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7.0 windPRO Visual

7.0.1 Introduction to Visualizations

The windPRO visualization modules are tools to assist with the assessment and 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 many of the turbines on the market has been entered in the turbine catalogue (as described in Chapter 2, BASIS). This way, one has only 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 wind turbines, windPRO can visualize Solar PV panels when combined with the Solar module. windPRO can actually visualize any objects defined as a dae file via the 3D object, such a power transmission lines, buildings ... Finally, the line- and area object, WASP obstacle and METEO object can be used in visualizations, which makes it a powerful tool for controlling the data used in energy calculations.

Visualizations can roughly be divided into the following types:

- A photomontage in which turbines and/or Solar PV panels are placed in a landscape photo.
- A landscape analysis where turbines are placed in an artificial landscape calculated via digital elevation data s in order to evaluate a project from any position contrary to the above where the positions are “locked” by the specific points from which photos are available
- A “fixed position” animation (2D animation), where the rotor of the turbines rotate on a photomontage, which can be published on the Internet.

Finally, the SketchUp Integration module allows to connect windPRO (and photomontages) to the SketchUp software, which is an advanced 3D editing software. No special skills in SketchUp are required, the Integration module makes it easy and fast to benefit from all the options offered in SketchUp.

7.0.2 Step-by-step guide Performing Photomontage

See also the [introduction video](#).

- ❑ Establish map and proposed turbine/solar PV panels project (see BASIS 2.0.5)
- ❑ If available, load elevation data into a line object or elevation grid object. Use the **Automatic Z value from DHM** for all objects and cameras (can be applied using the MultiEdit function)
- ❑ Establish a camera object. Pick the red camera object from right menu bar, place the cursor where the photo is taken, click once, and click again near the site, in the general direction in which the photo was taken. Load the photo (or switch on **Artificial surface**), set date, time and focal length if available (if EXIF data in the photo file, these are automatically loaded).
- ❑ Click OK to launch the photomontage window. Insert control points on the map as reference objects which are visible on the photo.
- ❑ Calibrate the camera model – this is best achieved using control points – Adjust pan, tilt, rotation and focal length in the left menu bar of the photo as required. Remember to adjust z-values to reasonable ones (especially if you don't use height contours) in order to get your sketch turbines inside the photo.
- ❑ The horizon line (in yellow) is very handy to check the camera model. The yellow line must follow the landscape on the 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: By default, all objects in visible layers are rendered, so use the layer structure (see Chapter 2.11 BASIS) to select which turbines, PV panels, 3D objects to render.
- ❑ Rub out parts of turbine or PV panels that should be behind trees etc.



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

7.0.3 Step-by-step Guide Performing 2D-animation

- ❑ Continue from 7.0.2 If rotor parts will be behind trees etc. during rotation, rub these parts (even if no turbine part is visible, rub out in any case – finally render the turbine on top of the part to be rubbed out to make sure that the right pixels will be removed.
- ❑ Click on the red button in the photomontage (**Create animation**) in the top toolbar.
- ❑ Save the animated "movie" in windPRO format or other and start animation.
- ❑ You can now send the animation file or use it on a web site using the flash format.



7.1 VISUAL – Photomontage

7.1.0 Introduction to Photomontage

A photomontage means to take a photo and then superimpose the proposed changes (i.e. 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, for example, local obstacles or positions of measurement 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 logging 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 are extremely important for measurement masts.

7.1.1 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, PV table or any 3D objects into the image with the correct proportions. The surface of the rendered object 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 viewing direction. The weather is described through simple choices such as: clear sky, light overcast, heavily overcast, etc.

7.1.2 Photographing

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 70 mm, however local regulations may stipulate a specific value. 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 field of view on the 36x24mm film format which corresponds to approx. 43°. If possible, use a fixed focal length 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.

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

The photo should be taken in landscape format, although the software also works with portrait format, which sometimes can be useful, for example, 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 perfect stitching of the individual photos. Make sure that all images are taken from exactly the same viewpoint (the rotational plane 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.), although local authorities may instruct you to use specific viewpoints.

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 and/or a manual positioning from an aerial map with high resolution.

7.1.3 Making a Photomontage

In the following, a typical procedure for the photomontage work will be outlined from the point where the photo is saved on your local or network drive.

Some examples can also be found on the DEMO projects, included in the windPRO installation (in folder windPRO Data\Samples\, see BASIS manual to download the Sample projects).

Check also EMD's YouTube tutorials to get inspiration on different visualization related topics:

<https://www.youtube.com/watch?v=ecwQZR1hJfU&list=PL6zroSoHTqaNZw8Pd7749w8cZSKYshOxY&pp=iAQ B>

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.

7.1.3.1 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.

7.1.3.2 Visualized Items

On the map you can then enter turbines and other objects directly on-screen.

1.3.2.1 Wind turbines,

You will find a detailed description of how to input turbines in BASIS Chapter 2.5.

The appearance of a given turbine model rendered in a photomontage is defined in the visual data of the turbine type in the wind turbine catalogue (see section 2.6.4.6 Chapter 2. BASIS). If no visual data is available, a standard model will be used.

Note that the angle of the blade rendered in a photomontage is defined under the **Rotor angle** input in the Visual tab of a given wind turbine object (see section 2.5.2.4 Chapter 2. BASIS). If no value is defined, windPRO chooses a random value.



1.3.2.2 Solar PV panels



Solar PV panels are entered as areas filled with solar panels. For more information, please refer to Chapter 14.

1.3.2.3 3D objects



The 3D object can be used to visualize objects, other than wind turbines/PV panels. It can also be used as a masking object.

A 3D object is defined by an external dae file that needs to be created in another software (like SketchUp) and linked to. For example, it could be a power line tower, transformer, trees, any building.

The 3D Object is inserted on the map at the relevant position.

3D Object (3D Object: Trafo green 5x2 m.dae (21))

Position Layers 3D Object Preview DAE Description

Object file (.dae):
C:\Users\Karina\OneDrive - EMD International A S\Documents\WindPRO Data\3D [...]

Orientation
Rotate: 0.00 °
(Around Z-axis)

Scaling
 No scaling
 Scale by factor

Row of objects
Number of: 3
Angle: 0.00 °
Distance: 100.0

Scale by factor
Width factor: 1.0000
Depth factor: 1.0000
Height factor: 1.0000

Illuminate with ambient light
Intensity: _____

Show 3D wireframe on map
 Show 3D wireframe on Photomontage
 Use as masking object

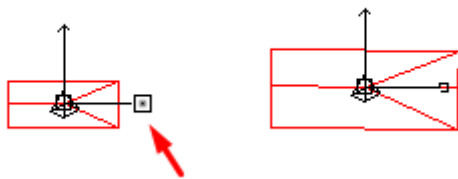
Ok
Cancel
Prev
Next

Orientation: the 3D object is defined in the dae file with a certain orientation. This orientation can be changed by a rotation around the z-axis. The orientation can also be changed manually from the map: select the 3D object on the map and an arrow pointing into the direction given by the orientation input will be shown. The arrow can then be rotated to change the orientation.

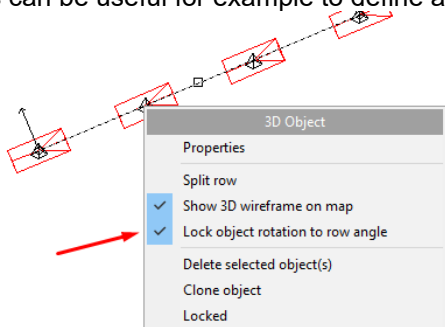


Note that the wireframe view of the 3D object on the map can be useful to check that the 3D object has the orientation as wished. The color of the wireframe can be changed from the Position tab of the 3D object.

Scaling: With no scaling the absolute dimensions of the 3D object are used, whereas scaling by a factor allow to change the dimensions of the object along the 3-axis x (width), y (depth) and z (height). The resulting size of the object can be seen on the photo before rendering as a white wireframe on the symbol layer. The scaling can be changed manually from the map as well, provided the option Scale by factor has been selected in the object properties: select the 3D object on the map, click on the small square at the end of the line perpendicular to the arrow and drag to change the dimension. Note that the same factor is applied to all three dimensions.



Row of objects: when the number of objects in a row is increased, the 3D object is reproduced on a line with a regular spacing. The orientation of each 3D objects of the row can be locked to the angle of the row: changing the angle of the row will automatically adjust the orientation of each 3D object by the same change. This can be useful for example to define a fence. The option is available with a right click on the map.



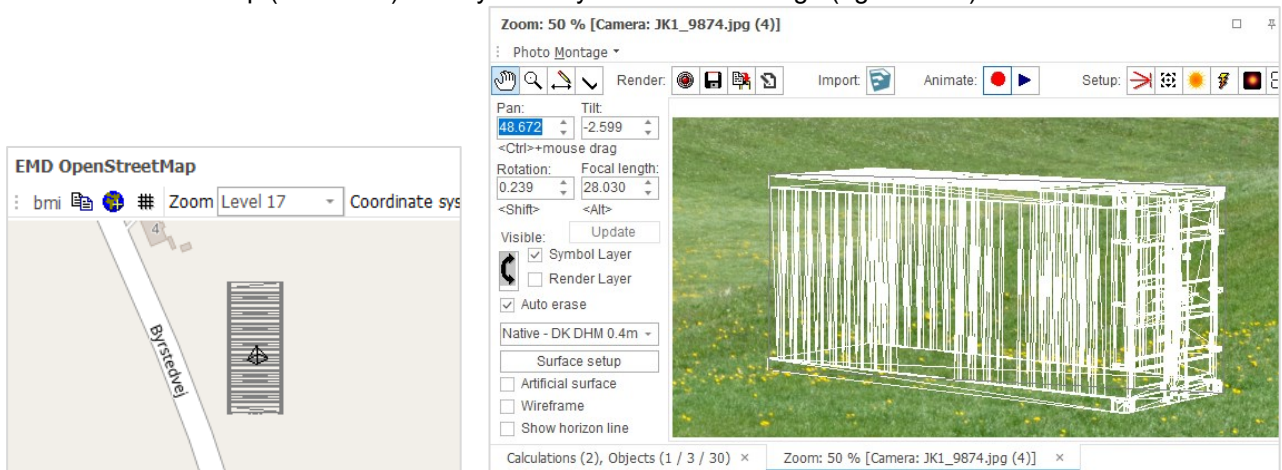
Illuminate with ambient light can be checked to ignore the reflections and shading that can be contained in the texture of the dae file. Below is an example with (left) and without (right) the option.



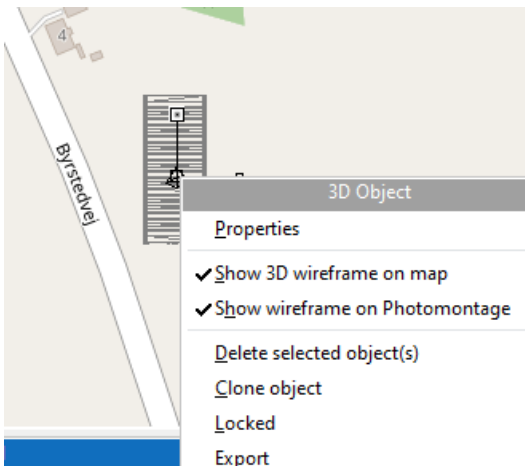
With this option, the sun position is ignored, and the object is illuminated equally from all sides. The intensity of the light can be adjusted using the slider. When the slider is at maximum, the object is fully bright, and when it is at the minimum it is black.



Show 3D wireframe on the map and **Show 3D wireframe on Photomontage** can be unchecked from the object to save time, visualizing the dae file when it contains many details. By default, the dae file is indeed visualized on the map (left below) and Symbol layer of Photomontage (right below)



Note that it is also possible to show/hide the wireframe of the 3D object from the map by ticking **Show 3D wireframe on map** or **Show 3D wireframe on Photomontage** available from the right click menu of the 3D object.



When **Use as a masking object** is selected, no rendering of any objects (WTGs, PV panels, artificial surface/grid ...) located behind the 3D object will be rendered. The 3D object will not be rendered either. This option can be useful for example for objects placed in between rendered elements, where the rubber tool cannot be used, like a building between two rows of PV-panels. Examples of dae files that can be scaled are to be found in \WindPRO Data\3D.dae_models\Glare Reflectors.

Preview DAE: the dae file can be viewed on the Preview DAE tab. Use the arrows in top right corner to rotate the view.



In windPRO, dae files are available under \WindPRO Data\3D.dae_models with examples of fences, offshore substructure, transformers, met tower, trees, ...

It is also possible to add user defined dae files following these recommendations:

- Maximum number of polygons of 10000
- 3D object placed at the origin in SketchUp (so that it is placed on the map in windPRO at the intended coordinates)
- be aware of the orientation and the dimensions in order to adjust the setup (orientation and scaling) in windPRO accordingly.

Note that with the SketchUp integration module, dae files can easily be exported from the very extensive SketchUp warehouse to a 3D object in windPRO (see 7.3 and video https://www.youtube.com/watch?v=PDNG2_jaWHM&t=160s @ 20:15).

1.3.2.4 Line object

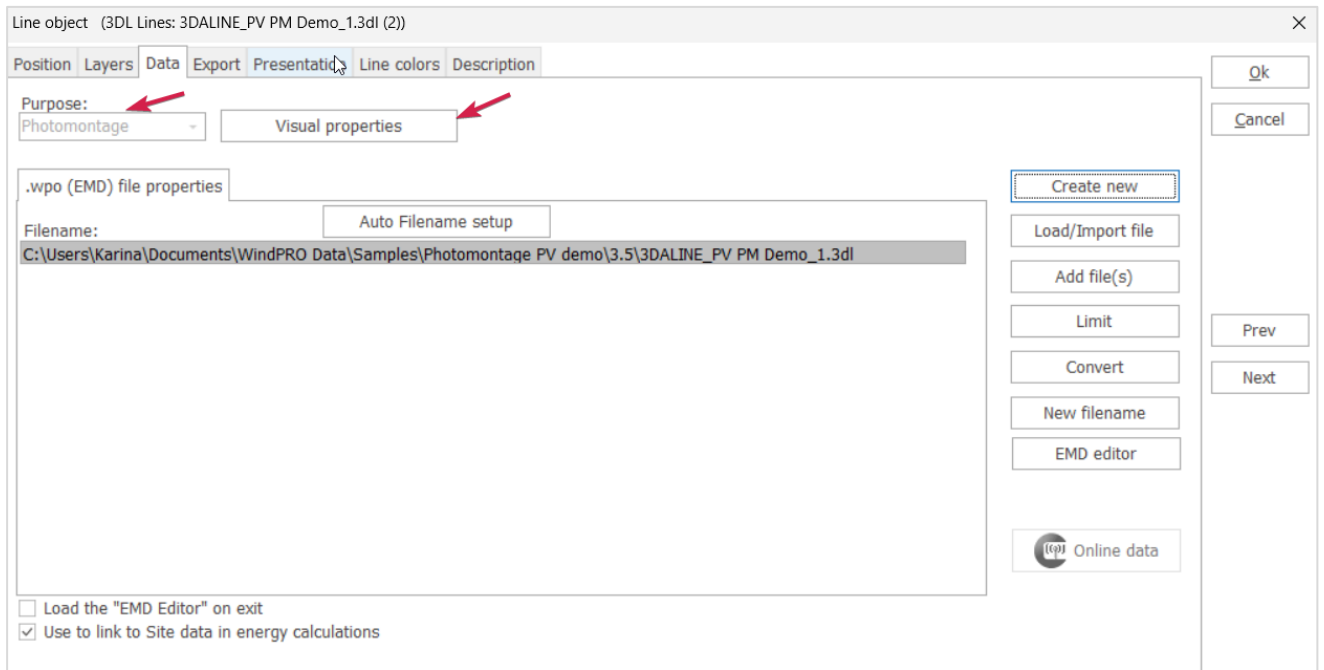


A line object can be used 2 different ways in a Photomontage:

- As an area with a height, where a 3DA file can be attached – e.g. a long row of trees, a fence.
- As a 2D feature, such as a road, where a bitmap showing a “road part” can be attached.

The purpose on the Data tab of a line object shall be Photomontage.

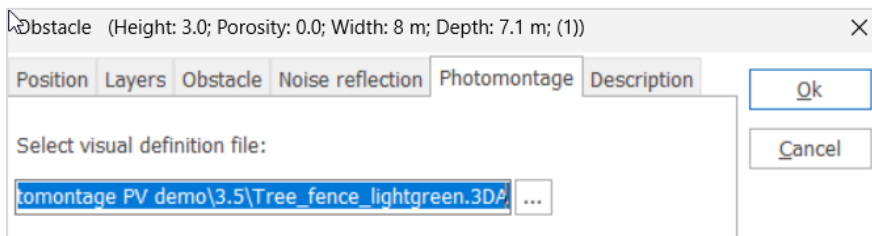
Then the selection of the visual option is made by clicking on Visual properties.



1.3.2.5 Obstacles and areas



A WASP obstacle can be “filled in” with a 3DA file (typically trees). The dimensions (height, width and length) must be specified on the Obstacle tab.

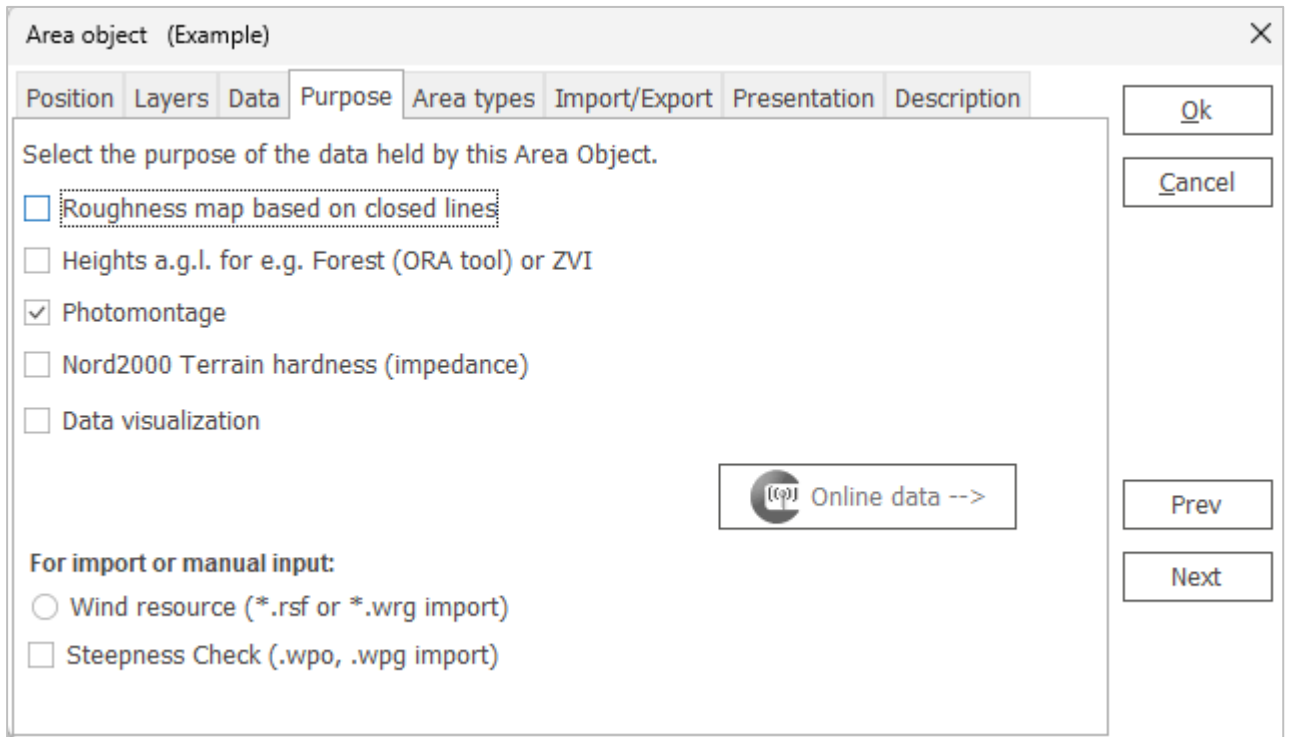


See an example in 7.1.3.16.

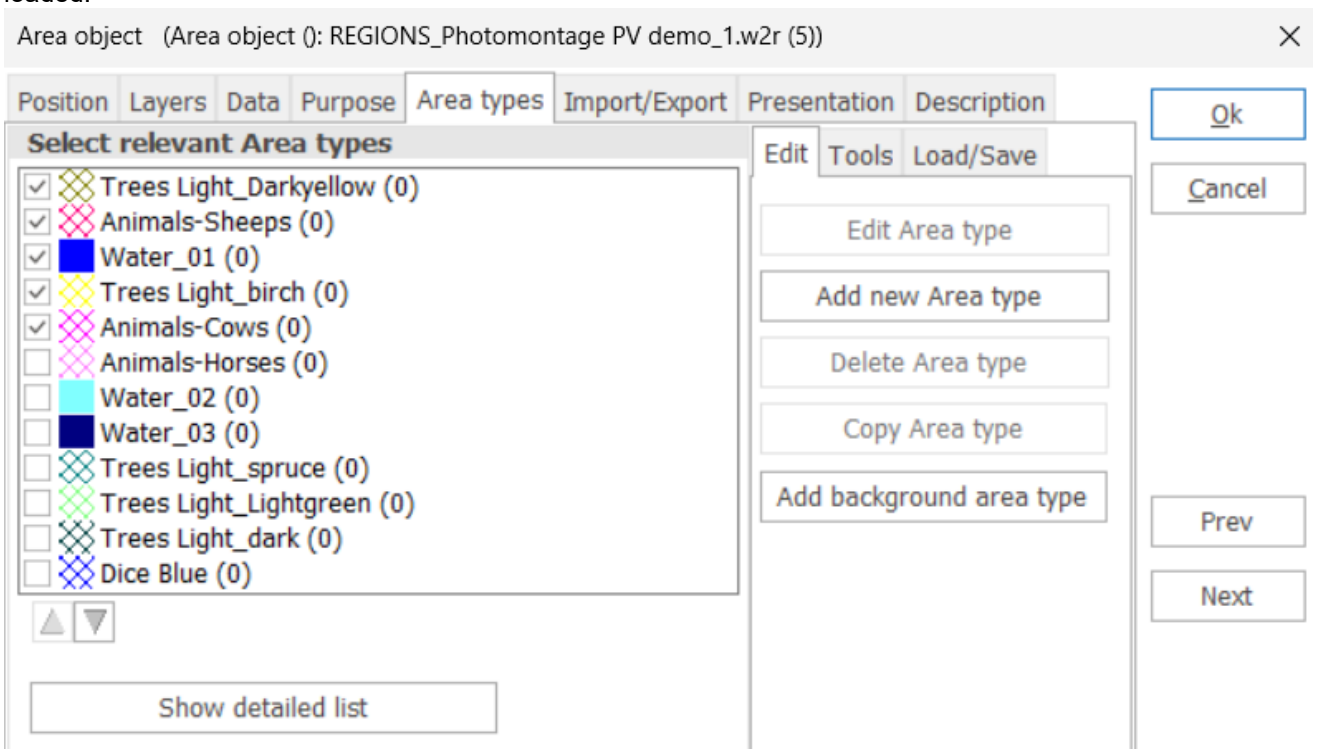


Larger regions as water, forest or cities can typically be incorporated through an area object. A 3DA file can be attached.

The purpose of the area object shall be set to Photomontage.



Under Area types, the pre-defined layer types available in the folder Standards of windPRO data can be loaded.



See an example in 7.1.3.16.

For more information about working with an area object, please refer to BASIS, chapter 2.9.3.



7.1.3.3 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 with a first click at the position from where the photo was taken (the Camera Point). Drag the camera line to the target point of the photo and click a second time to create the object. The camera object can also be created by dragging the photo file (from Windows) to its expected position on the map (in windPRO). In this case, if the coordinates are known from the EXIF file, the object will be moved to the registered position. If the direction is not available in the EXIF file (no compass in the digital camera), the camera object will automatically be pointing at the site centre. Several photo files can be dragged at the same time: one camera object will be created for each of these.

The properties of the camera object will pop up automatically when it is created. 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 – Camera tab

Camera (Camera (6))

Position Layers **Camera** Photo/Background Render Settings WTG Use Objects Artificial surface

Projection

Planar (normal photo)

Cylindrical (stitched panorama image)

Tilted turning axis

Focal length, lens: Horizontal field of view:

Auto-calculate film format.

Film format:

Camera Position

[More decimals?](#)

Easting Pan Angle:

Northing Tilt Angle:

Z (Offset): Rotation Angle:

Automatically from TIN (35.3 m) Arrow length:

Symbol color: Use as default color for new camera objects

Open photomontage when click Ok

Projection: Planar (normal photo)

Planar is to be selected for a photomontage based on a single photo.



The **Focal length** is the main parameter to be input. It is used together with the film format to calculate the dimension of the rendered object.

The focal length can be:

1. read automatically from the EXIF data of the photo file (see Photo/Background tab).
2. known from the lens used, especially when taken with a fixed lens (no zoom) or with minimum/maximum zoom. The focal length of the lens will normally be indicated on the lens, or it can be found in the technical specification of the camera.
3. found through the Camera model calibration process with the aid of good control points (described in 7.1.3.5)

Note that very small deviation on the focal length (defined from 1. or 2. above) may be necessary to compensate the light distortion that can be due to the transfer or the variation of the temperature. It is thus always recommended to check the focal length value with control points.

The focal length shall be input as the so-called 35 mm film equivalent focal length (related to the traditional 36x24 mm film format).

If the 35 mm film equivalent focal length is not available in the EXIF data, the focal length of digital camera has to be corrected to the 35 mm film equivalent focal length. The correction factor (typically varying from 1 to 6) can be found in the technical specification of the digital camera.

General information about focal lengths (36x24 mm film format):

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

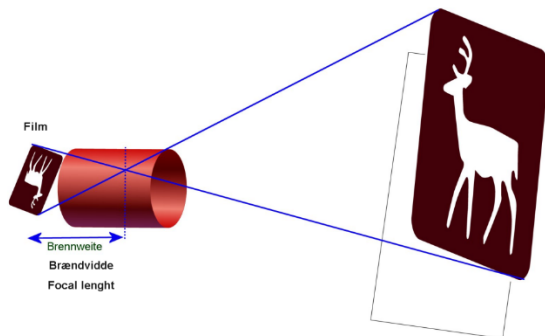
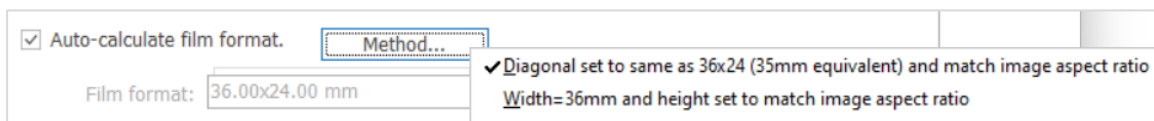


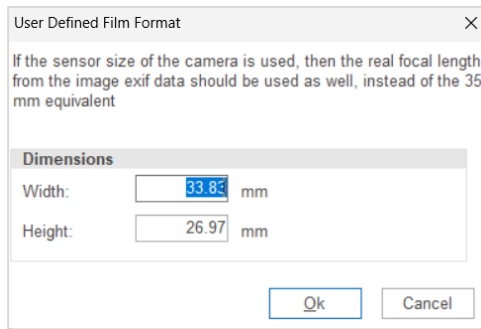
Figure 1 The illustration above shows how the image will be mirrored through the lens. The focal length is the distance in mm between the sensor surface or film negative and the crossover point.

Film format

With **Auto-calculate film format**, windPRO automatically calculates the “film format” (equivalent to sensor size for digital camera) based on the picture size. The Method to calculate the “film format” used by default keeps the diagonal similar to the one from a 35 mm film. With the second method, only the width of the image is set to 36 mm. This second method is to be used in special cases where the image has been cropped in height. Please note that if a photo has to be cropped it is preferable to crop the photo only once the Photomontage has been rendered.



Mainly for analogue photos, in some very special cases (cropped scanned analogue images), the film format can be user defined.



Projection: Cylindrical (stitched panorama image)

Cylindrical is to be selected for a photomontage based on stitched pictures.

The **Horizontal field of view** (FOV) is the main parameter. The dimensions of the photo (number of pixels) associated to the field of view will 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. Some stitching software can give an indication of the value of the resulting field of view obtained after stitching. Even then, the final field of view should be determined by calibrating the photomontage with control points (as described in 7.1.3.5).

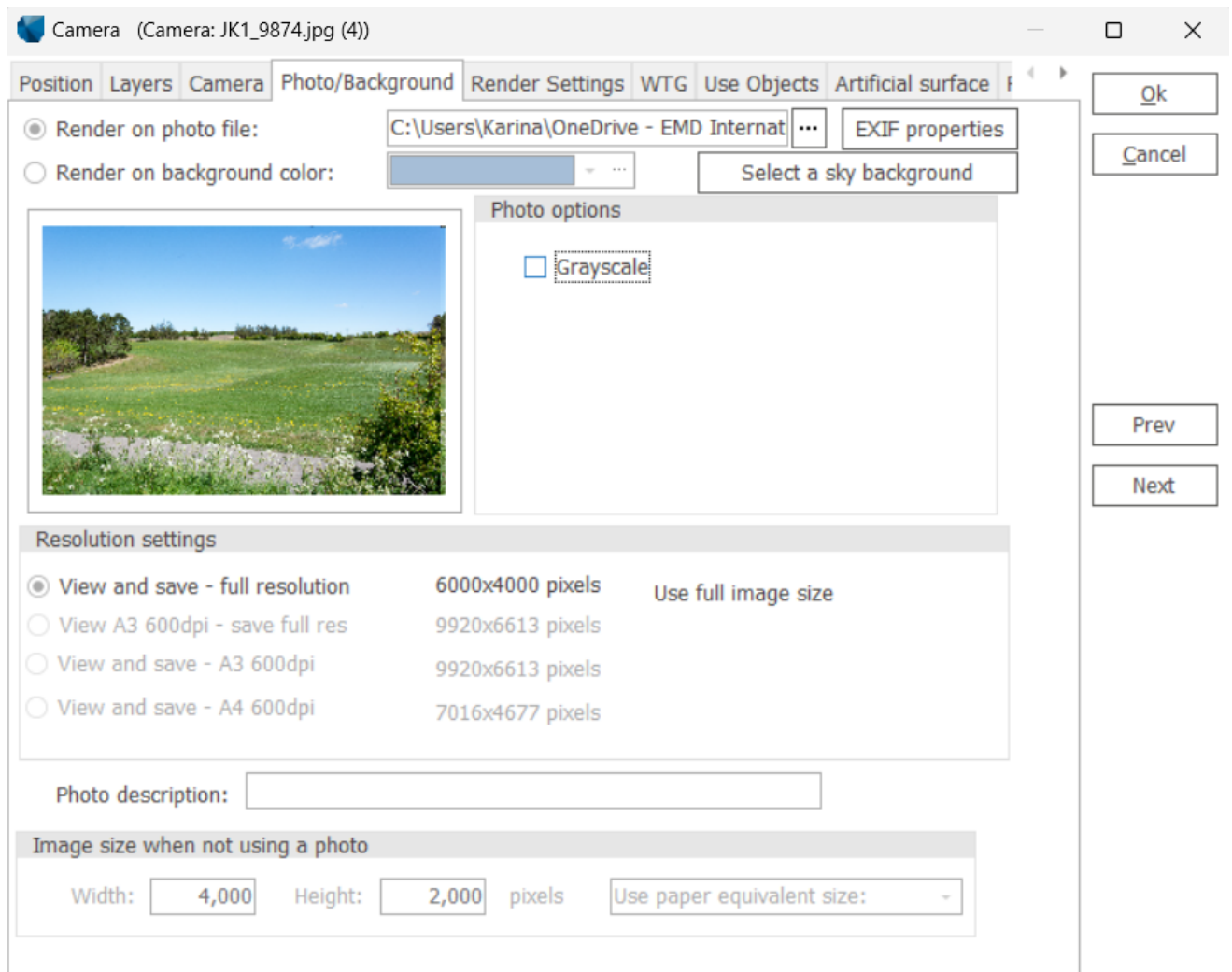
By default windPRO assumes that the individual photos are taken around a vertical axis and that the stitching of these is made on a cylindrical projection. If this is not the case (for example, if the photos are taken on a tilted axis) the option **Tilted turning axes** should be checked. The horizon line is then bent on the edges to match the panorama.

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 centre-line of the image) ends the definition of the camera model. In most cases, you will have to know the exact Camera Position, which significantly helps 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 – Photo/Background tab



It is possible either to make a photomontage with a photo file or to visualize the objects on a plain background (together with artificial surface, see 7.1.4.2).

To make a photomontage, select the file of the single photo or panorama to be used by clicking on the three dots button next to **Render on photo file**.

EXIF properties

If the photo file includes EXIF properties (such as the date and time, the focal, length, coordinates, etc.), the EXIF Data window will pop up so you can decide which properties is worth importing to **Import to Camera**. From the form you can, for example, input the conversion factor to convert of the focal length to the equivalent 35 mm focal length. The conversion factor can usually be found in the technical specifications of the digital camera. The conversion factor is saved for the Camera model and make 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.



	EXIF data	Conversion	Result	Import to Camera
Filename	C:\Users\Karina\Documents\Projects\Cli		Fotopunkt 9	<input type="checkbox"/>
Camera Model	iPhone X		(to be used in Object and Photo description)	
Camera Make	Apple			
Camera Lens	iPhone X back dual camera 4mm f/1.8			
Focal length	4 mm	x 1.0000	4.00 mm	<input type="radio"/> No focal length
Focal length 35 mm equivalent	28 mm		28.00 mm	<input checked="" type="radio"/>
Date & Time	21/04/2021 11.24.46	+ 0	21/04/2021 11.24.46	<input checked="" type="checkbox"/>
X-coordinate	10.457947		592,838	<input checked="" type="checkbox"/>
Y-coordinate	55.181111		6,115,915	<input checked="" type="checkbox"/>
Z-coordinate	60.03		60.030 m	<input type="checkbox"/>
Direction	158.20		158.20	<input type="checkbox"/>

Save conversion data for this camera model

Ok Cancel

Photo options

Check the grayscale option to convert the selected photo to a black and white version. This view can be useful to enhance the visibility of the rendered 3D elements (wind turbines, PV panels ...) in the landscape.

Resolution settings

Working with large photos slows down the performance of the PC. Therefore, different options of image resolution are available.

With the setting **View and save – full resolution**, the original image file is used both in windPRO (for viewing, calibration, rubber tool) and for the output when the photomontage is saved. However, for very large files (typically when photos have been switched into a panorama), the calibration process can become very slow and windPRO can run out of memory. In this case, it is relevant to decrease the resolution and even more when the resolution is over dimensioned for a given purpose of photomontage output, typically as A3 or A4 prints.

With **View A3 600 dpi – save full res**, the resolution of the image is decreased in windPRO for the viewing/calibration and in the VISUAL report. The full resolution is kept when the image is saved as output and when the advanced rubber tool is used. But the work process is faster. The decrease of resolution corresponds to the resolution requirements to get the photomontage filling an A3 format with 600dpi.

With the setting **View and save - A3 600 dpi**, it is not only the image in windPRO which is scaled to the dimension of a full A3 print (with 600dpi resolution) but also the output. This allows to avoid huge output images that will have to be scaled down to a normal A3 print format. The photomontage will furthermore be generated faster than when the full resolution is used.

The setting **View and save - A4 600 dpi** is similar to the above option but with a scaling of the image in windPRO and as output to the requirements of a A4 print format.

A short Photo description text can be added, which will then be included in the VISUAL reports (see 7.1.5.1).

Render on background color

If you do not have any photo from the site, the tool can be used with a background and an artificially-rendered landscape based on height contour lines (TIN model). In this case select **Render on background color**, select a color or alternatively a sky background and go the **Artificial surface** tab (see 7.1.3.9). The number of pixel (and thus the quality of the picture) can be increased in width and height at **Image size when not using a photo** (at the bottom). The upper limit for these values will be defined by the PC. It is also possible to select a size depending on the size of paper print.



Camera object – Render settings tab

Camera (Example of Photomontage)

Position Layers Camera Photo/Background **Render Settings** WTG Use Objects Artificial surfa

Date of exposure:(dd/mm/yyyy) 09/08/2023

Time of exposure:(:) 16.58

Defines sun position and thereby shading of rendered turbines.

Light - Weather type

Cloud coverage: Clear sky (0/8)

Visibility: Normal

Sun: Normal

Antialiasing

Extent: Normal

Antialiasing is a powerful tool to soften the edges of artificial objects rendered on the photo. Unfortunately it can consume a lot of memory, and slow down the rendering dramatically.

Ok

Cancel

Prev

Next

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

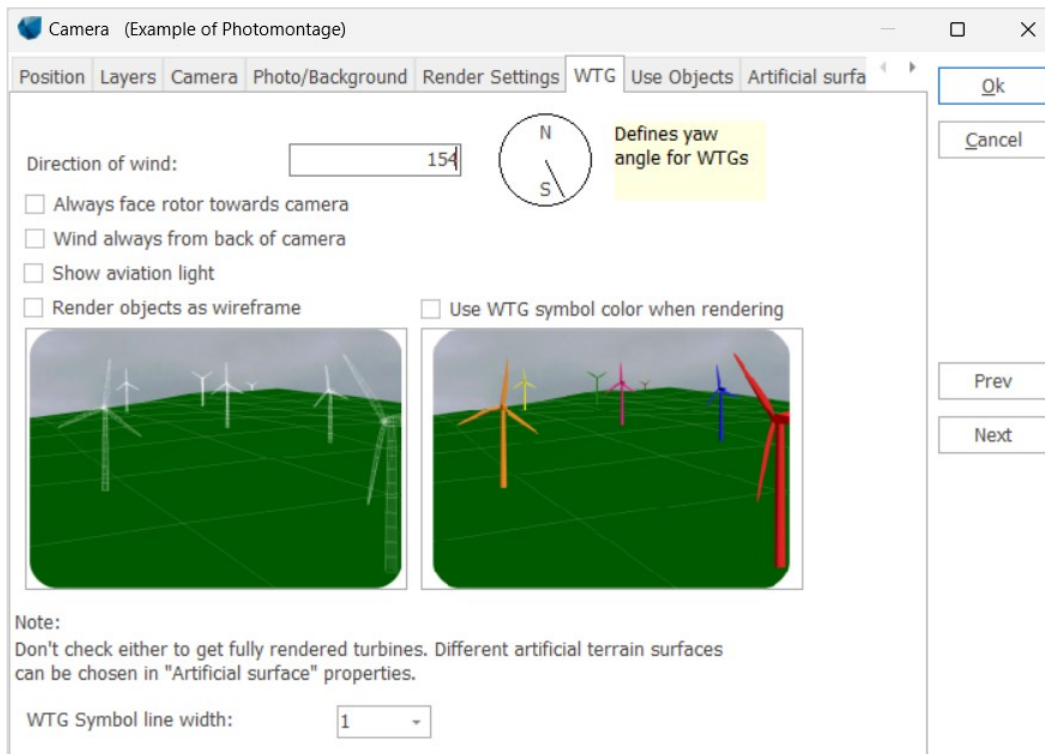
Date and Time of exposure control the angle of the direct light together with the geographic position and time zone. These are automatically set from the EXIF data if available.

Light - Weather type controls the light settings when the turbines are rendered into the image.

Antialiasing enlarges the photo in order to smooth the edges between the rendered turbines and the background photo. This can consume plenty of memory, but also improve the result significantly for a final presentation. So in the “experimental phase” this should be kept low and only put on maximum when rendering the final result.



Camera object – WTG tab



Direction of wind controls the yaw angle of the turbine nacelle. All turbines have the same setting. If the photo includes existing turbines or other objects, which indicate the wind direction, such as 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 pointing 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 turbine (cf. Section 7.1.3.17). 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. You can choose to generate only the wireframes of the turbines, 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. Colours are defined by the WTG symbols so you can clearly differentiate different projects by changing the symbol colours in the Object list.

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

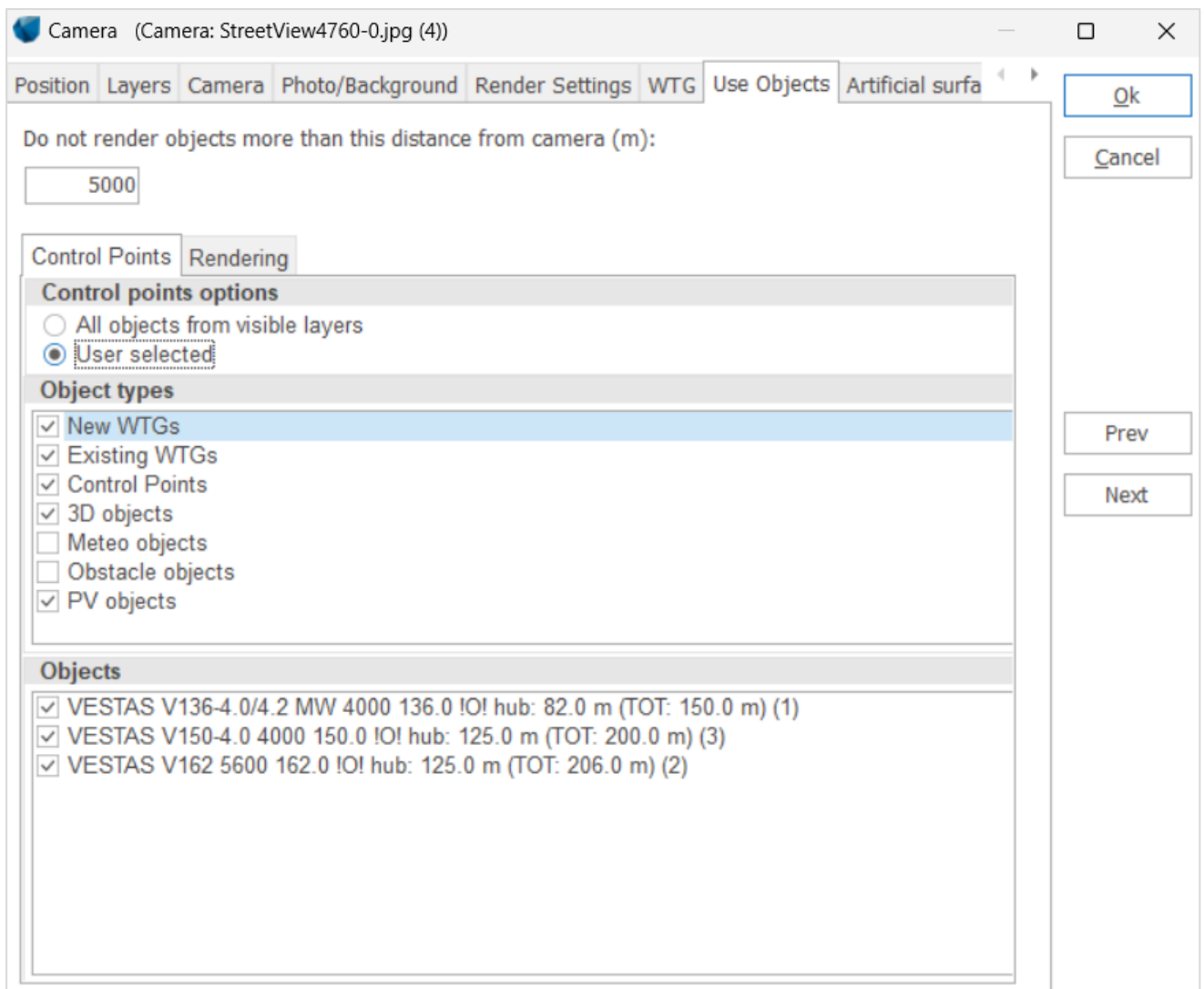
Use WTG symbol color when rendering: the virtual wind turbine is colored accordingly to the WTG symbol color.

Leaving both these options unchecked produces a photo-realistic WTG image.

WTG symbol line width allows to increase the thickness of the rotor presented in Symbol mode. This feature is mainly useful when the output of a photomontage includes the symbol view of the turbines. If the image has a high resolution, the width shall be increased to get the symbol visible. The unit of the number is the pixel width.



Camera object – Use Objects tab



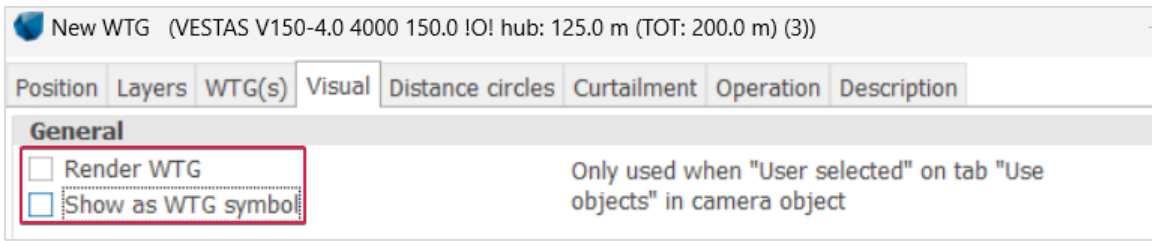
This tab decides which objects will be shown in the photomontage window. The objects selected on the Control Points tab will be shown on the Symbol layer of the photomontage, and the ones selected on the Rendering tab will be shown on the rendering layer of the photomontage (about the photomontage window see 7.1.3.4).

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 include or exclude specific objects.

Following objects can be used in photomontage:

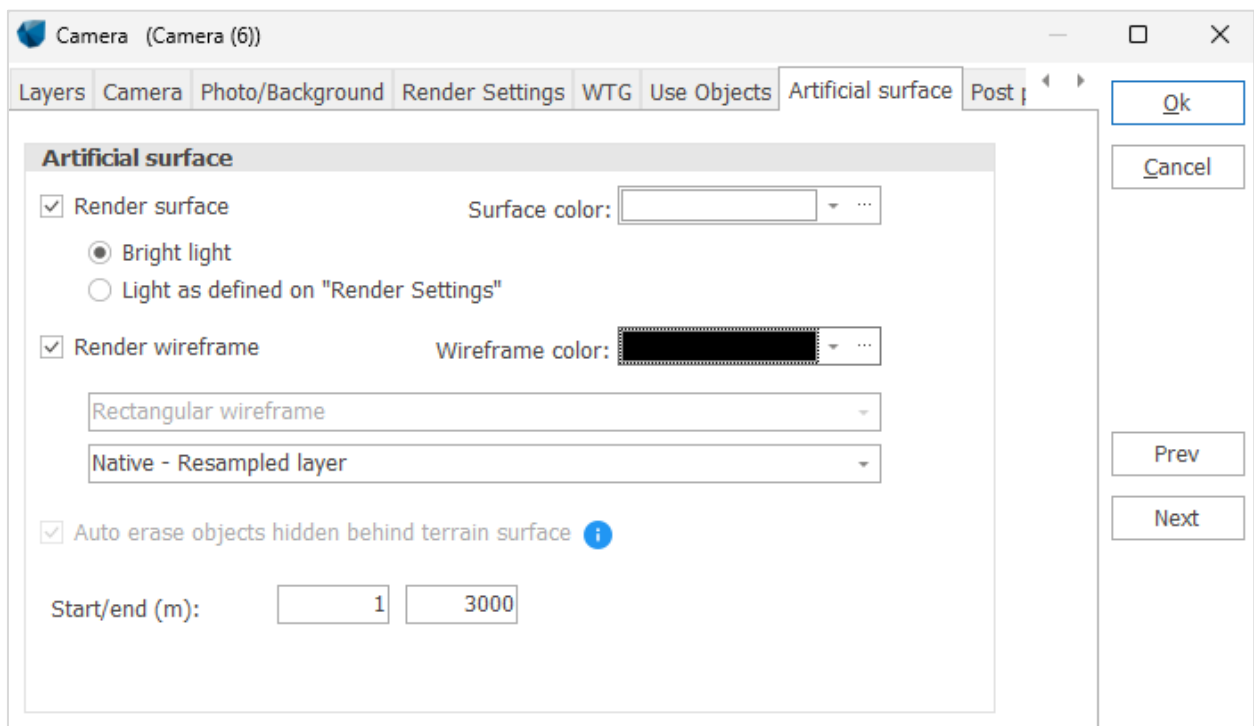
- Existing and new turbines
- Control points (only as control points)
- 3D Objects
- Meteo objects
- Obstacle objects
- Area objects (only for rendering)
- PV objects

Note that 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).



It is possible to limit the rendering of objects within a certain distance from the camera object to save some rendering time. By default, this distance is set to 5000 m. If objects are placed beyond this distance, a warning will appear while rendering to suggest for an increase of the distance to the visible object(s) to be rendered or not. The distance can be seen on the map with blue dashes as **MaxVisualDist**, when **Extended angle lines** of the Camera object is selected.

Camera object – Artificial surface tab



The rendering of artificial surface or wireframe 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. It should be noted that the processing time will increase significantly with distance; therefore the default value is kept rather low. Using the elevation grid object with the native grid resolution, handles very large areas extremely fast. More on artificial landscape is explained in 7.1.4.



Camera object – Post Processing tab

Camera (GPS 3 P6230101)

WTG Use Objects Artificial surface **Post processing** Rubber options Description

Save rendered result in file for post-processing

Output file: \\10.10.68.22\User\Karina\test\photomontage\Oappelstrup\Photos\gps3\25mmr ...

Backup existing file when creating a new (safer but consumes disk space)

Use image from above file in reports

Use this image in reports:

Report file: \\10.10.68.22\User\Karina\test\photomontage\Oappelstrup\Photos\gps3\25mmr ...

Post-processing is used when wanting to make enhancements to the rendered image in an external application before using the image in reports. Especially the rubber work be handled more advanced in other specialized tools (like Photoshop – see link to guide below). This can also be used to speed up the printing process in WindPRO, because the Photomontage is not re-rendered during report creation.

[Video: How to adjust colors and erase existing WTGs in Photoshop](#)

[Video: How to create rubber in Photoshop](#)

Field of view

Truncate the image to specified field of view, before saving or printing:

Truncate to this horizontal FOV (deg): 0.0 Max: 38.2

Truncate to this vertical FOV (deg): 0.0 Max: 29.1

Select position

Ok

Cancel

Prev

Next

In some cases, a photomontage made in windPRO can benefit being post-processed by specialized graphic editing software (such as Photoshop, GIMP). The two videos (linked from this tab), show examples of how to adjust the colors/light of turbines, how to erase existing turbines and how to use an efficient rubber in Photoshop.

The options for post-processing from windPRO allow to:

- 1) Create an output file that can be used in image editing software.
- 2) Use the resulting image from post processing in a windPRO VISUAL report (see Section 7.1.5).

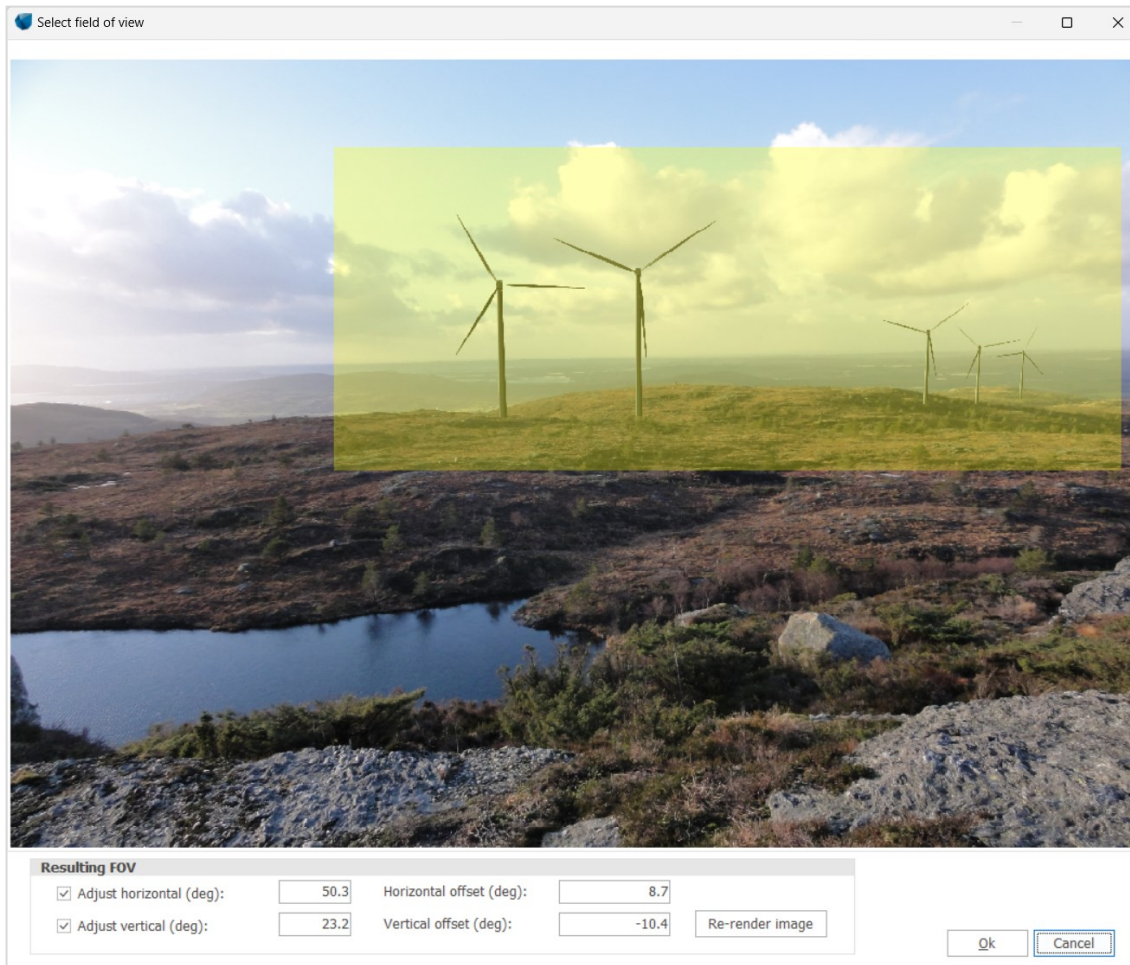
When **Save rendered result in file for post-processing** is checked an output file will be created every time the render button is hit. The name and path of the file can be defined manually if needed. By default, the output file is saved in the same folder location than the original photo. The output file can be saved as png, jpg, jpeg, tif, tiff and psd format. In the case of the Photoshop image (psd), two layers are created, the top layer being the photomontage and the lower layer being the original photo. **Backup existing file when creating a new** creates a backup of the output file modified by another software than windPRO when the render button is hit. When **Use image from above file in reports** is selected, the output file will also be used directly in the VISUAL reports instead of the file defined below in Use this image in reports. **Use this image in reports** tells which resulting image file from the post processing will be linked to the VISUAL report of windPRO for this Camera object.

Field of view (FOV)

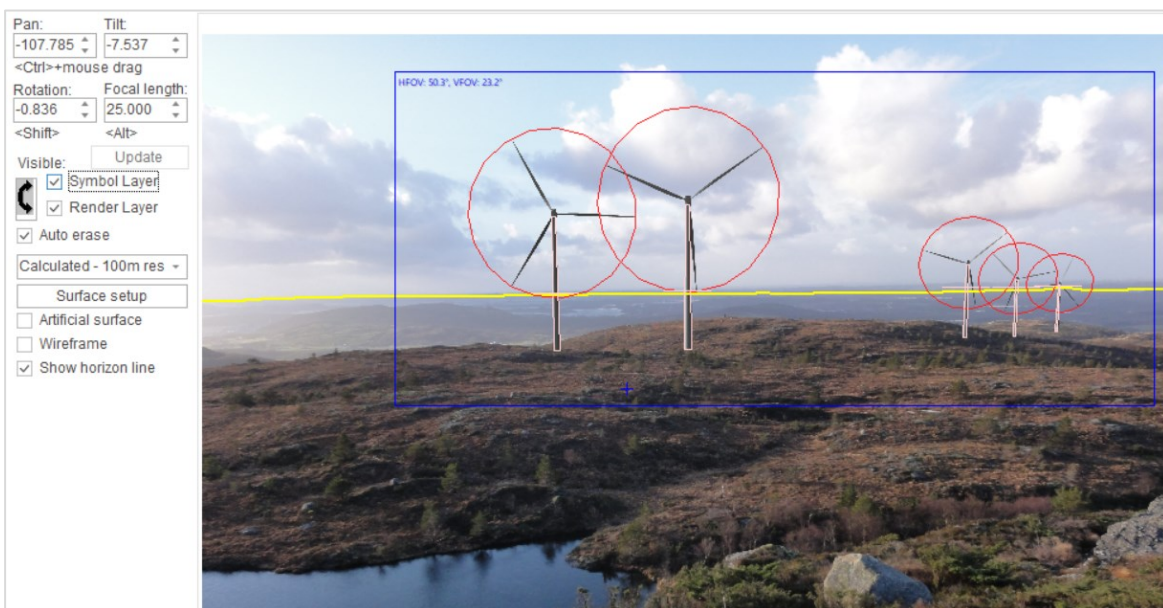
This option can be used to truncate a photomontage to a specific horizontal and/or vertical field of view. This is particularly relevant to get a standardized format for photomontages made from several stitched photos. When the option is selected, the photomontage is cropped accordingly to the horizontal and vertical field of view input in degrees. It is possible to select the part of the photomontage to be truncated: By clicking on **Select position**, the truncated area is shown in yellow in a new window. The size and position of the truncated area



can be adjusted from manual input of horizontal/vertical angle and offset, or graphically by dragging the area from the sides or center. The photo is truncated whenever the photomontage is saved or generated in the VISUAL reports.



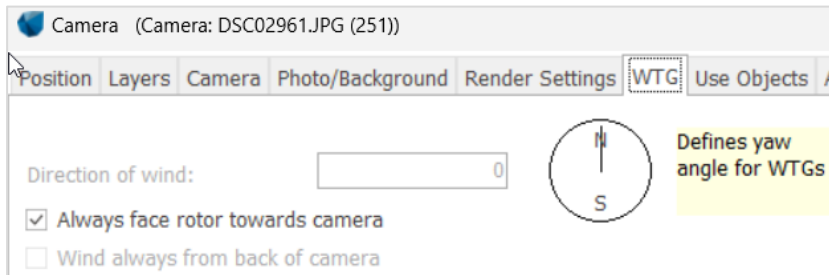
On the symbol layer of the photomontage, a blue frame shows what the photomontage will be truncated to when saved.



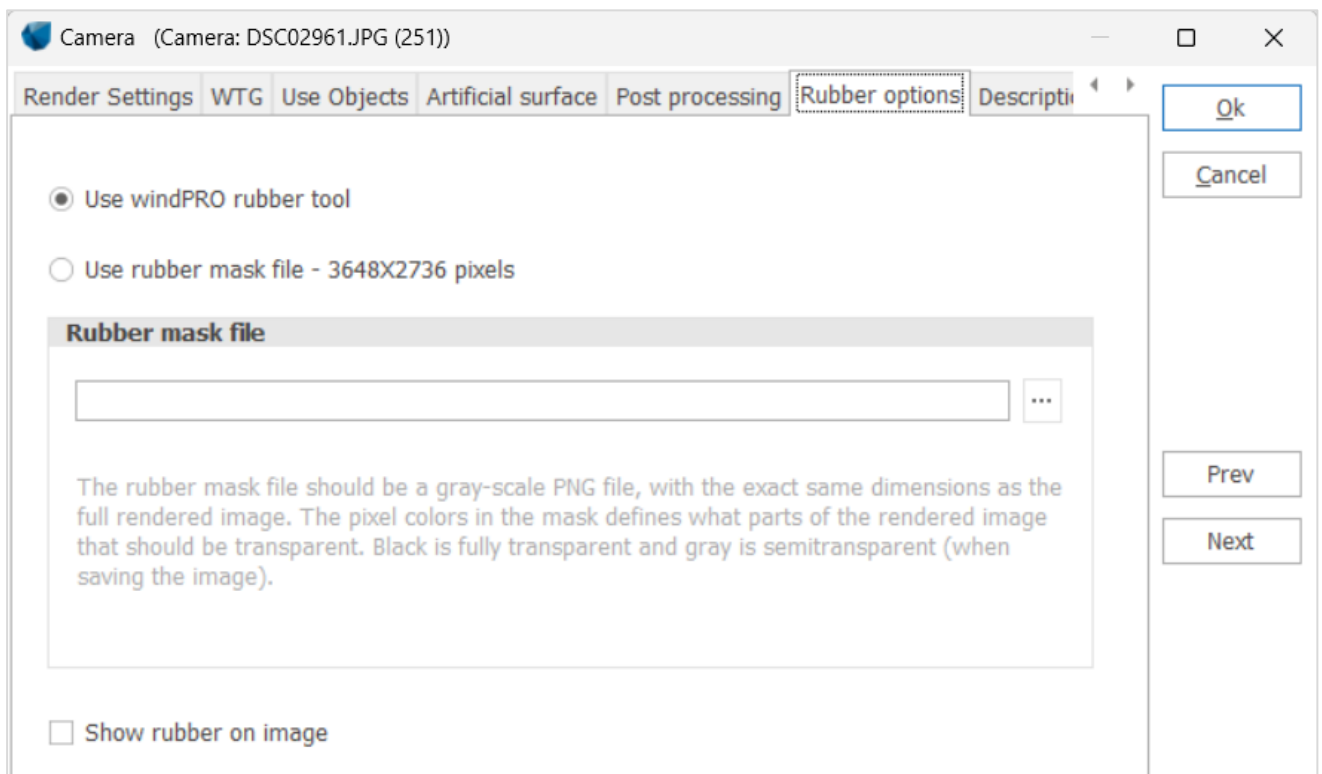
This option can also be used to “measure” the horizontal and vertical field of view of a group of turbines. The yellow area will have to be adjusted manually to encompass the rendered turbines. It can be an advantage to



select the option “Always face rotor towards camera” from the WTG tab of the Camera object (as shown below) to maximize the rendered rotor size. Note that the values of horizontal and vertical view are also available in a Result to file of a Visual report (see 7.1.5.1).



Camera object – Rubber options tab



By default, the rubber tool of windPRO is used (see 7.1.3.13). The rubber tool of windPRO erases the rendered wind turbines in the most refined setting pixel by pixel.

Use **rubber mask file** can be used in some specific situations (low resolution of the image with rather large pixel size) where the rubber tool of windPRO gives a non-smooth transition between the wind turbine rendered and the background because of the pixels shape. A rubber mask that can be used instead shall be made in a graphic program.

Camera object on the map

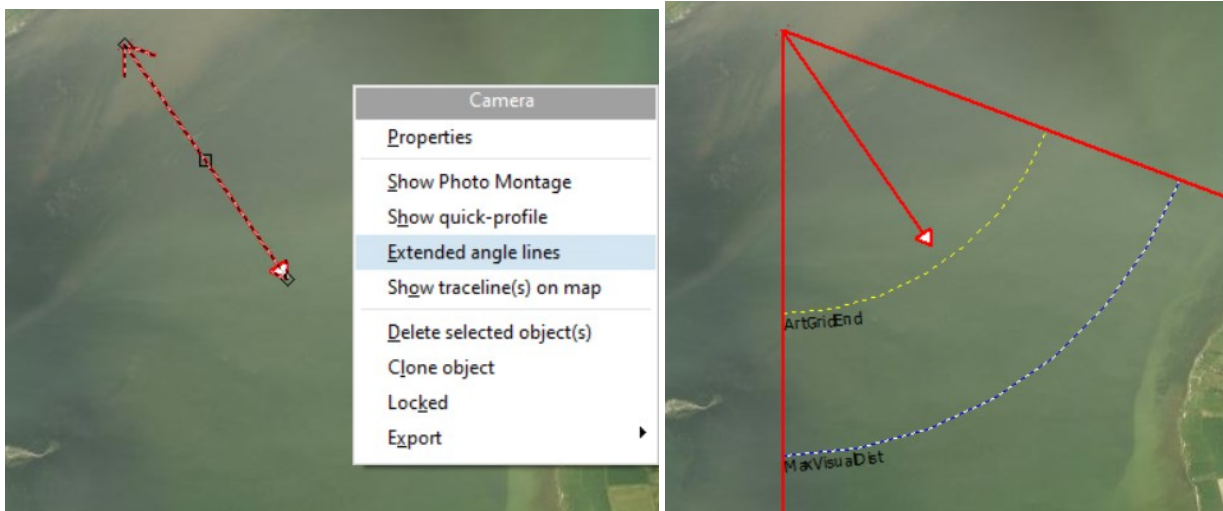
Notice that the Camera Angle is rendered on the map - approx. 45° for a focal length of 50 mm and 60° for a focal length of 35 mm.

Right-click on the camera object from the map to get access to several options:

- **Show photomontage** will open the photomontage window (see 7.1.3.4).
- **Extended angle lines** allows to draw the horizontal field of view on the map by extending and angle lines of the Camera. It can be used to check whether or not the lines on the map correspond to the edge of the



photo and/or whether some elements in the landscape are expected to be within the field of view, and thus visible on the photo.

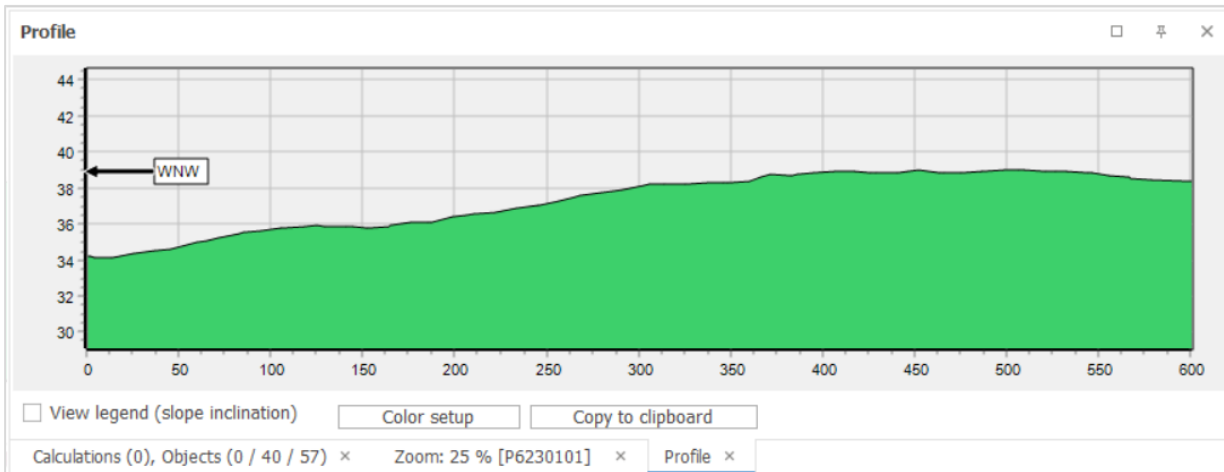


When Extended angle lines is selected, two distance limits are shown:

- **MaxVisualDist**, with blue dashes, is the distance limit after which no objects are rendered (defined on the Use Object tab)
- **ArtGridEnd**, with yellow dashes is the maximum distance used for rendering of artificial surfaces/wireframes and Auto erase (defined on Artificial surface tab).

• **Show quick-profile**

With a right-click on the Camera object from the map and the selection of Show quick-profile, a terrain profile based on the elevation data used for TIN is drawn on the section corresponding to the arrow of the camera object.



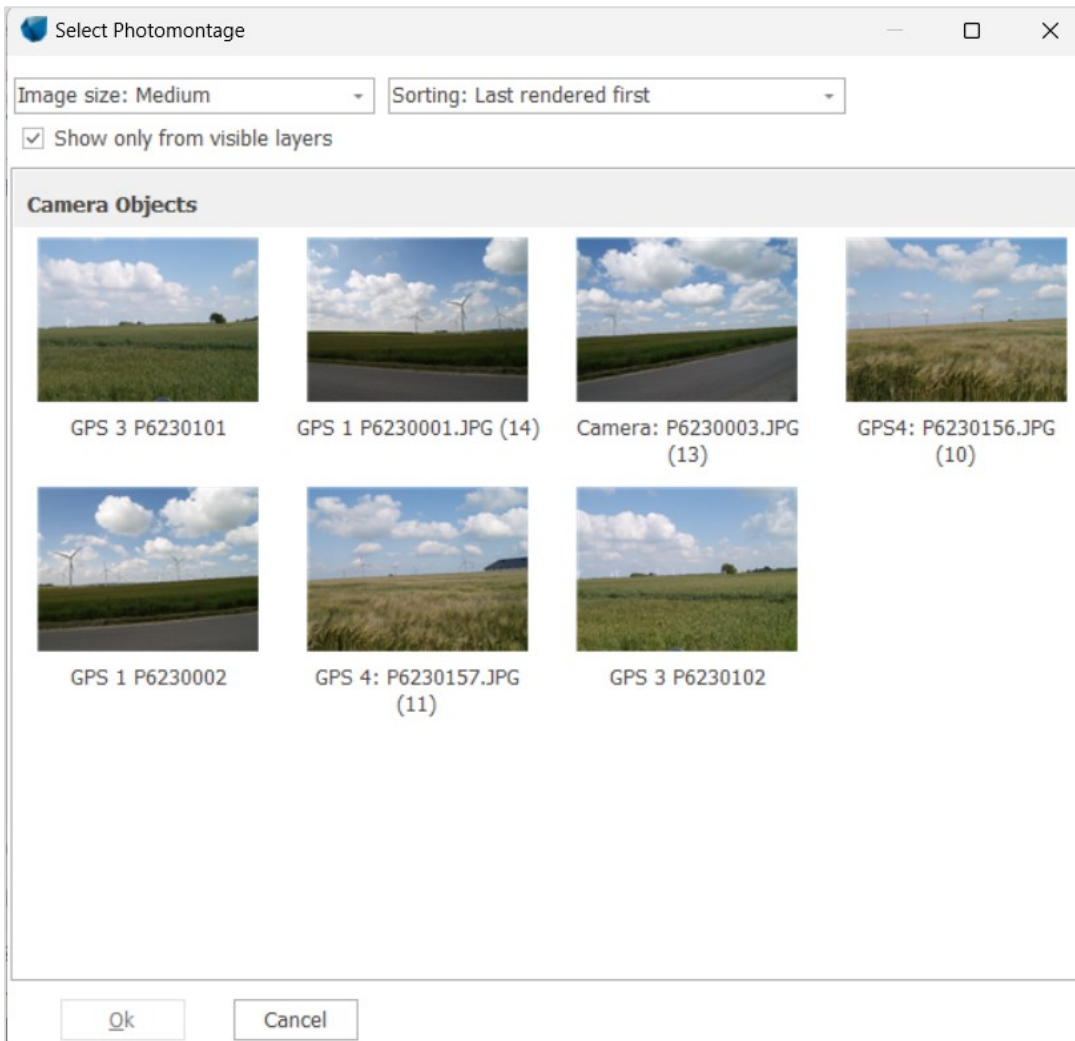
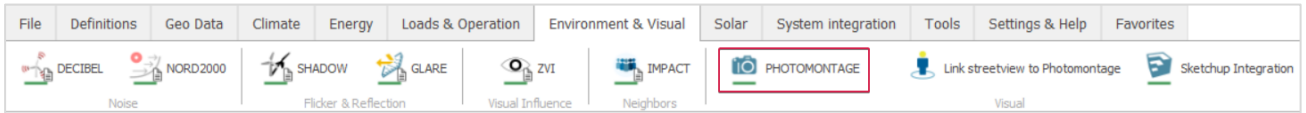
- **Show Traceline(s) on the map** is used to calibrate the camera model with tracelines, see 7.1.3.11.

7.1.3.4 Photomontage Window



When the data has been input into the Camera Object (see previous section), click OK, and the photomontage window will pop up.

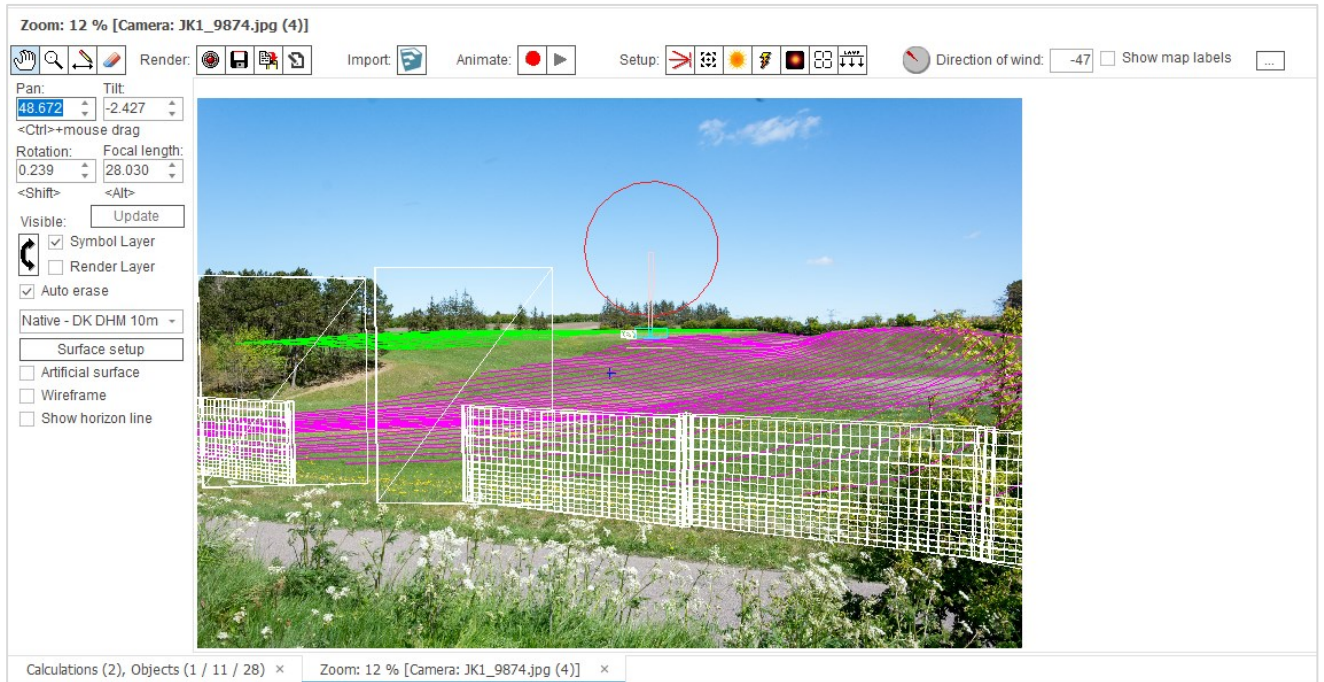
You can open an existing camera model/photomontage with a click on the Camera Icon, under the Environment & Visual tab of the ribbon:



It is also possible to open an existing camera model/photomontage from the map by selecting the camera object, right-click and **Show photomontage**.



The next image shows the photomontage window on a dedicated tab and how the camera model initially arranges the objects (turbines, PV panels...) visible on the map.



From the photomontage window top bar, the following tools can be used:



Move around the photo



Zoom in and out on the photo



Add text, lines, arrow on the photomontage



Delete invisible parts of rendered objects



Start rendering the objects (wind turbines, PV panels, 3D objects...)



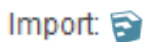
Save the photomontage in a file (jpeg, tiff...)



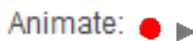
Copy the photomontage to the clipboard



Edit Post-processing and view output/report files (see 7.1.3.3)



Starts a SketchUp integration session linked to this photomontage (see 7.3)



Starts Animation (see 7.2)



Properties of the Camera objects








More Adjustment tools (see 7.1.3.5)



Set up Manual light (see 7.1.3.15)



-  Auto optimize the Camera model (see 7.1.3.10)
-  Aviation light on/off (see 7.1.3.18)
-  Tracelines (see 7.1.3.11)
-  Layer marker (see 7.1.3.17)
-  Direction of wind: Set up of the wind direction (i.e. 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:

Pan:	Tilt:
<input type="text" value="48.672"/>	<input type="text" value="-2.599"/>
<Ctrl>+mouse drag	
Rotation:	Focal length:
<input type="text" value="0.239"/>	<input type="text" value="28.030"/>
<Shift>	<Alt>
Visible:	<input type="button" value="Update"/>

Settings used for the calibration of the Camera model. Hotkeys can be used with the mouse on the photomontage (Ctrl to change Pan and tilt; Shift for rotation; Alt for Focal length/field of view)

<input checked="" type="checkbox"/>	Symbol Layer
<input type="checkbox"/>	Render Layer

Show symbol layer and/or render (=result) layer

Auto erase

Selection of Auto erase (see 7.1.3.13)

Selection of artificial surface/wireframe (see 7.1.4.2)

Artificial surface

Wireframe

Show horizon line

Show the yellow horizon line (see 7.1.3.6) options

The symbol layer shows the objects (WTG, control points, obstacles, PV panels, 3D objects) placed within the field of view of the Camera object. It is a schematic view used to calibrate the photomontage.

The render layer shows the resulting simulation of WTG, 3D objects, PV panels... (see 7.1.3.12) once the render button has been pressed. Pixels of the rendered layer can be removed with the rubber (see 7.1.3.13).

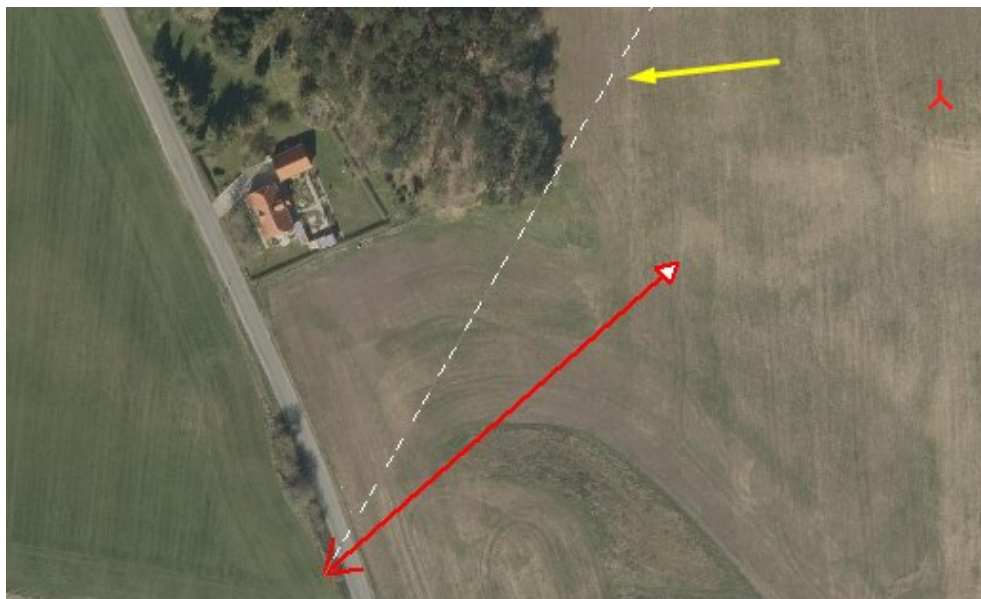
The blue cross on the photo marks the centre of the picture, as defined by the Pan angle (or direction) of the Camera object. This symbol can be deactivated in windPRO (for all projects) by accessing the Registry database and Computer\HKEY_CURRENT_USER\Software\EMD\WindPRO\3.6\map to change the value of PhotomontageShowCenterMarker from 1 to 0.



The position of the mouse on the map is shown with a cross in a circle on the symbol layer of the photo. This symbol can be useful to quickly find calibration points. The color of the symbol is the same as for the camera object.

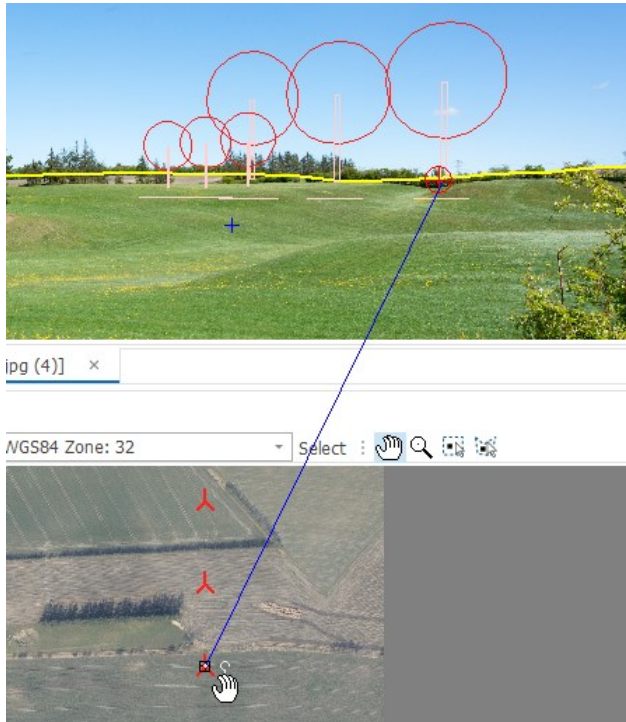


The other way around, the mouse on the photo triggers a dash line on the map centred at the camera position and passing through the point over moused on the photo. This can be useful to find elements on the map which are seen on the photo and that could be used as calibration points.

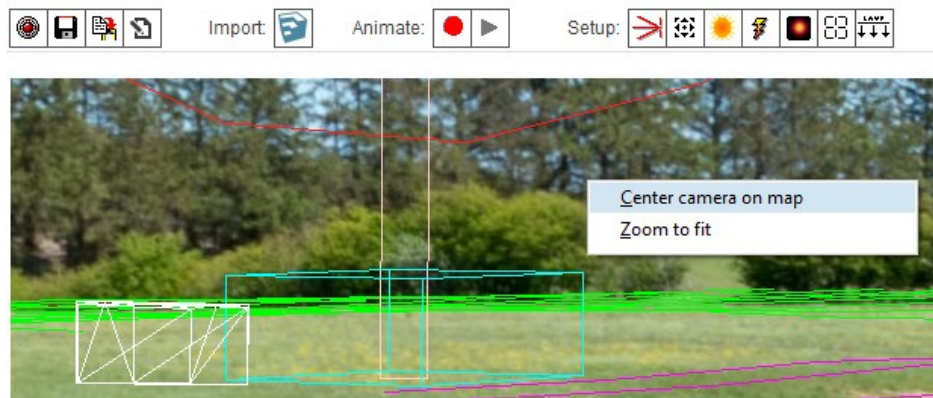




It is possible to identify a WTG from the map onto the photomontage: select the WTG on the map, press Control down and move at the same time the mouse over the symbol; a blue line will link the symbol on the map to the symbol on the photo.



With a right click on the photomontage, it is possible to center the related camera object on the map or to change the zoom of the photo to fit the Photomontage window.



7.1.3.5 Calibrating the Camera Model

In order to have windPRO calculate the correct position and dimension of the WTGs, the camera model needs to be calibrated. The calibration consists in finding the exact/actual properties of the camera which were used while taking the photo: the position, direction, Pan, Tilt, angle of the camera and focal length/field of view used.

Having entered the relevant references (horizon line, control points - see following sections) the user has to adjust the camera settings until the references are shown in 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:




Pan:	Tilt:
48.672	-2.599
<Ctrl>+mouse drag	
Rotation:	Focal length:
0.239	28.030
<Shift>	<Alt>
Visible:	Update


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 reduce the sensitivity.

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 window below which pops up below the photomontage. The photomontage calibration gets updated with the changes made from this window once the Apply button is clicked. If the window is closed, it can be opened again by clicking on this  icon in the top bar of the photomontage window.

Camera: JK1_9874.jpg (4) x

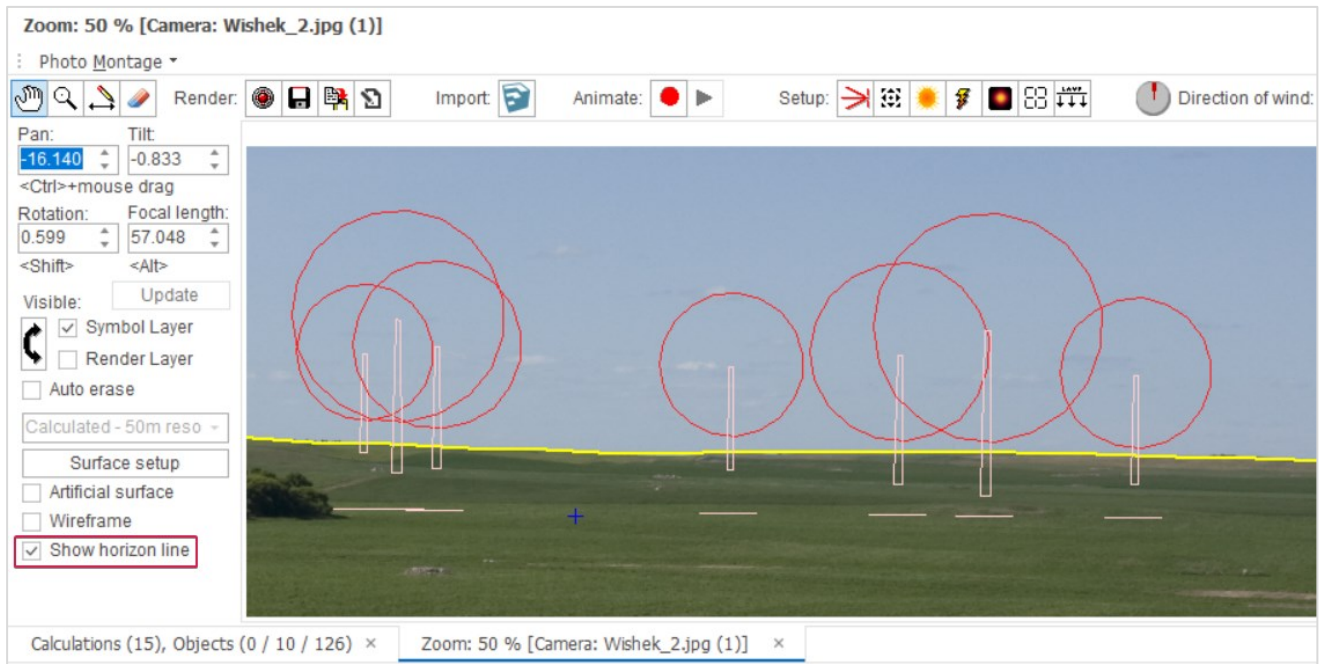
Camera point	Information
Easting: 541,877	Field of View (deg): 65.4x46.4
Northing: 6,305,212	WTGs within field of view: 6
Z(Offset): 1.5	Visible WTGs at tip height: 6
Height above sea-level: 45.8 m	Visible WTGs at hub height: 6
 View direction (deg): 49	Closest WTG (m): 555
Wind direction (deg): 313	Furthest WTG (m): 1265
<input type="checkbox"/> Show compass on prints	
<input type="checkbox"/> Auto-open this dialog when starting Photo Montage	Apply

Some information is also shown: the Field of View also known as the angle of view, the View Direction is the direction to which the camera is pointing, the WTGs within the field of view, the number of visible WTGs at tip height and at hub height, the distance to the closest and furthest WTG.

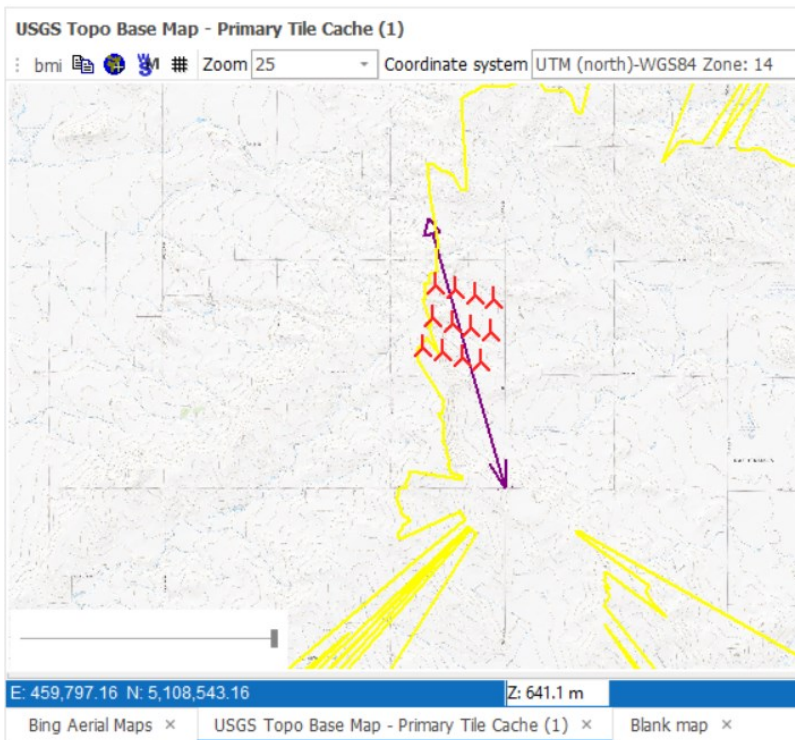
7.1.3.6 Calibrating the Camera Model – Horizon Line

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 elevation data has 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 elevation 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 red and the part below the horizon will not be rendered. This is illustrated below.



Figure 2 The rightmost turbine has same colour for its 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 furthest turbines symbolized with the red colour are below the horizon. For all turbines the user needs to 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 suitable offshore foundations in the turbine catalogue (as extension of tower).

7.1.3.7 Calibrating the Camera Model - Control Points



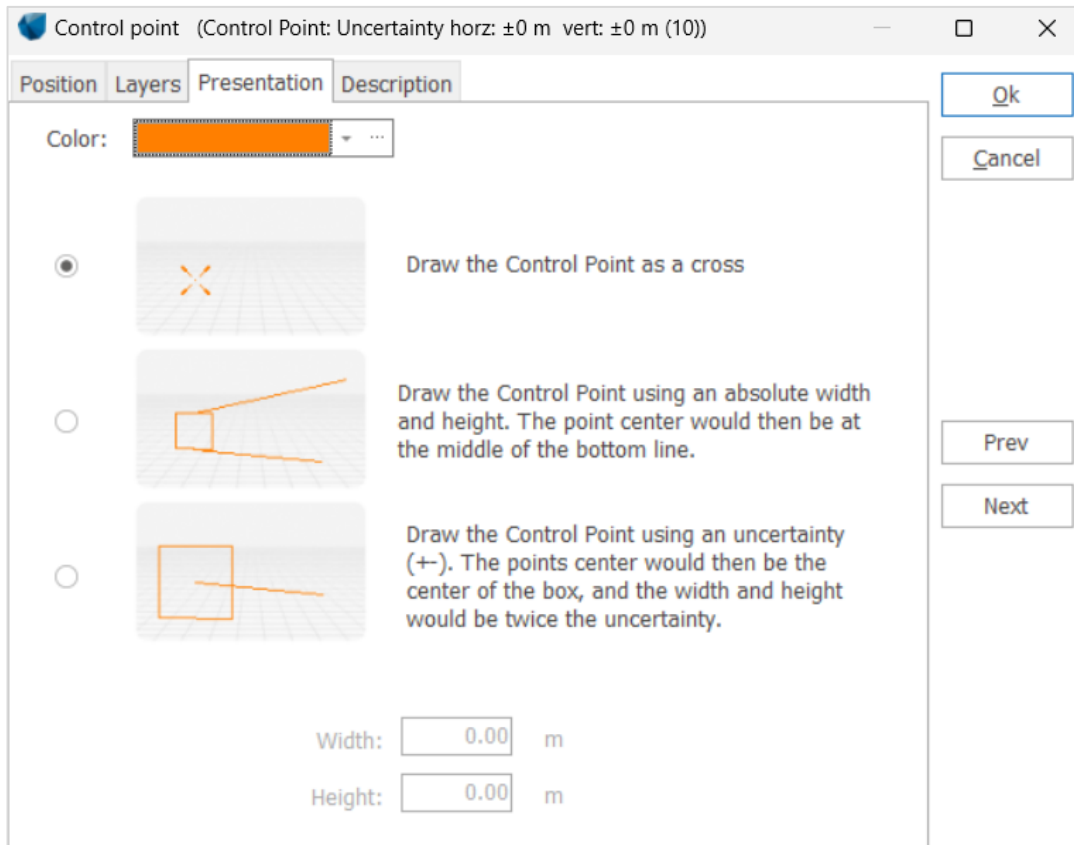
Control Points can be used as reference point to calibrate the camera model. Control points are objects that can be identified precisely on both the map and photo. The best control points are those relatively far away from the camera (some kilometres away and preferably at least one on the left and one on the right side of the photo).


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. Note that the more unknown/uncertain parameters you have in the Camera Model, the more Control Points you will have to define in order to be able to establish a correct Camera Model. Control Points close to the planned turbines give accurate positioning of the turbines in the image. Control Points near the edge of the image, on the other hand, give 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 on the map by picking the Control point object on the right side of the map. They can also be created from a list of coordinates pasted in the object list (See 2.5.4).

By default, the control point is symbolized by a cross on the map and on the Photo, to represent a punctual reference.

If the size of the reference object is known (like a chimney with known height, a building facing the camera with known the height and width ...) control point can also be defined by height and width with the second option below. The third option is used for a punctual reference but accounting for a given uncertainty.



Note that tall elements like electrical power towers, antennas, masts, and chimneys can be downloaded as control points, using the icon  Towers & WTGs (see 2.7.2).

7.1.3.8 Calibrating the Camera Model – Obstacle, Meteo, Existing WTG Objects

Besides the control point object (see 7.1.3.7), other objects can be used to calibrate the camera model, such as the obstacle, meteo and existing wind turbine objects. Please refer to the BASIS chapter for information about how to input objects.



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




A measurement mast can also be used as a reference point. The heights of measurements defined in the Meteo object are also shown on the orange symbol.



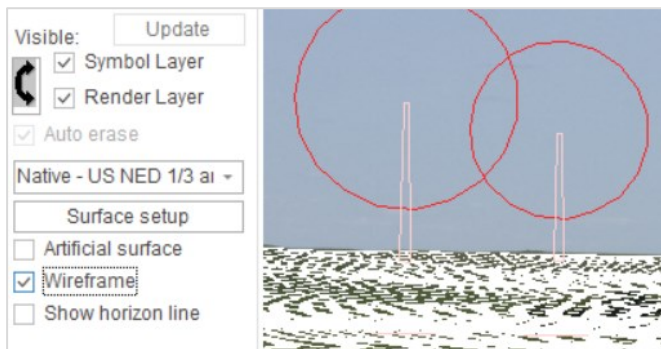
Existing turbines will have a symbol with a blue rotor. The dimension of the hub height and the rotor will be reported in the right proportions. The rotor shown only will match if the turbine on photo has the rotor fully perpendicular to the photo direction. Note also that the top of the tower will be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



Note that existing turbines can be downloaded from the icon  Towers & WTGs (see 2.7.2).

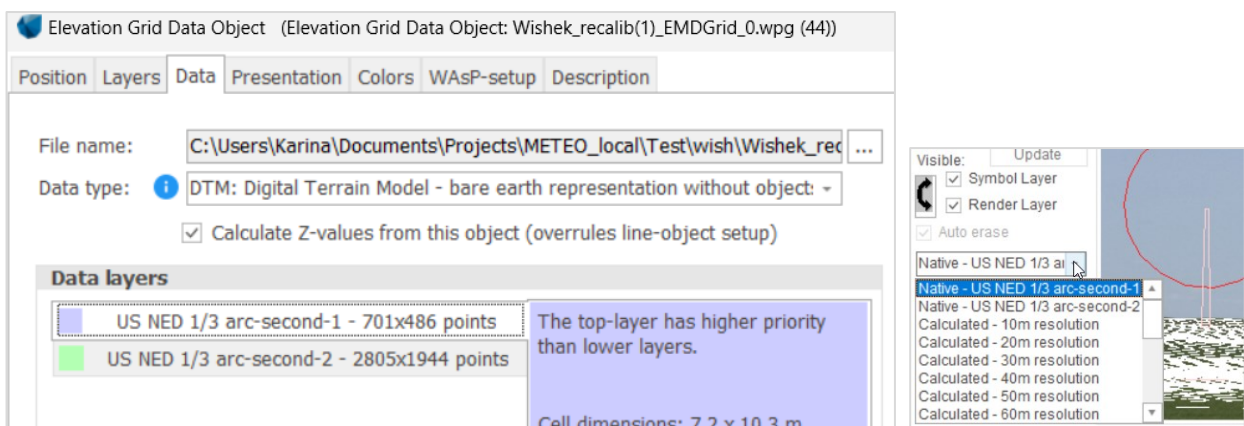
7.1.3.9 Calibrating the Camera Model – Wireframe

By checking **Wireframe**, a wire grid is shown on top of the photo on the symbol layer. This can be helpful to calibrate the camera model, especially when outstanding elevation features are seen in the foreground (and not on the horizon).



The wireframe generation can be quite time consuming. It is recommended to use elevation data from an elevation grid object. In an elevation grid object, it is possible to use the **native** grid spacing and thereby speed up the processing time to almost none.

To use the elevation grid object, check **Calculate Z-values from this object** for calculation of Z-values. You should also name the different layers (if more) in a way so you can identify these in the photomontage selection tool.



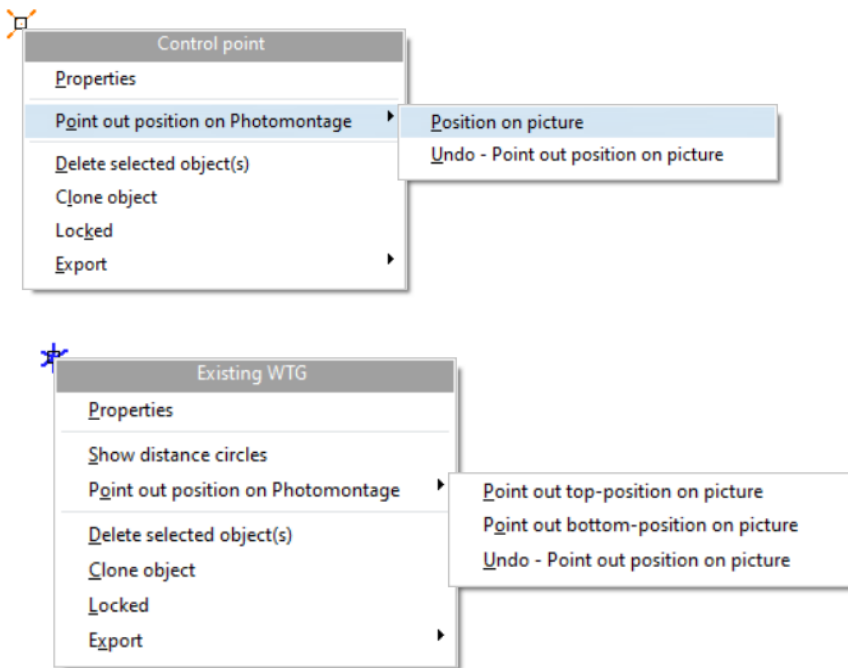


7.1.3.10 Calibrating the Camera Model – Auto Optimisation

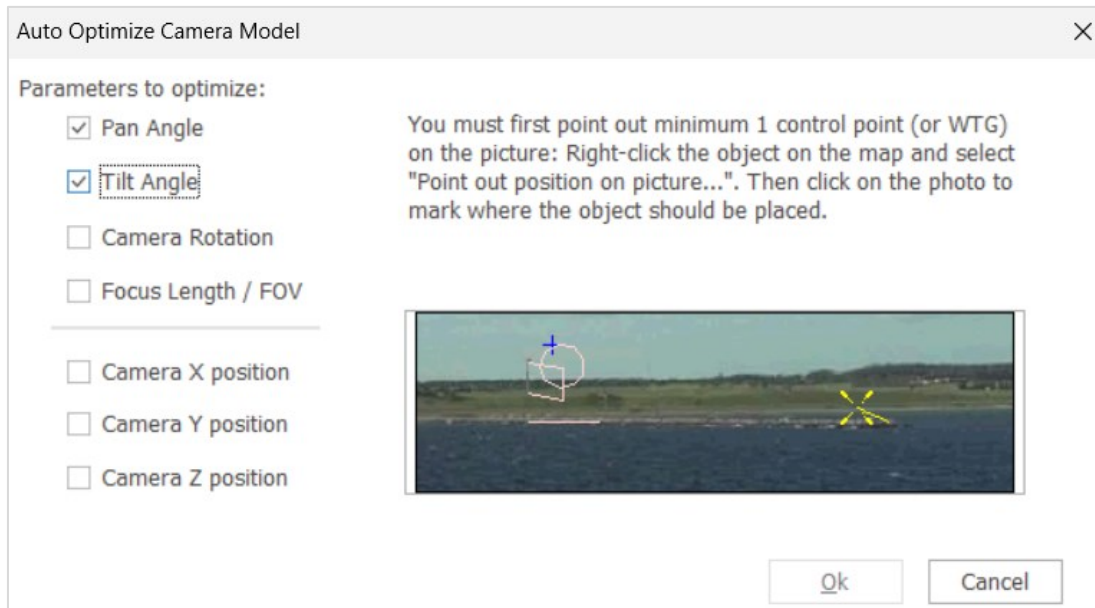


It is also possible to let the computer define the camera model, by finding the best combination of parameters (position, pan, tilt and focal length).

As a prerequisite, 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 (that is for which the exact position on photo is known), select **Point out position on picture**, and click on the picture the corresponding position of the object.



The more linked objects you have, the better the chance to find the best fitting camera model – and the more settings of the camera model are already known (and thus excluded from the optimization), the better the unknown ones can be estimated. The parameters that can be auto optimised are: (Menu appears when **Auto Optimise Camera model** is chosen):



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.



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



Note that with too few 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. On the contrary, if high precision GNSS (GPS) is for the control points together with specific landmarks, the calibration with Auto optimisation gives a very fast and precise result, as demonstrated in this video <https://www.youtube.com/watch?v=xcjp9UPYrSE>.



7.1.3.11 Calibrating the Camera Model – Tracelines



Tracelines are used to calibrate a camera model using information from other calibrated cameras. This option is very useful in the case where there are no good reference points available. A reference point is generally a feature that is visible on the photo and for which the coordinates are known (from GPS or map). With tracelines it is possible to use a reference point without knowing its coordinates, simply by defining it within the photo of a calibrated camera object (the “helping” camera).

If the camera object is already calibrated, the tracelines option can also be used to validate the calibration.

A traceline is a 3D line that goes straight from the camera to a target point that can be seen on the photo.

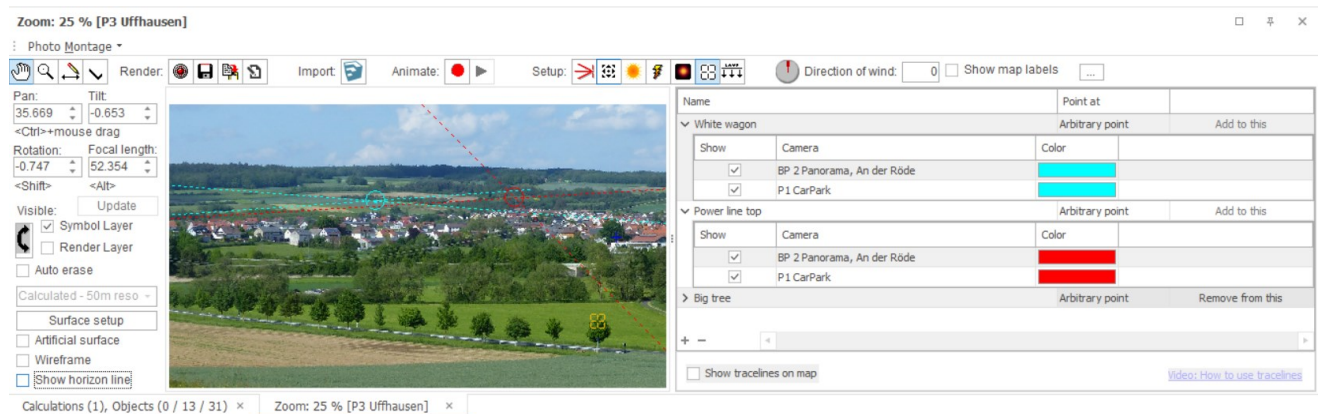
The requirements for the “helping camera(s)” are to be well calibrated and to include on the photo, the same element/object(s) that is being calibrated in the photo of the current camera object.

A video of how to use tracelines can be found here: <http://emd.dk/files/tutorials/Link003.htm>.

Traceline editor window

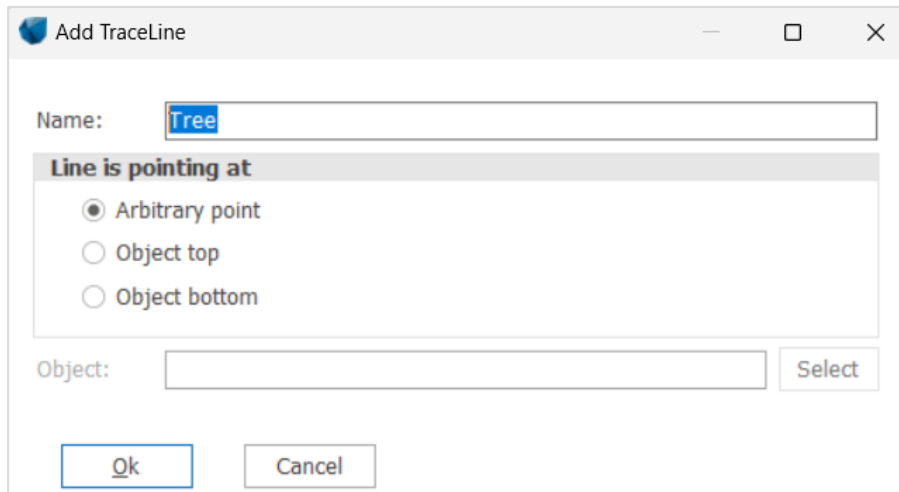


Click on the icon at the top of a photomontage window to open the **Traceline editor** window on the right side of the photomontage.



Tracelines can be created, with + or removed from all Cameras with - at from the bottom of the traceline editor window.

A new traceline is to be created on calibrated camera models, based on an arbitrary point or object (turbine, control point) that has already been linked from the map to a photo as described in 7.1.3.10.



For each traceline shown in the table or the traceline editor, it is possible to see in which camera model it has been defined and which one of these should be shown on the current photo.

When **Show** is selected, the lines of a given traceline can be seen on the photo. If a traceline has been defined from two “helping cameras” at two different positions, two lines will be shown as well as a circle. The circle indicates the closest point between the lines; the lines will indeed never exactly cross each other. The circle then shows the position of a new **reference point** which can be used to calibrate the camera model. If the “helping cameras” are viewing from the same position as the camera object being calibrated, no lines will be shown, just a circle.

Add to this: to add an existing traceline to the current camera.

Point out on Photomontage: when **Add to this** is selected, the target of the traceline must be defined on the photo with a click.

Re-point out on photo: an existing target can be redefined.

Remove from this: the traceline defined from this camera is removed.

7.1.3.12 Rendering



Click on the red button to begin the rendering of the objects (wind turbines, PV panels, 3D objects) into the image. When the control lamp turns green the rendering is finished. If you change some data on which the rendering was based, the control lamp will turn red again, and you have to render the image again to update it. The rendered objects will show on the **Render layer**.



By default, the objects rendered are all turbines, PV panels and other “render-able” objects **visible on the map** (from visible layers, see Section 7.1.4.3.4 Camera object – Use Objects tab and see Section 2.11 on layer structure).

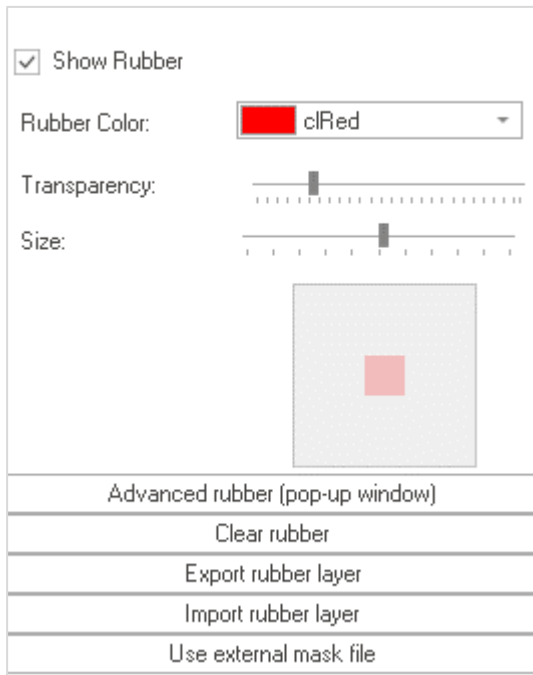
Having rendered the objects, you are welcome to check how realistic the result look like and see if adjustments have to be made. If, for example, the turbines are dark and the photo is taken in glaring sunlight, you have probably made an error in the photo time setting. Also, the weather parameters can be incorrect. If the proportions are incorrect you have to check the Camera Model once more and maybe add more Control Points to find the right focal length/field of view. Finally, the information in the WTG Catalogue could be missing or not as expected (see more on this subject in chapter 2, BASIS). If that’s the case open the actual turbine in the WTG Catalogue and check the data. If no Visual data are available for the turbines selected, a default three-bladed turbine model is used.

To isolate the rendered layer on a transparent background another application will be necessary (Photoshop, GIMP) as demonstrated in this video <https://www.youtube.com/watch?v=N9hmwPvShmY>

7.1.3.13 The Erase Tool (the Rubber)



The Erase Function is used to remove parts of the rendered objects behind trees, buildings, etc.



The manual option is immediately available after activating the rubber tool: you can set-up the pixel size of the rubber and how to show it on the photo (the color &, transparency). You can then easily see where the rubber has been used.

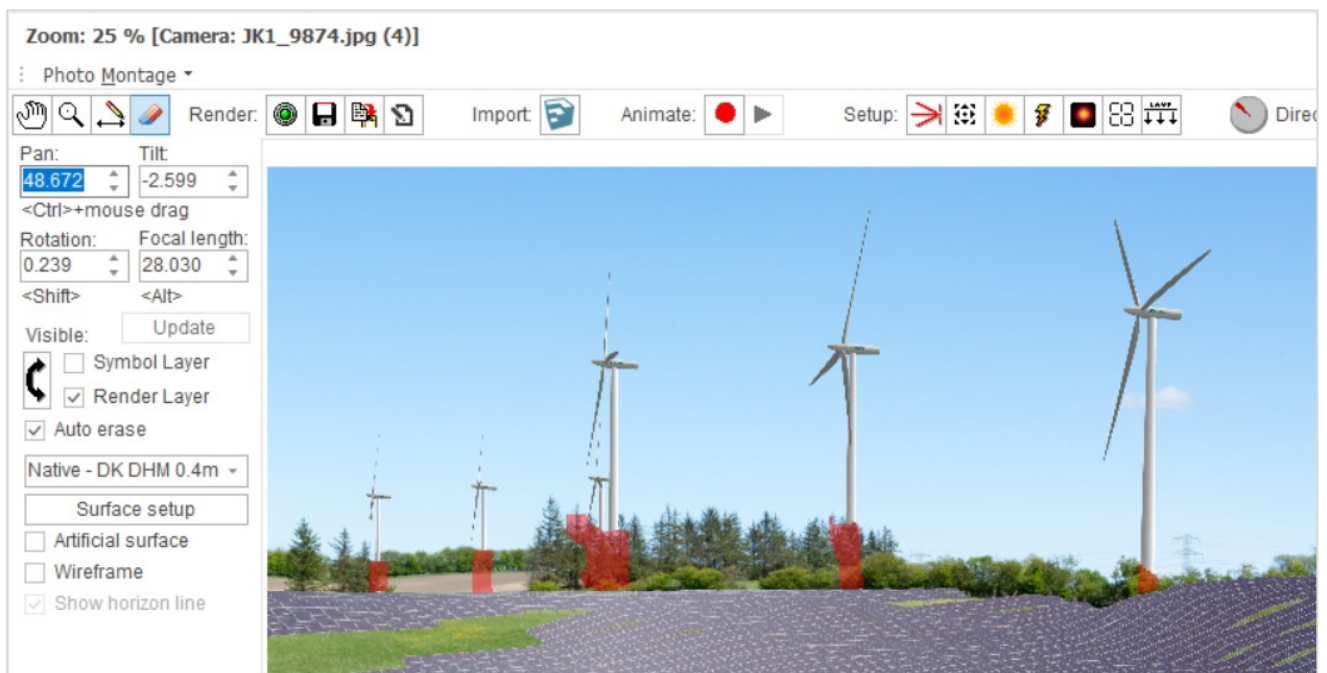


Figure 4 The rubber tool: simply "paint" the rubbed-out areas, where you do not want rendering.

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

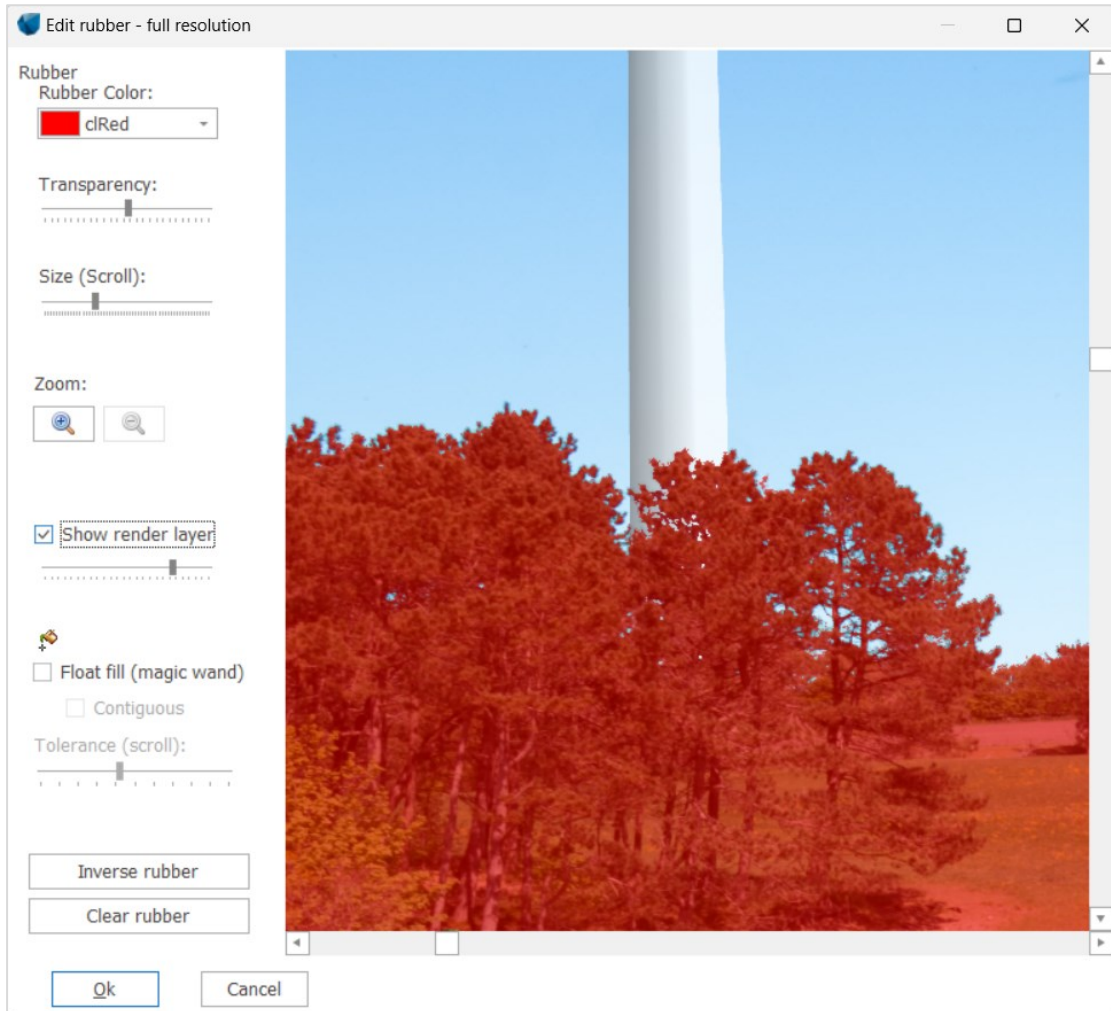
- Left mouse button - erases pixels
- Right mouse button - re-establishes erased pixels

Advanced rubber

Advanced rubber tool is similar to the **magic wand** common to many photo editors. It allows for an easy selection of the areas to be masked. In the pop-up window, activate the **Floating fill (magic wand)**, and select the part of the object which should be in front of the turbine, like the trees in the example below. All pixels with



the same color will now be marked, leaving portions of the sky behind the trees open to let the turbine tower appear. The **Tolerance** is a crucial parameter here, because it defines the precision of the color-recognition routine. The option **Contiguous** limits the automatic selection to contiguous pixels. Finally, **Inverse selection** can be very practical in the case where the magic wand works better on parts of the image which shouldn't be masked. It could be for example used for the sky with a uniform color. Inversing the selection of the sky, will select everything which is not the sky, thus all the vegetation. With a bit of practice, this tool makes the task extremely fast compared to the previously available manual selection.



Export/Import rubber layer,

Other options in the Rubber window include the use of a previously generated masking file in windPRO. Rubber layer can be exported (also useful as a backup) and imported again.

Use external mask file

With this option, it is possible to modify the mask file in an external photo editing software and see the resulting modifications in the windPRO Photomontage window.

Auto Erase

Auto erase

Native - US NED 1/3 ai ▾

Surface setup

The digital elevation model used for the TIN/z coordinate will be used with **Auto erase** to delete the part(s) of the rendered objects (WTG tower, PV panels ...) hidden by the terrain surface. The elevation data used to Auto erase can be seen in the dropdown menu. The distance limit defined in Surface setup can be changed if necessary.



Note that the best result of Auto erase is obtained with native elevation grid data (loaded in an elevation grid object).

It might be necessary to refine the deletion with the erase tool as the height data might not be precise enough.

As an alternative, it is possible to use the artificial landscape as a mask in Photoshop.

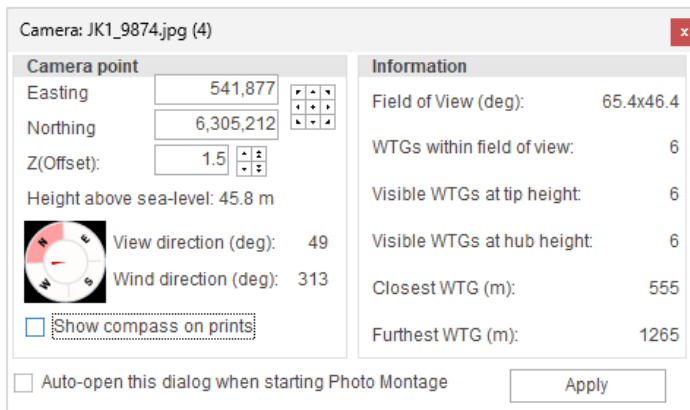
Finally, masks between 2 rendered objects can accurately and easily be defined with the photo mask option in SketchUp Integration module (see 7.3).



7.1.3.14 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.



The information relates to the WTGs which are within the distance input on the **Use Objects** tab of the Camera object. The centre line of each WTG is used to calculate the visibility or not. So, if only a part of the blade of a WTG very close to the Camera is visible, the centre line of the tower is not visible, and the information will not count this WTG as visible.

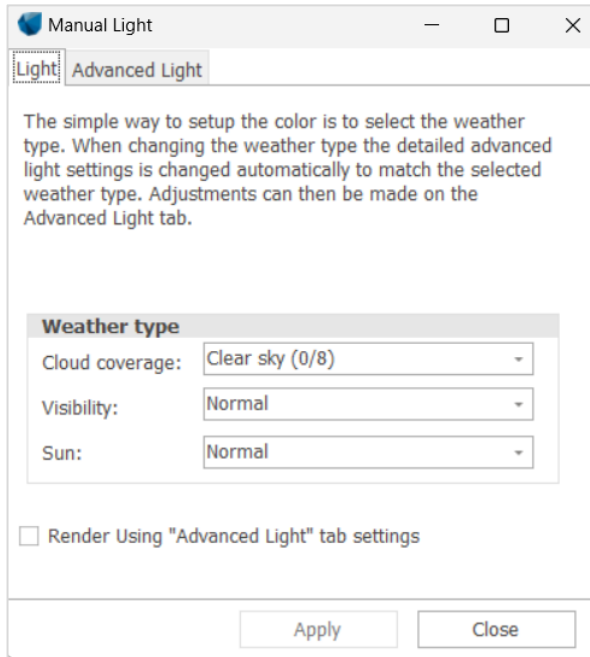


You can also activate the complete Camera Object and adjust any or all parameters.

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.



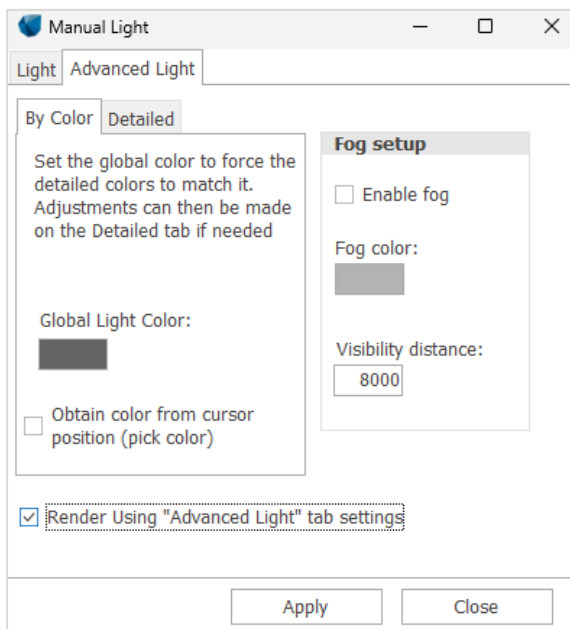
7.1.3.15 Adjust Light (color)



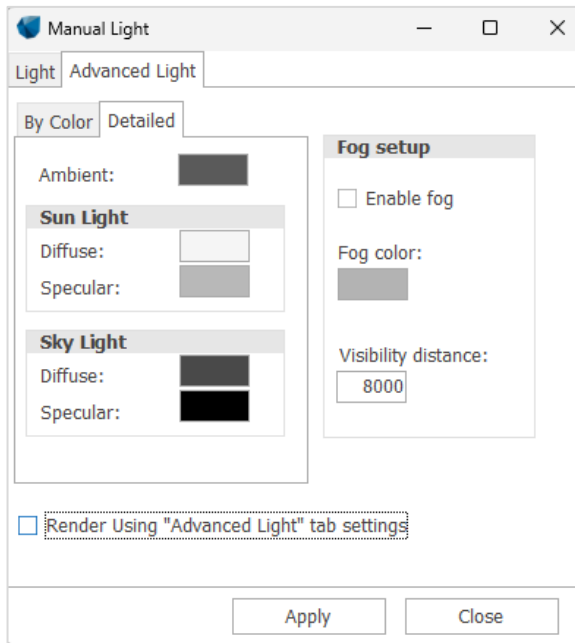
Light (or color) adjustment is in general made by selection of weather conditions in the render set-up. For some purposes, a more detailed adjustment can be required, for example if some new WTGs are added to a place with already existing WTGs. Here it would look better if the new WTGs matched the colour of the existing as closely as possible.



Within the light adjustment tool, access to **Advanced light** options can be chosen.



In the advanced light settings, the global light colour can be set, which is the colour you wish to give the WTGs. 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.



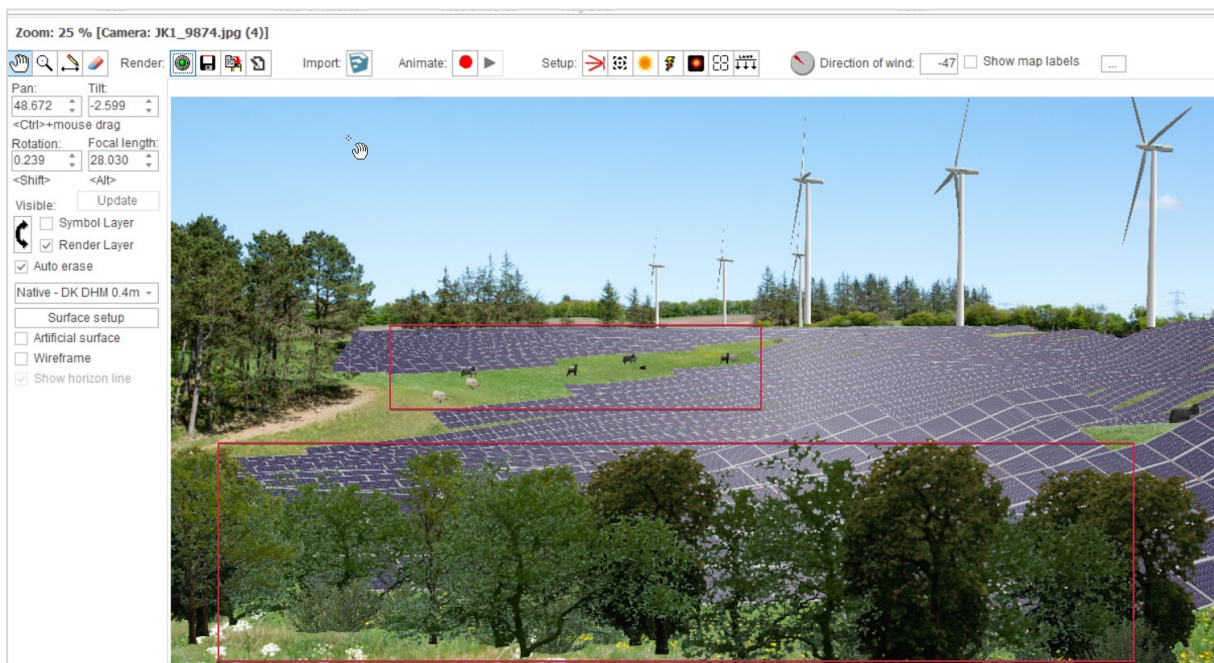
The detailed settings, where all colour parameters in the render model can be set. But be careful – it is very difficult to adjust all these handles and can be very time-consuming and not very logical how the result reacts to your input.

7.1.3.16 Bitmap Elements

Bitmaps, such as 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 artificial surface) or it can be used to add other elements in the landscape than turbines if a photo from site is available.

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

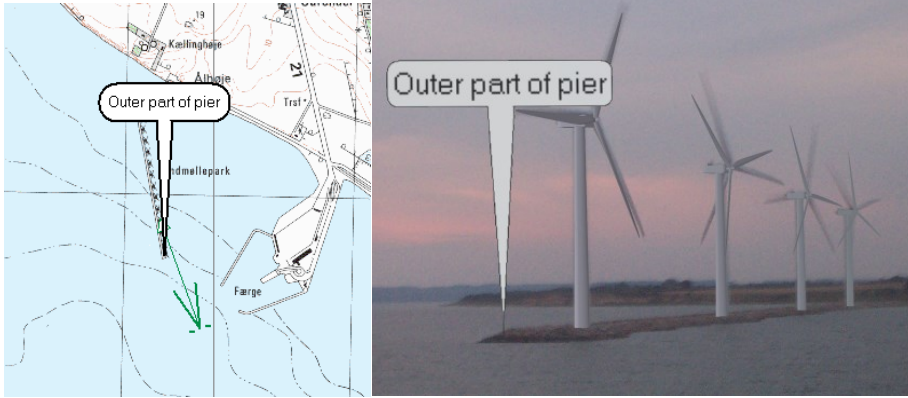
Bitmaps can be input through the Area object, the Obstacle object or the Line/Road object (see 7.1.3.2). In the example below, the sheeps have been added with the area object, and the vegetation fence in the foreground with the obstacle object.





7.1.3.17 Text Elements

A text on the map can be rendered as a billboard via the text object **T**, see example below.

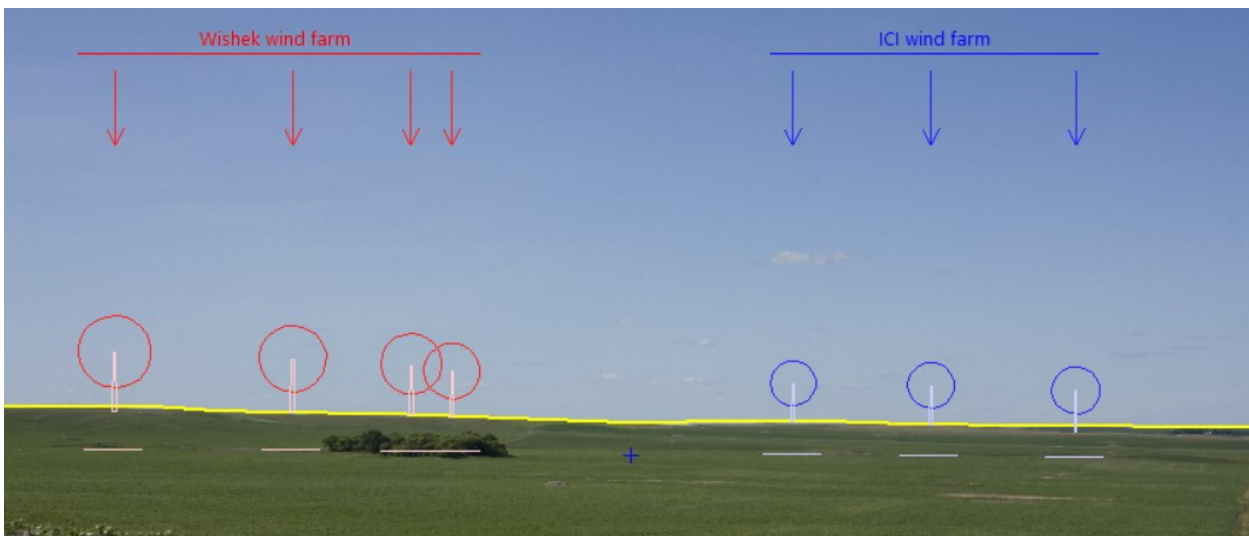


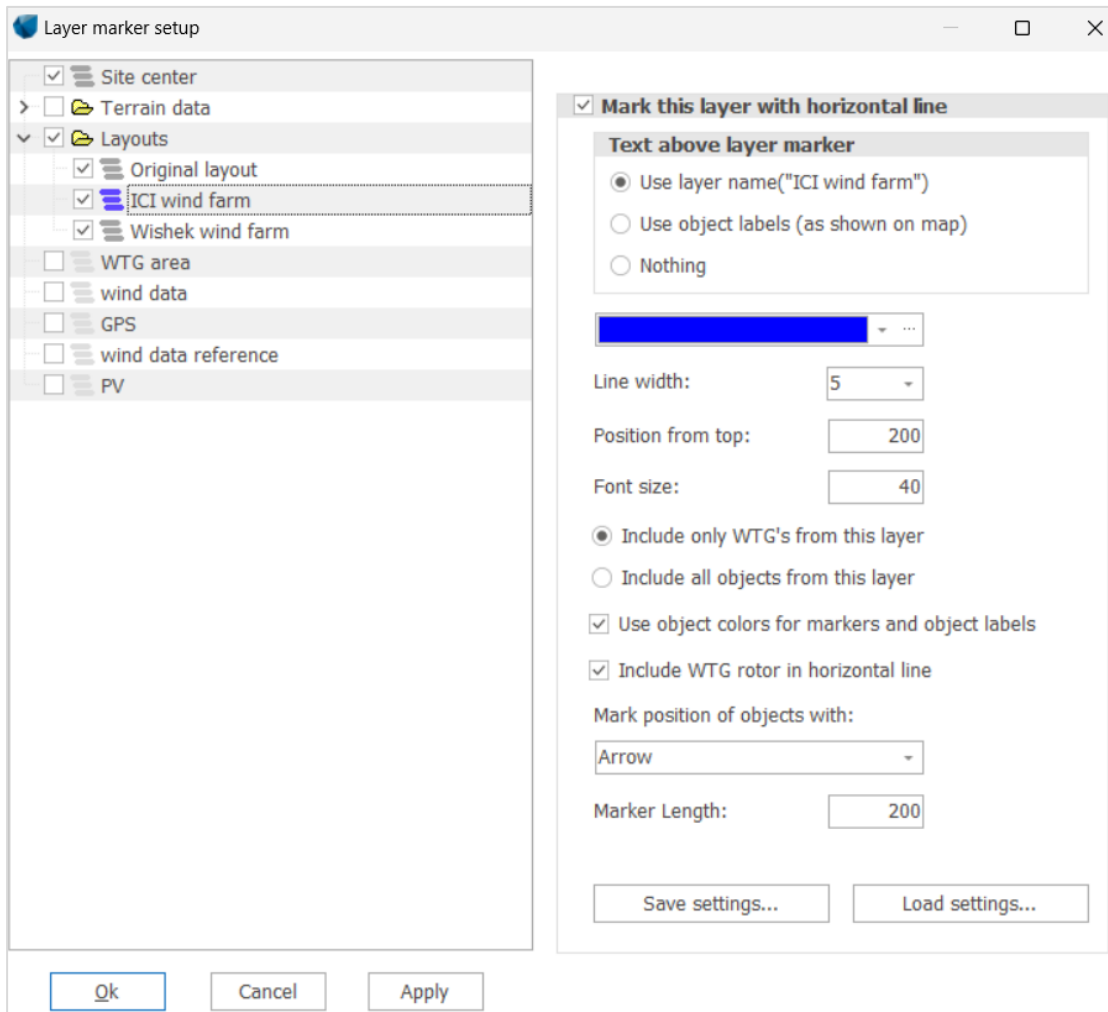
With the drawing/test tool you can draw or write directly on the photo.



Layer marker

It is possible to show as a text the layer name to which the wind turbines or any objects belong. A horizontal line will be drawn from the position of the leftmost turbine/object of the selected layer to the position of the rightmost turbine/object. By default, each turbine/object will be pointed out with a vertical arrow or line. The name of the layer will be written on the top of the horizontal line. Alternatively, the label of each turbine/object can be shown. A different setup can be defined for each layer. So, by organising the different groups of turbines/objects on dedicated layers, they can easily be identified on the photomontage.





In the layer marker setup, the layer must first be checked and selected on the left side. On the right side, **Mark this layer with horizontal line** must be checked. The text above the line can be the layer name, or the object label name (defined in the object properties) or nothing.

The Line width, Position from the top and Font size refer to the pixel size. Therefore, these parameters might need to be adjusted accordingly to the resolution of the image. In the case of overlapping horizontal lines, the position from top can be customized, so that one line gets below or above the other one(s).

Include all objects from this layer allows to show the marking not only for wind turbines but any other object such as a measurements mast (define as a meteo object), a control point, etc...

Use object colors for markers and object labels allows to add a new color code to the one used for the line.

Include WTG rotor in horizontal line will extend the horizontal line to the outmost point of the rotor diameter. This way, the full horizontal field of view of the given wind farm will be visible.

It is possible to select whether the vertical line should be an arrow, a line or nothing. Its length can be adjusted so that it matches the pixel resolution of the image.

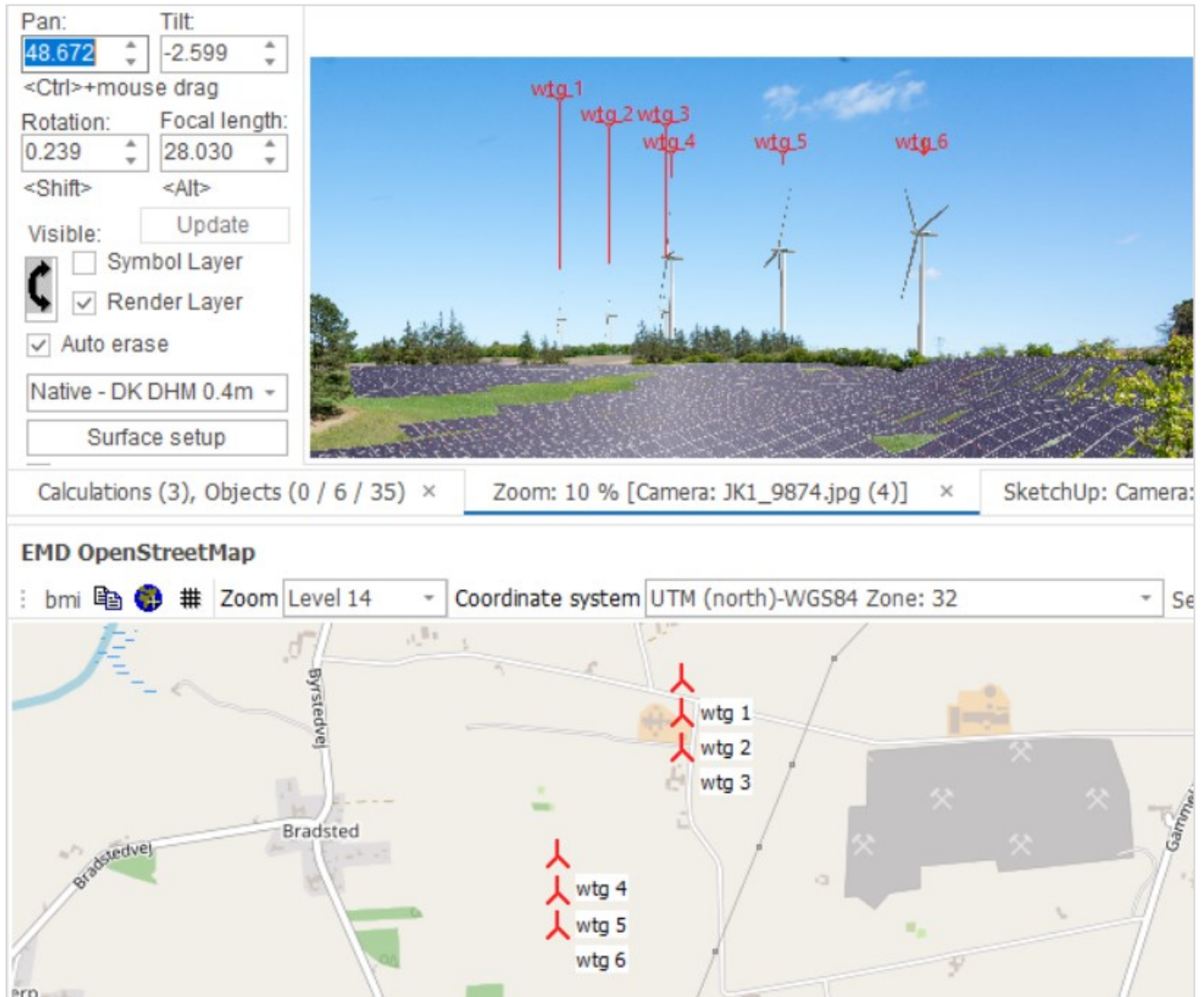
Finally, a given setup can be saved and reused.

Note that in order to view the changes in the setup, the Apply button should be hit.



Show map labels ...

With the option **Show map labels**, the label of the WTG will be shown on the top of the photomontage and pointed to the corresponding turbine.



As a prerequisite, each label has to be defined in the WTG properties (either as Description or User label) as well as the selection on which label to show the label on the map.



New WTG (Siemens SWT-2.3-93 60Hz 2300 92.6 !O! hub: 80.0 m (TO

Position Layers WTG(s) Visual Distance circles Curtailment Op

Position Userdefined

Easting 542,733

Northing 6,306,145

Z (Offset): 0.0 Automatically from TIN (62.1 m

Description: Siemens SWT-2.3-93 60Hz 2300 92.6 !O! hub

User label: wtg 1

Position locked

Label on map

None User label Coordinate

Description System label Result

The setup of the labels on the photomontage can be defined by clicking on the three dots. It is possible to change the number of rows of labels, the font size and the line width. The color of the label follow the color of the WTG object.

WTG Label Setup

Options

Number of rows: 5

Font size

Small Medium Large User defined

Font size: 40

Line width: 5

Show lines even if no text

Ok Cancel

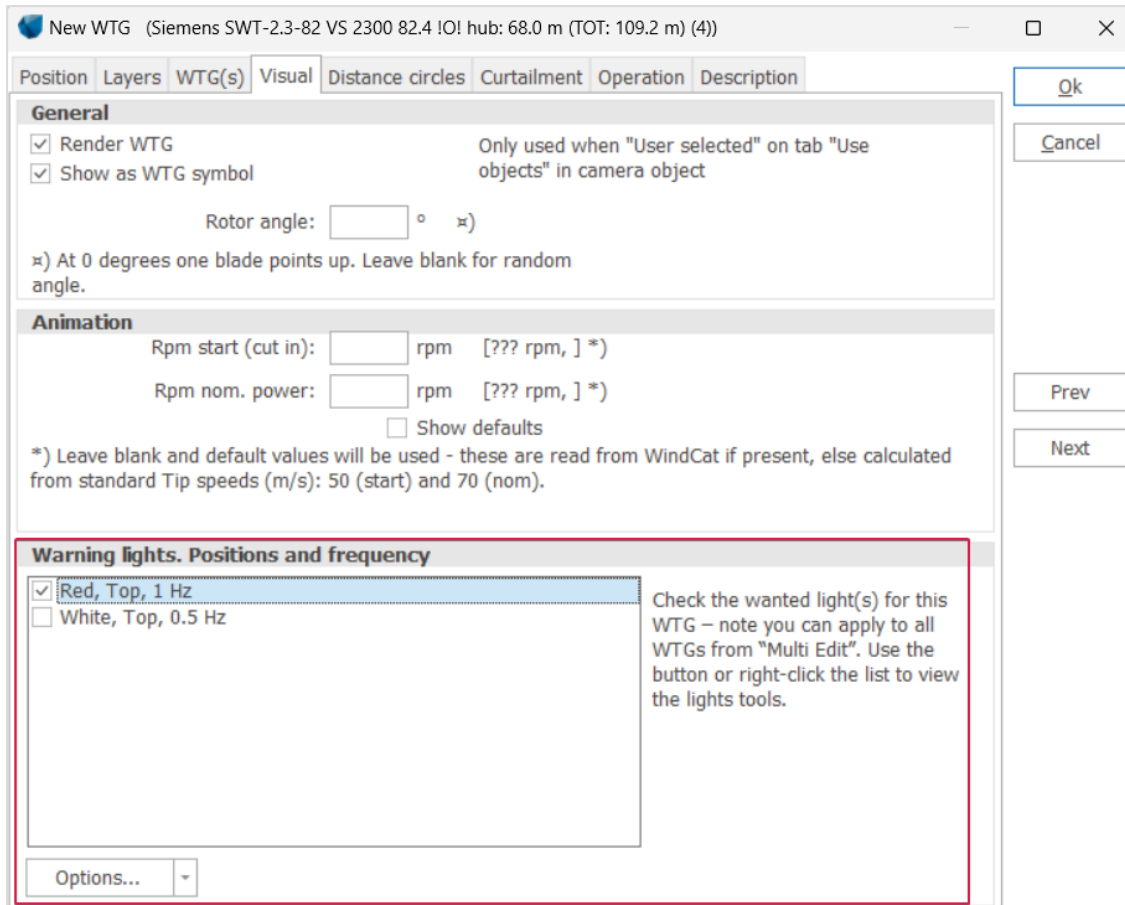


7.1.3.18 Aviation Lights

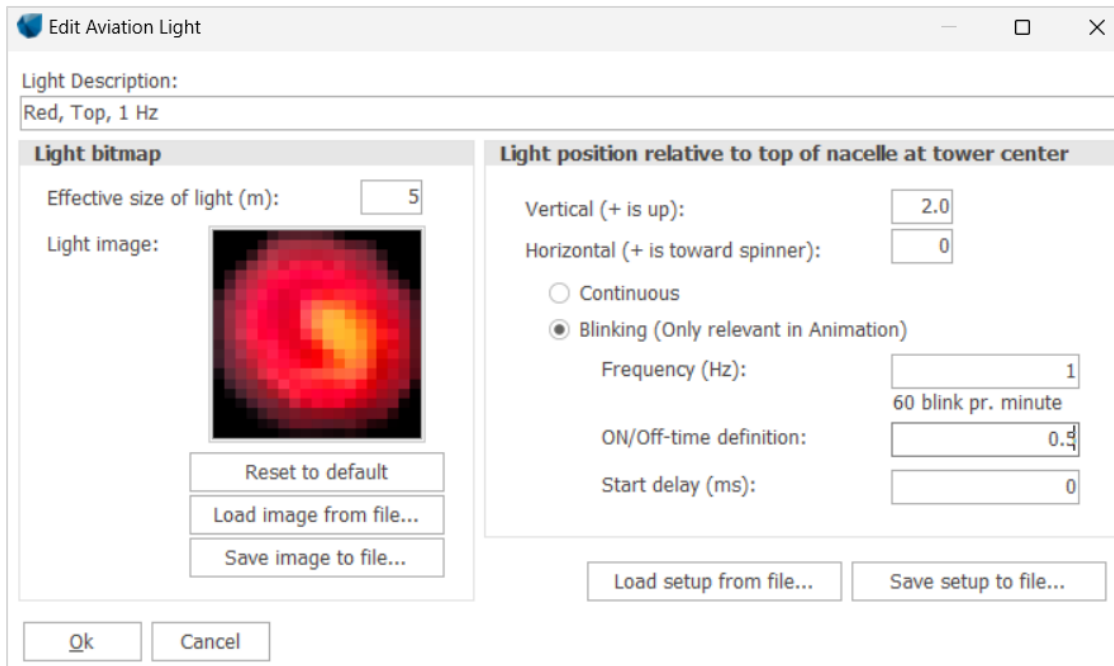
Lights can be added on the top of the nacelle or on the tower of the WTGs. The visual simulation of the light is based on a bitmap which is scaled in size according to the distance to the Camera object. The change in light intensity is not calculated by the model in the current version of windPRO.

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 function.

By default two types are available as bitmaps.





It is possible to adjust each light property by clicking on **Options** and **Edit**.

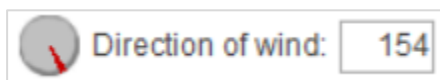


In Edit Aviation light the following properties can be found:

- **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.
- **Continuous** 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 lights is required.

Once 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 switched on/off via the symbol  or by a new rendering.

7.1.3.19 Direction of Wind



The definition of the **Direction of wind** made from the Rendering tab of the Camera object can also be defined from the top bar of the photomontage. The **Direction of wind** controls the yaw angle of the turbine nacelle. All turbines have the same setting. See 7.1.3.3 for more details.



7.1.3.20 Link Streetview to Photomontage

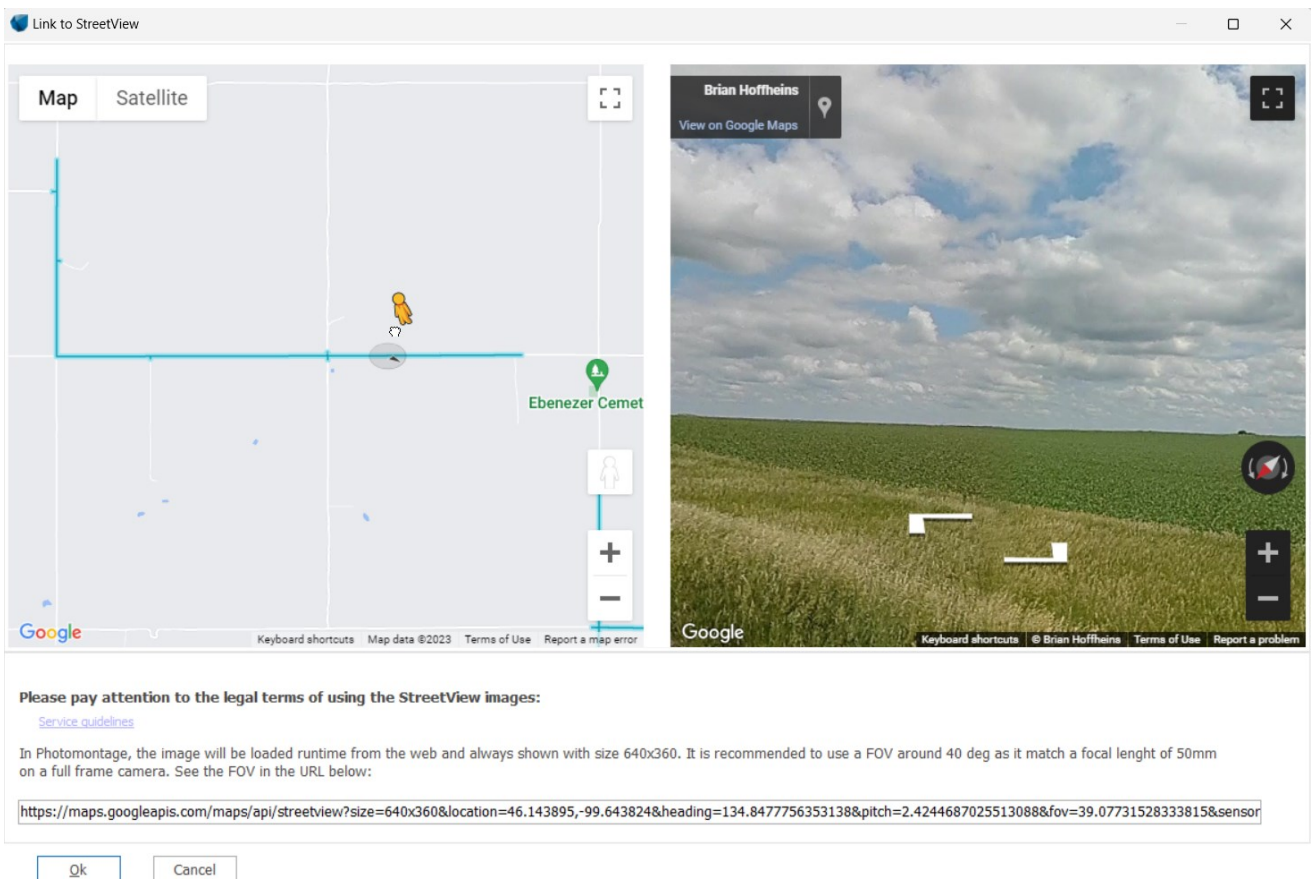


Link streetview to Photomontage

Google Street view images can be linked to a Camera object so that a photomontage can be made from it.

Click on the **Link streetview to Photomontage** icon in the Environmental and & visual tab of the ribbon. In the Link to Streetview window, the Google map can be seen on the left side. Pick the Goggle Street view icon (yellow person) and drag it to a selected position for which a Google Street view is available (on a road colored in blue).

The Street view is then shown on the right side of the window. It is possible to rotate, move the position of the photo forward or backward and zoom in or out to select the proper view to link to. Note that the view on the screen does not show the whole image. The selected view will have the same center as shown on the screen, but it will become wider horizontally and will be truncated vertically in order to fit the allowed import dimensions of 640x360 pixels. The field of view corresponding to the image linked to windPRO is calculated automatically (by Google Street view) and can be seen in the url at the bottom of the window. This field of view is imported automatically in the camera object and converted to the appropriate focal length according to the film format provided by Google Street view. The image can then be calibrated in windPRO as for any photomontages. The focal length is usually correct, only tilt, pan and rotation (rarely) shall be adjusted making use of control points and/or the horizon line.



The resolution of the images allowed to be linked to is low (only suitable for presentation on screens).

7.1.4 Photomontage with artificial surface as background

A photomontage with an artificially generated landscape/surface allows to visualize a project without any photography. Only elevation data is required.



It is possible to render an artificial surface as a plain color (including shadows) and/or by a wireframe.

Moreover, when combined to a photo, the artificial surface gives a unique control of the camera model: errors in the camera model or the elevation data are clearly unveiled when the artificial surface smoothly fits the real landscape in the photo or not.

Finally, the artificial landscape model can also be used to see if the object to render is behind or in front of a hill because windPRO will automatically erase the part of the WTG hidden by the terrain.

7.1.4.1 Establishment of Elevation Data

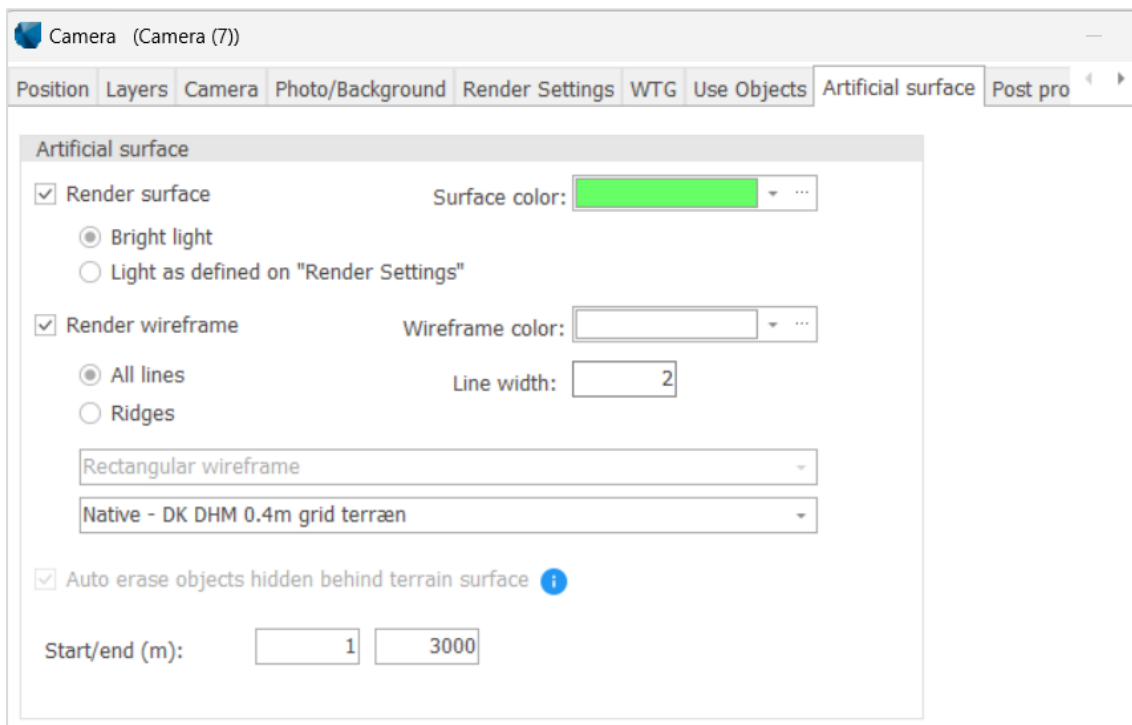
A prerequisite for the establishment of an artificial landscape is the availability of elevation data loaded into a line object or an elevation grid object. Please see the BASIS manual chapter 2.8 Line object or 2.10 Elevation grid object, for a detailed description on how to input elevation data, either through import from Online data sources or from own data file (shp, xyz etc...or manually digitized!). Note the elevation grid object is preferable to the line object because it is more efficient to handle a large amount of data.

Important when using elevation data: make sure that the object containing the elevation data to use (line or grid) is set to decide the TIN/z (see 2.8 and 2.10).

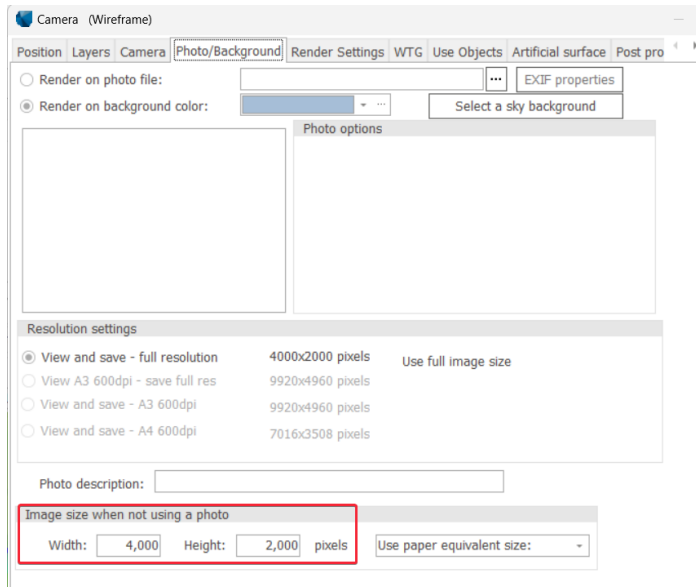
7.1.4.2 Camera Model: Artificial Surface

On the **Artificial surface** tab in the Camera object, the elevation data can be rendered as a solid surface and/or as a wireframe. The artificial surface is based on the elevation set for TIN/z (see 7.1.4.1).

The settings of the Camera model are as described in 7.1.3 but with two exceptions: it is not necessary to select a photo (file name) nor to calibrate the Camera model.



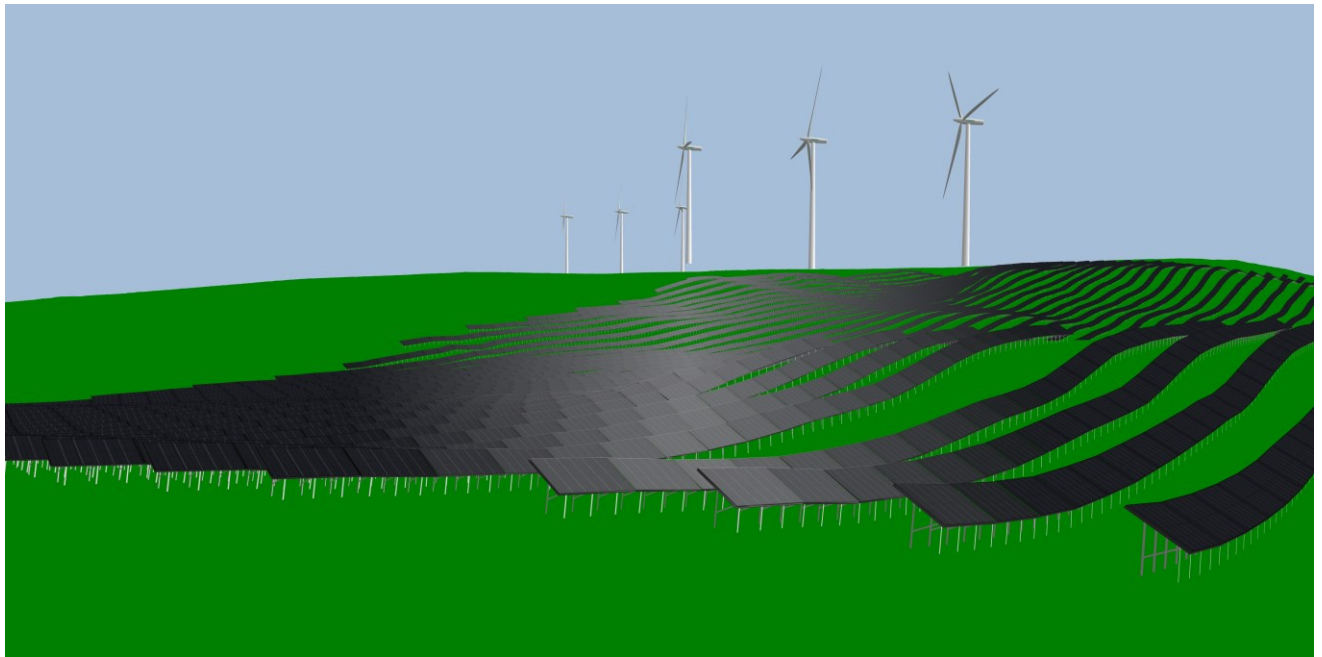
If no photo file is selected, the size of the image (and of the pixels) will depend on the input defined on the Photo/Background tab:



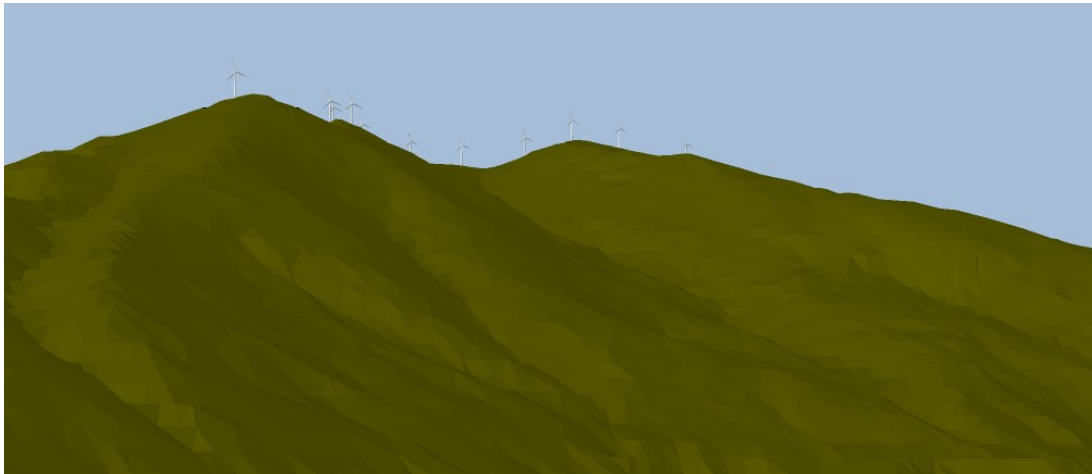
Render surface

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 tab of the Camera object. In this latter case the shadow of the terrain will be simulated with respect to the sun position.

The colour of the surface can be changed. The colour of the sky is defined on the Photo/background tab of the Camera object. The example below is using the option bright light.



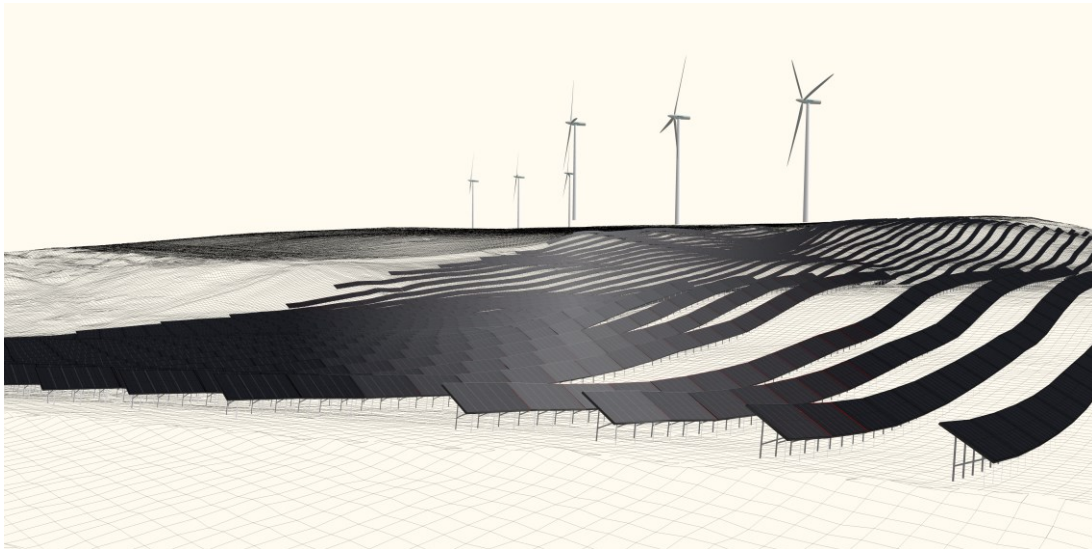
Below an example is shown of a quite realistic view based on artificial landscape rendering, for a site in Greece.



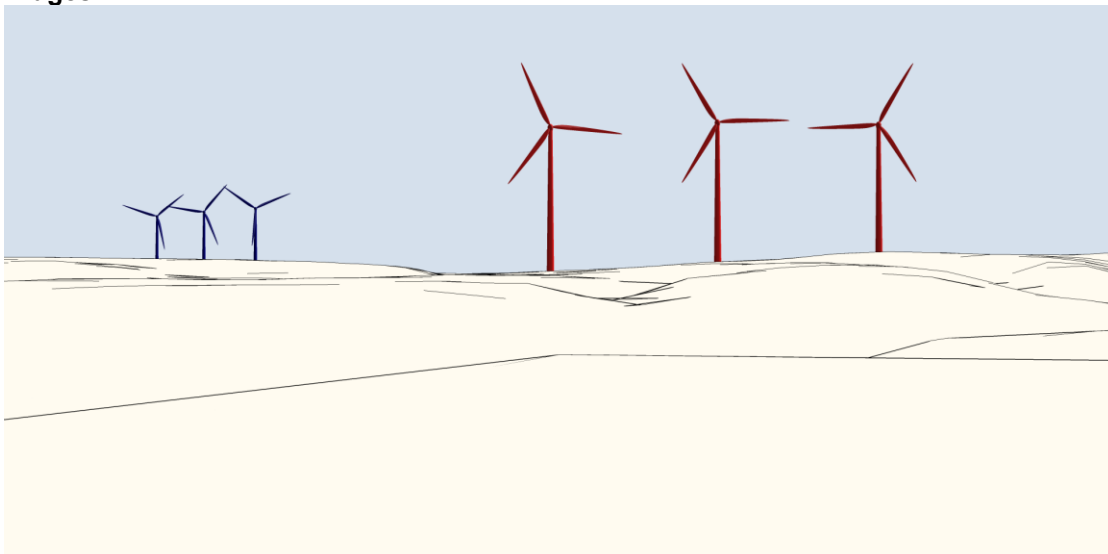
Render wireframe

You can choose to render a wireframe by ticking the **Render wireframe** checkbox. The wireframe can either be shown with all the lines or with ridges.

All lines



Ridges





The color of the wireframe can be changed as well as the line width (unit:pixel).

Note: a wireframe model can also be rendered with a photo as background and thus be used for checking the Camera model.

Elevation data used

With elevation data in a line object, it is possible to choose between rectangular or triangular wireframe. The triangular wireframe is based on calculated triangles (TIN) from the DHM and is therefore the fastest and the most accurate one. Wireframe based on rectangular grid often gives a better result where it is easier to see the contours of the landscape.

With elevation data loaded in an elevation grid object, the options are either to use the native data (one of the layer data of the elevation grid object, see BASIS 2.10) or a recalculated grid at a given resolution.

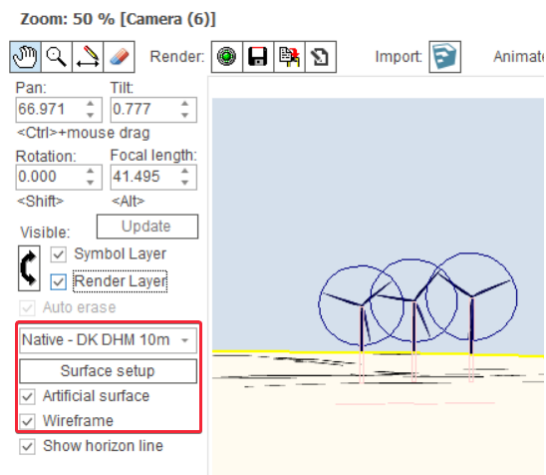
Start/end

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

The Start point can be changed to save some time, if the area of interest is further away.

The input of “end” depends on the landscape and the elevation data available for a site. If there is a mountain landscape behind the object to render, it might be important to include this though it requires a substantial enlargement of the calculation and data site. Elevation data defined from a grid object can easily be extended loading a new layer on online data.

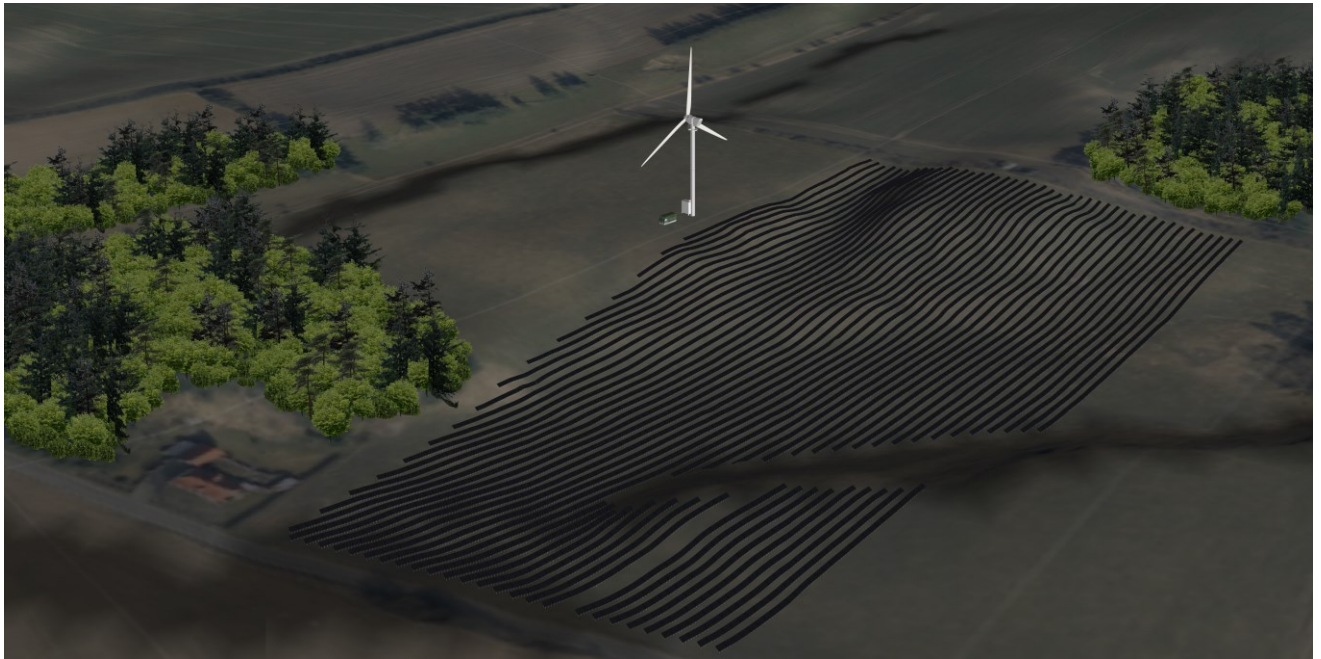
Note: the options related to artificial surface and wireframe can also be adjusted from the Photomontage window:



Besides the terrain features, it is possible to input more artificial landscape details through different objects, see 7. 1.3.2.3 and 7.1.3.16.

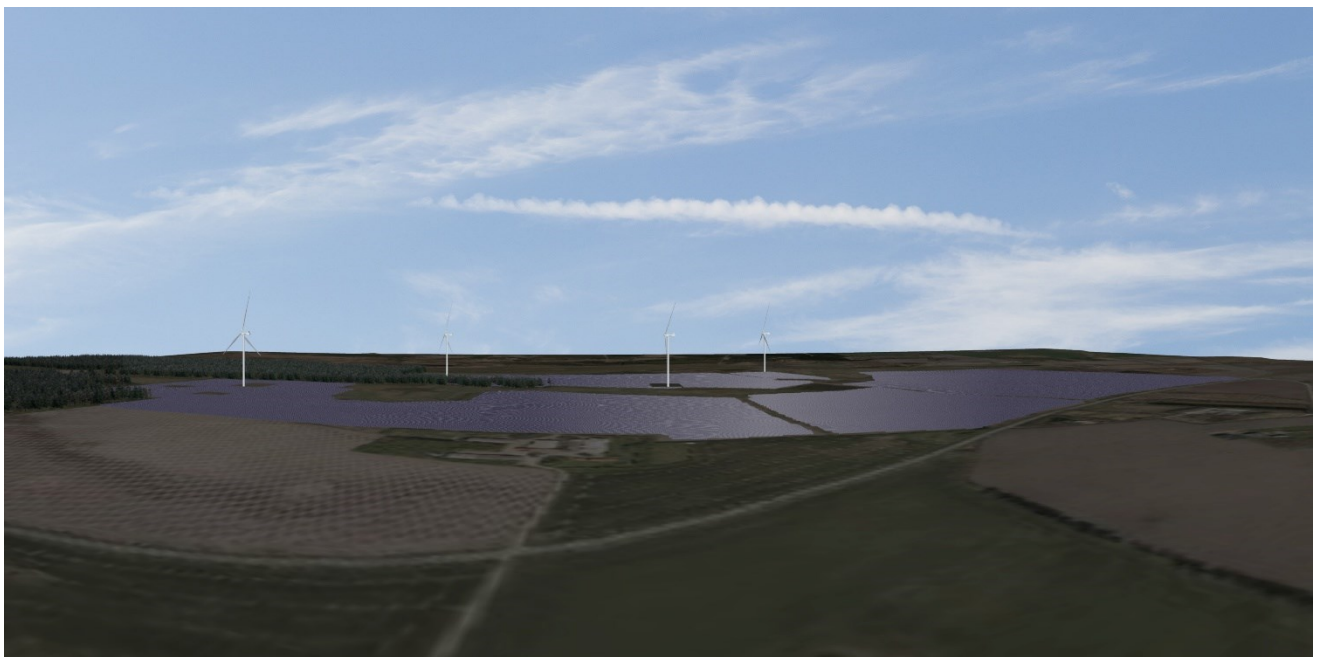
7.1.4.3 Aerial Photo as Surface Wrapping

Instead of using a plain color as artificial surface, a background map as can be used to wrap the elevation data. Note that SketchUp integration module together with Sketchup software are required to perform this action (see 7.3).



The principle is the following: load an aerial photo as a background map, export it using “ Create 3D surface/map” option in SketchUp integration module. In SketchUp, select the surface and just export it back to windPRO as a 3D object. After rendering, the surface will be shown on the Photomontage. See SketchUp Integration section for more details (7.3).

For a good result, it is recommended to use an aerial photo with a proper resolution as background map and a relatively limited area.



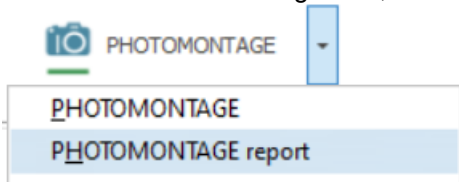


7.1.5 Exporting the Final Image

You have the following options as photomontage output: the photomontage as image file and/or a visual report with input details and relevant information (for wind turbines).

7.1.5.1 Visual Report

The report is only available for wind turbines in the present version. It is generated from the dropdown menu of the Photomontage icon, under the Environment & Visual tab of the ribbon.



Once it is done, the report is then to be found under the Calculations tab.

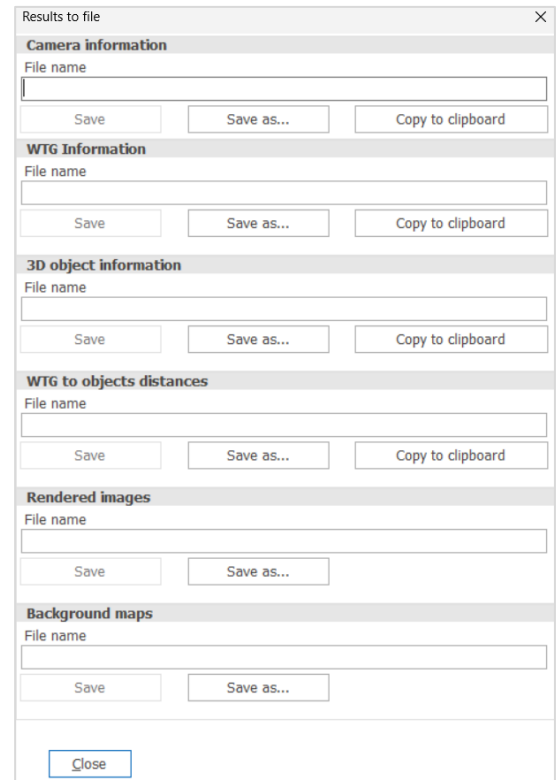
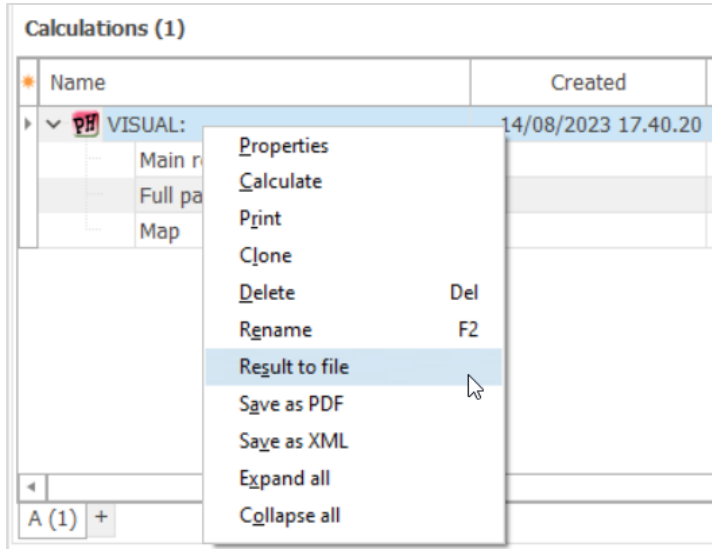
Calculations (1)						
Name	Created	Calculated	Duration	Version	Size [MB]	
<div style="display: flex; align-items: center;"> ▶ PH VISUAL: </div>	17/08/2023 14.23.40	17/08/2023 14.23.43	0:01 (min)	4.0.401	0.3	
<div style="display: flex; align-items: center;"> ┆ Main result </div>						
<div style="display: flex; align-items: center;"> ┆ Full page photo </div>						
<div style="display: flex; align-items: center;"> ┆ Map </div>						
A (1) +						
Calculations (1), Objects (0 / 11 / 38) ×			Zoom: 8 % [Camera: StreetView29528-4.jpg (6)] ×			

Such a report presents the selected photomontages together with relevant information, such as:

- On the main result page: information about the wind turbines and their distance to the different camera objects, the miniature of the photomontage and map showing the location of the wind turbines and camera objects,
- Full page per photomontage where the details of the calibration as well as the recommended observation distance are given; the recommended observation distance depends on the printing format (A4, A3...) from the printer setup; when printed, the page can be held at the recommended observation distance to give a realistic size of the projected wind turbines.
- Map: a full page map showing the location of the camera objects.

Result to file

Once the calculation is done, the content of the report (and more details) can be exported to the clipboard or as files with a right click on the title line of the calculation.



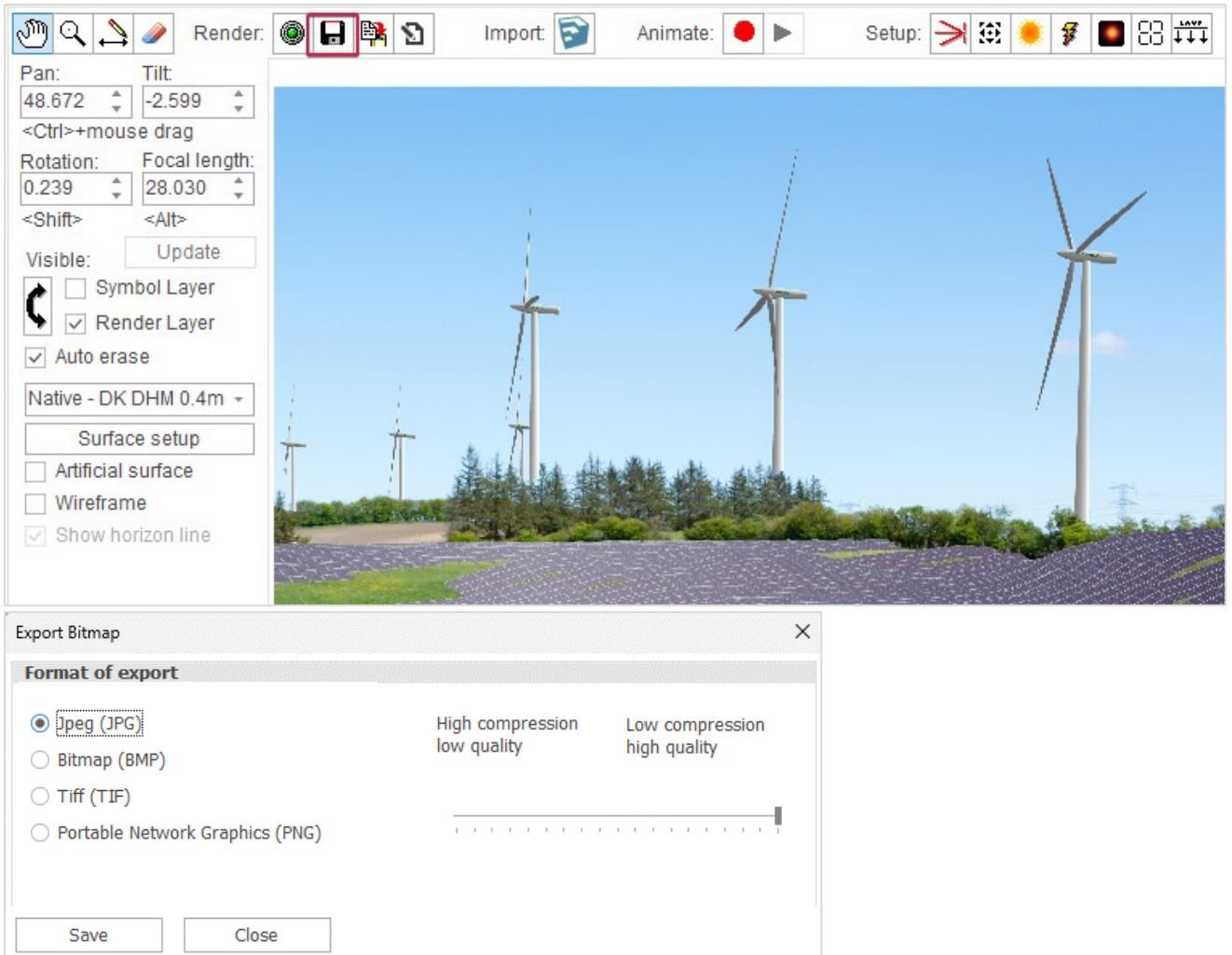
For example, the result to file of Camera information can be seen on the image below.



Camera object(s)																	
No	Easting	Northing	Z	Target point Easting	Target point Northing	Target point Z	Photo direction	Clouds	Visibility	Sun	Wind dir.	Image width	Image height	Field of view	Vertical field of view	Focal length	
			[m]			[m]	[°]				[°]	[pix]	[pix]	[°]	[°]	[mm]	
A	305186	6579950		292	304215	6579693	159.076	261.355	Clear sky	Normal	Normal	0	3648	2736	41.3957	14.8361	25

Focal length	Film format width	Film format height	Panorama	Image filename	HFOV	VFOV	View Direction	WTGs In View	Visible WTGs Count Tip	Visible WTGs Count Hub	Closest Wtg	Distant WTG	Closest Wtg Description	Distant Wtg Description	Camera Agl
[mm]	[mm]	[mm]			[°]	[°]	[°]				[m]	[m]			[m]
25	34.6133	25.96	NO	U:\TRAV\...	69.3871	54.8766	-104.85	5	5	5	502.58	1750.47	Siemens S	Siemens S	2

7.1.5.2 Export as a File

In the photomontage window you can save/export the image as an image file from the disc icon.



- Export to Google Earth can be made from the object list (right click on the Camera object) or from the Google Earth Icon under the Geo data tab of the ribbon
- Export as an output file that can be used in image editing software (see Post-processing in 7.1.3.3)
- Export to SketchUp can be made from the SketchUp Integration Tool  (see 7.3)
- Copy to the clipboard with  , available on the top bar of the photomontage window

Link to YouTube channel



7.2 VISUAL – Animation (2D)

Animated visualization consists in rotating the wind turbine blades in a sequence of renderings called an animation. The animation, which is stored as a file, can then be shown on any device supporting the standard file formats. 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 software can be 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. This way, it is easier to evaluate alternatives such as many smaller but faster-rotating turbines and less big but slower-rotating turbines. Blinking aviation lights on the top of the nacelle can also be shown.

It is possible to export the animation as a file that can be published on the Internet and shown in a standard browser (Internet Explorer, Firefox, Chrome, etc.).

Besides the 2D animation based on photos, it is possible to get the turbines animated in Google Earth (see BASIS chapter 2.15 for more information) or in SketchUp (see 7.3).

Finally, Animation can be used to generate a visualization on a video (from a fixed point) with the help of an external editing software, as demonstrated in this video: <https://www.youtube.com/watch?v=ICT-t09ADeY>

7.2.1 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 an effective animation of the turbines with rotating blades.

The program automatically creates the necessary number of rendered images for a complete cycle.

7.2.2 Preparation – Individual Speed for Each Turbine

Before creating an animated visualization a photomontage has to be made. This is described in detail in paragraph 7.1. VISUAL – Photomontage. Remember to rub out not only the rotor parts that are behind obstacles such as trees but also all areas of the rotation.

Next, ensure that the rotational speed settings in the WTG Catalogue for the relevant turbines are correct. Alternatively, the rotational speed can be entered together with the turbine data. By default, the input of Rpm for nom. power (revolution-per-minute at nominal power) is used. The Rpm start (cut in) can be used instead when the option “Use value for low power” is checked in the Animation setup (see 7.2.3).

If no Rpm value has been defined in the WTG object nor in the wind turbine catalogue, the Rpm will be calculated from the rotor diameter and the assumed tip speed of 50 or 70 m/s respectively for cut in or nominal power conditions.



New WTG (Siemens SWT-2.3-93 60Hz 2300 92.6 IO! hub: 80.0 m (TOT: 126.3 m) (6.3))

Position Layers WTG(s) Visual Distance circles Curtailment Operation Description

General

Render WTG Only used when "User selected" on tab "Use objects" in camera object

Show as WTG symbol

Rotor angle: ° ↻)

↻) At 0 degrees one blade points up. Leave blank for random angle.

Animation

Rpm start (cut in): rpm [??? rpm,] *)

Rpm nom. power: rpm [??? rpm,] *)

Show defaults

*) Leave blank and default values will be used - these are read from WindCat if present, else calculated from standard Tip speeds (m/s): 50 (start) and 70 (nom).

Warning lights. Positions and frequency

Red, Top, 1 Hz

White, Top, 0.5 Hz

Check the wanted light(s) for this WTG – note you can apply to all WTGs from "Multi Edit". Use the button or right-click the list to view the lights tools.


Options... ▾

Ok Cancel

Prev Next

When aviation lights have to blink, verify that the option "blinking" has been selected and defined (see 7.1.3.18).

7.2.3 Generating an Animation

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



Rotor revolutions per minute

Use object values Use value for low power

Calculate from blade tip speed:

Quality

Low Frames pr sec.: 40

Reduce demands to exact rpm for all WTGs with: 1 %

High Save as default

Result

Animation length: 1.3 sec Number of frames: 50

Media

Export types	Export type description
<input type="radio"/> AVI file format (.AVI) (FFMpeg)	H.264 Video format (.mp4) (FFMpeg)
<input type="radio"/> Separate bitmap files (.bmp)	
<input type="radio"/> Animated Gif (.GIF)	
<input checked="" type="radio"/> H.264 Video format (.mp4) (FFMpeg)	
<input type="radio"/> windPRO Animation format (.wpa)	

Post process animation frames

- Don't apply any post-processing
- Don't apply any post-processing
- Select sub-area or change resolution
- Create panning effect

Rotor revolution per minute

Use object value: the rpm for nominal power defined in each WTG object (See 7.2.2) is used by default. If the option “Use value for low power” is checked, the rpm start (Cut in) value from the WTG object is used instead. Calculate from blade tip: the revolution speed can also be calculated from the rotor diameter and the blade tip speed (set to 50 or 70 m/s respectively for cut in or nominal power conditions).

Quality

The quality of the animation depends on two parameters:

- 1) The number of frames (rendered images) per second
The number of frames per second should be selected between 20 and 50 – standard TV uses approximately 25 frames 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 between several options:

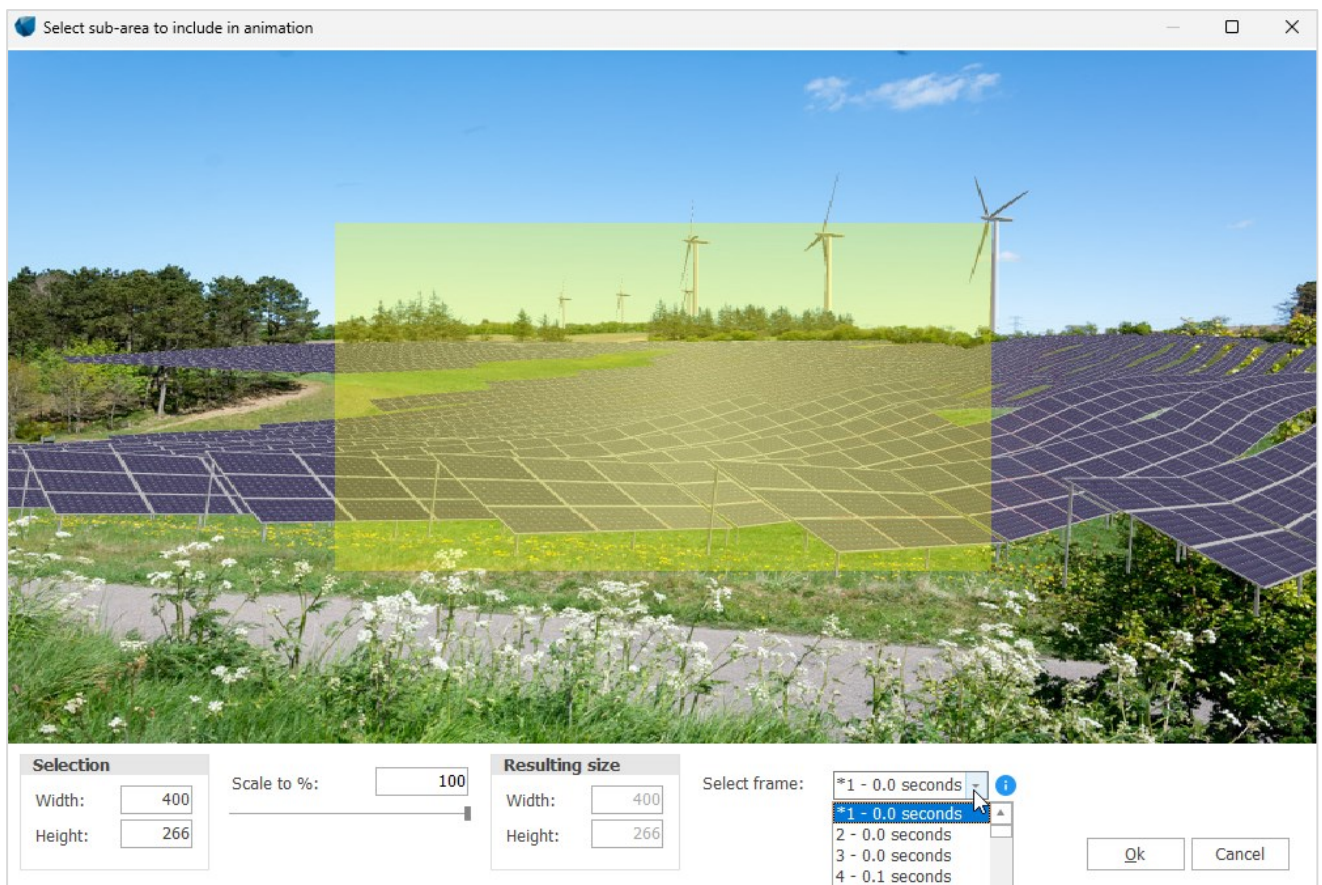
- 1) .AVI Uncompressed video format.
- 2) bmp files, i.e. standard bitmap files that in themselves do not show an animation. If you have a recording tool of your own capable of using the .bmp file format it is possible to create the animation based on these files. For example the Paint Shop Pro Animation can create an animated .GIF file based on these.
- 3) Flash – is the right choice for presentation of the animation in a web browser.
- 4) Animated GIF for playing in standard web browser and published on web pages.
- 5) H.264 Video format (FFMpeg) where a 30 seconds long animation is made
- 6) 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.

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.

Post process animation frames

With this option, it is possible to select sub-area, change the resolution of the animation or to create a panning effect.

With **Panning effect**, the view can be moved around the animation to create like a video from a fixed point. Once all the frames have been rendered, frames /sub areas of focus can be defined with different dimensions and zoom levels. The time at which a selected frame is shown during the animation is shown next to the frame number in **Select frame** menu.





7.2.4 Recording and Play a 2D Animation

When the calculations are completed, the animation will show in a separate window on the screen.

If you have chosen the output format of .wpa file the EMD Player application, it is possible to change the recording speed under Animation/settings (but only 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 with the EMD Player, you need to copy both the animation file (.wpa) and the animation player EMDplay.exe both found in the folder: Program Files\EMD\windPRO4.x\

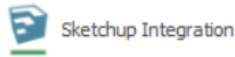
You start the animation by opening (left double click) the EMD player and select **Play**.





7.3 VISUAL – SketchUp Integration

7.3.1 Get Started with the SketchUp Integration Module



This tool can be used for multiple purposes:

- As a helper tool for Photomontages (to add vegetation/fence, roads, visualized power transmission lines, add any 3D objects from SketchUp warehouse, create masks between two rendered objects ...)
- Edit elevation data in 3D
- View a windPRO project in AR or VR.
- Sharing windPRO project online in 3D
- Visualize WTG shadow flickering

The SketchUp Integration tool manual is available online at this location:

<https://www.emd.dk/redirectUrl.php?category=windPRO&id=SketchUpManualOnline>

A long list of YouTube tutorials that can be found here:



<https://www.youtube.com/playlist?list=PL6zroSoHTqaOAZiYatQqPRrAzmvuRMTHU>