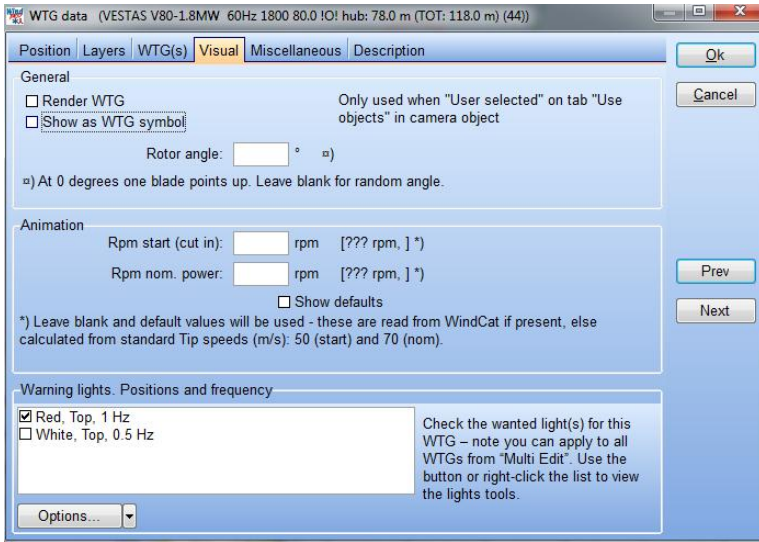
Camera object – tab sheet artificial surface
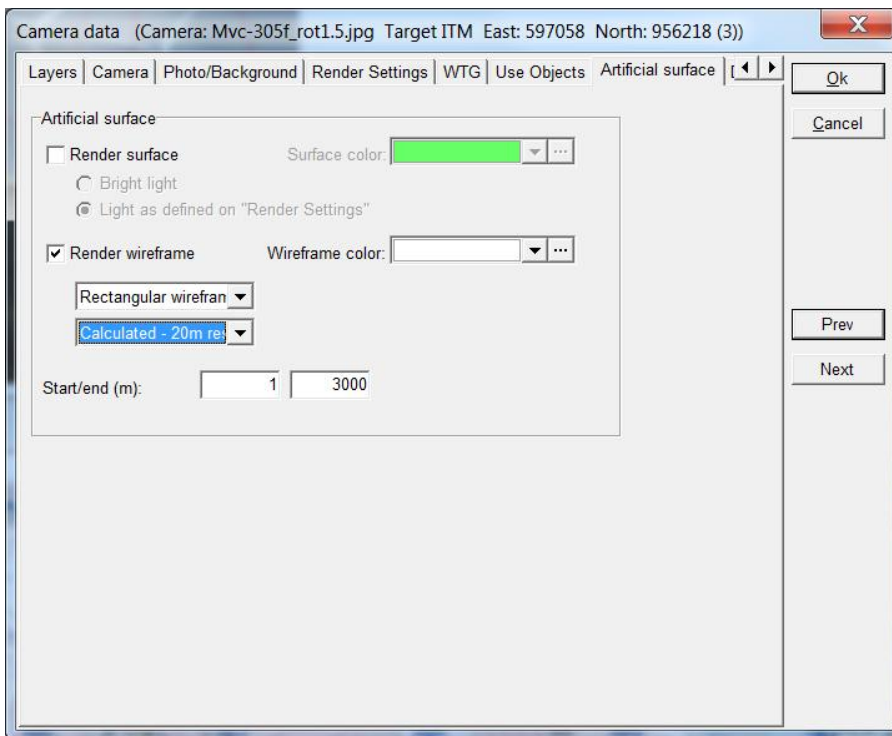
When rendering the artificial surface or wireframe, this is limited to the distance given in this form. The default value of 3000 m is often too short if there are some hills at a longer distance that should be included. But the processing time will increase much with distance; therefore the default value is kept rather low. Although using the elevation grid object with the "native" grid resolution", handles very large areas extreme fast. More on artificial landscape is explained later.

Camera object on the map

Notice that the Camera Angle is rendered on the map - approx. 45° for a focal length of 50mm and 60° for a focal length of 35mm. Click with the right mouse button on the Camera Object to extend the Camera Angle Lines by selecting "Extended angle line". This gives you access to controlling whether or not the lines on the map correspond to the edge of the photo.

5.1.3.4 Photomontage window

When the data has been entered into the Camera Object you click OK, and the photomontage window will pop up automatically. You can open an existing camera model/photomontage with a click on the Camera Icon at left menu bar or from the map by selecting the camera object, right click and Show photomontage. You can then arrange the photo and the map horizontally above each other. The next image shows how the camera model initially arranges the turbines.
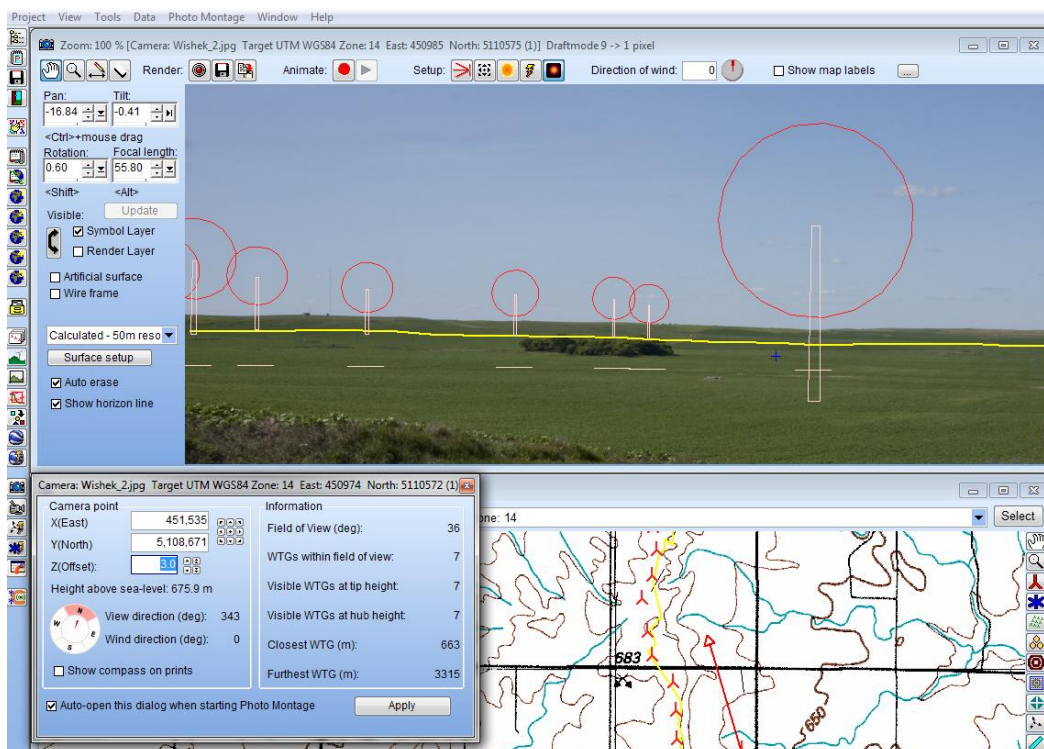
From the photomontage window top bar, the following tools can be used :

(hand)	Move around the photo
(magnifier)	Zoom in and out on the photo
(line)	Add text, lines, arrow on the photomontage
(v)	Delete invisible parts of rendered objects
Render:	Start rendering the objects (wind turbines, 3D objects...)
(disk)	Save the photomontage in a file (jpeg, tiff...)
(copy)	Copy the photomontage to the clipboard
Animate:	Starts Animation
(red arrow)	Properties of the Camera objects
(adjust)	More Adjustment tools
(sun)	Set up Manual light
(lightning)	Auto optimize the Camera model
(light)	Aviation light on/off
Direction of wind: 180	Set up of the wind direction (ie. orientation of the rotor)
☑ Show map labels	Add the label of the wtg with arrow on the photomontage

The left part of the photomontage window has the following relevant options:
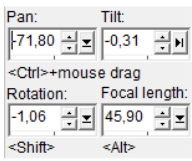
Settings used for the calibration of the Camera model
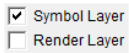
Symbol layer and render (=result) layer
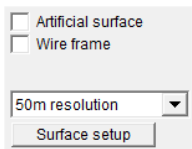
Selection of artificial surface/wireframe
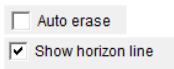
Auto erase and Show horizon line options

It is possible to identify a WTG from the map onto the photomontage: select the WTG on the map, press Control down and move at the same time the mouse over the symbol; a blue line will link the symbol on the map to the photo.
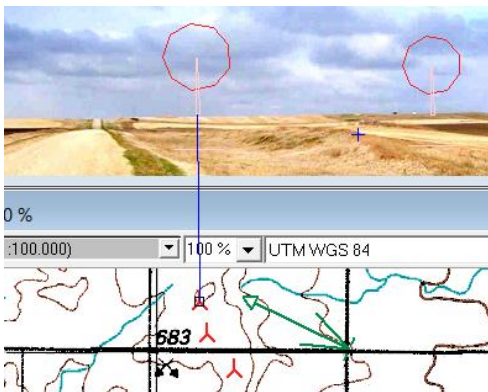
5.1.3.5 Calibrating the Camera Model

In order to have WindPRO to calculate the correct position and dimension of the WTGs, the camera model needs to be calibrated. The calibration consists in finding the exact properties of the camera which were been used to take the photo: the position, direction, Pan, Tilt, angle of the camera and lens used.

Having entered the relevant reference (horizon line, control points ...cf following sections) you have to adjust the camera settings until the references are on the right place on the photo. This can be done in different ways.

Firstly, the left area in the photomontage window offers a wide range of adjustment features.

An even easier way is to drag directly on the photo:
Holding <Ctrl> down, mouse drag on photo adjusts both Pan and Tilt angles. You can simply drag the symbols to the right spot on the photo.

Holding <Shift> down, rotate the camera, so a skew-recorded photo can be corrected. Note drag near the edge of the photo to set down the sensibility.

Holding <Alt> down, mouse drag on photo adjusts the focal length. Again
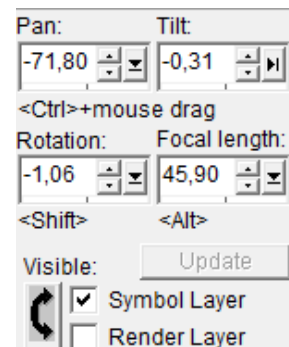
dragging near the edge decreases sensitivity.

The position of the camera object can be defined in the properties of the object but also from the below window which pops up below the photomontage. The photomontage calibration gets updated with the changes made from this window with the Apply button. If the window is closed, it can be opened again by clicking on this icon ⊡ in the top bar of the photomontage.
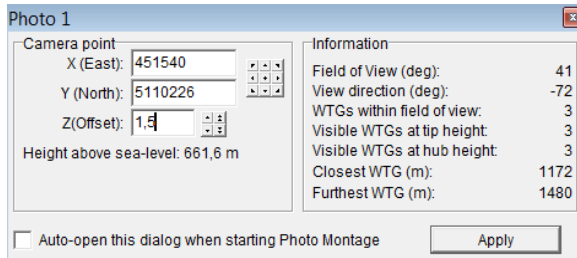
Some information is also shown: the field of View also known as the angle of view, the View Direction is the direction at which the camera is pointing at, the WTGs within the field of view, the number of visible WTGs at tip height and at hub height, the distance to the closets and furthest WTG.

5.1.3.6 Calibrating the Camera Model – Horizon line

By checking "Horizon line" at the bottom of the left pane, the horizon line is drawn in yellow on the photo and on the map provided that height contour data have been loaded. The horizon line consists of the blocking points of the line of sight calculated for each degree from the Camera position. The horizon line is a powerful tool to calibrate the Pan, tilt and rotation parameters of the photo. Be aware that the horizon seen on the photo must be covered by height data (TIN).
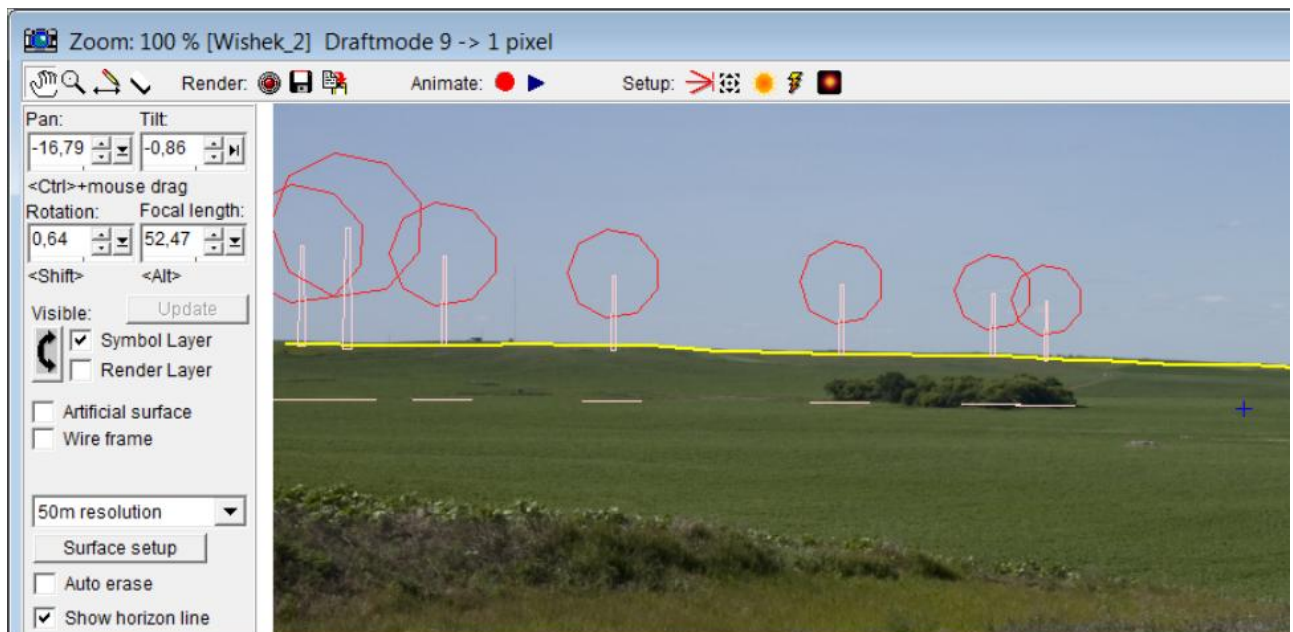
The horizon line is simultaneously drawn in yellow on the map, see below. This can be used for identifying where on the map the highest elevated point is found seen from the photo position.
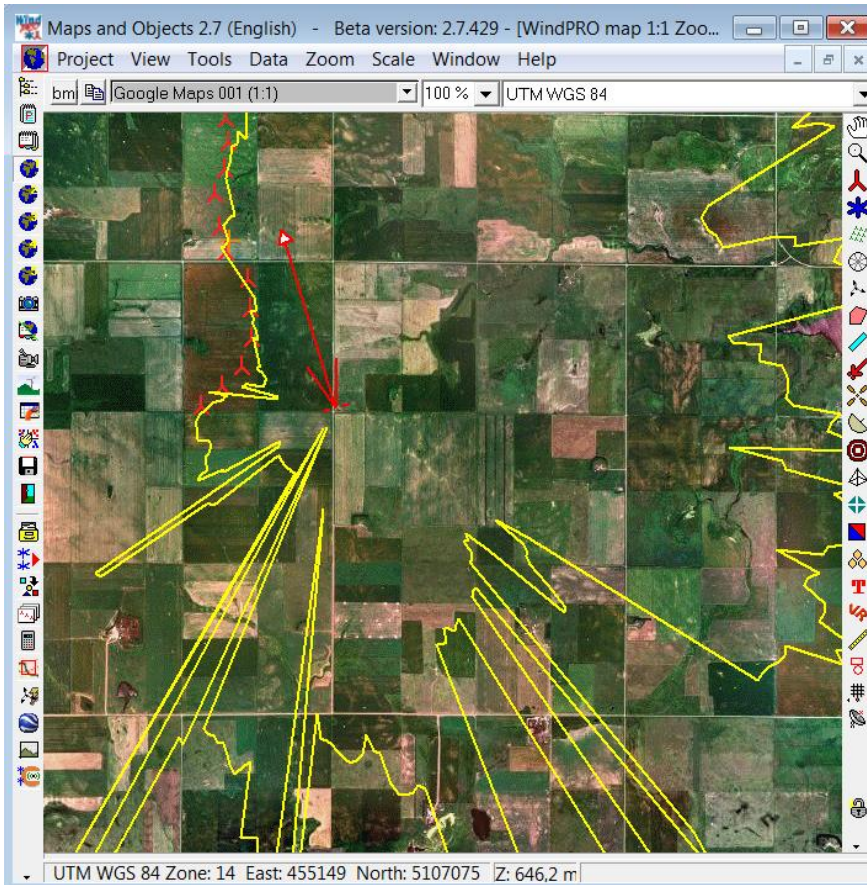
In addition to the horizon line, a 0 m line is shown as a part of the WTG symbol. This line can be used for offshore photomontage. If the turbine is behind horizon -> the line turns read and the part below the horizon will not be rendered. This is illustrated below.

Figure 2 The large rightmost has same colour at the horizon line as the symbol colour: This wind turbine is in front of horizon. The first of the group on the left, is just at the horizon, while the following symbolized with the red colour is behind the horizon. For all turbines the user shall just make sure that the lines follow the horizon, then the rendering takes care of the rest, see next photo with the rendered turbines.

Figure 3 Rendering offshore turbines with automatic adjustment for the horizon. Note: it is of course possible to define nice offshore foundations in the turbine catalogue (as extension of tower).

5.1.3.7 Calibrating the Camera Model - Control Points

Control Points can be used as reference point to calibrate the camera model. Control points are objects that can be identified precisely on both the map and on the image. The best Control Points are those furthest away from the camera (some kilometres away and preferably at least one in the left and one in the right part of the photo). If you do not have an exact location of the Camera Point, you will also be able to use Control Points, which are situated closer to the camera.

Control Points are used to control the accuracy of the Camera Model as well as to establish any missing/uncertain information in the Camera Model. Please notice that the more unknown/uncertain parameters you have in the Camera Model, the more Control Points you will have to enter in order to be able to establish a correct Camera Model. Exactly how many Control Points you need depends on the positions. Control Points close to the planned turbines gives accurate positioning of the turbines in the image. Control Points near the edge of the image, on the other hand, gives you good control over the focal length which in turn results in accurate image proportions. The Control Point Coordinates may be established by using GPS equipment or from a reliable background map (aerial photo)

Control Points are inserted via the Map Tool Bar and information about z-coordinates is added. The z-coordinate is not the height of the object, but the elevation of the object's base. Each Control Point can optionally be assigned a dimension.
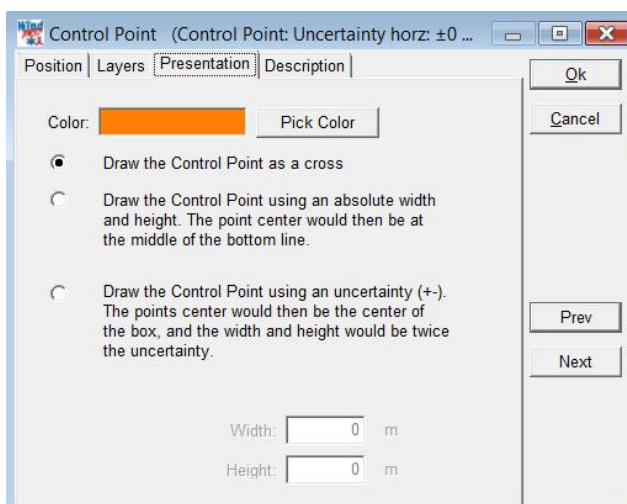
High objects like chimneys and high buildings can be shown using a wide and a height. In that case the point should be placed at the centre of the button line of the object.

You can measure the height of an obstacle, e.g. a fence, by using the commonly accepted "drei-eck" method, i.e. using a 45° triangle with two equal legs. When base and top are flush with the triangle, then the height of the obstacle equals the distance to the obstacle.

5.1.3.8 Calibrating the Camera Model – Obstacle object, meteo object & existing wtg

Please refer to the BASIS chapter about how to define these objects.

The obstacle object is a convenient reference for squared elements such as houses, straight roads when these can be defined from the real dimension as seen on an aerial photo background map. The symbol of the obstacle will appear as a light blue cube shaped objects.

A measurement mast can also be used as a reference point. The height of measurements defined in the meteo object is also reported on the orange symbol.

Existing turbines will have a symbol with a blue rotor. The dimension of the hub height and the rotor will be reported in the right proportions. But note the rotor shown only will match if the turbine on photo has the rotor fully perpendicular to the photo direction. Note also that the top of the tower shall be found at the bottom of the nacelle, it is not the hub height that is shown as tower height.

5.1.3.9 Calibrating the Camera Model – Wireframe

By checking "Wireframe", a wire grid is shown on top of the photo in order to help you editing the camera parameters. See example below.

The wireframe generation can be quite time consuming. With the new elevation grid object, it is possible to use the "native" grid spacing from this and thereby speed up the processing time to almost none.
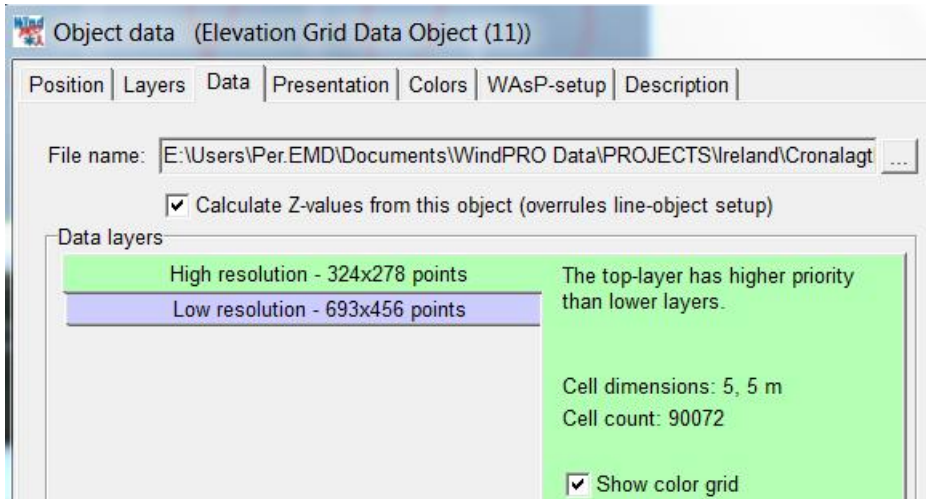
To use the elevation grid object, this shall be chosen for calculation of Z-values, see above. You should also name the different layers (if more) in a way so you can identify these in the photomontage selection tool.
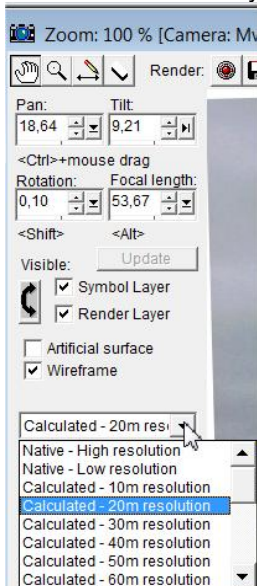
Here it is seen how the two "native" elevation grid object resolutions appear in the list. Chosing one of those makes the wire grid rendering very much faster.

An example tested rendering in a distance of 20 km from camera (very large area) took almost 15 minutes by "traditional method", but less than 5 seconds with native elevation grid data.

5.1.3.10 Calibrating the Camera Model – Auto Optimisation

Finally there is a possibility to let the computer calculate the camera model.

Before using this, objects (turbines, control points and Meteo objects) have to be linked to the photo.
From the map, right click on the object you want to link (where you know the exact position on photo), select "Point out position on picture", and click on the picture the corresponding position of the object. Below you can see how the silo on the right is linked to a control point and the turbines on the left are linked with either top or bottom point or both.
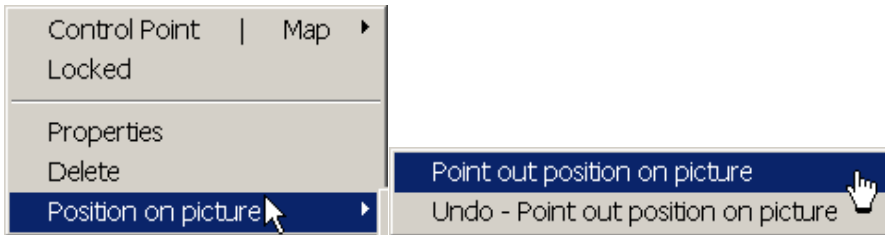
The more linked objects you got, the better possibilities the software have to find the best fitting camera model – and the more settings of the camera model you already know, the better the unknown can be estimated. The parameters that can be auto optimised are: (Menu appears when "Auto Optimise Camera model" is chosen):
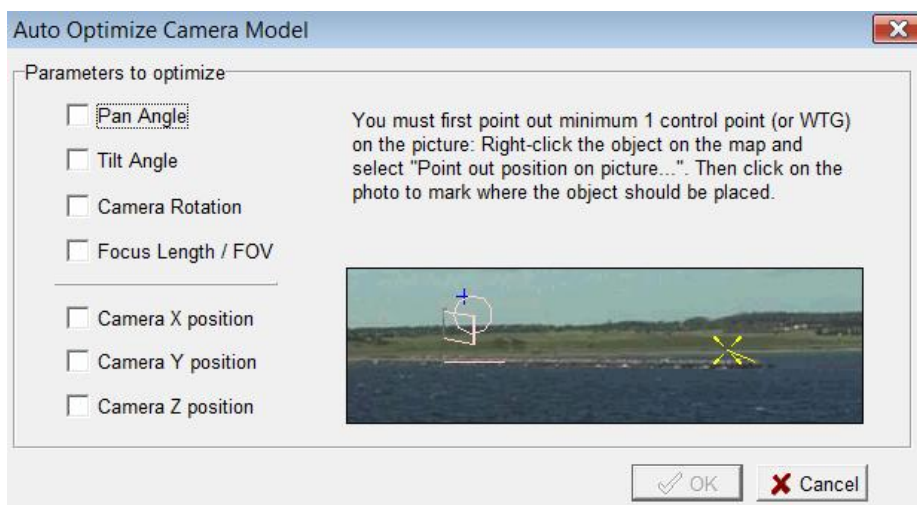
All seven parameters can be optimized in one operation, but then you need several good linked objects. Only the ones you check will take part in the optimisation.

After running the Auto Optimise Camera model, the control objects fit very well on the background photo.

But, be careful with this feature – with too few good control points, many solutions can give the optimum for just these points, but still give a totally false camera model. So you must always evaluate the result critically.

5.1.3.11 Rendering

Click on the red button to begin the rendering of the turbines into the image. When the control lamp turns green the rendering is finished. If you change the data on which the renderings were based, the control lamp will turn red again, and you have to render the image again.

By default you will render all turbines and other "renderable" objects **visible on the map** (from visible layers, see section 5.1.4.3.4 Camera object – tab sheet Use Objects and see section 2.11 on layer structure)

Figure 4 New turbines rendered on top at the existing ones - here the new is rendered as white, while the existing's are gray.

Having rendered the turbines, you have to decide whether or not they look realistic. If, for example, the turbines are dark and the photo is taken in glaring sunlight, you have probably made an error in the photo time setting. Also, the weather parameters can be incorrect. If the proportions are incorrect you have to check the Camera Model once more and maybe add more Control Points to it. Finally, the information in the turbine Catalogue could be erroneous (see more on this subject in chapter 2, BASIS) and you would thus have to open the actual turbine in the turbine Catalogue and check the data.

5.1.3.12 The Erase Tool (the Rubber)
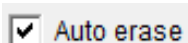
If height contours are available in the project, they will be used with to delete the part(s) of the WTGs hidden by the terrain. It might be necessary to refine the deletion with the erase tool as the height contours might not be precise enough.

The Erase Function is used to remove parts of turbines behind fences, buildings, hills etc.
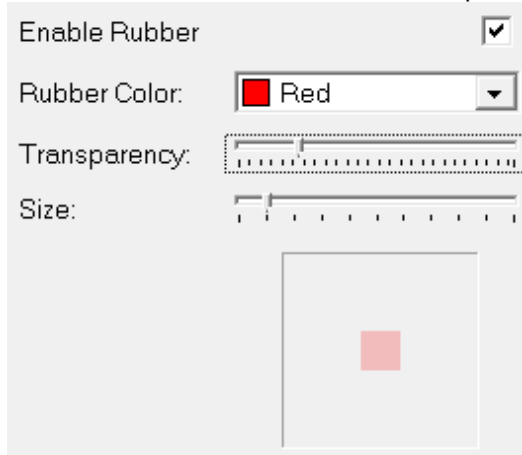
After activating the rubber tool, you can set-up the size of the rubber and how to show the rubber on the photo. You can then easily see where your rubber has been.

Figure 5 The rubber tool simply "paint" the rubber areas, where you do not want rendering. In that way you can rub a whole hill so even though you slightly move the turbines to be rendered behind the hill, there will be no visible parts in front of the hill.

NOTE: You can also un-erase or undo rubber areas by right clicking.

Left mouse button - erases pixels
Right mouse button - re-establishes erased pixels

5.1.3.13 Adjust camera position/ information

With the "adjust" icon you can open a window for some extra adjustment and information features that often can be comfortable to have on top of the photomontage.

Setup:
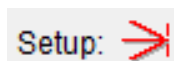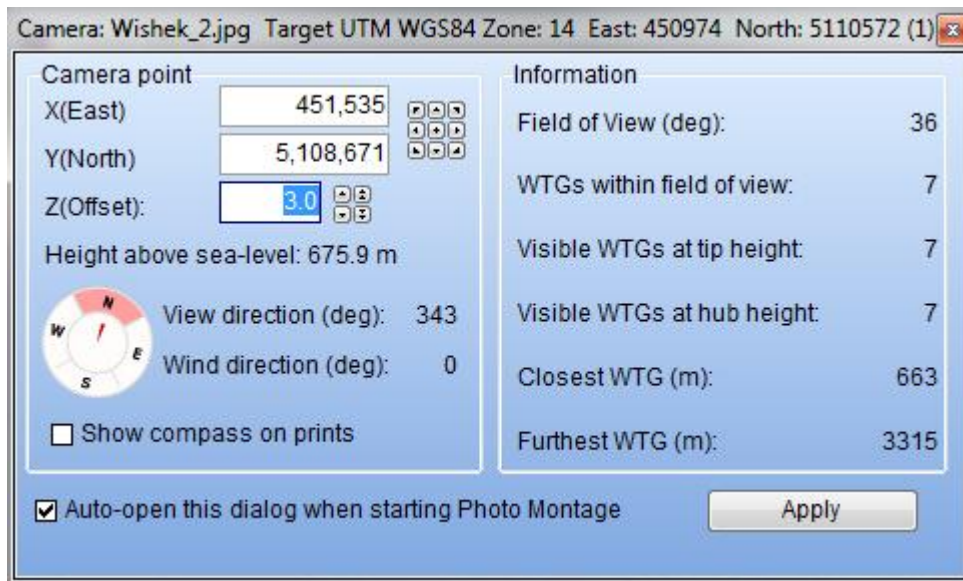
You can also activate the complete Camera Object and adjust any or all parameters.

The Z-coordinates of the turbines and other objects can be found in the digital Terrain Model (DTM) (see Chapter 2. BASIS, part 8). This is a very powerful option, which is advantageous to use when visualizing in complex areas.

5.1.3.14 Adjust light (colour)
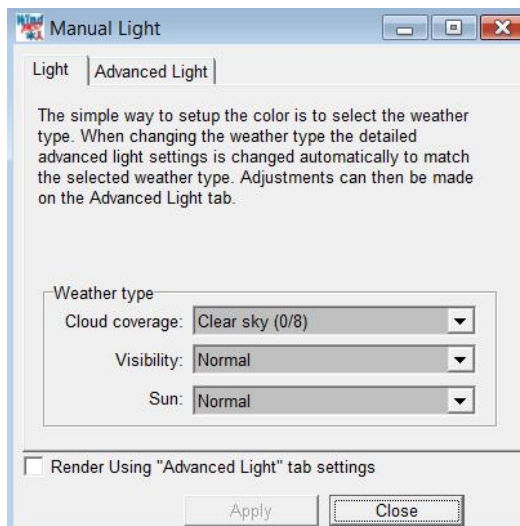
Light (or colour) adjustment is in general made by selection of weather conditions in the render set-up. But for some purposes, a more detailed adjustment can be needed, e.g. if some new WTGs are added to a place with already existing WTGs. Here it would look better if the new WTGs match the colour of the existing as good as possible.

With the light adjustment tool, access will be given to "Advanced light".
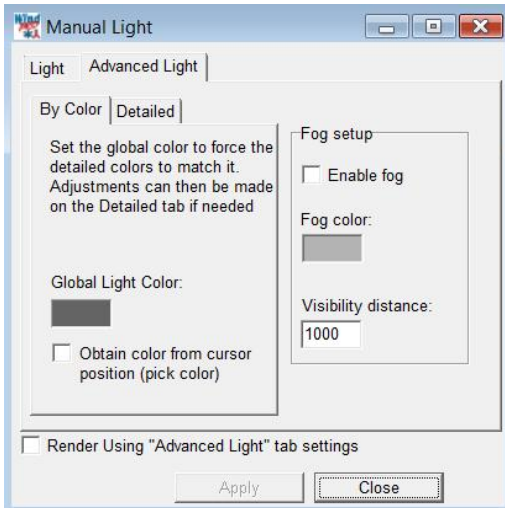
In the advanced light setting, the global light colour can be set, which is the colouryou wish to give the WTG. Therefore it is possible to "pick" the colour from the photo. But it is not that simple. A colour is not just a colour, but a mix of many pixels with different colours. This mix cannot be taken into the render model. Therefore it will only be an approximation. Another complication is that the colour is "not just painted", but generated dependent on distance, angles etc. So behind the render model, there are more "lamps" that together makes the colours. At the detailed tab sheet, you get access to the all lamps directly to give the full freedom of colour setting input to the render model.
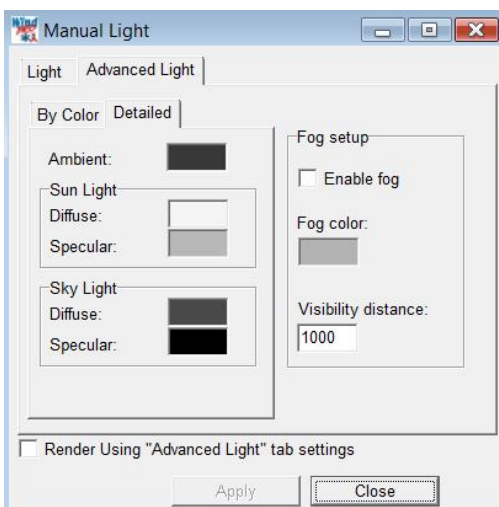
The detailed settings, where all colour parameters in the render model can be set. But be careful – it is very difficult to adjust all these handles and can be very time consuming and not very logical how the result react on your input.

5.1.3.15 Bitmap elements integrated in the photomontage

Bitmaps, e.g. photos of any object (tree, building, vehicle etc.) can be integrated in a photomontage. This can be used if there is no landscape photo to make a semi realistic photomontage (see next chapter) or it can be used to add other elements in the landscape than turbines if a photo from site is available.

This feature makes it also possible to use the WindPRO photomontage features to visualise any project, e.g. a new power plant, planned forest etc.

The methods of integrating bitmap elements in a photomontage are detailed described in the 3DAnimator manual part, see chapter 5.3.4 and 5.3.5.

Take a look at an example, where we have visualised a planned new lake in Northern Jut land, including a reed forest at:

5.1.3.16 Text elements integrated in the photomontage

A text on the map can be rendered as a billboard via the text object $\boxed{T}$, see example below.
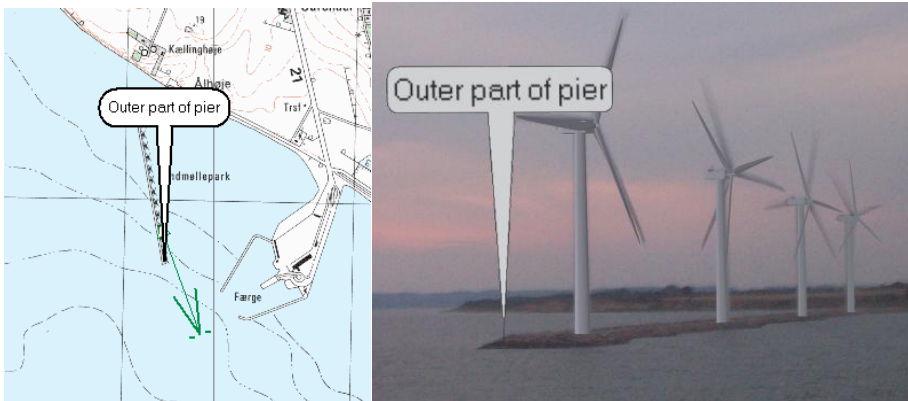
With the drawing/test tool you can draw or write direct on the photo.
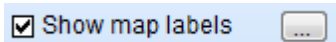
If you select "Show map labels", the label of the wtg will be shown on the top of the photomontage and pointed to the corresponding turbine. The setup of the labels on the photomontage can be defined by clicking on the three dots.
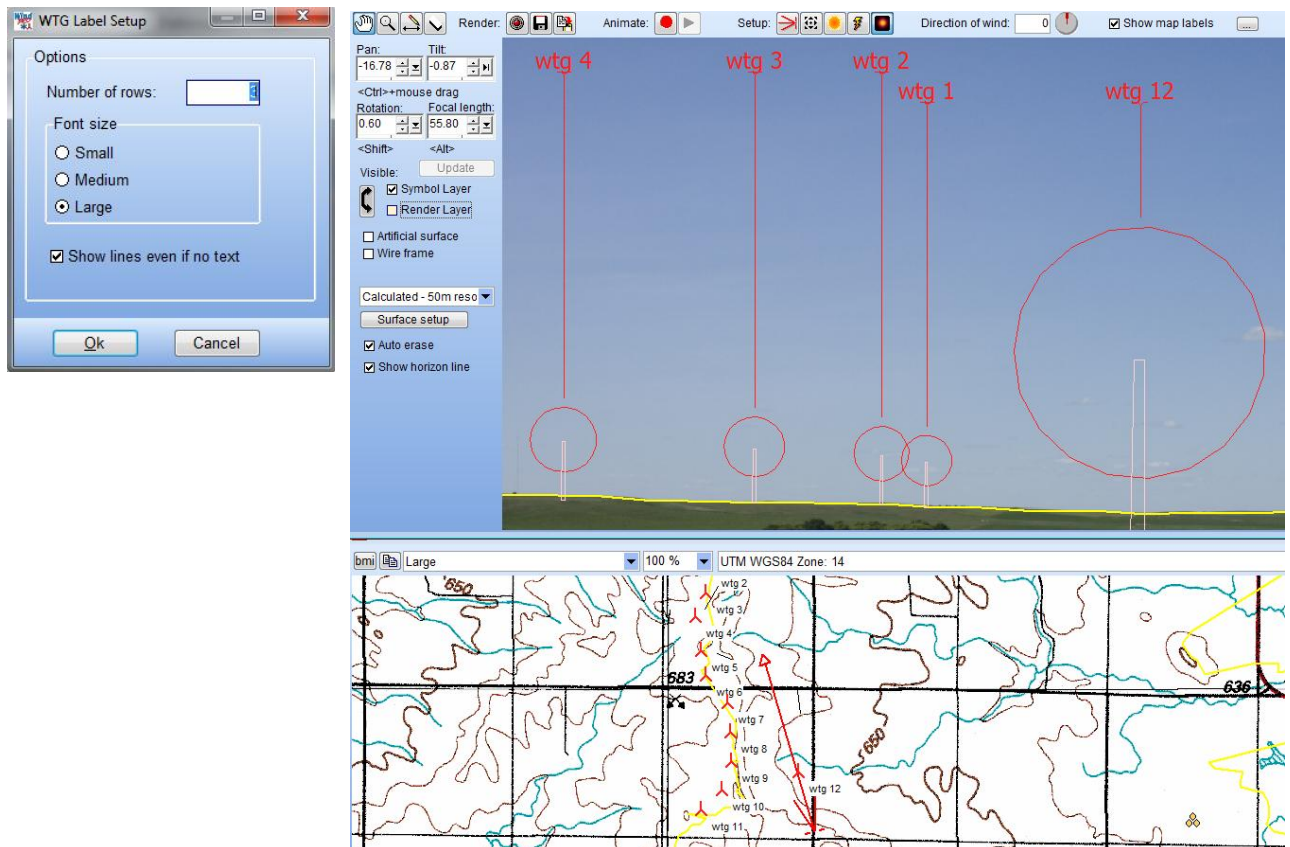
Finally you can copy the result direct to clipboard for paste into a text or other document, see example below.

5.1.3.17 Aviation lights integrated in the photomontage

Lights can be added on the top of the nacelle or on the tower of the WTGs. The visual simulation of the light is based on a bmp files which is scaled down in size according to the distance to the Camera object. The change in light intensity is not calculated by the model in the current version of WindPRO.
The aviation light has to be selected for each turbine. This is done from the Visual Tab in the properties of the WTG. It is also possible to select all turbines and use Multi Edit/WTG propreties.

By default two types are available as bmp files.
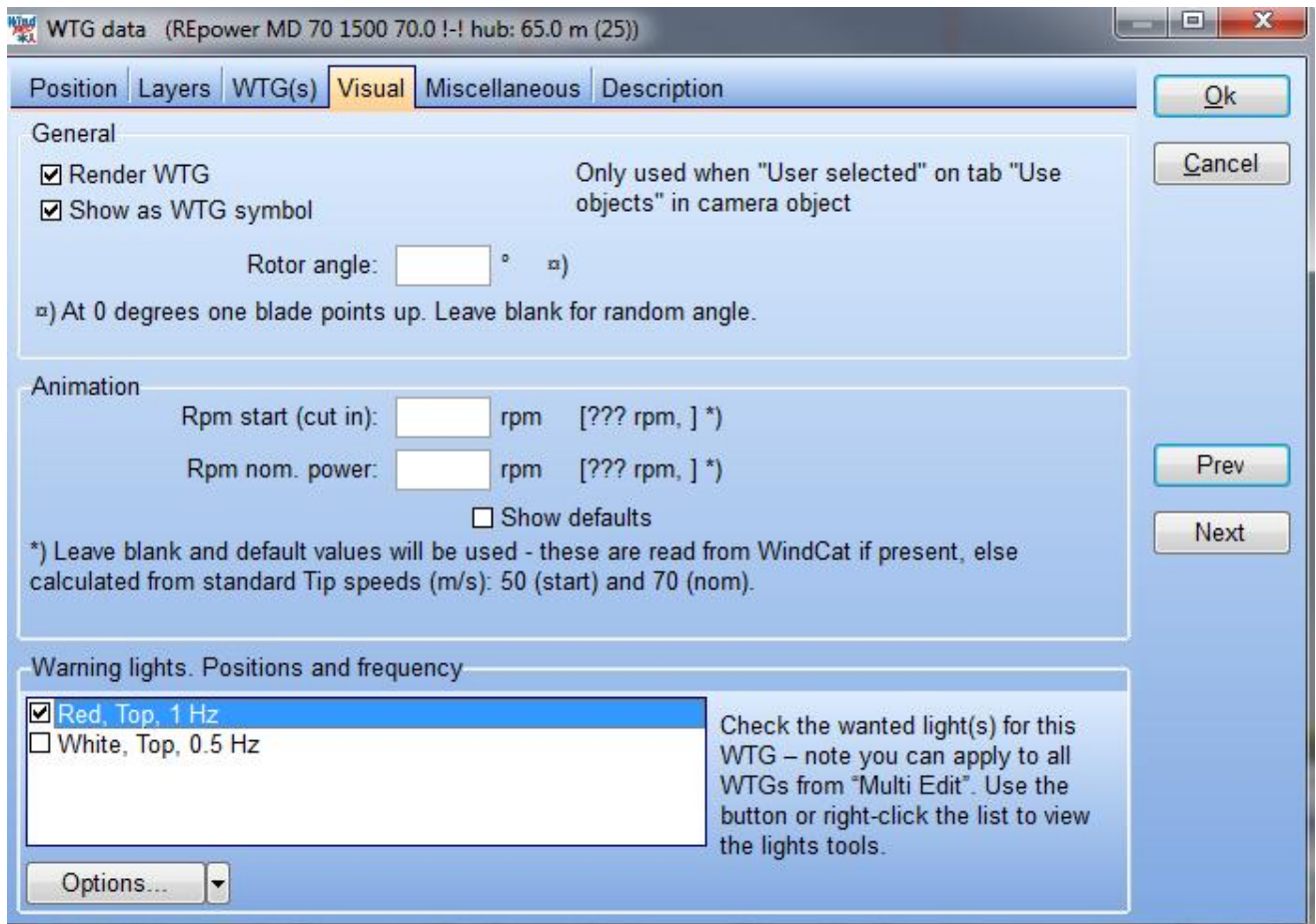
It is possible to adjust each light properties by clicking on **Options** and **Edit**.
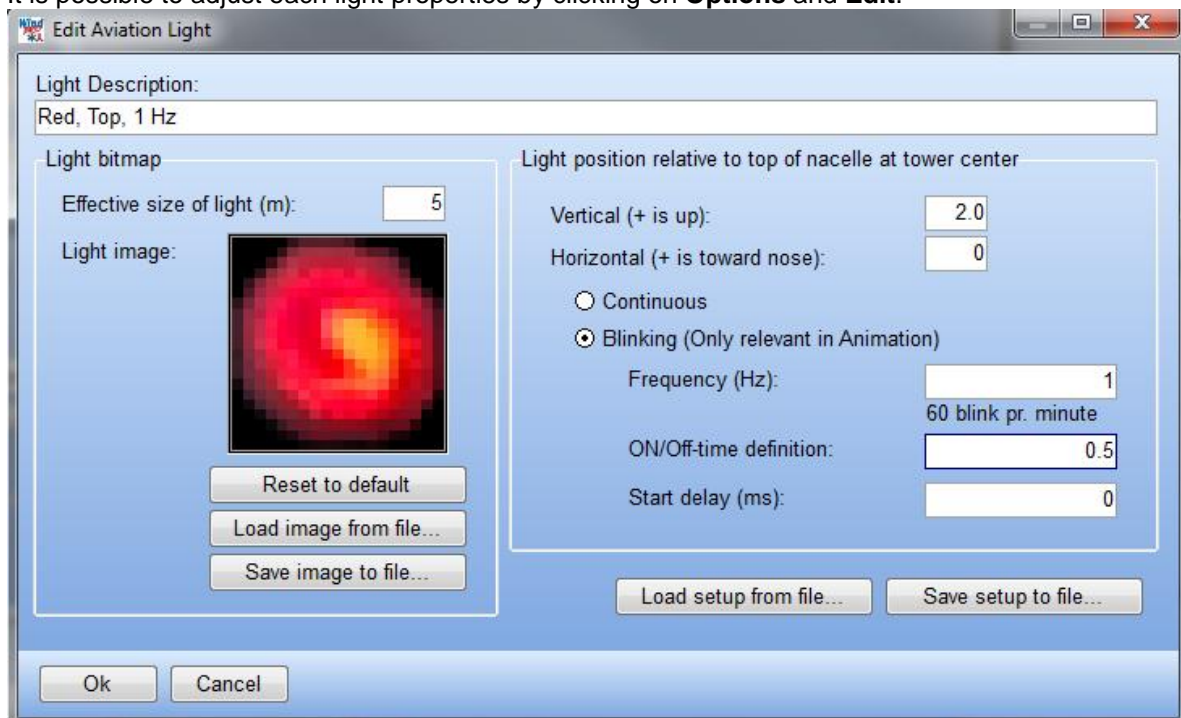
 In Edit Aviation light the following properties can be found:

Light description : name of the light settings so that same settings can be used for other WTGs.

Effective size of light (m): decides how big the light should appear relatively to the turbine. It is up to the user to change the effective size of the light to give a realistic result.

Light image: preview of the bmp file which can be loaded from a file.
Light position relative to top of nacelle at tower center: the light can be moved vertically along the tower either downwards (-negative vertical offset) or above the tower (positive vertical offset). A **vertical offset** of 0 m corresponds to the light being on the top of the nacelle. The light can be moved horizontally by changing the value in **Towards the WTG nose**. When the **Towards the WTG nose** is 0 m, the light is at the hub. To get the light at the end of the nacelle, the length has to be input as a negative value.
Contiuous or **blinking** is only relevant for Animation. The **frequency** of blink decides the number of blink per minute. With **On/Off time definition** you can setup the part of time the light should be on and off. 0.1 means that 1/10 or 10% of the time the light is on. **Start delays** can be used when a delay between several light occurs.

Once an aviation light is selected in the WTGs properties, make sure that the camera model is set up for "show aviation light" on the WTG of the Camera object or that the symbol for aviation light 🔴 is on. Then click on Render. The aviation light can be switch on/off via the symbol 🔴 and a new rendering.

5.1.4 Photomontage with artificial landscape as background

Photomontage with artificial landscape is usable in complex terrain where the shape of the terrain and the fitting of the turbines are more essential than the local terrain with trees, buildings, etc. Nevertheless, a photomontage with an artificial generated landscape via height contour lines also gives the possibilities to analyse a project without series of photomontages. Finally having a photo, an artificial landscape model also gives a unique control of the camera model, as errors are unveiled clearly in the camera model or the height contour line when the artificial landscape smoothly fits the real landscape in the photo. The artificial landscape model can also be used to see if the Wind turbines are behind or in front a hill because WindPRO will automatically erase the part of the wtg hidden by the terrain.

5.1.4.1 Establishment of height contour lines

As a condition when establishing an artificial landscape is that the height contour line is loaded into a line object. Please see chapter 2. BASIS part 8 Line object, for a detailed description how to establish height contour lines either by digitising on-screen or through import of height contour lines from internet or height contour line file information in various formats (shp,.gtx, .dxf, .ntf etc.)

Important when creating the height contour line object:
DHM (Digital Height Model) has to be selected and ticked in the tab sheet "POSITION".
The object has to be centrally placed in the area to use.
Set the TIN-radius under the tab sheet "PRESENTATION" to ensure that the yellow circle, which will appear around the height contour line object, covers the site where to create the artificial landscape.

5.1.4.2 Camera model: Artificial landscape

Settings of the camera model are as described in photomontage VISUAL but with exceptions:

It is not necessary to select a photo (file name) neither to calibrate the model.

"Artificial surface" is where all the relevant parameters concerning the above are set. The artificial surface can be rendered as a full surface and/or as a wire grid. The artificial surface is based on the height contours form the line object set for TIN (see 2.8).
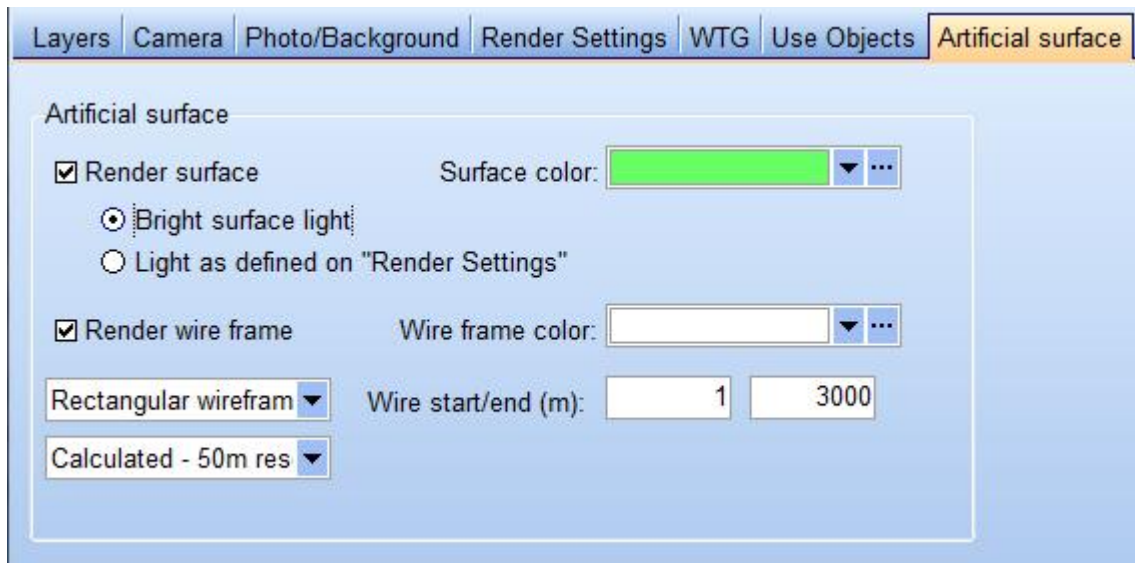
Render surface
You can choose to render an artificial landscape by ticking the "Render surface" checkbox. The surface can be rendered with a bright light or using the light setup defined in Render settings. In this last case the shadow of the terrain will be simulated with respect to the sun position. The colour of the surface can be changed.

Render wireframe
You can choose between rectangular or triangular wireframe. The resolution of the rectangular wireframe can be defined. The triangle is based on calculated triangles (TIN) from the DHM and is therefore the fastest and the most accurate one. But based on rectangular grid it is often easier to see the contours of the landscape (see following). The colour of the grid can be changed.
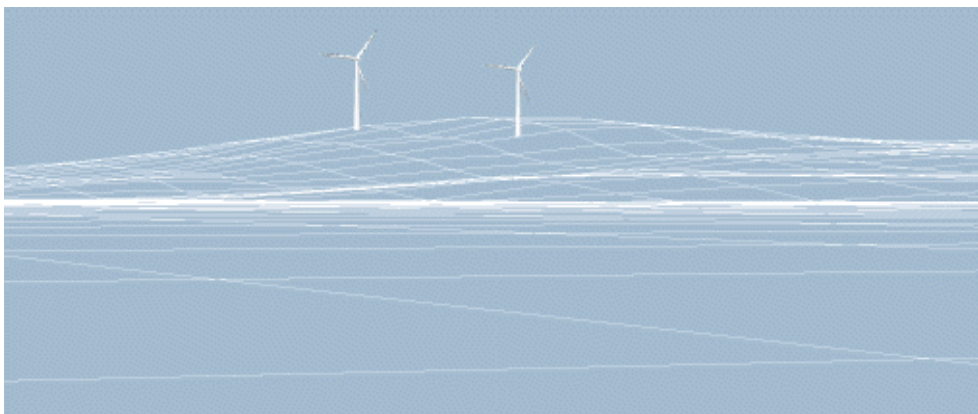
Note: a wire grid model with a landscape photo, as background is very suitable for checking the camera model.

The distance in front of the camera where the rendering "starts " and "ends" can be changed.

The "start" point can often and with advantage be set for "1" if the turbine is within a distance of 3 kilometres from the camera. On the contrary, you can utilize the value to give an impression of the waters in front of the turbine by reducing the landscape site to generate. See following example.
Where the site "ends" is a more complex matter as it depends on the landscape and the height contour lines for a site. If there is a mountain landscape behind the turbine it might be important to include this though it requires a substantial enlargement of the calculation and data site (TIN radius in height contour object).
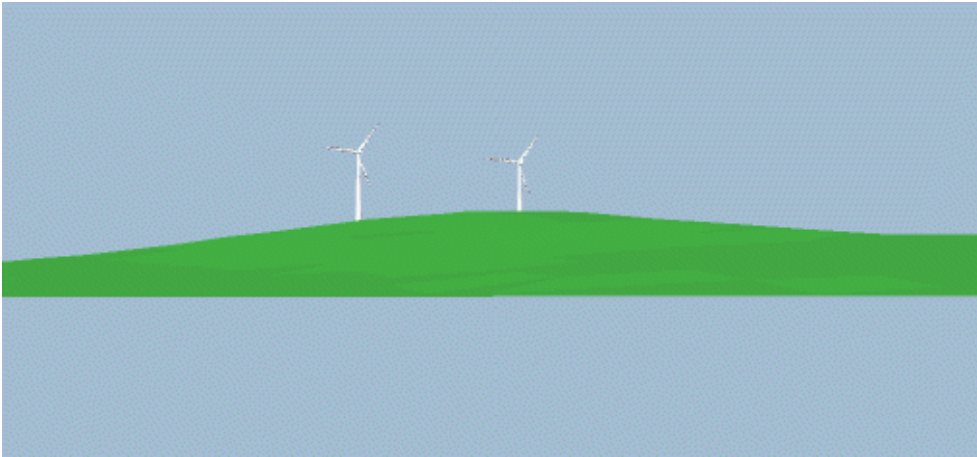
The model for generation of an artificial landscape is improved in connection with development of the new module 3D-Animator. It is now possible to input more landscape details through different objects, see 5.1.4.8.

Above the real photo regarding the above example is shown (only the existing turbines are seen).

Above an example from Greece with "real" mountains is shown as an example of getting a quite realistic view based on artificial landscape rendering.

See also: 5.1.3.10 Bitmap elements integrated in the photomontage, which make it possible to build up any landscape you wish.

5.1.5 Printing or exporting the final image

You have the following options to get the generated image out:

- In the print menu of WindPRO you can define the printout settings yourself, e.g. include several images on one page, combine an image with a map, print a full-paged image or a full-paged map including camera point and turbines, etc.

- In the export menu you can export the image as a graphics file, which can be imported into other documents or be used for professional printouts.

- An export to Google Erath can be made from the object list.

Below you will find some general comments on how visualizations may be presented:

- On a PC display
  This is straight forward option. You bring your PC along with you to wherever the result is to be shown and have no problems with "presenting it".
- On TV/Video
  When the image is transferred to TV/video you will experience a loss in quality since these media use significantly lower resolutions than the PC display. We do not have any experience with this option so far.
- On paper prints
  Printing directly on paper is probably the most commonly used option. You have several options ranging from using your own colour printer (either a cheap but good jet-ink, or a somewhat more expensive colour laser printer), to having a professional photo laboratory doing the job by using expensive colour laser printers, jet-inks or sublimation printers capable of making photo realistic prints
- As slides or overhead film
  Slides/overheads can be made at a professional photo laboratory directly from an image file, which, of course, gives the best quality. Overheads can also be made simply by printing directly on OH film or by copying from a paper print directly on OH film, e.g. by using a colour-copying machine.

When the image with the turbines has been rendered into one of the 4 above options it can be used for a presentation of the result.

5.2. VISUAL – animation (2D)

Animated visualization consists in rotating the turbine blades in a sequence of renderings called an animation. The animation, which is stored as a file, can then be shown on any computer having the necessary animation player installed, i.e. not necessarily on a computer running WindPRO. The animation player developed by EMD comes with the software.(EMDplayer.exe is found in the WindPRO program installation folder) or can be downloaded from www.emd.dk. This softwareis freely distributed to anyone).
The animation has the advantage that it shows the rotating blades, the dynamic appearance that characterizes a turbine – contrary to other objects in the landscape. By this it is easier to evaluate alternatives like e.g. many smaller but faster rotating turbines and less big but slower rotating turbines. Blinking aviation light on the top of the nacelle can also be shown.

It is also possible to export the animation as a file that can be published at the Internet and shown in a standard browser (Internet explorer, Firefox).

## 5.2.1 Calculation methods in 2D animation

The technique behind an animation is as follows: the program renders a sequence of photomontages of the turbines in which the blades of the turbines are rotated slightly on each rendering. When a complete cycle of renderings has been made, the sequence can then be played repeatedly to make a continued animation of the turbines with rotating blades.
The program automatically creates the necessary number of renderings for a complete cycle. A build-in routine allows the rotational speed to be adjusted within 5% in order to keep the number of renderings close to the minimum required in the animation set-up parameters, thereby reducing the rendering time and necessary storage capacity considerably.
The file format and the film player have been developed by EMD on the basis of a once used but now outdated format for Windows 3.11. The new film players on the market today turned out to have critical errors or demanded each user to have separate licenses. Therefore EMD chose to develop those components in-house.

5.2.2 Preparation – individual speed for each turbine

Before creating an animated visualization a photomontage has to be made. This is described in detail in paragraph 5.1. VISUAL – Photomontage. But also remember to rub out, not only the rotor parts that are behind e.g. threes but also the ones that during rotation might become behind.
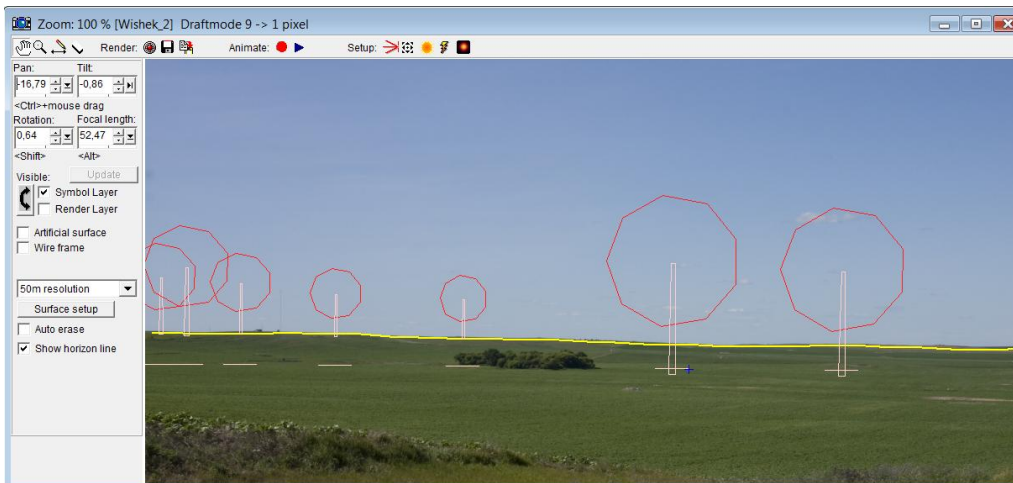
Next, ensure that the rotational speed settings in the turbine Catalogue for the relevant turbines are correct. Alternatively, the rotational speed can be entered together with the turbine data.
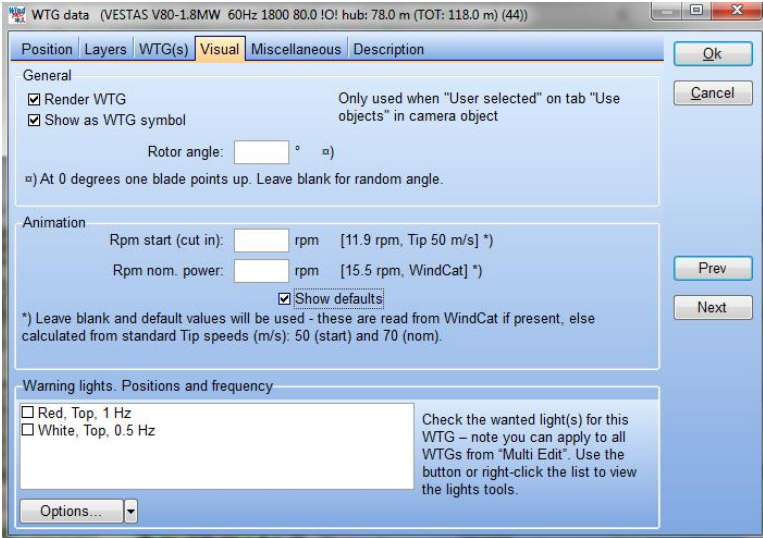
5.2.3 Generating an animation

In the photomontage window, click on the red button next to "Animate" and the photomontage window below will be shown.

In the above figure enter the necessary information in order to generate an animation.

Speed
Choose speed information for each turbine object to be used or if you want new calculated values based on a different rotational speed, state this. The latter is indeed usable if you want to try out how it works with different speed levels.
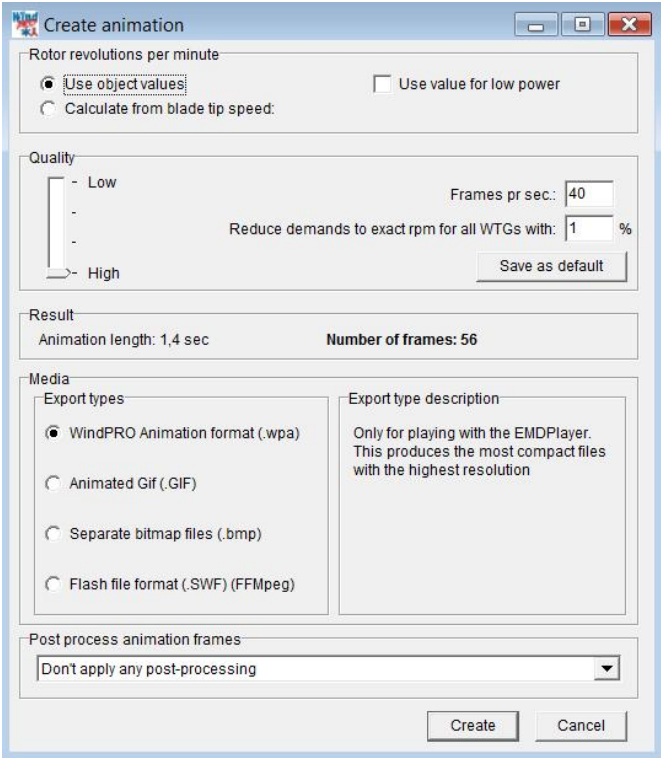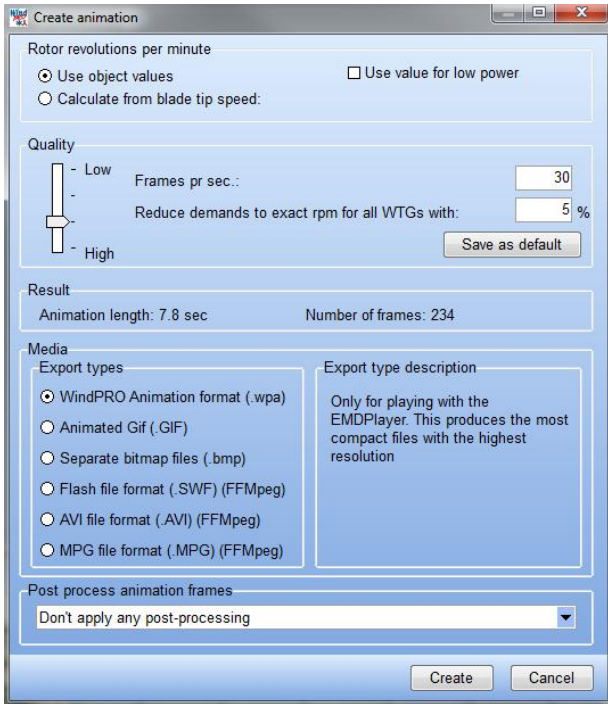It is possible to choose between 2 rotational speeds, to simulate either the rotational speed at "cut in" (small generator) or at "normal" operation (rated rpm.).

Quality
The quality of the animation depends of 2 parameters:
1)   The number of frames (renderings) per second
        The number of frames per second should be selected between 20 and 50 – standard TV uses approximately 25 pictures per second. A problem when choosing a too large number of pictures per second is that a slow computer cannot keep up with the real time player speed. On the other hand too few pictures per second will result in flickering.
2)   How much can the speed diverge from the specified if there are turbines with different rotor rpm?
        If the turbines have different speed levels it might be necessary with a large number of frames (longer rendering time) before a whole cycle is generated. An optimisation routine which allows the rotor speed of the individual turbines to vary within 5-10% (which is hardly visible in the animation) drastically reduces the number of frames needed and thereby the rendering time.

Based on the entered values for the above two parameters the program calculates and shows the necessary number of frames together with information on the length of the animation sequence.

Output Media
Finally the output media can be chosen. There are two choices:

1) a .wpa file, a WindPRO animation file that can be shown with EMD's animation player (EMDplay.exe). The animation player is distributed with the program and can be copied freely to other users.

2) animated Gif for playing in standard web browser and thereby be published on web pages.

3).bmp files, i.e. standard bitmap files that in themselves do not show an animation. If you have a recording tool of your own capable of using the .bmp file format it is possible to create the animation based on these files. For example the Paint Shop Pro Animation shop can create an animated .GIF file based on these.

4) Flash – is the right choice for presentation of the animation in a web browser.

5) .AVI Uncompressed video format.

6).MPEG - Compressed video format

When all the selections are made click on "Create". You will be asked for the folder to hold the animation and the calculation will start.

5.2.4 Recording and play a 2D animation

When the calculations are completed the animation will show in a separate window on the screen. You can control the view of the animation and you can play another animation by dragging it from the animation menu.

The recording speed should only be changed for experimental reasons since it changes the rotational speed of the turbines too, thus resulting in a false, unrealistic animation.

If you want to play the animation on another computer you need to copy both the animation file (.wpa) and the animation player EMDplay.exe both found in the folder: Program Files\EMD\WindPRO2\

You start the animation by opening (left double click) the EMD player and select "Play".

5.3. VISUAL – 3DAnimator

With the 3D-Animator you can build an artificial landscape based on height contour lines and a texture wrapped on top of this. Use a map, flight photos, satellite photos or simply a bitmap texture. On top of this landscape model the WindPRO objects, e.g. the Area object gives a realistic scenario specifying forests, cities, and animals etc., which are rendered. Last but not least the turbines that of course will be rendered with rotating blades.

In this artificial world you can walk, drive or fly around, controlled by the mouse. A specific track can be recorded and played. A 3D animation can also be played aside by any external person via the viewer shareware program.
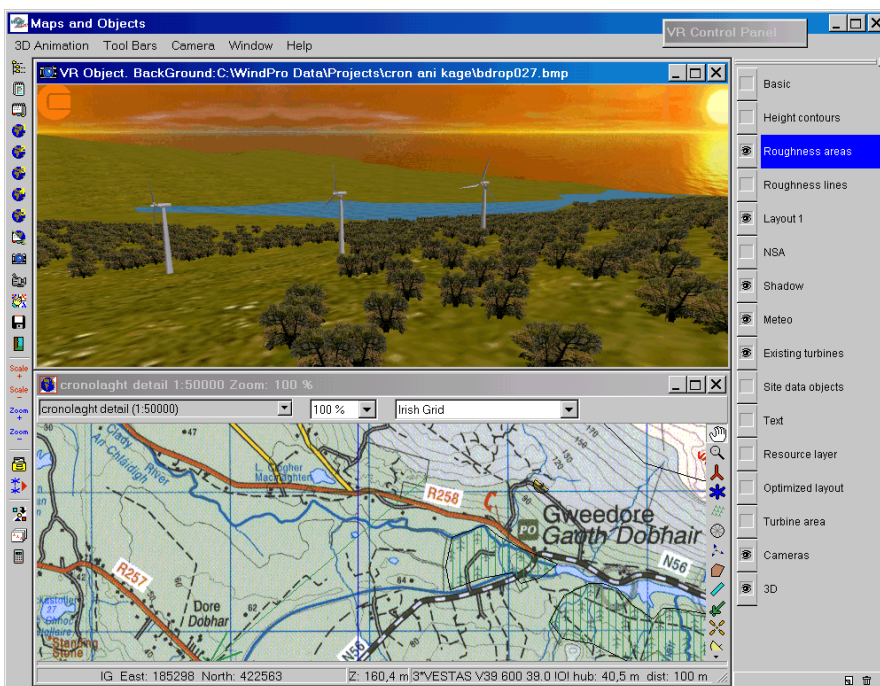
5.3.1 Calculation methods in 3DAnimator

The technique behind an animation is as follows: The software converts all data into triangles specified with three 3 dimensional corner coordinates. On top of each triangle a surface is drawn. This surface is adjusted for light settings. The camera position, focal length, pan and tilt angle now decide what shall be shown in the render window. This information is updated while the camera is moved or its properties are changed.
A render engine called Morfit is used to control all this. Morfit is, among other purposes developed, for PC games.

5.3.1.1 Hardware and Operating System Recommendations

The following software and hardware recommendations apply to the 3DAnimator module only. Other WindPRO modules may run on less powerful computers.

A 3D-animation is much like a simple PC-game, and is thus very hardware demanding. The actual hardware requirement depends much of the setup of the project and especially the number of polygons that the computer must process and render. An old computer, e.g. a 600 MHz Pentium III with a 3D video card, may run small projects with a limited rendering area (say, 1000 x 1000 m^2 with only a few turbines). The version of operating system is also of major importance. The 3DAnimator must run on a Windows 2000 / XP/ Vista or a later release.

For an optimum 3D-performance with the WindPRO 2.7, we recommend a software/hardware setting as shown in the table below.

Hardware	Minimum	Recommended
Processor	1 GHz Pentium 4	>= 2 GHz Pentium 4
Video Card	3D card with 32Mb ram	Nvidia 3D card with >=256 Mb ram and hardware antialiasing
Memory	256 Mb	>= 1 Gb
Operating system	>= Windows 2000	Windows XP/Vista/7 or later

5.3.2 The VR object

The VR object is mainly used for specifying the information about the size of the area to be rendered and the texture to be put on the top of the landscape. Besides this many options can be set from the VR object, but these can also be changed from the menus that appear when the 3D-animation is running.

The two left most tab sheets: Position and Layers are common for all objects and therefore not described here – see chapter 2 Basis for detailed information. (2.5.2.2 for position and 2.11 for layers)

5.3.2.1 Set-up tab sheet

Exaggerate Z-value is used to make the changes in the z-levels (elevation) more visible, and thereby help the user to see the differences in the landscape elevations more clearly. To make a "realistic" presentation, this value shall of cause always be set to "1".

Texture on ground is used for draping a picture on the top of the digital height model (DHM). The purpose can be to make it look realistic – then a flight photo will often be preferable, but in e.g. a mountain region, a simple bitmap showing a ground with rocks can be working quite well. There are four options:

1) Auto colours based on heights – this simply gives a colour change with elevation – this is often powerful for a "first study" of the site and show very clearly where the proposed turbines are sited relatively to the highest elevations. And this is a very PC-power "inexpensive" solution.

2) Use map covers many options. This allows to drape one of the attached maps to the project on top of the DHM, and can give a very informative presentation, where e.g. place names are shown in the 3D-animation. But this is also the way to use e.g. aerial photos to drape on the top of the DHM, which often gives the most realistic presentation. Before an aerial photo can be used, it has to be georeferenced, which is done by attaching the photo as a map (as described in chapter 2.x Basic).

3) Use bitmap simply places a photo or other texture on top of the landscape. This can be stretched to cover the whole area or it can be tiled (repeated) more times over the region by giving the dimensions of the rectangle the bitmap is supposed to cover.

4) Use colour is finally the very simple solution where nothing better are available – or for very "stylistic" presentations.

Area width and height simply describes the region to be rendered. Depending on the complexity of the terrain-model, the area should not be too big (bigger than e.g. 5000x5000). If a big area is required, simplifying the used height-contour using the EMD-editor, is highly recommended.

Use grid as surface is an option, which can speed up the render process very much. Especially if very detailed height contour lines (and thereby detailed TIN) are used, the number of triangles to be rendered will be very large. This can be reduced much by just taking one point for each e.g. 50m – and often the realism will be just as good.

Maximum allowed polygons in grid is used as a safety-net when running the 3D-Animator. It is very easy accidentally creating a world containing a huge number of polygons, causing the program to spend hours creating a world, that is too large to run on the computer anyway. This feature is offered to save the users time and nerves, and to give helpful information regarding where the overflow of polygons comes from (which object). Do not set the value too high! The turbines are NOT included in this test!!

5.3.2.2 Background tab sheet
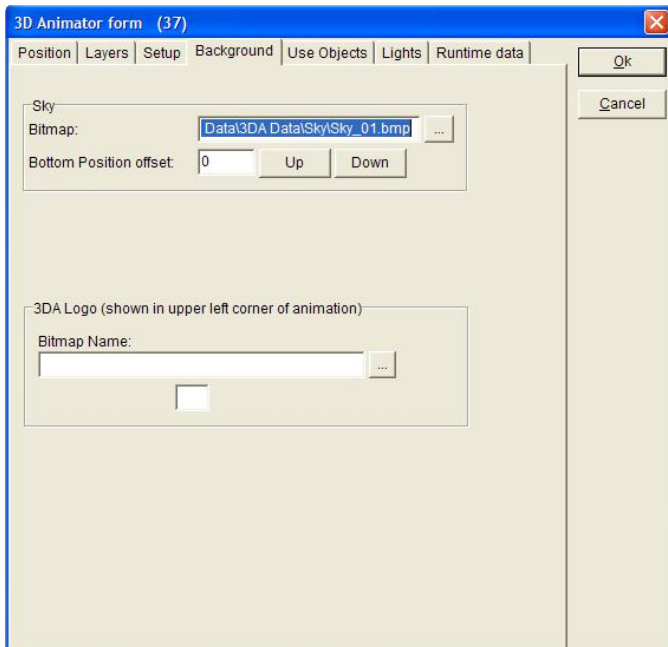
At this tab sheet the bitmap used for showing the "Sky" is selected. This is only an option – if no sky bitmap is selected, the colour outside the render area is used as background.
There will be some "sky-bitmaps" in the library included, but you can also use your own photos. Just notice that the width/height relation of your photo might need to be adjusted between 1.5-3.
The bottom position of the sky bitmap can be adjusted in case the sky bitmap does not "fill" the background in a proper way f,f e.g. there is a "blank" part between the ground and the sky bitmap. This normally is adjusted after the landscape is rendered and there will be a menu for this adjustment in the 3D-animation window.

The colour outside the render area is simply the background colour used where there are no surface or sky bitmap.

Also a logo to appear at the left top of the 3D-animation window can be set here.

5.3.2.3 Use object tab sheet
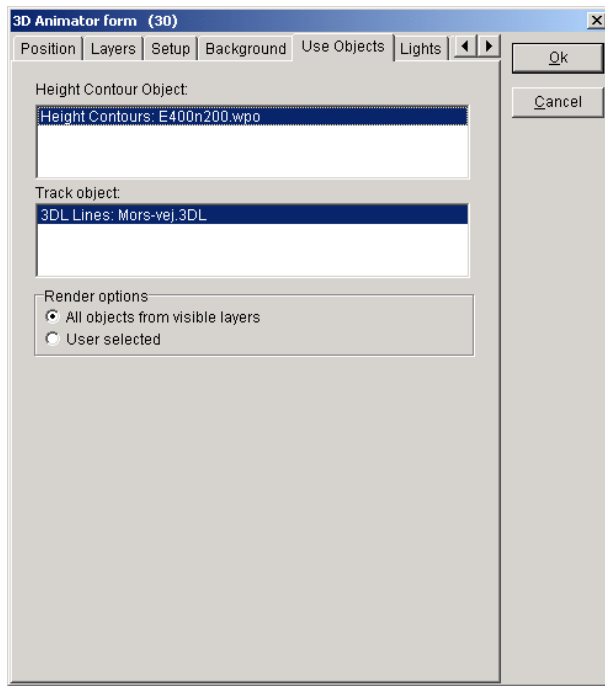
If you have several height contour line objects, you must decide which one to use for creating the DHM – only one can be chosen, but notice that you can merge two or more height contour files in the line object (see chapter 2.8, Line object, Basis).

If you want to use a "track", normally a road to link your camera to, you can select here which line object will be used for this purpose.

Finally you can decide which objects that shall be rendered. The default setting is "all object from visible layers". In that way you can use the layer manager to decide what to be visible. But you can also manually select object by object.

5.3.2.4 Lights tab sheet
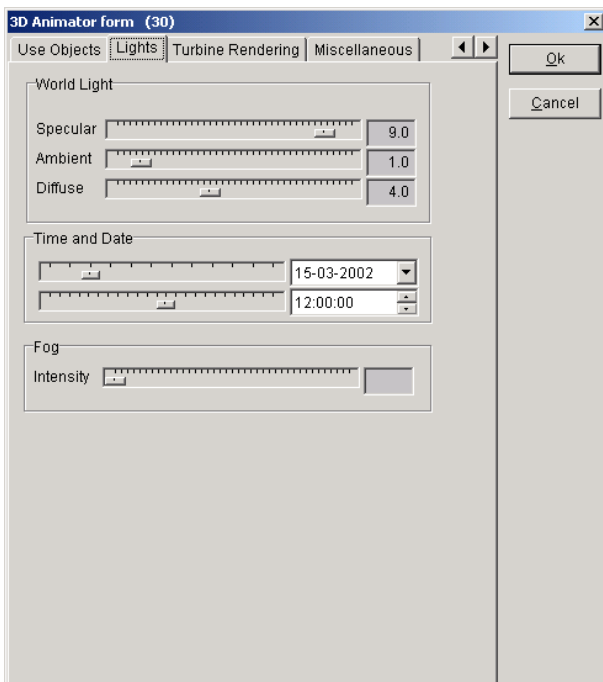
In the lights tab sheet you can set the light at the landscape rendering . Note that when the 3D-animation is running the light setting can be made "on-line" from the toolbar menu, where you see the changes at once. Here only the initial settings are given.

The 3 "types" of lights that can be changed are:
**Specular:** Comes from a particular direction but is reflected of the surface depending of the surface specular value. The ground surface gives almost no reflection.
Ambient: Background light. Has no direction, and covers all surfaces.
Diffuse: Comes from a particular direction but is reflected evenly of all surfaces. Gives less contrast compared to specular light.

On top of this the date and time graduates the light in combination with the location on earth (and time zone). The sun position and strength is simply calculated at specific place, date and time.

Finally there can be simulated fog, where the intensity can be adjusted.

5.3.2.5 Runtime data tab sheet
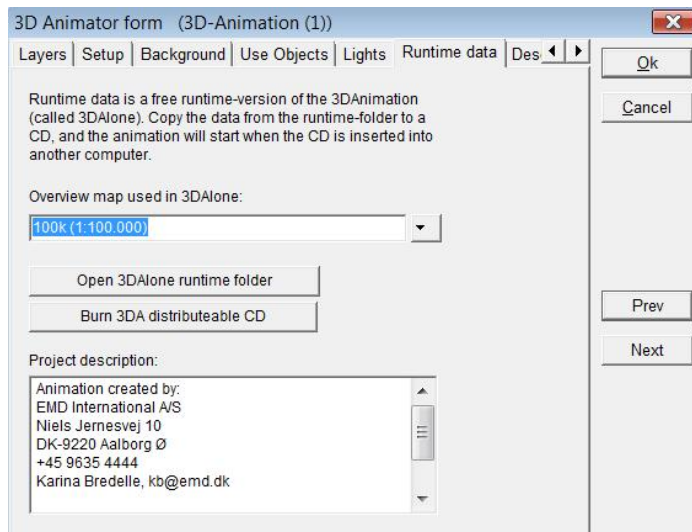
The Runtime data tab sheet concerns the stand alone 3D animation which will be created with the current VR object (see chapter 5.3.7). In this tab sheet, you can select the map where the location of the viewer in the stand Alone version of the 3D animation will be displayed.

The "Open 3DAlone runtime folder" button opens the folder which has been created after the first generation of the 3D animation of a VR object.

The "Burn 3DA distributeable CD" will enable you to start the burning on a CD.

The project description of the runtime data tab sheet makes it possible to add a small text in a frame below the 3D animation.

5.3.3 Generating and controls of a 3D-animation

Click on the video camera icon at the left menu bar and the 3DA window will appear.
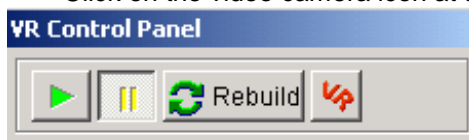
Then click on the green arrow in the VR control panel to start building the artificial landscape. From this part of the controller the animation can be paused)(yellow ||) and started again at the green arrow.

Rebuild is used to recreate the whole 3Danimation. Only WTG's, sky and light settings are updated immediately. All other changes require a rebuild to take effect. Since the animation is stored for the runtime version, the rebuild is faster if only a few changes are made, because it re-uses the unchanged parts from the runtime. This means that the rendering of e.g. a big forest may take 10 min. the first time and 20 sec. the second time it is built.

The VR button is used to open the 3DA properties dialog.

5.3.3.1 Main control of a VR flight/drive

The arrow keys at the keypad are the "basic" keys for controlling the drive/flight around in the landscape.

Move forward (hold down)

Move backwards (hold down)

Turn left (hold down)

Turn right (hold down)

The **<PgUp> – <PgDn>** "lift" the helicopter and takes it down again. (Scroll wheel on a mouse normally has same functionality)

Look up/down (tilt) with mouse click at top/bottom of render window (alternative **<u> - <d>** keypads can be used).

Look left/right (pan) with mouse click at left/right of render window (alternative **<l> - <r>** keypads can be used).

A joystick or a mouse can also be used.

5.3.3.2 The VR Control panel
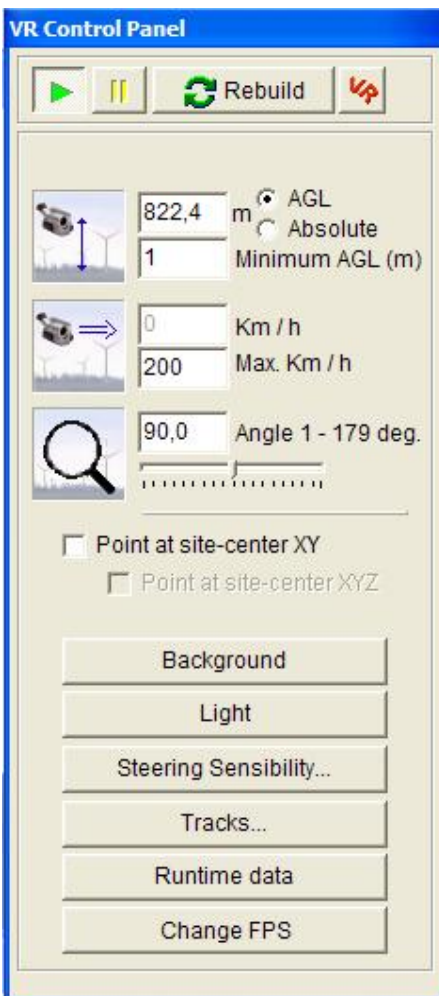
From this panel following settings can be controlled/surveyed:

Height of camera can be set either Above Ground Level (AGL) or absolute. The last option typically by virtual flights, where the plane then follow a "direct line" instead of changing elevation with the terrain below the plane. The minimum height AGL can be set – to avoid that the camera goes "below" terrain surface in rough changing terrain, the value can be set a little up.

The height is (besides by entering values here) controlled by:
The <PgUp> keypad for "up"
The <PgDn> keypad for "down"
Or typically by the scroll wheel at a scroll mouse (depend on windows setting on scroll wheel)
Finally a joystick normally will have features for this function.

Speed of camera can be entered as a maximum speed. When the Arrow up keypad is held down, the camera relative fast reach this maximum speed – at release it decelerate again fast to zero speed.

Camera angle (focal length – or zoom) can be set free from 1-179 degrees.

3DA Camera angle compared to Photomontage
V: Angle 3DA (typical value 90 grader)
F: Film Width (typical value 36 mm)
B: Focal Length (typical value 50 mm)

$V = 2 * ATan(F/(2*B)) <=>$
$B = F / (2*Tan(V/2))$

F=36, B=50 => V = 40 degrees

Point at site-center XY(Z) – with this checked, the camera always point towards the site centre.

The 2 following buttons are for opening detailed control menus for Background and Light. These are explained in 5.3.2.

Steering sensibility makes it possible to change the sensibility of the controlling device.
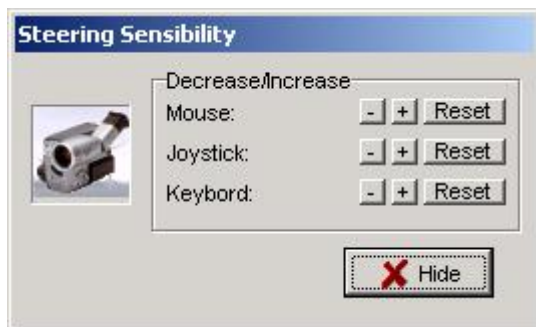
Tracks makes it possible to record a track, replay it or create an .AVI file based on the recorded track see 5.3.6 for further details. Note that the camera track can be locked to a line object created as a "road".
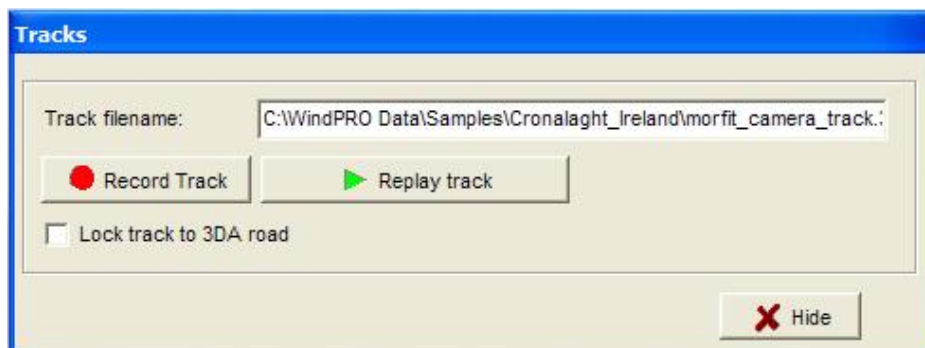

Runtime data opens the properties of the stand alone 3D-animation as explained in 5.3.7

Change FPS makes it possible to change the number of frames (pictures) rendered per second. This is used for setting the compromise between the capability of the PC, the complexity and size of landscape and the "smoothness" of the "video" presentation. A normal television works with 25 (CHECK) FPS.

5.3.3.3 Brief note on video quality

The video quality heavily depends on the performance of the graphics card in your computer. The best results and performance are obtained if you use a 3d-graphics card with hardware antialiasing properties enabled, such as the nVidia GeForce 2,3 or 4. To illustrate this matter, see the pictures below.
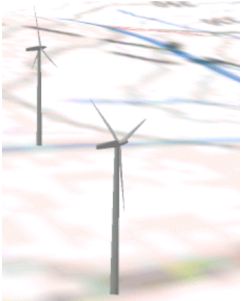
Rendering with antialiasing   Rendering without antialiasing

5.3.4 Objects that can be used in 3D-animation

New and existing turbines can be used. The data in the turbine catalogue is used if there are "visual" data in the catalogue. If there are no data specified for visual, a default turbine is rendered based on hub height and rotor diameter.

A Meteo object is rendered with a mark for each measure height there is created in the Meteo object. The colour of the Meteo mast reflects the "purpose", Black means "no data", blue mean "set for energy calculation" and finally orange means "set for STATGEN" purpose.

A WAsP obstacle can be used for creating a rectangle with the specified height. A 3DA file can be attached, where as well "free bitmaps" as boundary box (button, sides and top bitmaps) or a combination can be attached. (See next chapter for 3DA file description).

A line object can used 2 different ways:
As a road, where a bitmap showing a "road part" can be attached
As an area, where a 3DA file can be attached – e.g. a long row of trees.
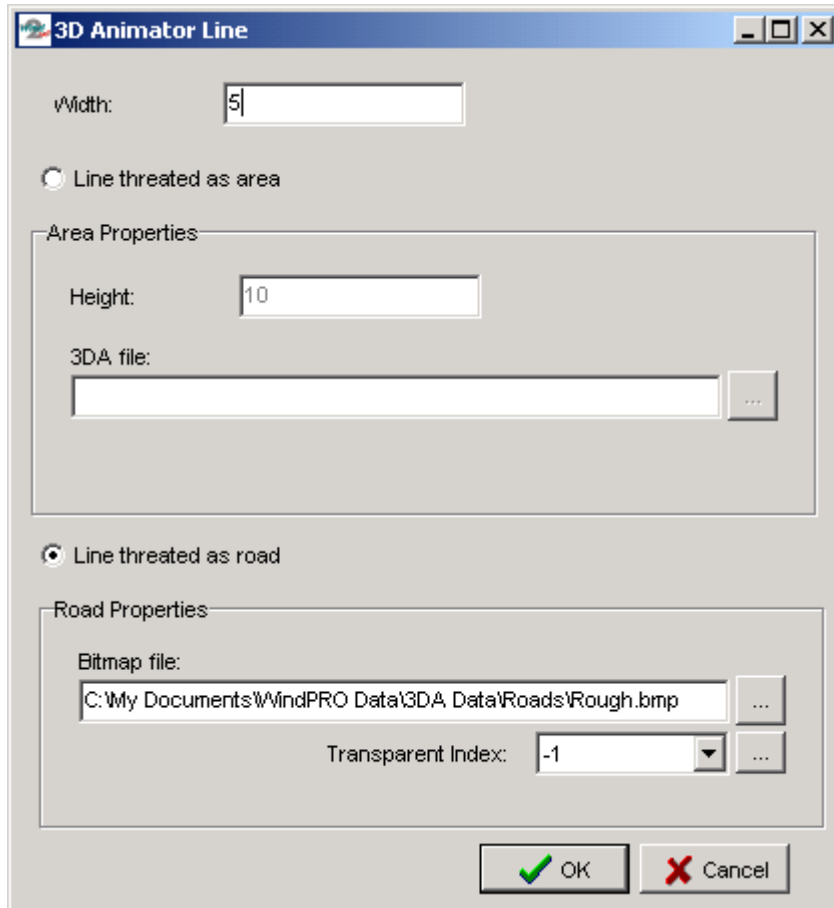
Common for the line object in a 3D-animation is the width, which is entered. Additionally a 3DA file or road bitmap is attached.

⬧ The 3D object can be created as a row of more with equivalent distance. For each object a bitmap object can be attached. This can be a simple fixed, rotating or crossed bitmap or it can be a simple house. See details on bitmap objects in next chapter.

T The Text object can be used in 3D Animation as billboards, which link a specific point on the map to the artificial landscape. See in chapter 5.1.3.12.

⬥ Finally the area object is an important object for 3D-animations. Larger regions as water, forest or cities can typically be incorporated through an area object. A 3DA file can be attached, where as well "free bitmaps" as boundary box (button, sides and top bitmaps) or a combination can be attached. (See next chapter for 3DA file description).

5.3.5 3DA editor and browser

The 3DA editor makes it possible to attach predefined landscape elements and to create your own elements.

There are "3 levels" of elements:

**The bitmaps** (simple pictures)

The bitmap objects, which are bitmaps given properties as dimensions, how to view (e.g. rotating bitmaps, always facing camera) and which colour that might be transparent. Also a "simple house" which is a 3D presentation with width, height, debt and roof angle, see detailed explanation in 5.3.5.3.

The 3DA object, or Area collection, is typically used for larger areas, which can be described by a "boundary box", where bitmaps on bottom, sides and top can be attached. For water surface only the bottom surface are given, while e.g. a forest only are described by sides and top. But also individual bitmap objects can be input for a 3DA object. Many trees can describe a forest instead of a side and top bitmap. This often gives a more realistic presentation, but it is also setting much higher demands to the PC while the number of objects to be rendered increases.

5.3.5.1 Browser for 3DA elements

The 3DA editor works as a browser, where all 3 types of elements mentioned above appear at the same time – but only the relevant type can be selected. It makes it easy to create bitmap objects based on bitmaps or 3DA objects based on bitmap objects if the needed element not already appears in the browser.
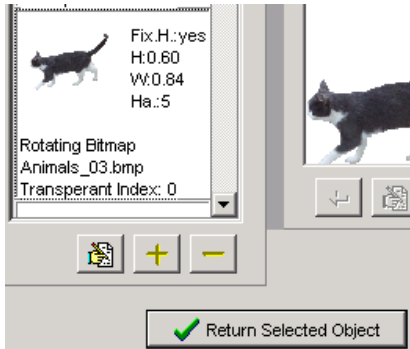
Below the 3DA editor in "browse mode" is shown.
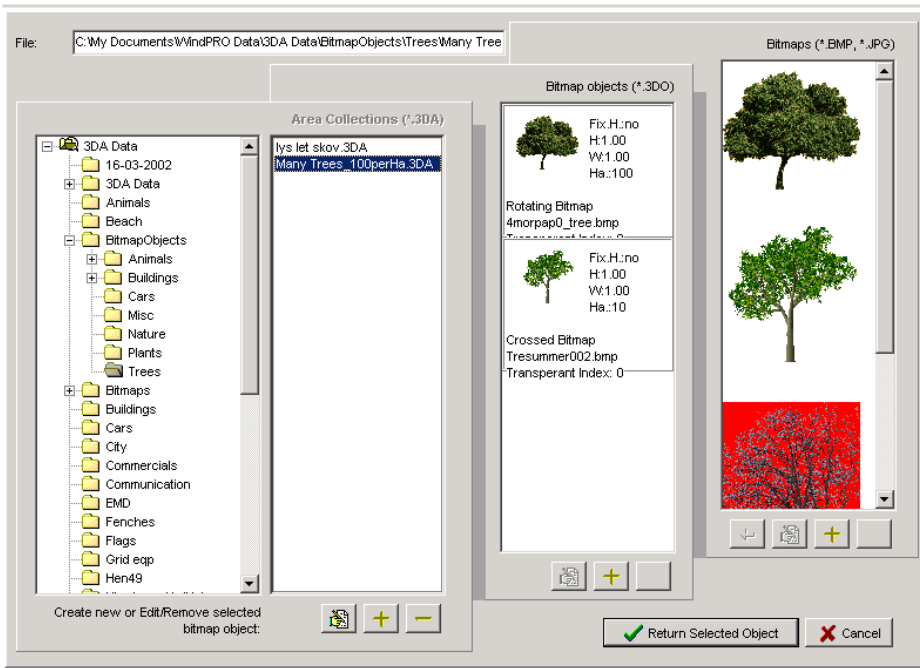
The default folder to be browsed is: WindPRO Data\3DA Data\ - but more folders can be browsed by adding a search path.
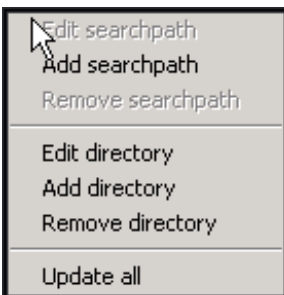
By right click in the path column (leftmost) in the 3DA editor/browser, a menu appears, which enable adding or editing the paths for the browser.
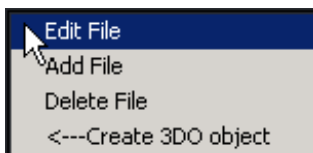
Clicking on one of the items (files) in the relevant column (column with blinking header) makes it possible to "return selected".

5.3.5.2 Edit or add 3DA elements

The 3 buttons below any of the 3 columns in the 3DA Editor/browser, makes it possible to **edit, add or delete** an element to the given column.

By right click on a bitmap, it is possible to use this for creating a bitmap object (3DO object).

5.3.5.3 Bitmaps add and prepare for use in 3DA.

To prepare a bitmap for use in 3DA, there are 3 important rules:

The size of the bitmap shall be reduced to a minimum – typically not more than 100 kB file size after reduction. Another measure is that no more than 300 DPT (Dot per inch) should be used – 75 DPI will normally be fully enough.

The number of colours should not be more than 256.

The background colour MUST be one uniform colour.

To fulfil these demands, a photo editing software tool will be needed. There are many possibilities, e.g. the Paint Shop Pro (Enclosed on WindPRO install CD) or Adobe Photo Shop.

The resize and colour reduction options should be simple to find and use, so here just the more refined functionality, for making the background colour uniform, is described.

Assuming the biogas tanks from the photo above shall be used. Step one is to cut out the relevant part and reduce the numbers of colours to 256:

Now the background sky shall be given a uniform colour. In this case the lasso tool seem the best solution – if there are only vertical and horizontal lines, a rectangle selection tool would be preferable.


With the lasso tool, there is drawn around the background sky piece by piece and the background is simply "deleted" (which means that the default background colour will appear).

After marking all background, it is a good idea to cut out a piece, so the edges are ignored (while these often not are "caught" with the lasso).

Note that the "magic wand" tool often can be a very fast tool for selecting the background if the colour is different from the colour of the object on the photo to be used.

5.3.5.4 Creating a bitmap object from one or more bitmaps
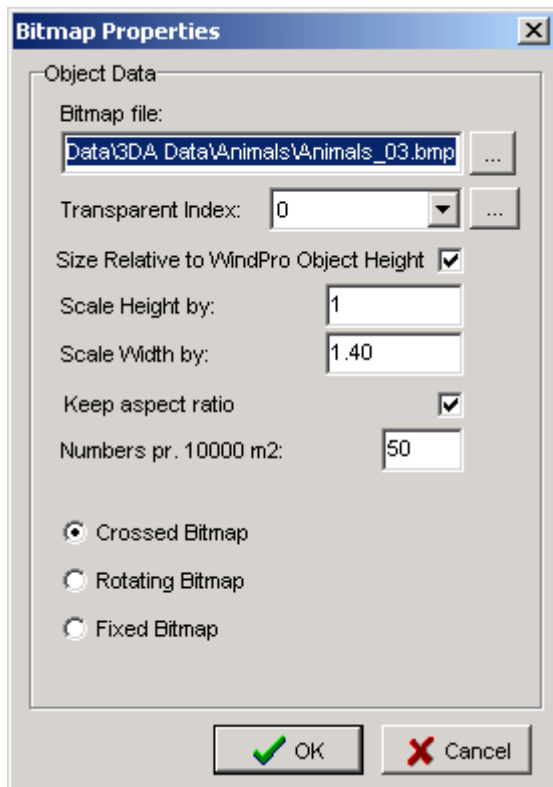
A bitmap can be given some properties "once for all", so it is not necessary to tell the program the height of e.g. a horse every time this bitmap is used. In general the properties given, is considered default values, and some values can be overruled by the properties of the object it is called from.

The transparent index normally will be "0", while this is the colour that appears most times in the bitmap. But in some very special cases, e.g. a barn with a very clear colour it can happen that the colour of the element to be visualized is the one with the most dominant colour, and the background then is the second most used colour. Then the index shall be set to "1". With 2 more dominant colours in the bitmap than the background, the index shall be set to "2" and so on. With a click on the browse button next to the selection field, the transparency colour can also be selected by clicking on the picture.

Size relative to WindPRO object height checked means that the height of the bitmap object is scaled automatically. This is typically used for trees, so they used from e.g. an obstacle, will appear with the height the obstacle are given in the obstacle object.

If the above is checked, it is possible to give a scale factor on height and width – otherwise here the "real life" height of the bitmap is given here.

Numbers pr. 10000m2 (Ha) is used as default value, when the bitmap object is used in a 3DA file (object collection), where the bitmap object is placed random in the object region (area, line or obstacle).

Finally the way the bitmap is shown in the 3D-animation can be selected.
Crossed – 2 bitmaps crossed typically used for trees.
Rotating – always facing camera typically used for animals or symmetric elements, e.g. some type of buildings (towers, lighthouses etc.). This kind is the slowest to render.
Fixed – most used for elements of a certain distance from the path where the 3D-animation are shown, e.g. a village at a certain distance.

Especially buildings can not often be shown properly with one of the above options. A house, which shall be passed closely in the 3D-animation, will often give a poor presentation as a single bitmap. Therefore a first step for compensating for this is the "simple house", were a 3 dimensional house can be build based on 5 bitmaps.
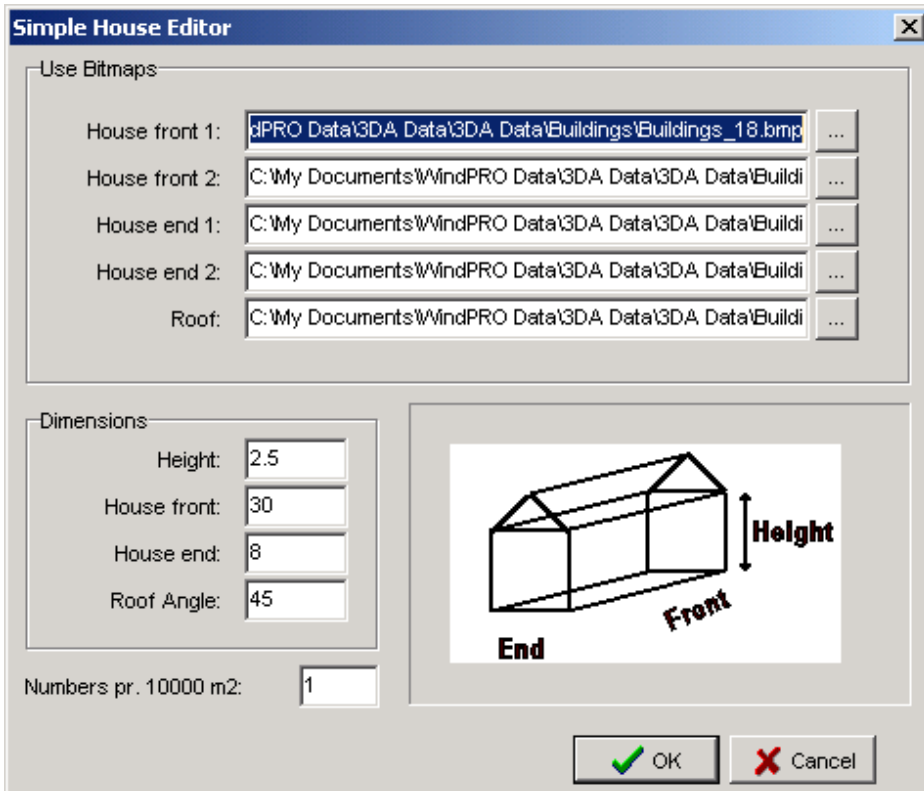
The front (and back), the two ends and the roof can have each a bitmap. Besides this the dimensions of the house can be given as shown in the definition window above.

5.3.5.5 Creating a 3DA file (bitmap collection) from one or more bitmaps and/or bitmap objects

A 3DA file or object collection, are based on one or two main elements, where both describes the area covered by the object from which it is used:
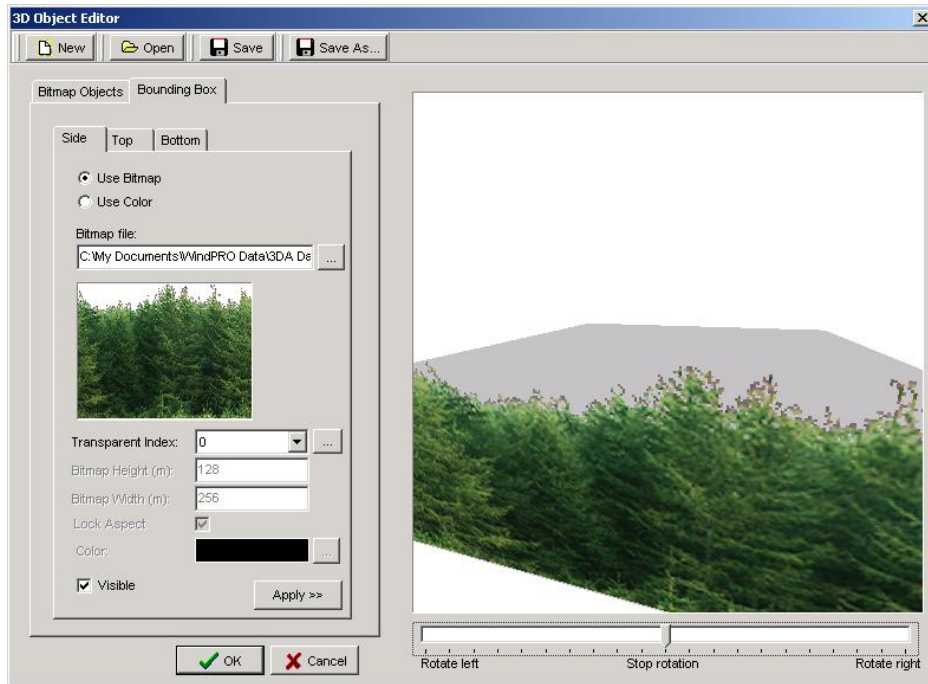
Bounding box (button, side and top) of the area
Free bitmap objects random distributed in the area

Both elements are entered when a 3DA file is added or edited from the 3DA bitmap editor/browser by clicking on one of the 2 leftmost symbols:

When 3DA file is added or edited, the 3DA file editor above show up.

Bounding box

The bounding box (the right tab sheet), gives 3 sub tab sheets, Side, Top and Bottom.

Each can be given a colour or a bitmap. In the example above a side is added. Note that sides always will be tiled and the object it is called from will control the height.

The bottom and top bitmap needs to be given a "real world" size. This information is used for tiling the bitmaps.

Below an example on a top is added. Note that there is gab between sides and top, while the side bitmap has a transparent part in the top of the bitmap. This is one reason for using bitmap objects like described in next paragraph instead of boundary box for a forest. But note that the bounding box work much faster (especially in a not to complex terrain), and if you only see it from the road, the boundary box is just as good as the individual bitmap objects.
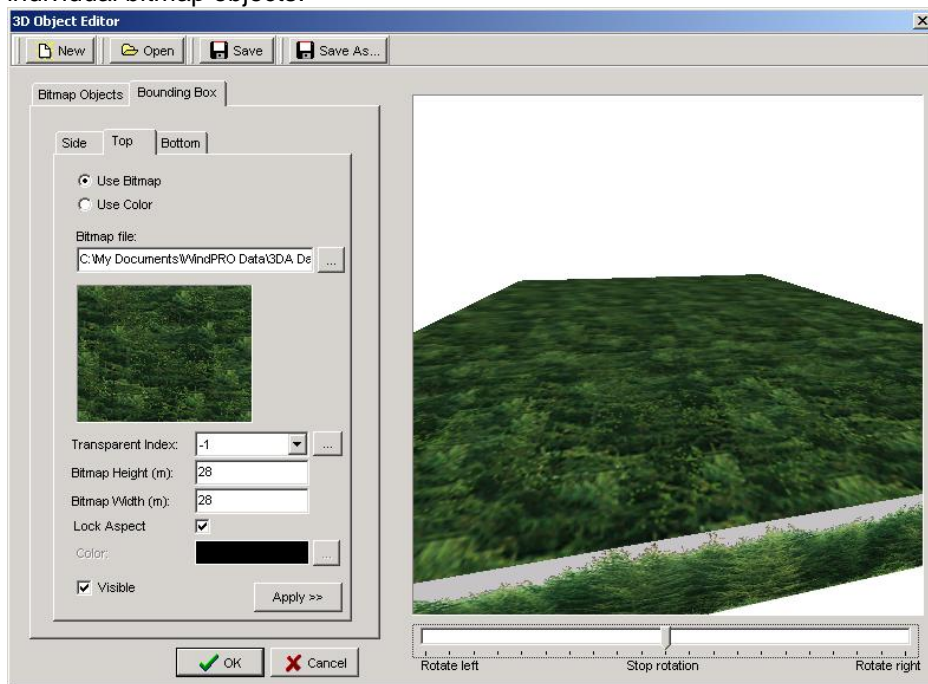
Bitmap objects

Left tab sheet give access to define random distributed bitmap objects.
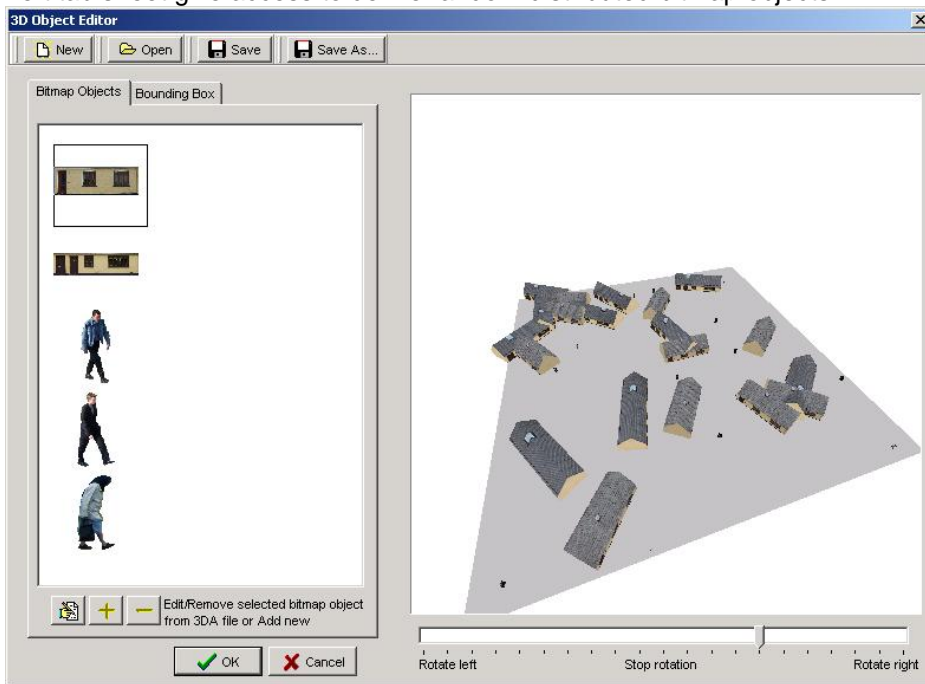
Here the edit-add-remove buttons are used to change which bitmap objects shall be included:
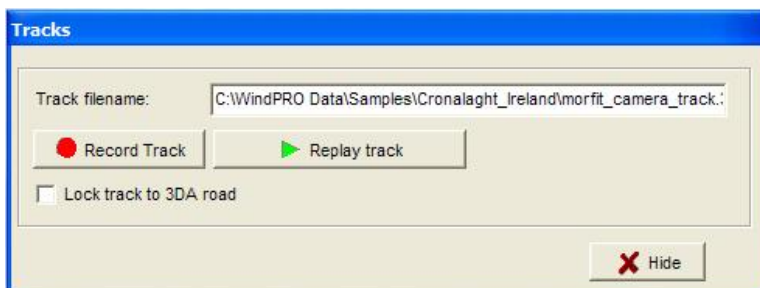

The edit and delete button are only active when one of the bitmap objects in the graphic list are selected.

By right click or double click on one of the bitmap objects, the bitmap object properties can be adjusted, e.g. the number of objects per 10 000 m2 (Ha).

5.3.6 Tracks

With the "Track" button on the VR Control panel, it is possible to start recording a track.

As soon "Record Track" is clicked, the recording starts. You can now move freely around and the 3Danimator register all movements, including pan, tilt and zoom. Click again at the "record" button, and it stops recording.

Now the "replay track" can be used to let the PC automatically run through the same track again and again until the user stops by clicking again on "replay track".

3D-animation

It is possible to change the name of the file where the track is stored, and in that way to create and store different tracks.

5.3.6.1 Lock to track

As described in section 5.3.4 a line object can be given the special purpose "road". This gives 2 possibilities:

It can show a road bitmap in the 3D animation
It can be used as a track the camera "lock" to.

Both can be used individually, but of cause also in combination, so you see the road you follow.

When the track is locked to 3DA road, the camera moves to the starting point of the 3DA road (also if it is outside render area), and the normal move functions works, except for the "turn left/right" functions – these are locked to follow the road. Instead the "Pan left/right" can be used.

5.3.7 Stand alone 3D-animation

3D animation created in WindPRO 2.7 can be played remotely from WindPRO with full user control of views through the EMD viewer shareware program.
Whenever a 3D-animation is created from a VR object in WindPRO (see chapter 5.3.2), a folder containing all the needed files is automatically created.
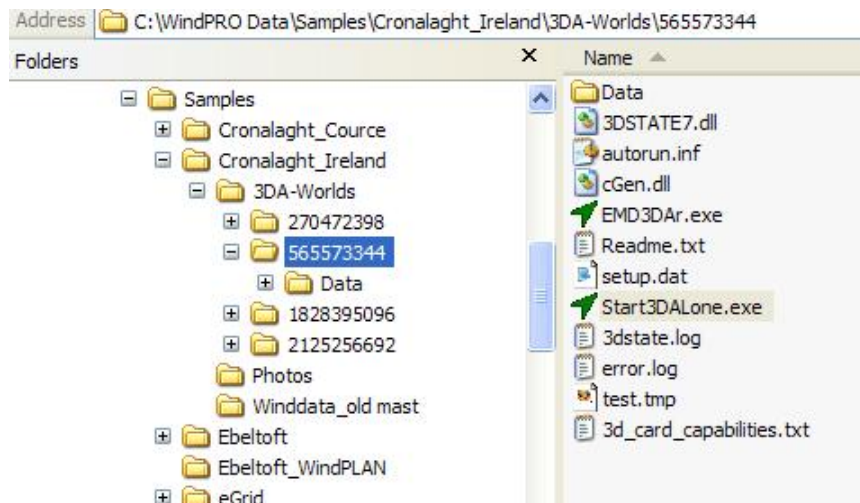

The folder is created under a 3DA-Worlds folder in the current WindPRO project folder. To run the animation, the viewer has to select Start3Dalone.exe.
This folder can be mailed to make the 3D-animation run independently on any computers. It is also possible from the Rundata tabsheet of the VR object properties to burn the 3DA directly on a CD.
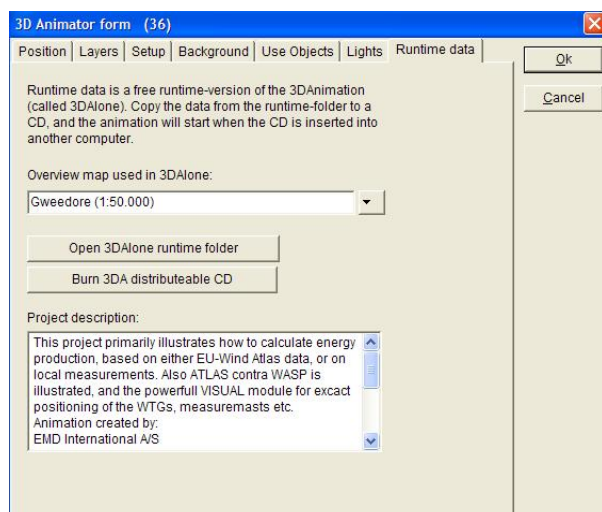
The picture below shows how the 3DAlone program will run the animation externally of WindPRO.
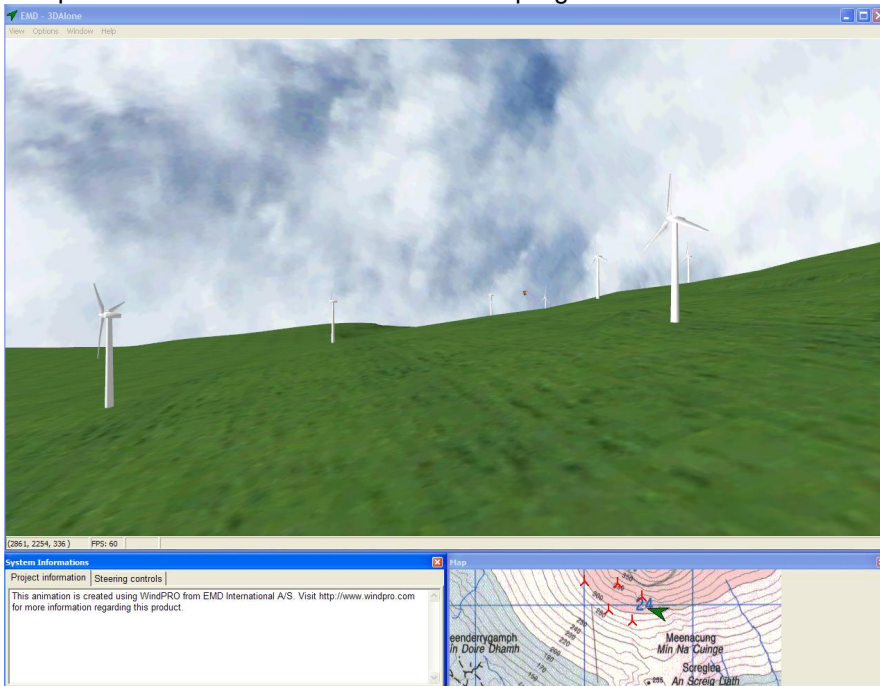
The animation is displayed in the upper frame where the user can fly in the 3D world in the same way as this is done in WindPRO (with the arrow keys, the mouse or a joystick). But it is also possible to define the steering controls manually from the frame at the bottom on the left.
The project description made by the creator is shown in this left part of the program. On the right at the bottom, the viewer can follow the moving on the background map. These settings are described in chapter 5.3.2.5 Runtime data tab sheet.

Note that WindPRO has to be shut down to be able to run the Stand Alone 3D animation program.

Please note that your monitor may give resolutions up to 1024x768 pixels or higher – a very high resolution compared to other 'traditional' video sources.