7 windPRO Visual

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 only has to place the turbines on a map and select the turbine type. The program will then render the turbines taking into consideration such factors as lighting conditions, position of the Sun, wind direction, etc. The turbines are placed in a landscape photo or in a digital landscape model.

Beside turbines, windPRO can visualize Solar PV panels when combined with the Solar module. windPRO can actually visualize any objects defined as a dae file via the 3D object. 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 height contour lines 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), which makes the turbines rotate on a photomontage, which can be published on the Internet

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 height contour lines into a line object or elevation grid object. Use the **Automatic Z value from DHM** for all turbines 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 turbine site, in the general direction in which the photo was taken. Load the photo (or switch on **Artificial landscape**), set date, time and focal length if available (if EXIF data in the photo, 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 your photo.
- If digital height contours lines are available, the horizon line (yellow) is very handy to check the camera model. The yellow line must follow the landscape on photo (if elevation data are available far enough out in the landscape).
- Click the render button in the menu bar on the top of the photo. NOTE: By default, all turbines in visible layers are rendered, so use the layer structure (see Chapter 2.11 BASIS) to select which turbines to render.
- Rub out turbine parts that should be behind trees etc.
- Export the photomontage as an image or from 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 in order to make sure that the right pixels will be removed.
- Click on the red button in the photomontage (**Create animation**) in the top toolbar.
- Apply information on the animation.
- Save the animated "movie" in windPRO format or other and start animation.
- When finished, the EMD player automatically starts showing the animation.
- You can now send the animation file together with the EMDplayer.exe to any PC to be run. Or you can integrate the animation on a web site by using the flash format.

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 into the image with the correct proportions. The surface of the turbine is controlled by various parameters. Some of these parameters are linked to the turbine (colour, reflection, etc.), and others are linked to the weather conditions at the time when the photo was taken (Sun position, brightness, haziness, etc.). We have tried hard to simplify the set-up of these parameters: The Sun position is calculated by the program based on time of day, date, time zone, latitude/longitude and camera viewing direction. The weather is described through simple choices such as: clear sky, light overcast, heavily overcast, etc.

7.1.2 Photographing

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

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

The focal length of the camera lens should be between 35 and 70mm, 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.

7.1.3 Example of making a Photomontage

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

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

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

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 (turbines, solar PV …)

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 enter 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.

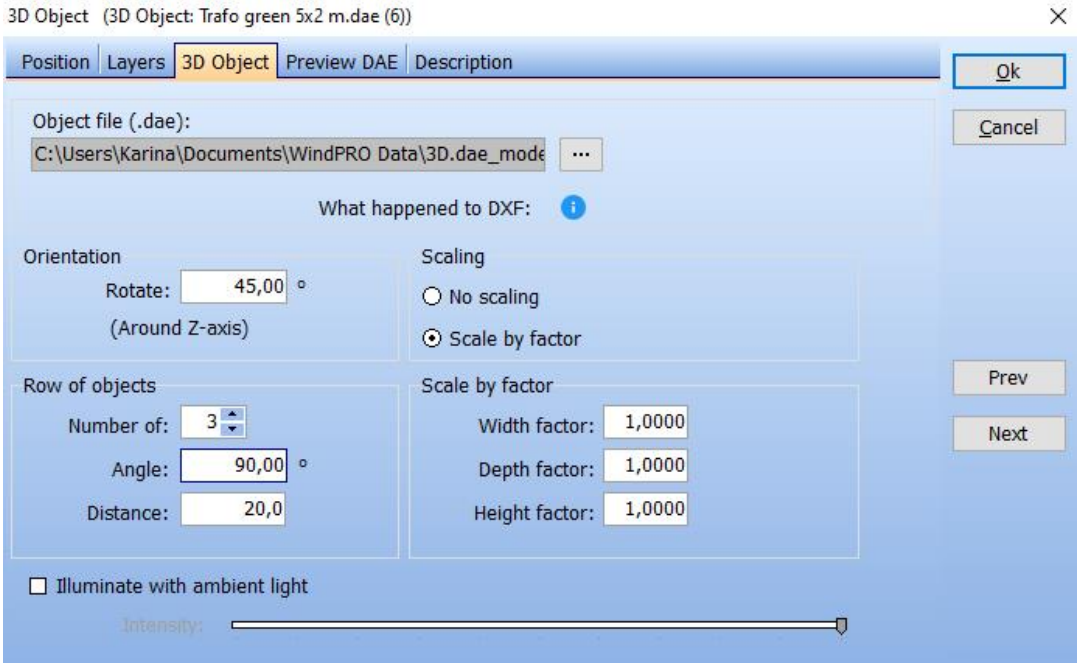
Note that the angle of the blade rendered in a photomontage is defined under the **Rotor angle** input in the Visual tab of a given wind turbine object (see section 2.5.2.4 Chapter 2. BASIS). If no value is defined, windPRO chooses a random value.

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 visualized objects, other than wind turbines. 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.

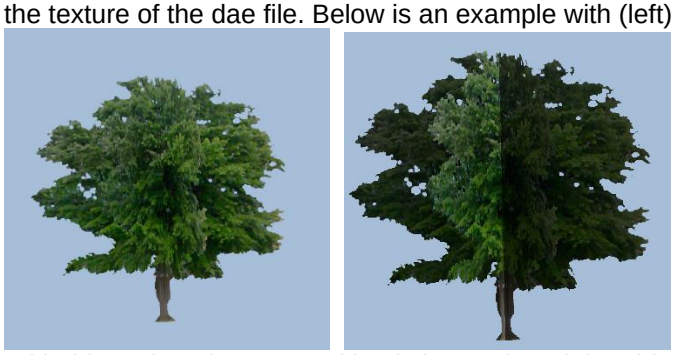


Orientation: the 3D object is defined in the dae file with a certain orientation. This orientation can be changed by a rotation around the z-axis. The orientation can also be changed manually from the map: select the 3D object on the map and an arrow pointing into the direction given by the orientation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

Note that the red wireframe view of the 3D object on the map can be useful to check that the 3D object has the orientation as wished.

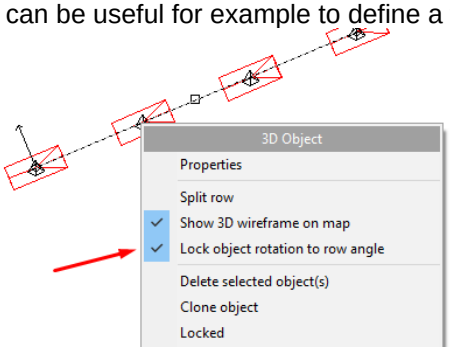
Scaling: With no scaling the absolute dimensions of the 3D object are used, whereas scaling by a factor allow to change the dimensions of the object along the 3-axis x (width), y (depth) and z (height). The resulting size of the object can be seen on the photo before rendering as a white wireframe on 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.

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.



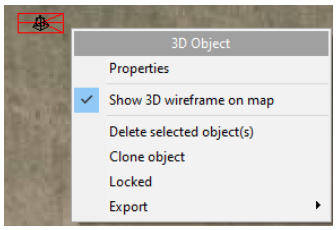
With this option, the sun position is ignored, and the object is illuminated equally from all sides. The intensity of the light can be adjusted using the slider. When the slider is at max the object is fully bright, and when it is at the minimum it is black.

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.



The dae file can be viewed on the Preview DAE tab.

The wireframe of the dae file can be shown/hidden on the map by ticking **Show 3D wireframe on map** available from the right click menu of the 3D object on the map. For large dae files, it can be an advantage to deselect the option of showing the wireframe on the map, as shown below.



The wireframe is shown in red on the map and in white on the photo in the symbol layer.

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:

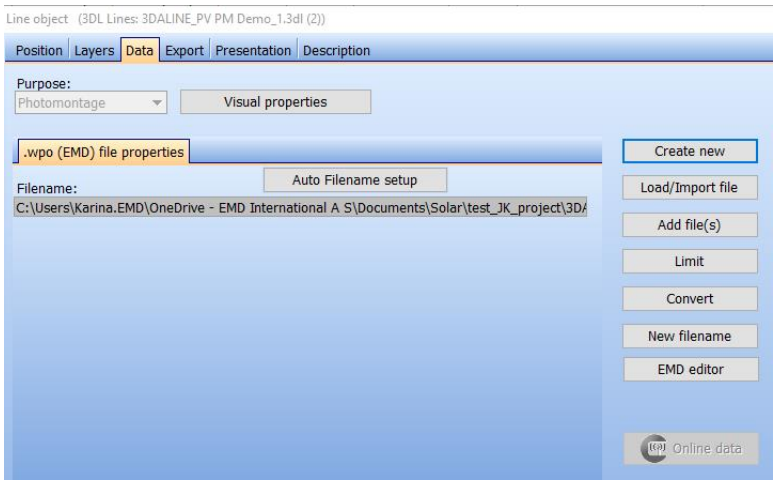
- Maximum number of polygons of 10000
- 3D object placed at the origin in SketchUp (so that it is placed on the map in windPRO at the intended coordinates)
- be aware of the orientation and the dimensions in order to adjust the setup (orientation and scaling) in windPRO accordingly.

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).

1.3.2.4 Line object

A line object can used 2 different ways:
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.

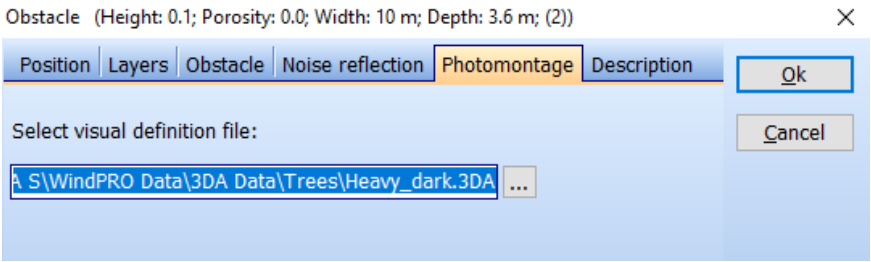
The purpose on the Data tab of a line object shall be Photomontage.



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

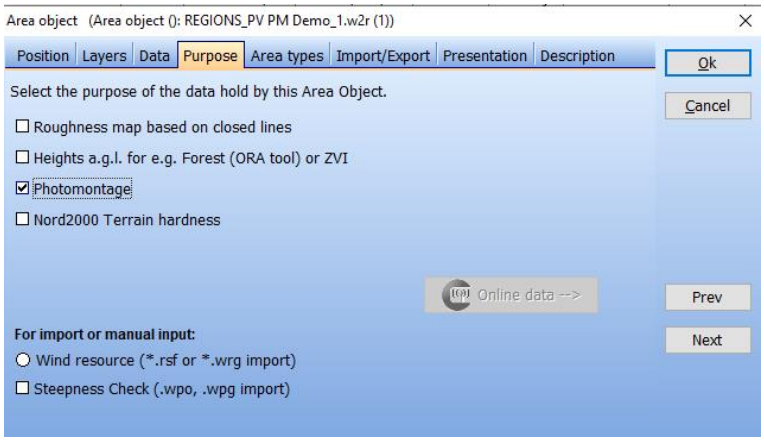
1.3.2.5 Obstacles and areas

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.

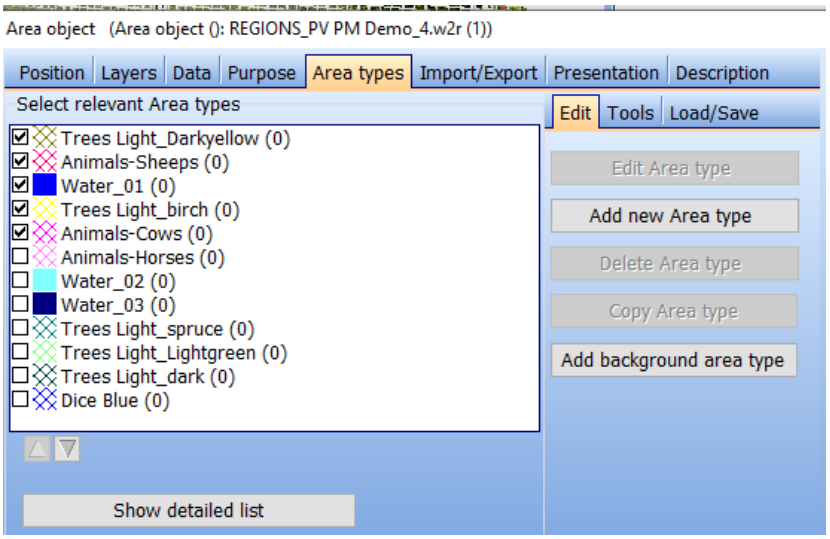


Larger regions as water, forest or cities can typically be incorporated through an area object. A 3DA file can be attached.

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.

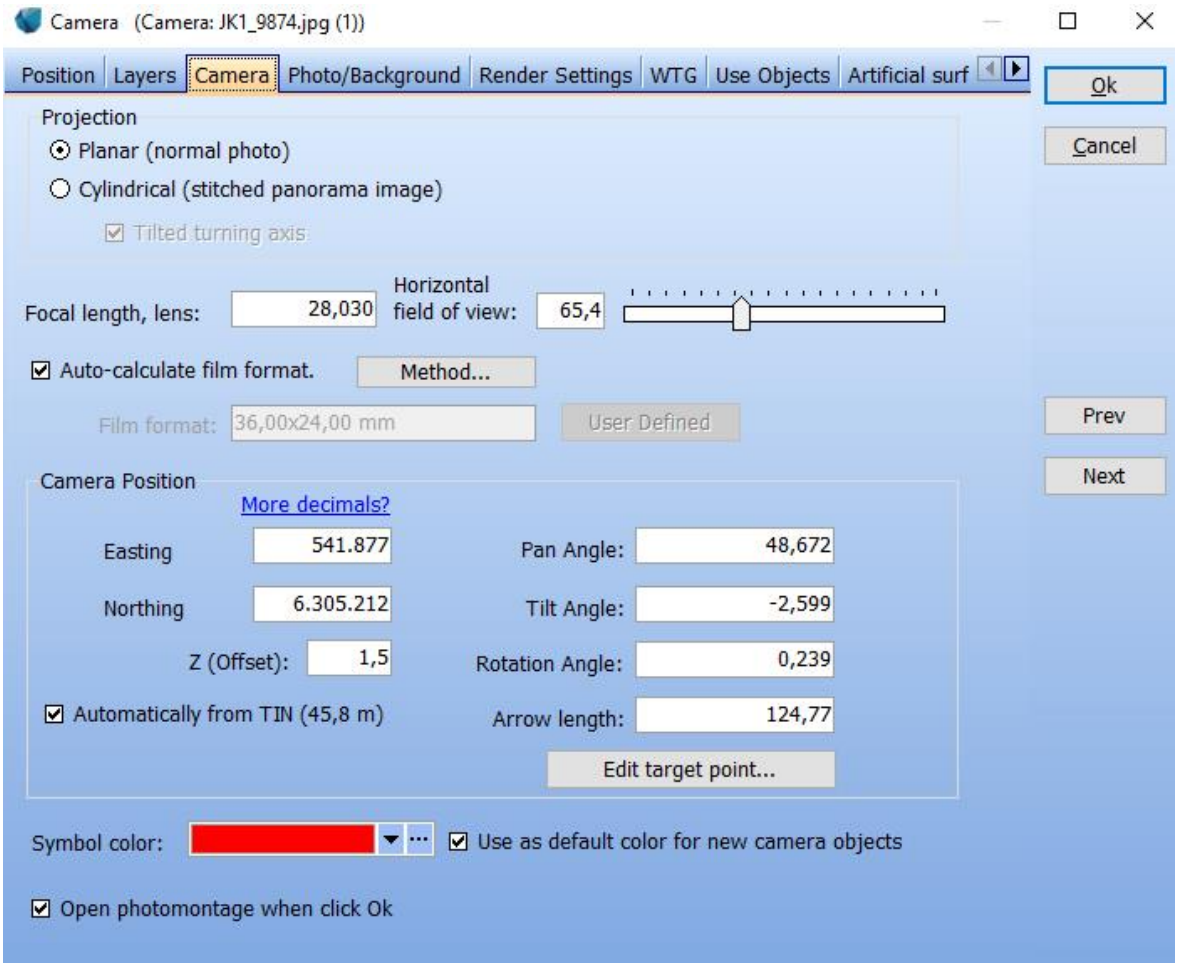


For more information about working with an area object, please refer to BASIS, chapter 2.9.3.

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 by clicking on the map at the position from where the photo in question was taken (the Camera Point). Drag the camera line to the target point of the photo and click again to position the object. The 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 right 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 – tab sheet Camera



Projection: Planar (normal photo)
Planar is to be selected for a photomontage based on a single photo. The film format associated to the focal length will then decide the size of the turbines. windPRO can automatically calculate the film format width and height corresponding to a 36 x 24 mm film format as the default option **Auto- calculate film format corresponding to 35mm equivalent focal length** is checked. The focal length of the lens will normally be indicated on the lens or it can be found in the technical manual for the camera (or lens). Very small deviation on the focal length may be necessary to compensate the light distortion that can be due to the transfer or the variation of the temperature. If you use a variable zoom lens it might be necessary to establish the focal length used by the aid of control points (see a later description of this).

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

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

The above formats change for other film formats. If, for example, the film format is 6 x 6 (60x60mm), the normal lens will have a focal length of 80mm

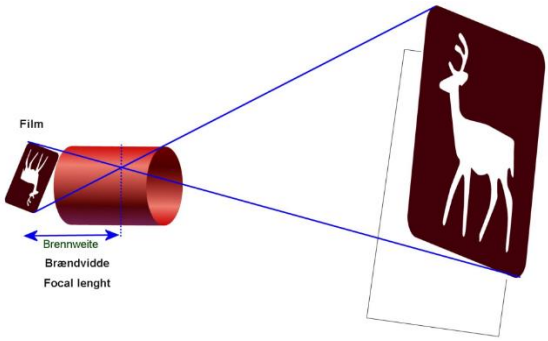
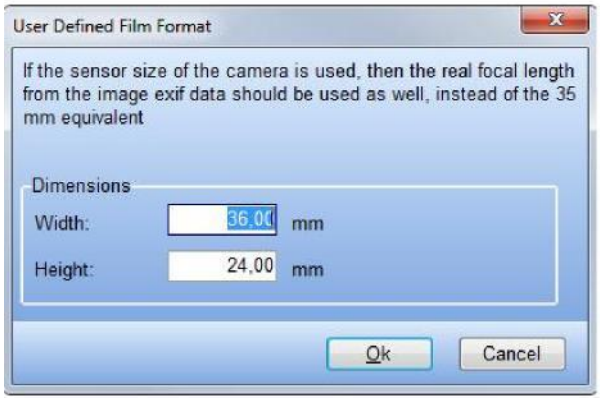


Figure 1 The illustration above shows how the image will be mirrored through the lens. The focal length is the distance in mm between the sensor surface or film negative and the crossover point. This shows that another negative format, will give another focal length for catching the same image.

The focal length given by a digital camera has to be corrected to the equivalent focal of the traditional 36x24mm film format (sometimes known as “35mm equivalent”). The correction factor (typically varying from 1 to 6) can be found in the technical specification of the digital camera. The focal length and sometimes also the corrected focal length can be read automatically by windPRO from the EXIF properties of the picture file (see Photo/Background tab).

For digital cameras windPRO can calculate the film format width and height corresponding to a 36 x 24 mm film format. For this, check the **Automatic calculate film format based on picture size** option. You can also add your own definitions in the following form, which appear by unchecking **Auto-calculate film format corresponding to 35mm equivalent focal length** and by selecting **User defined** in film format:



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

Scanned images (including professionally scanned photo images on a photo CD) often get the edge of the actual image cut away during the scanning process to avoid possible black edges on the image due to misalignment of the photo in the scanner. To compensate for this “cropping”, you either have to change the film format or the focal length. It is usually more convenient to change the focal length, which should normally be increased by 2-5% for photos on a photo CD. Use the control points (which will be discussed later) to establish the precise focal length.

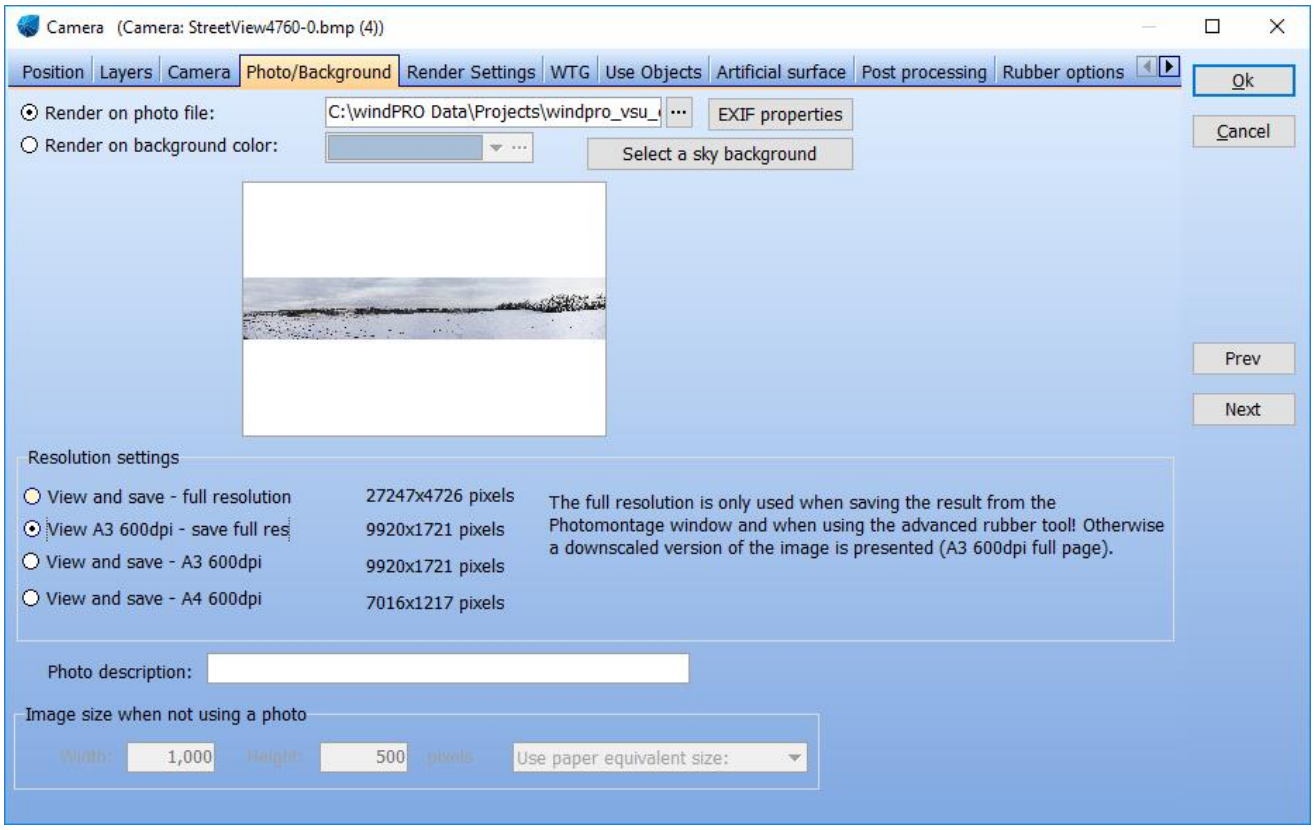
Projection: Cylindrical (stitched panorama image)
Cylindrical is to be selected for a photomontage based on stitched pictures. The field of view (FOV) is the main parameter. The dimensions of the photo (number of pixels) associated to the field of view will then decide the size of the turbines. The field of view is the angle formed by the two rays encompassing the horizontal view that can be seen on the photo. The FOV is defined in degrees. Some stitching software can give an indication of the value of the resulting field of view from the 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.

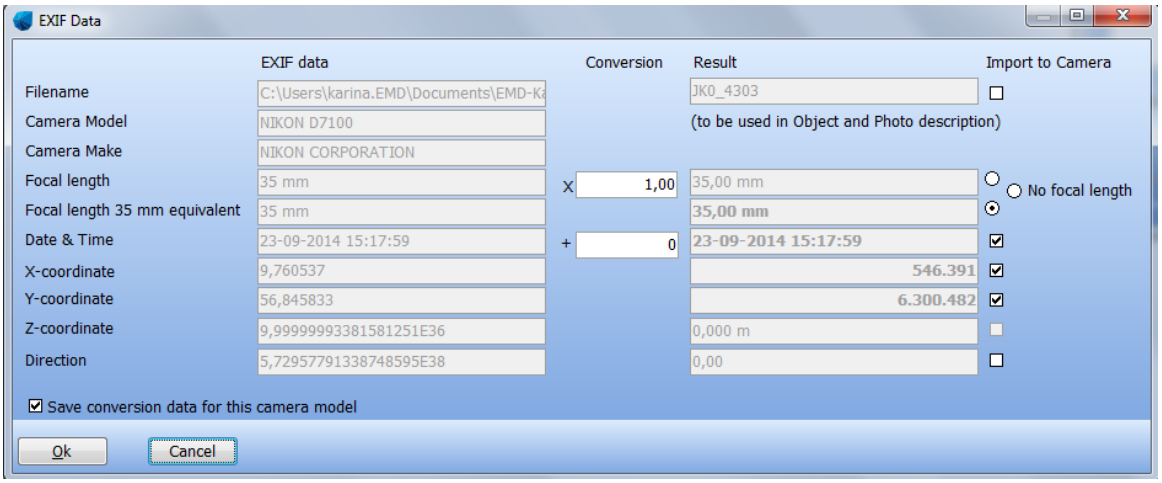
Camera position
The 3-dimensional coordinates for the camera point and the target point (the centre of the photo - can be any point on the centre-line of the image) ends the definition of the camera model. In most cases, you will have to know the exact Camera Position, which significantly helps in the 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 – tab sheet Photo/Background



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

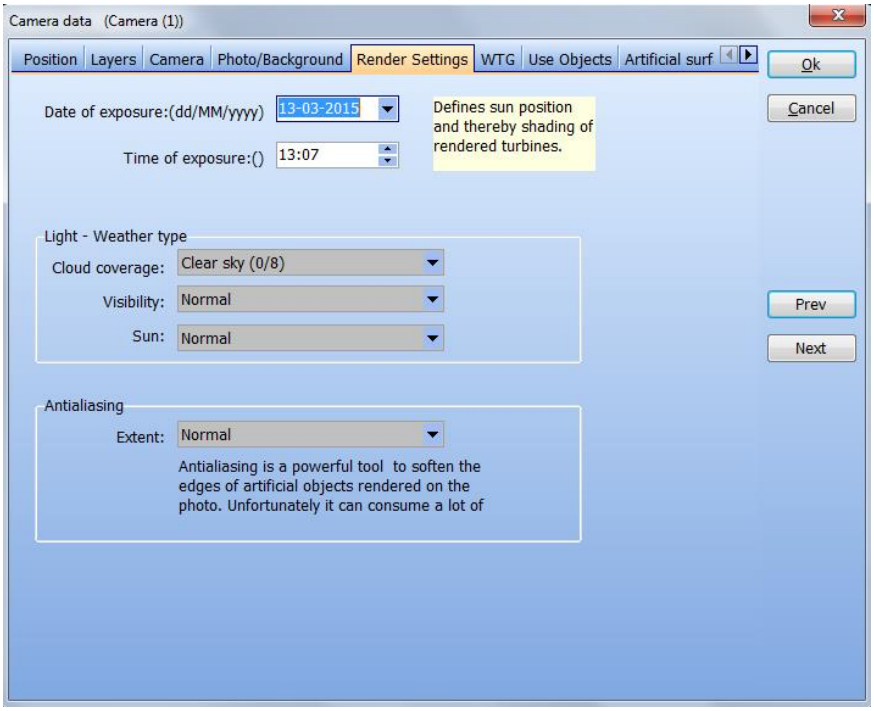


Resolution settings
Working with large photos slows down the performance of the PC. Therefore, different options of resolution of the image are available.
With the setting **View and save – full resolution**, the original image file is used both in windPRO (for viewing, calibration, rubber tool) and 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 description of the photo can be added, which will then be included on printouts later on.

If you do not have any photo from the site, the tool can be used with a background and an artificially-rendered landscape based on height contour lines (TIN model). In this case select **Render on background colour**, select a colour and alternatively a sky background and go the **Artificial surface** tab. In following it is assumed that a photo or panorama is available. You can increase the number of pixel (and thus the quality of the picture) by increasing the **Image size** (at the bottom). The default is 1000 x 500 pixels and this can produce a very coarse result. Increase the number of pixels to improve the resolution of the image. The upper limit for these values will be defined by the PC.

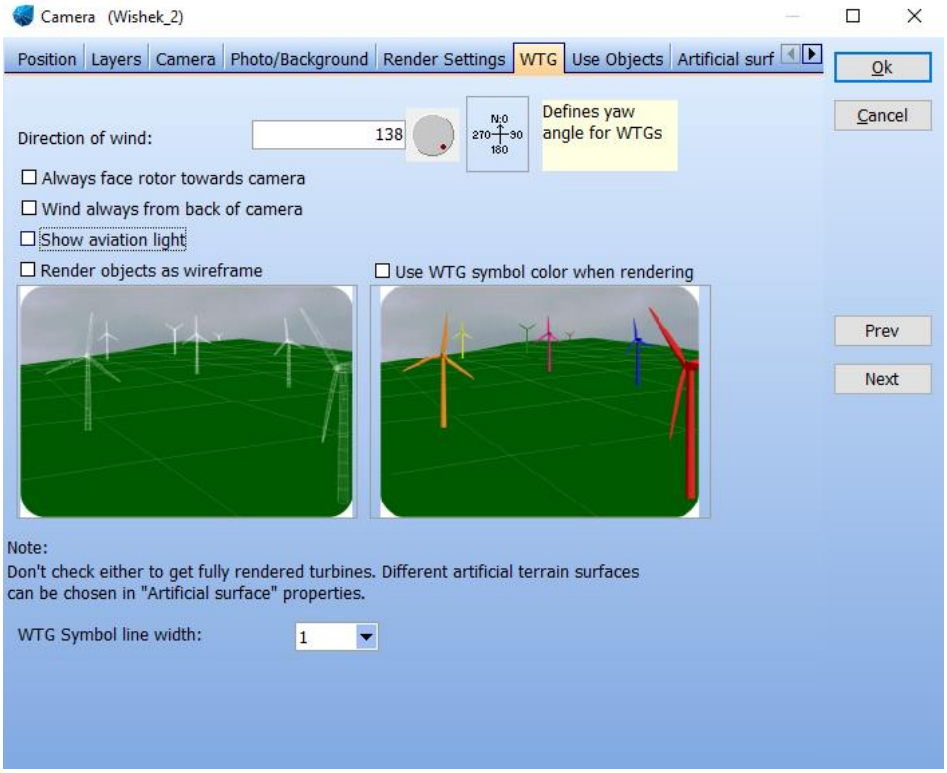
Camera object – tab sheet Render settings



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

Date and time control the angle of the direct light together with the geographic position and time zone. 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 much 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 – tab sheet WTG



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.

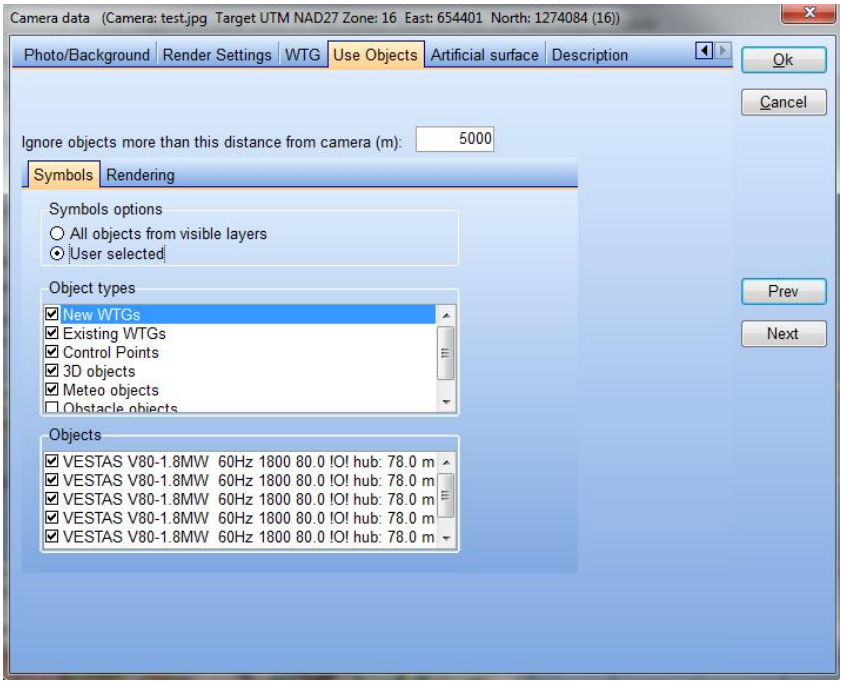
Render objects as wireframe: the wind turbine is simulated as a white wireframe.

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 – tab sheet Use Objects



This tab decides which wind turbines, 3D objects or area objects will be simulated on the photomontage.

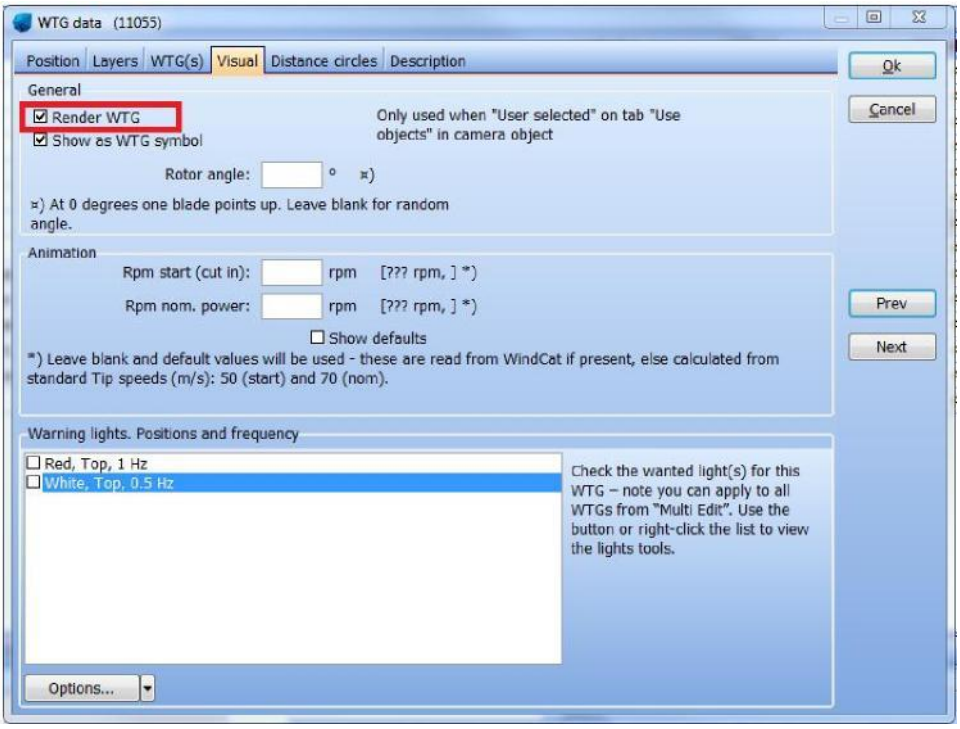
Beyond the default distance of 5000m, the objects will be ignored, saving some rendering time.

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

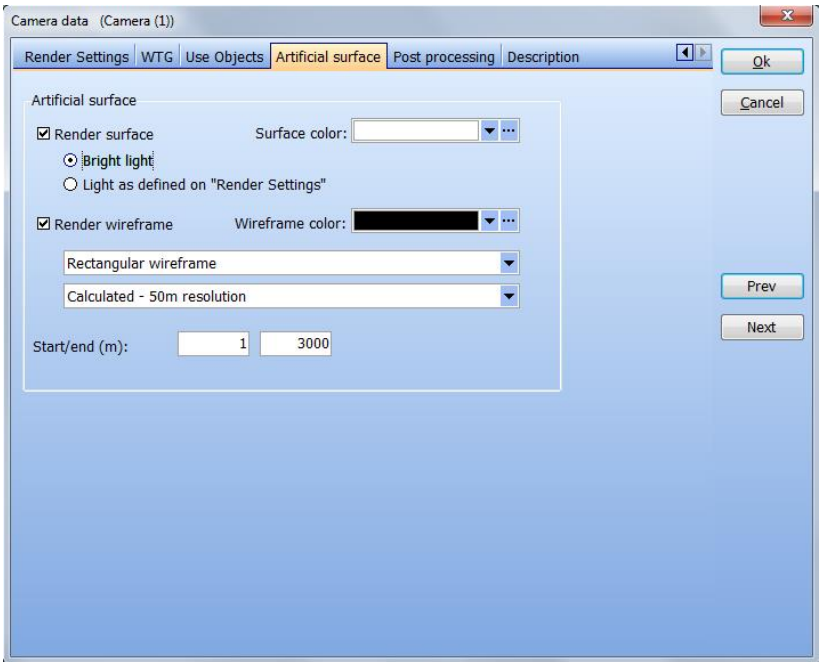
Following objects can be used in photomontage:

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

A wind turbine can be excluded from the symbol and/or render layer of a photomontage by selecting **User selected** and unchecking **Render WTG** and/or **Show as WTG symbol** in the Visual properties of the wind turbine (See Chapter 2).

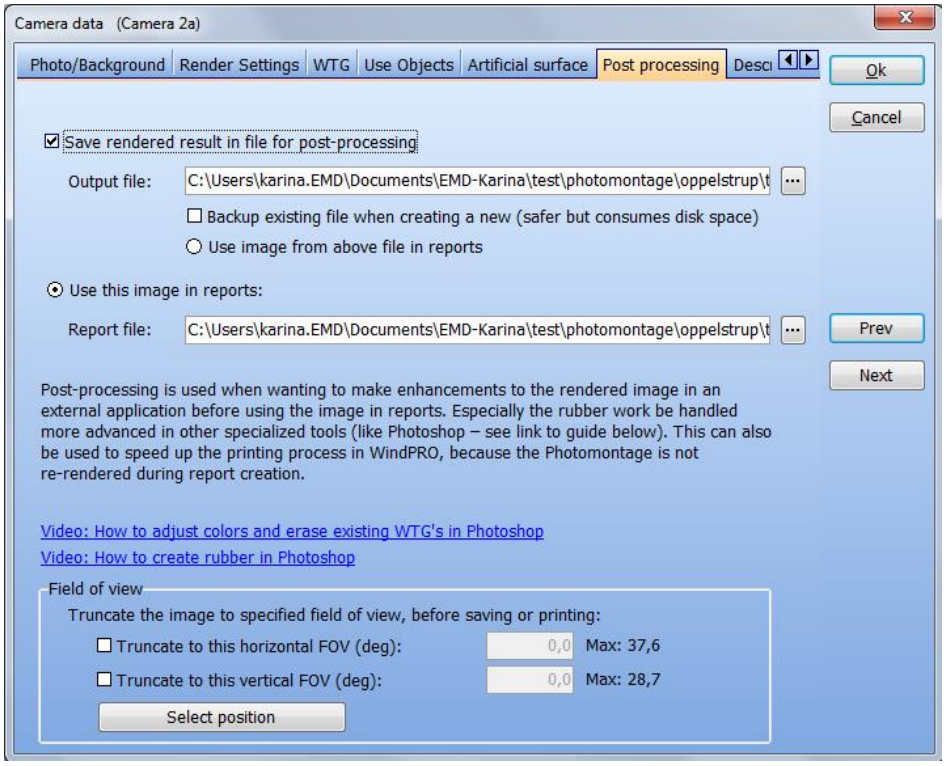


Camera object – tab sheet Artificial surface



When rendering the artificial surface or wireframe, this is limited to the distance given in this form. The default value of 3000 m is often too short if there are some hills at a longer distance that should be included. 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 later.

Camera object – tab sheet Post Processing

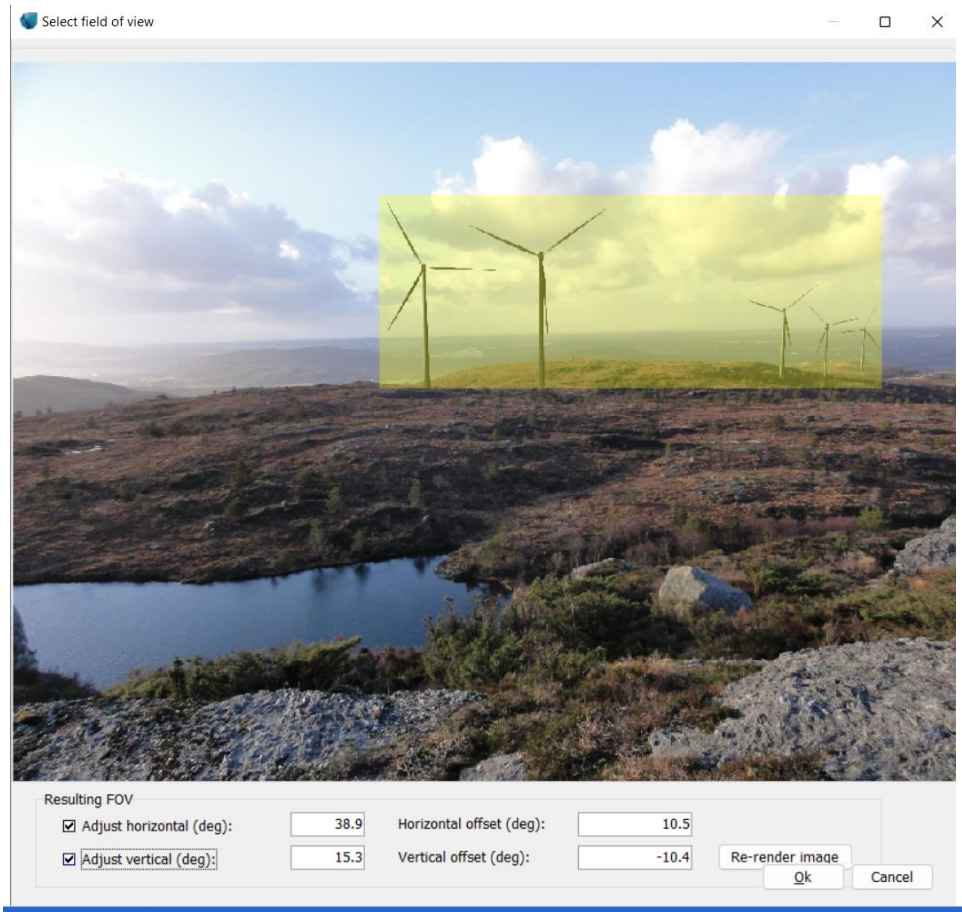


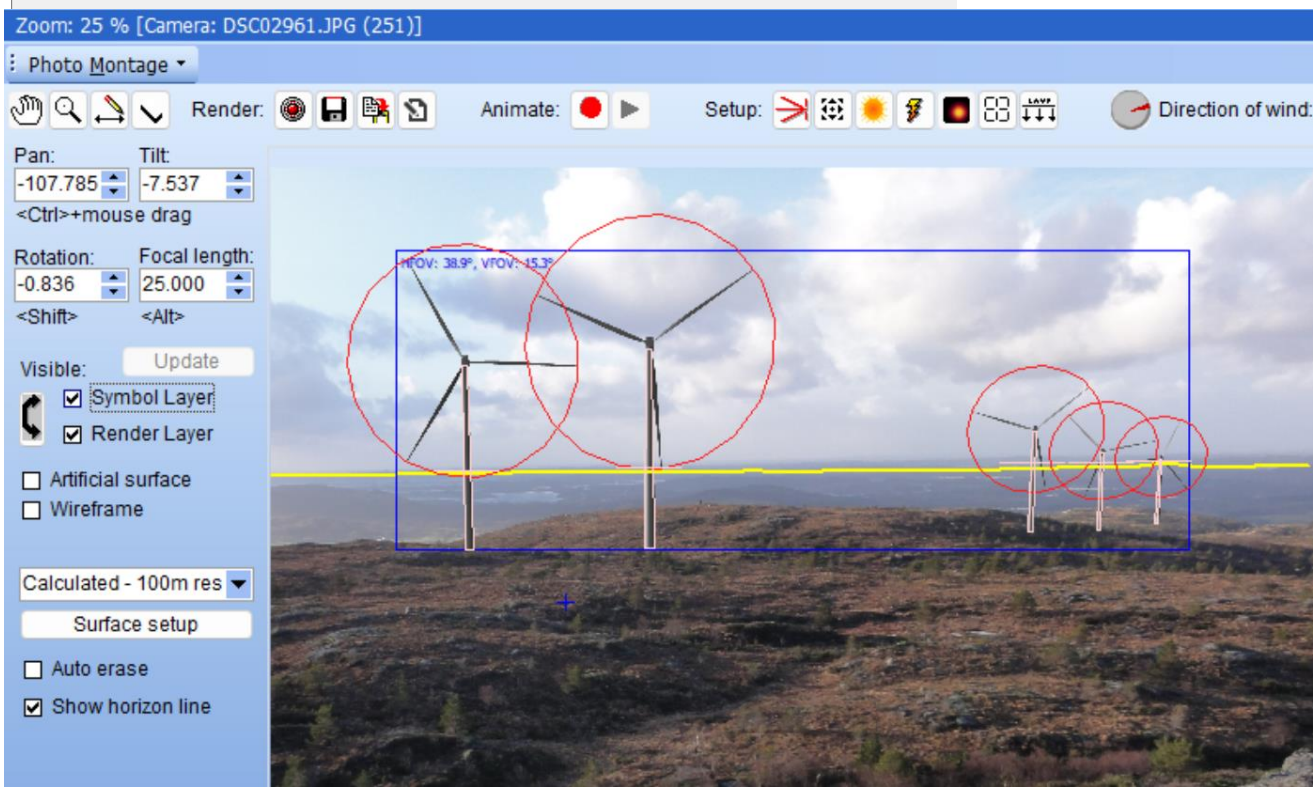
In some cases, a photomontage made in windPRO can benefit being post-processed by specialized graphic editing software (such as Photoshop). The two videos (linked from this tab), show examples of how to adjust the colors/light of turbines, how to erase existing turbines and how to use an efficient rubber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

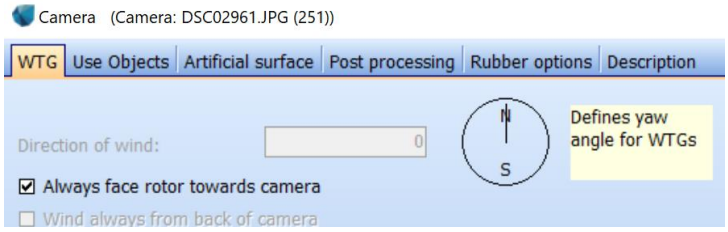
When **Save rendered result in file for post-processing** is checked an output file will be created every time the render button is hit. The name and path of the file can be defined manually if needed. By default, the output file is saved in the same folder location than the original photo. The output 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
This option can be use to truncate the 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 field of view entered 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 the rendered turbines. It can be an advantage to select the option “Always face rotor towards camera” 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



Camera object – tab sheet Rubber options

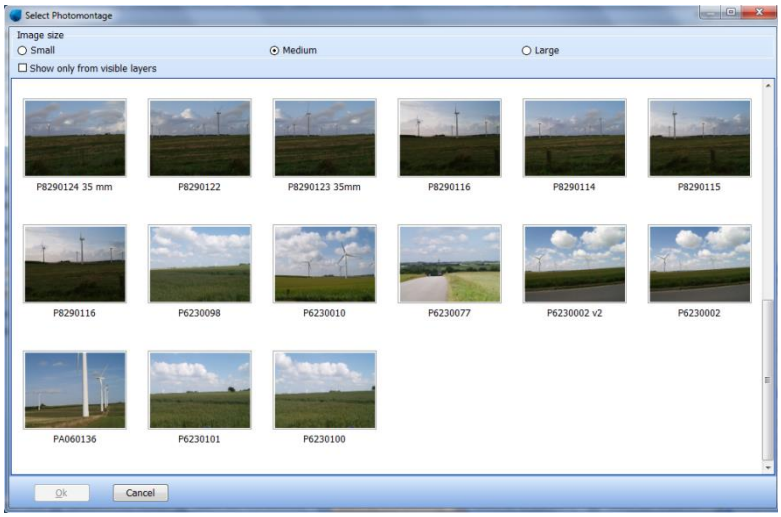
By default, the rubber tool of windPRO is used (cf. Section7.1.3.13). The rubber tool of windPRO erases the rendered wind turbines in the most refined setting pixel by pixel.
Use **rubber mask file** can be used in some specific situations (low resolution of the image with rather large pixel size) where 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 50mm and 60° for a focal length of 35mm. Click with the right mouse button on the Camera Object to extend the Camera Angle lines by selecting **Extended angle line**. This gives you access to controlling whether or not the lines on the map correspond to the edge of the photo.

7.1.3.4 Photomontage window

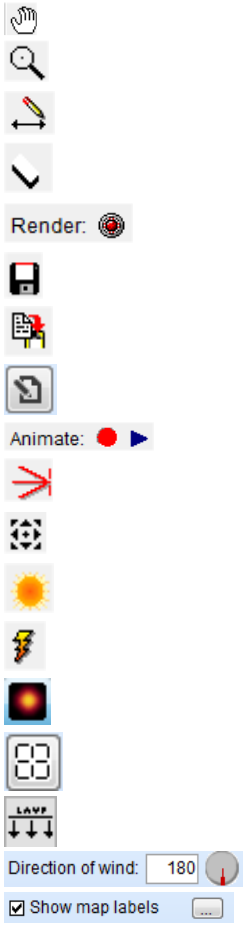
When the data have been entered into the Camera Object you click OK, and the photomontage window will pop up automatically.
You can open an existing camera model/photomontage with a click on the Camera Icon at left menu bar:



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 how the camera model initially arranges the turbines.

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

Starts Animation

Properties of the Camera objects

More Adjustment tools

Set up Manual light

Auto optimize the Camera model

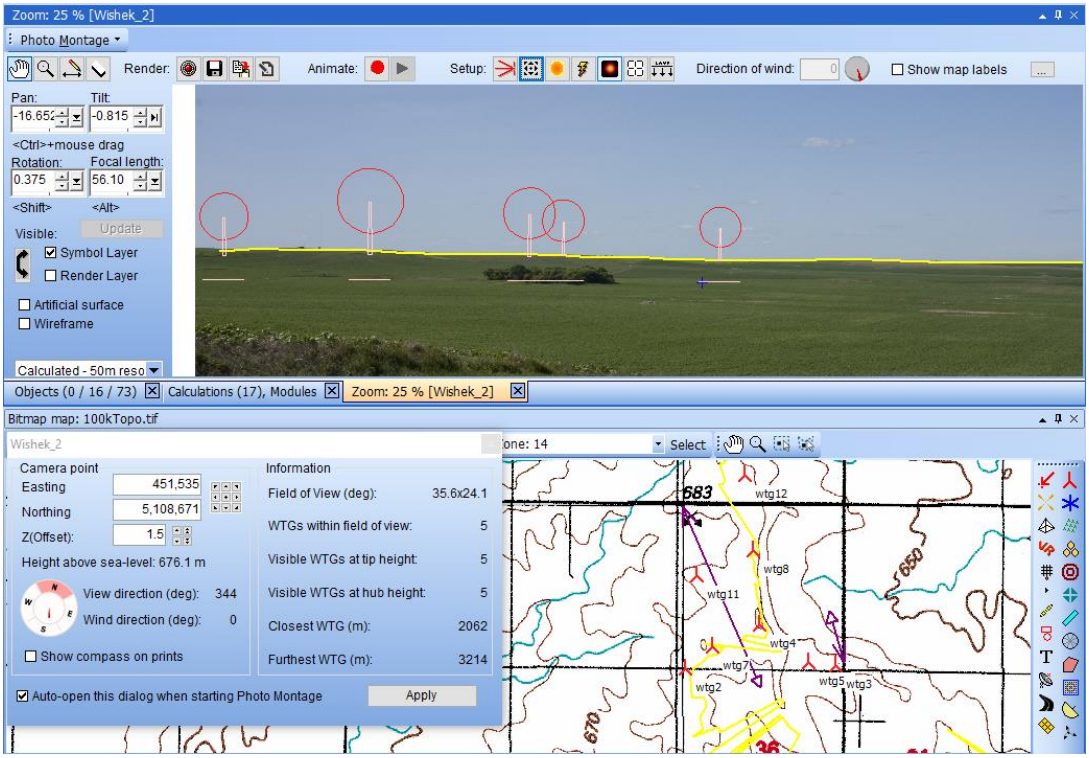
Aviation light on/off

Tracelines

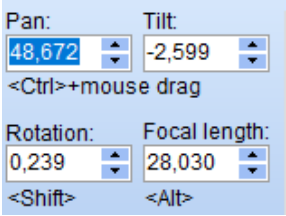
Layer marker

Set up of the wind direction (i.e. orientation of the rotor)

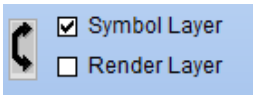
Add the label of the WTG with arrow on the photomontage



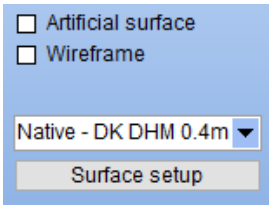
The left part of the photomontage window has the following relevant options:



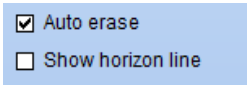
Settings used for the calibration of the Camera model. Hotkeys can be used with the mouse on the photomontage (Ctrl to change Pan and tilt; Shift for rotation; Alt for Focal length/field of view)



Symbol layer and render (=result) layer



Selection of artificial surface/wireframe (see 7.1.4.2)

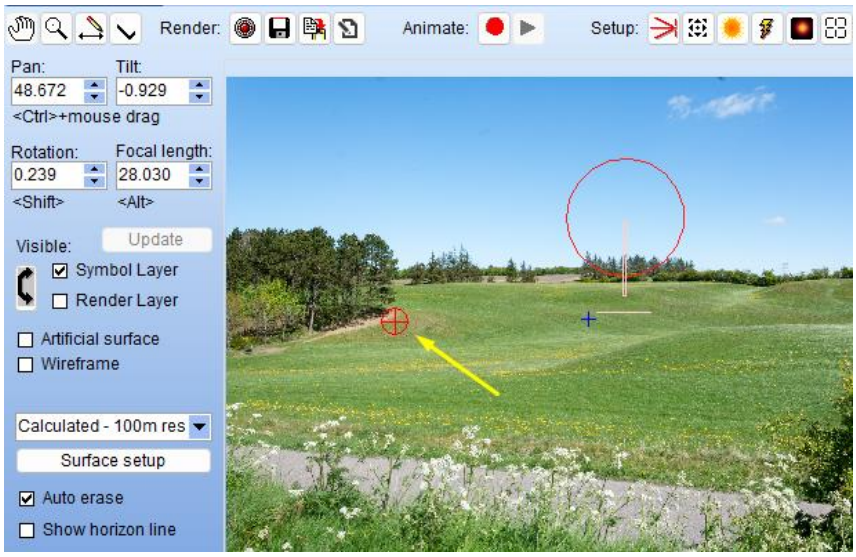


Auto erase and Show horizon line (see 7.1.3.6) options

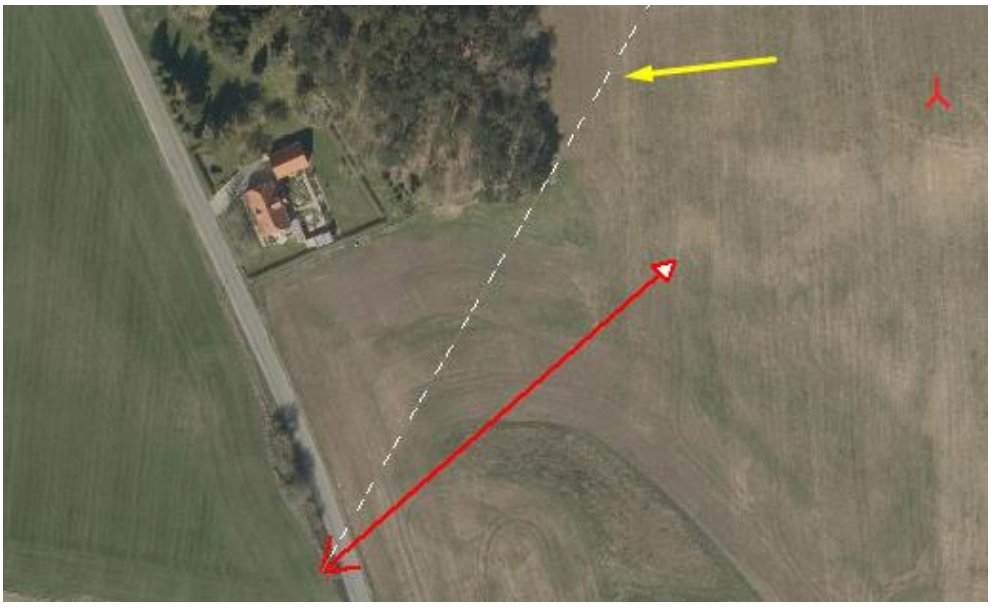
The symbol layer shows the objects (WTG, control points, obstacles, PV panels, 3D objects) placed within the field of view of the Camera object. It is a schematic view used to calibrate the photomontage.
The render layer shows the resulting simulation of WTG, 3D objects, PV panels… (see 7.1.3.12). Pixels 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.

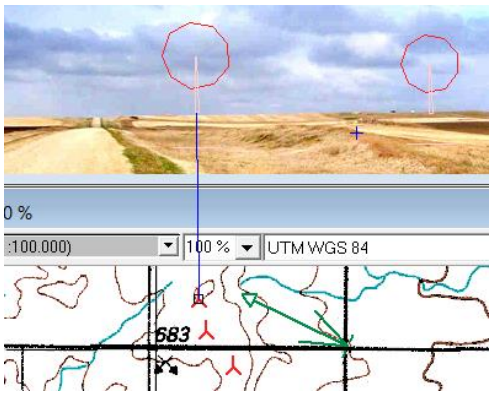
The position of the mouse on the map is shown with a cross in a circle on the symbol layer of the photo. This symbol can be useful to quickly find calibration points. The color of the symbol is the same as for the camera object.



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.



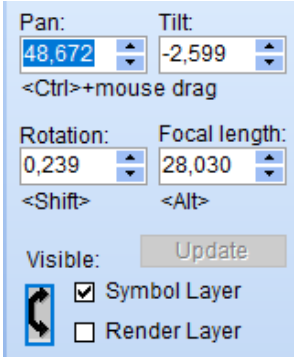
It is possible to identify a WTG from the map onto the photomontage: select the WTG on the map, press Control down and move at the same time the mouse over the symbol; a blue line will link the symbol on the map to the photo.



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 properties of the camera which were been used to take the photo: the position, direction, Pan, Tilt, angle of the camera and lens used.

Having entered the relevant 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.



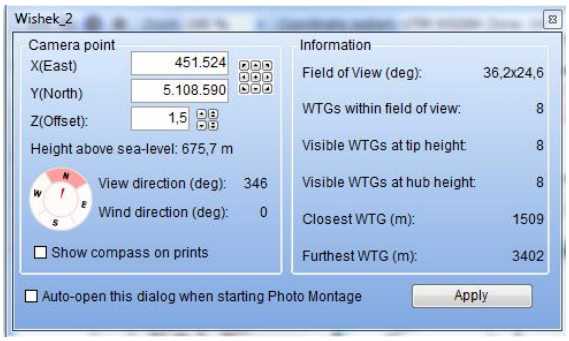
Firstly, the left area in the photomontage window offers a wide range of adjustment features.

An even easier way is to drag directly on the photo:
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.

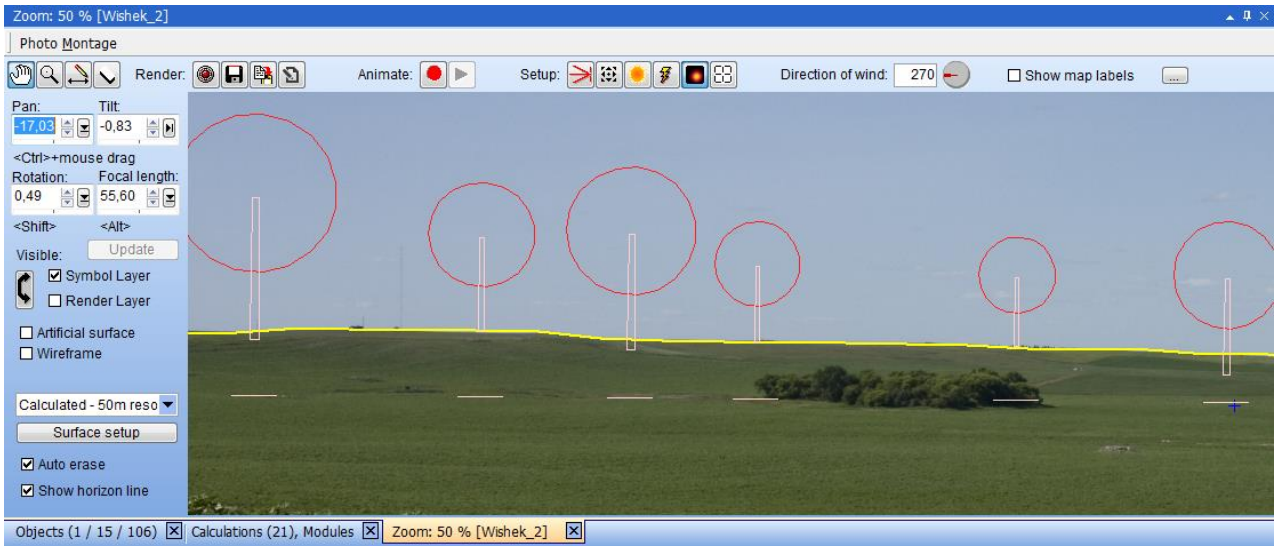
The position of the camera object can be defined in the properties of the object but also from the window below which pops up below the photomontage. The photomontage calibration gets updated with the changes made from this window once the Apply button is clicked. If the window is closed, it can be opened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



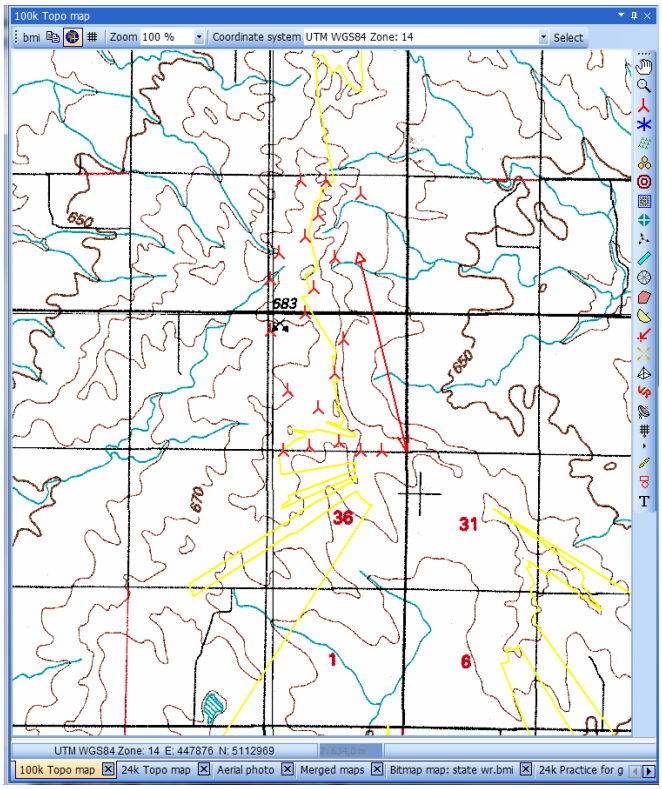
Some information is also shown: the Field of View is also known as the angle of view, the View Direction is the direction to which the camera is pointing, the WTGs within the field of view, the number of visible WTGs at tip height and at hub height, the distance to the closest and furthest WTG.

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 height contour data have been loaded. The horizon line consists of the blocking points of the line of sight calculated for each degree from the Camera position. The horizon line is a powerful tool to calibrate the Pan, tilt and rotation parameters of the photo. Be aware that the horizon seen on the photo must be covered by height data (TIN).



The horizon line is simultaneously drawn in yellow on the map, see below. This can be used for identifying where on the map the highest elevated point is found seen from the photo position.



In addition to the horizon line, a 0 m line is shown as a part of the WTG symbol. This line can be used for offshore photomontage. If the turbine is behind horizon -> the line turns 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 furthermost 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.

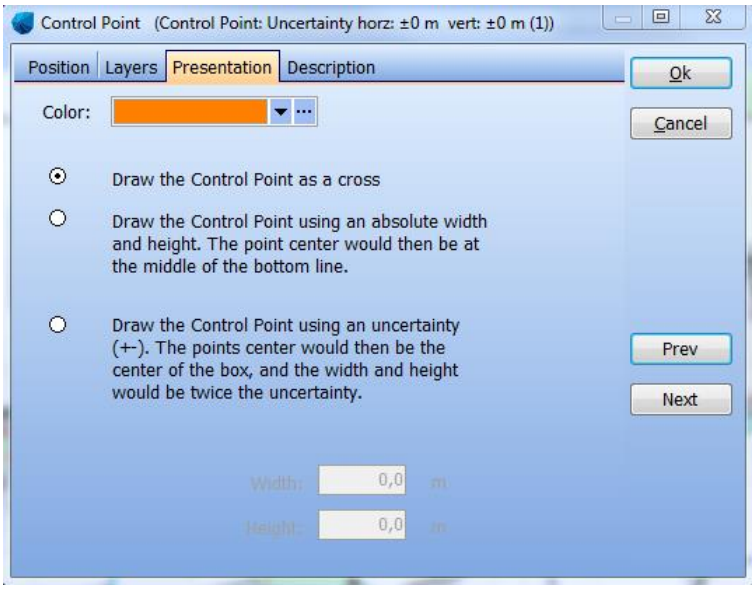
Figure 3 Rendering offshore turbines with automatic adjustment for the horizon. Note: it is of course possible to define suitable offshore foundations in the turbine catalogue (as extension of tower).

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 on the image. The best Control Points are those furthest away from the camera (some kilometres away and preferably at least one in the left and one in the right part of the photo). If you do not have an exact location of the Camera Point, you will also be able to use Control Points, which are situated closer to the camera.

Control Points are used to control the accuracy of the Camera Model as well as to establish any missing/uncertain information in the Camera Model. Please note that the more unknown/uncertain parameters you have in the Camera Model, the more Control Points you will have to enter in order to be able to establish a correct Camera Model. Exactly how many Control Points you need depends on the positions. Control Points close to the planned turbines 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 via the Map Tool Bar and information about z-coordinates is added. The z-coordinate is not the height of the object, but the elevation of the object's base. Each Control Point can optionally be assigned a dimension.



Tall objects such as chimneys and high buildings can be shown using a width and a height. In that case choose the middle option above.

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

Note that tall elements like antennas, masts, and chimneys can be downloaded from  in the top bar (cf 2.7.2) as control points.

7.1.3.8 Calibrating the Camera Model – Obstacle object, Meteo object & existing WTG

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

The obstacle object is a convenient reference for 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.

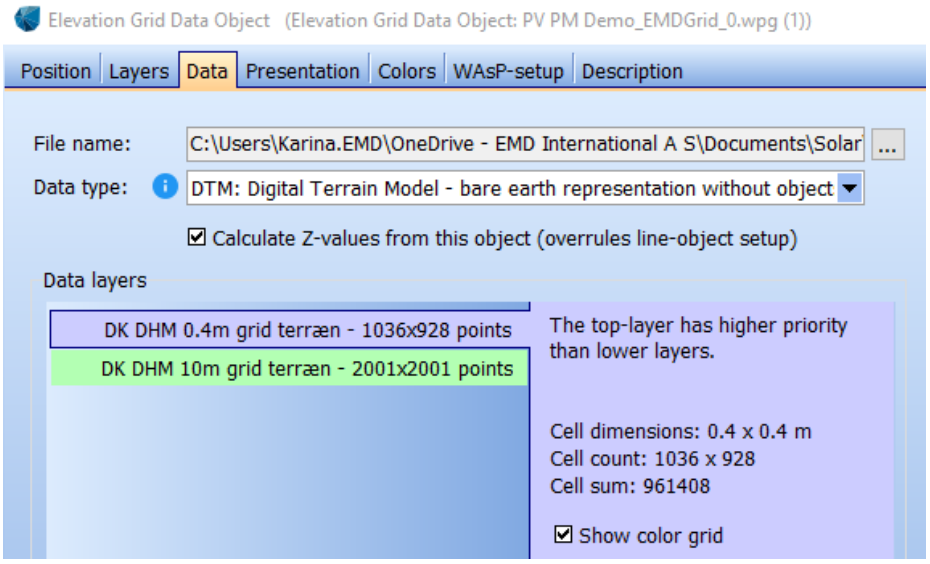
Existing turbines will have a symbol with a blue rotor. The dimension of the hub height and the rotor will be reported in the right proportions. The rotor shown only will match if the turbine on photo has the rotor fully perpendicular to the photo direction. Note also that the top of the tower will be 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  in the top bar (cf 2.7.2).

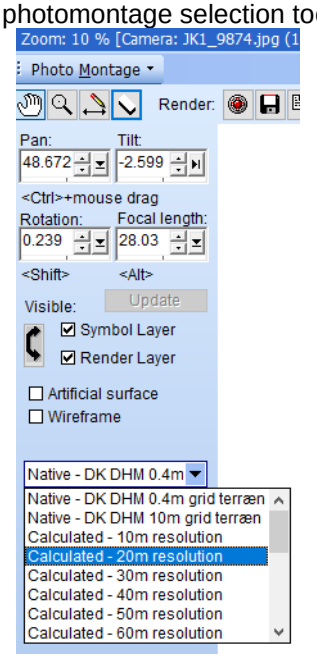
7.1.3.9 Calibrating the Camera Model – Wireframe

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

The wireframe generation can be quite time consuming. With the new elevation grid object, it is possible to use the **native** grid spacing from this and thereby speed up the processing time to almost none.



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



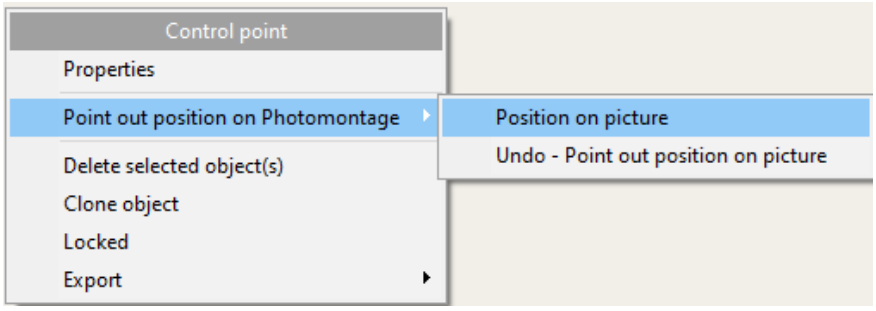
Here it is seen how the two native elevation grid object resolutions appear in the list. Chosing one of those makes the wire grid rendering very much faster.

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

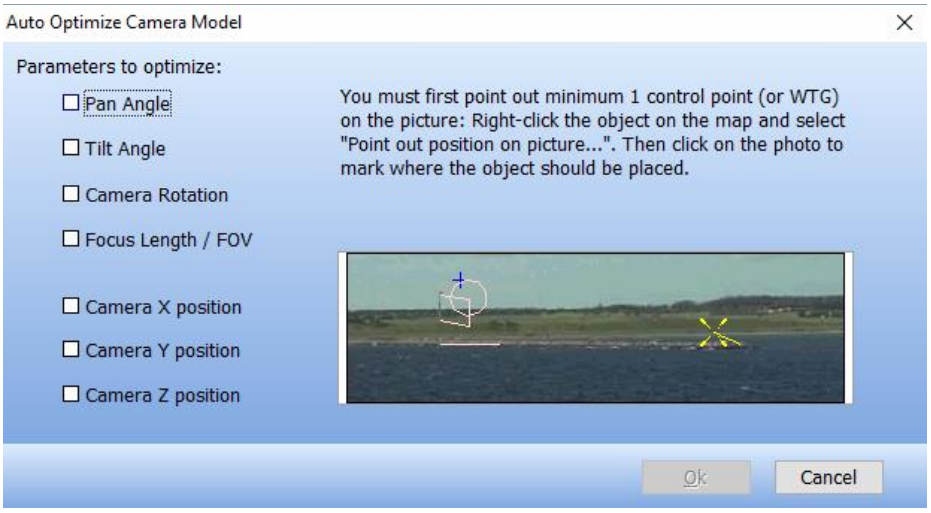
7.1.3.10 Calibrating the Camera Model – Auto Optimisation

It is also possible to let the computer calculate the camera model.

Before using this, objects (turbines, control points and Meteo objects) have to be linked to the photo.
From the map, right-click on the object you want to link (where you know the exact position on photo), select **Point out position on picture**, and click on the picture the corresponding position of the object. Below you can see how the silo on the right is linked to a control point and the turbines on the left are linked with either top or bottom point or both.



The more linked objects you have, the better the possibilities that the software has to find the best fitting camera model – and the more settings of the camera model you already know, 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):



All seven parameters can be optimized in one operation, but then you need several good linked objects. Only the ones you check will take part in the optimisation.

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

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

7.1.3.11 Calibrating the Camera Model – Tracelines

Tracelines are used to calibrate a camera object 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.

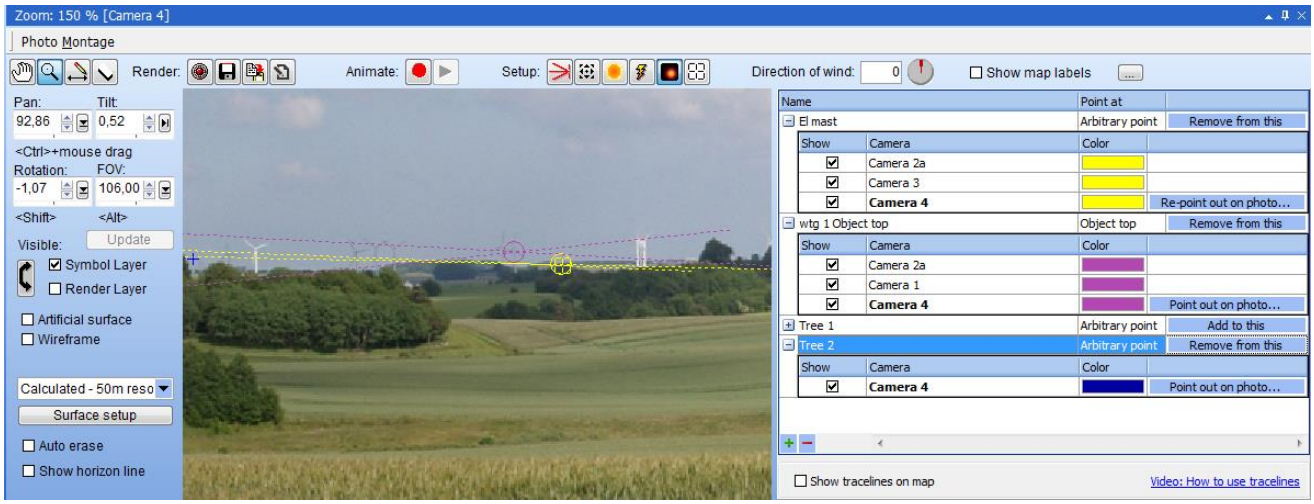
A traceline is a 3D line that goes straight from the camera to a target point that can be seen on the photo.

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.



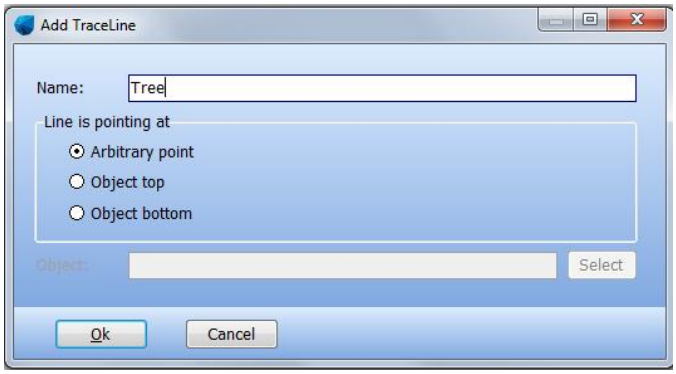
The tracelines are listed in a table. For each traceline, it is possible to see in which camera model it has been defined and which one of these should be shown on the current photo. When **Show** is selected, the lines of a given traceline can be seen on the photo. If a traceline has been defined from 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.

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

A new traceline can be created from an arbitrary point or from an object (turbine, control point) that has already been linked from the map to a photo as described in 7.1.3.10 Calibrating the Camera Model – Auto Optimisation.



7.1.3.12 Rendering

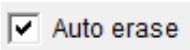
Click on the red button to begin the rendering of the turbines into the image. When the control lamp turns green the rendering is finished. If you change the data on which the rendering was based, the control lamp will turn red again, and you have to render the image again.

By default you will render all turbines and other “renderable” objects **visible on the map** (from visible layers, see Section 7.1.4.3.4 Camera object – tab sheet Use Objects and see Section 2.11 on layer structure)

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

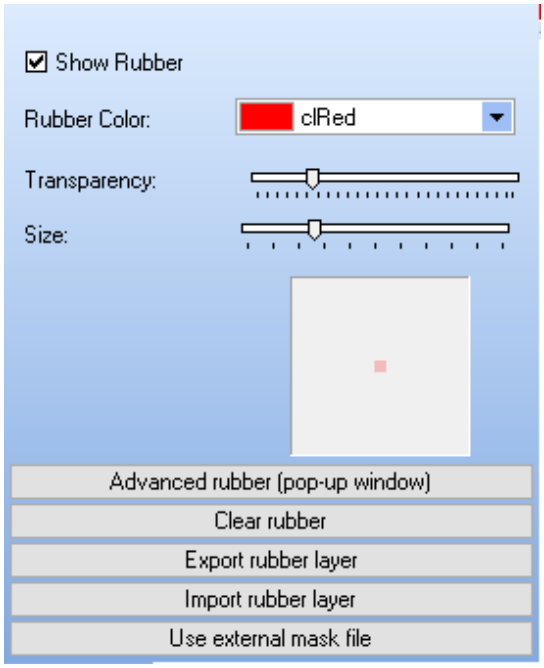
Having rendered the turbines, you have to decide whether or not they look realistic. If, for example, the turbines are dark and the photo is taken in glaring sunlight, you have probably made an error in the photo time setting. Also, the weather parameters can be incorrect. If the proportions are incorrect you have to check the Camera Model once more and maybe add more Control Points to it. Finally, the information in the WTG Catalogue could be erroneous (see more on this subject in chapter 2, BASIS) and you would thus have to open the actual turbine in the WTG Catalogue and check the data. If no Visual data are available for the turbines selected, a default three-bladed turbine model is used.

7.1.3.13 The Erase Tool (the Rubber)



The digital elevation model used for the TIN will be used with **Auto erase** to delete the part(s) of the WTGs hidden by the terrain. It might be necessary to refine the deletion with the erase tool as the height data might not be precise enough.
As an alternative, it is possible to use the artificial landscape as a mask in Photoshop.

The Erase Function is used to remove parts of turbines behind fences, buildings, hills, etc.



The manual option is immediately available after activating the rubber tool: you can set-up the size of the rubber and how to show it on the photo (the colour, transparency and size of the marked layer, to be deleted). You can then easily see where your rubber has been.

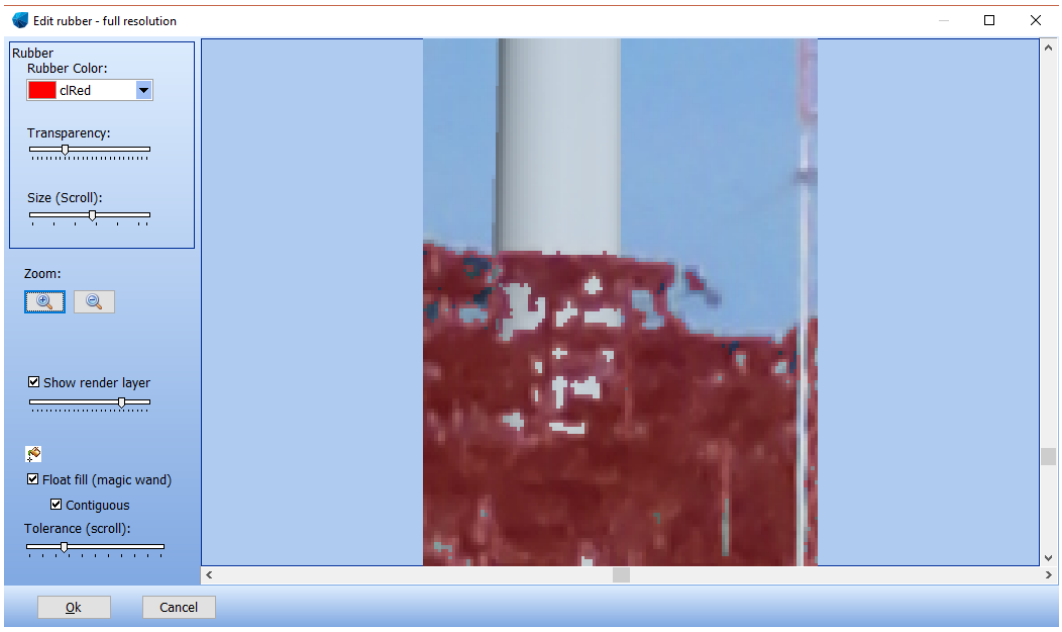
Figure 5 The rubber tool: simply "paint" the rubbed-out areas, where you do not want rendering. In that way you can rub a whole hill so even though you slightly move the turbines to be rendered behind the hill, there will be no visible parts in front of the hill.

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

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

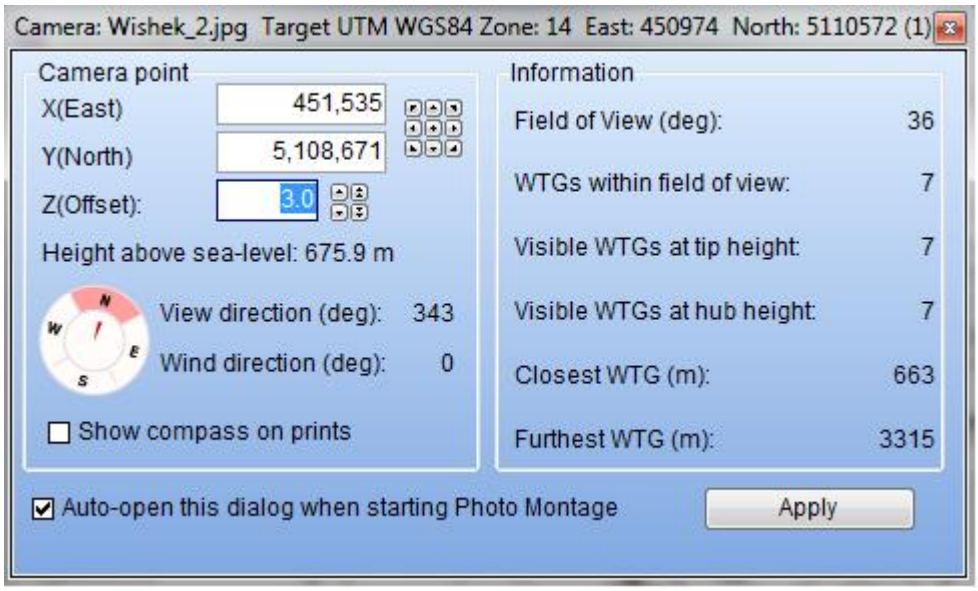
Other options in the Rubber window include the use of a previously generated masking file. Two choices are available here: to import a previously created **Rubber Layer**, which will be statically applied to the picture, or **Use an external mask file**. The latter allows to modify at the same time the file in an external photo editing software, with the modifications being automatically updated in the windPRO Photomontage window.

Lastly, an advanced tool, based on the **magic wand** common to many photo editors, is available to help selecting the areas to be masked. In the pop-up window, activate the magic wand, and select the perimeter of the object which should be in front of the turbine, like the trees in the example below. All pixels with the same colour 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 colour-recognition routine. Finally, the option **Contiguous** limits the automatic selection to contiguous pixels, whereas deactivating it all pixels of the same colour (+Tolerance) in the visible portion of the picture will be marked. With a bit of practice, this tool makes the task extremely fast compared to the previously available manual selection.



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.



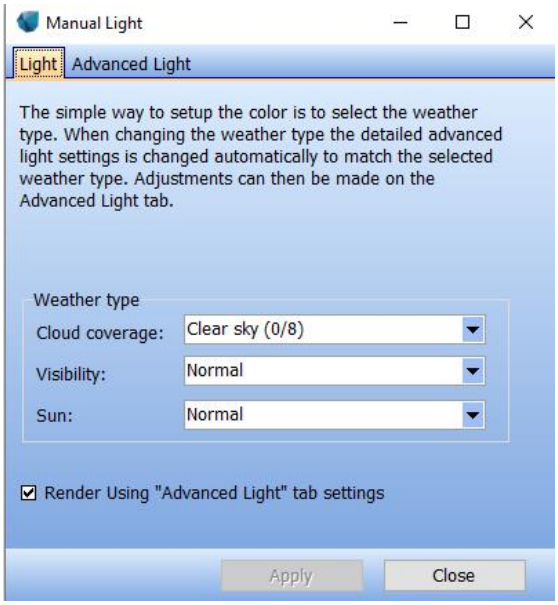
The information relates to the WTGs which are within the distance input on the **Use Objects** tab of the Camera object. The centre line of each WTG is used to calculate the visibility or not. So, if only a part of the blade of a WTG very close to the Camera is visible, the centre line of the tower is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

Setup:

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

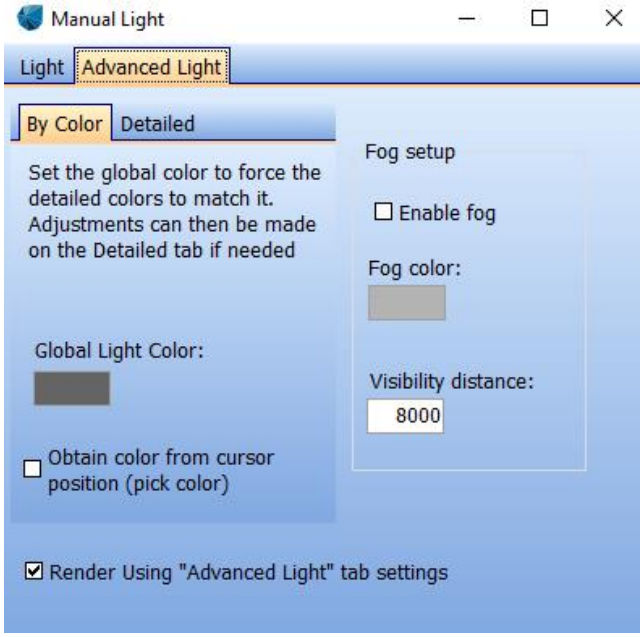
The Z-coordinates of the turbines and other objects can be found in the digital Terrain Model (DTM) (see Chapter 2. BASIS, Part 8). This is a very powerful option, which is advantageous to use when visualizing in complex areas.

7.1.3.15 Adjust light (colour)

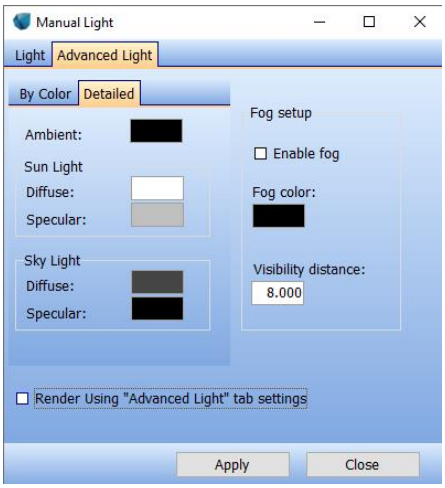


Light (or colour) adjustment is in general made by selection of weather conditions in the render set-up. For some purposes, a more detailed adjustment can be required, for example if some new WTGs are added to a place with already existing WTGs. Here it would look better if the new WTGs matched the colour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

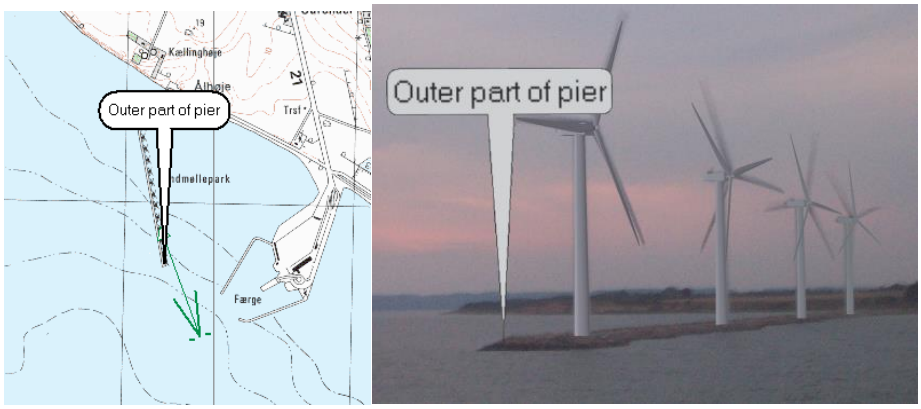
Bitmaps, such as photos of any object (tree, building, vehicle etc.) can be integrated in a photomontage. This can be used if there is no landscape photo to make a semi realistic photomontage (see next chapter) or it can be used to add other elements in the landscape than turbines if a photo from site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

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

The methods of integrating bitmap elements in a photomontage are described in detail in the 3DAnimator sections see Chapter 7.3.4 and 7.3.5.

7.1.3.17 Text elements integrated in the photomontage

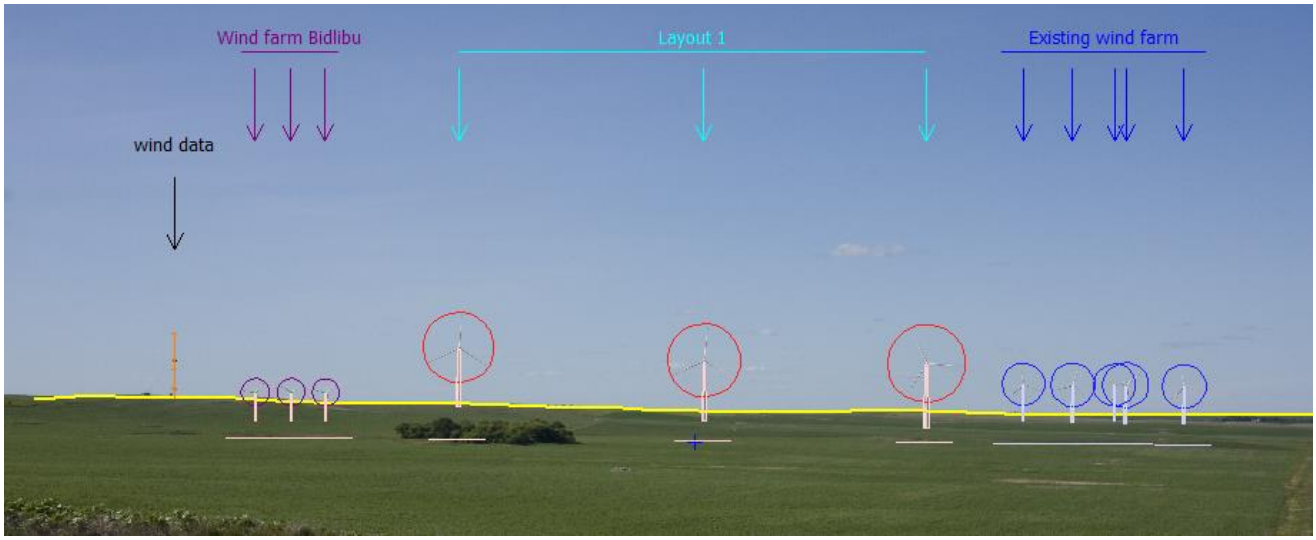
A text on the map can be rendered as a billboard via the text object T, see example below.

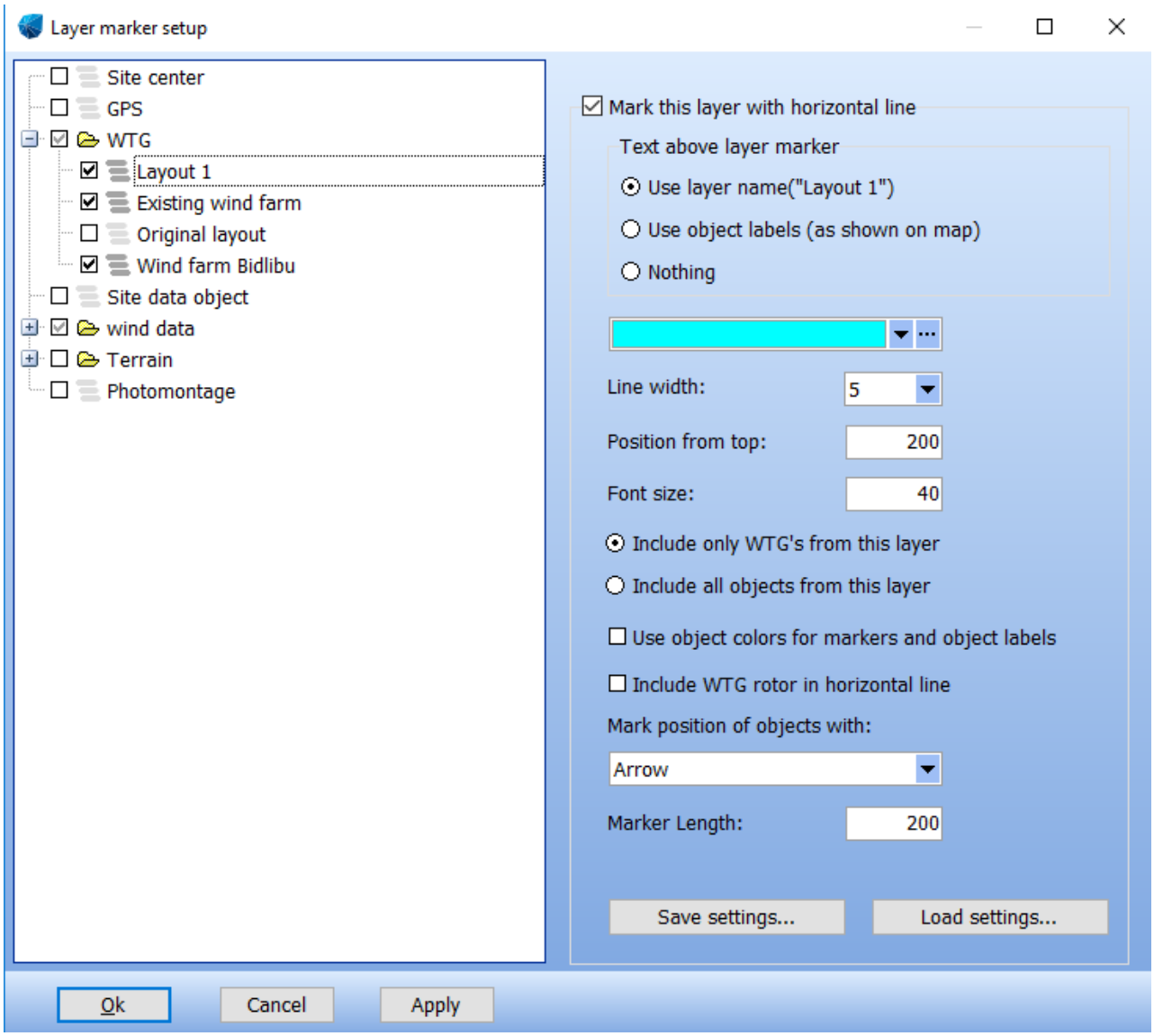



With the drawing/test tool you can draw or write direct on the photo.

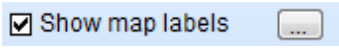

Layer marker

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.

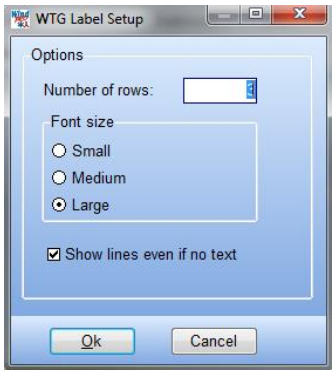


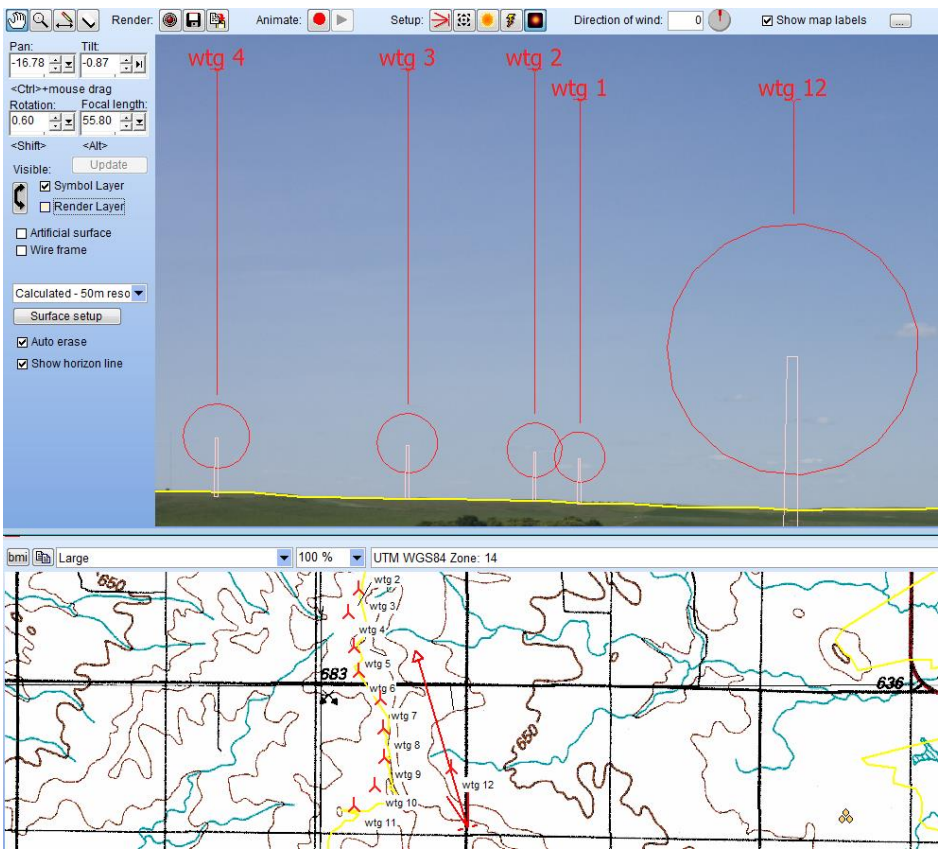


In the layer marker setup, the layer must first be checked and selected on the left side. On the right side, **Mark this layer with horizontal line** must be checked. The text above the line can be the layer name, or the object label name (defined in the object properties) or nothing.
The Line width,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

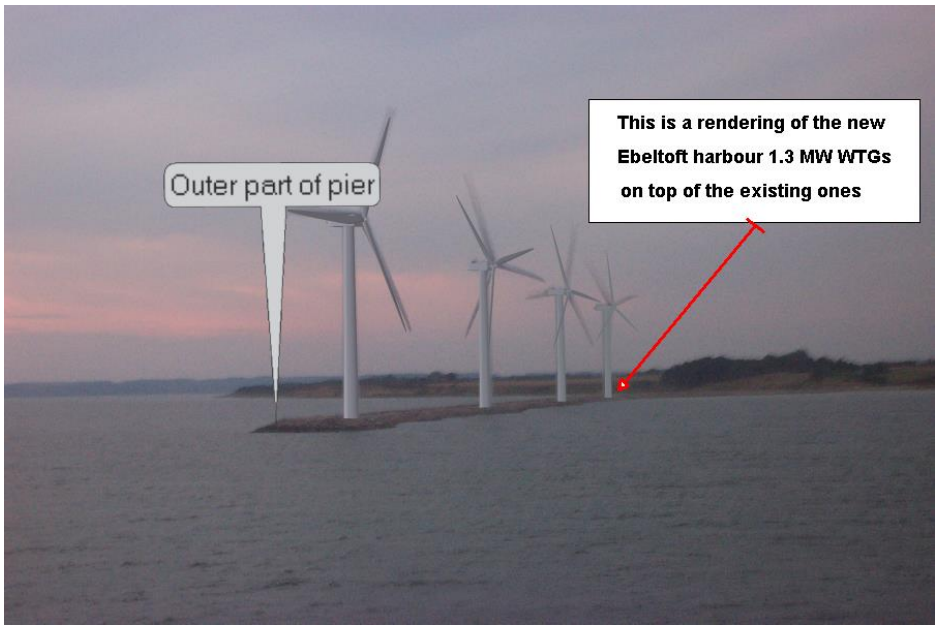


If you select **Show map labels**, the label of the WTG will be shown on the top of the photomontage and pointed to the corresponding turbine. The setup of the labels on the photomontage can be defined by clicking on the three dots. The labels have to be defined in the WTG properties first.





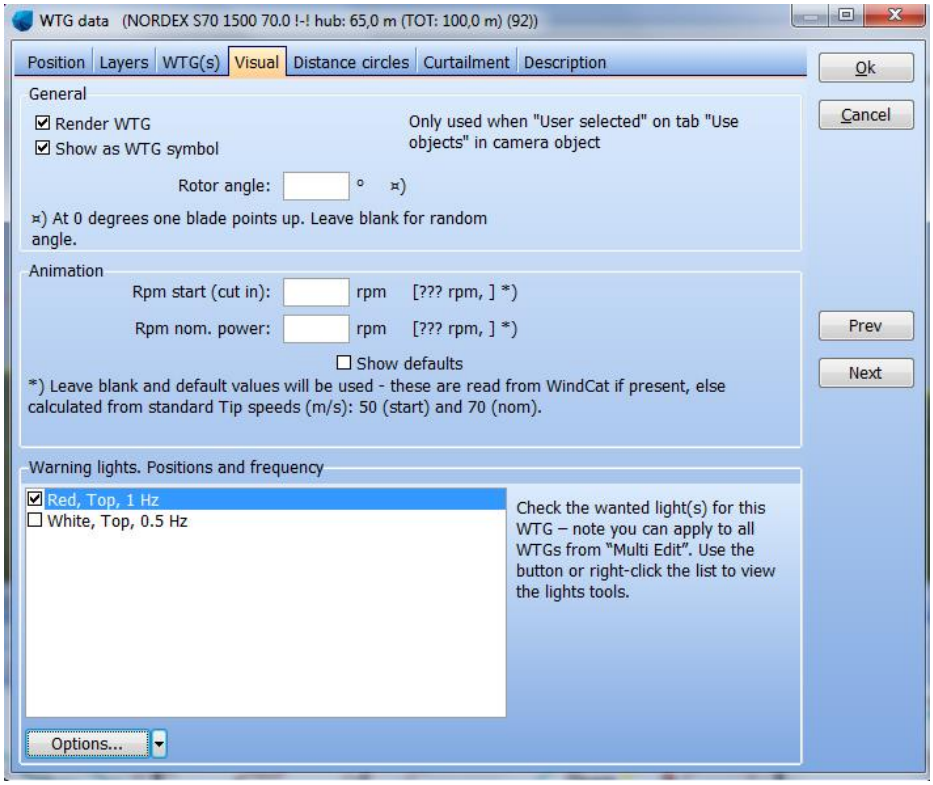
Finally you can copy the result direct to clipboard for paste into a text or other document, see example below.



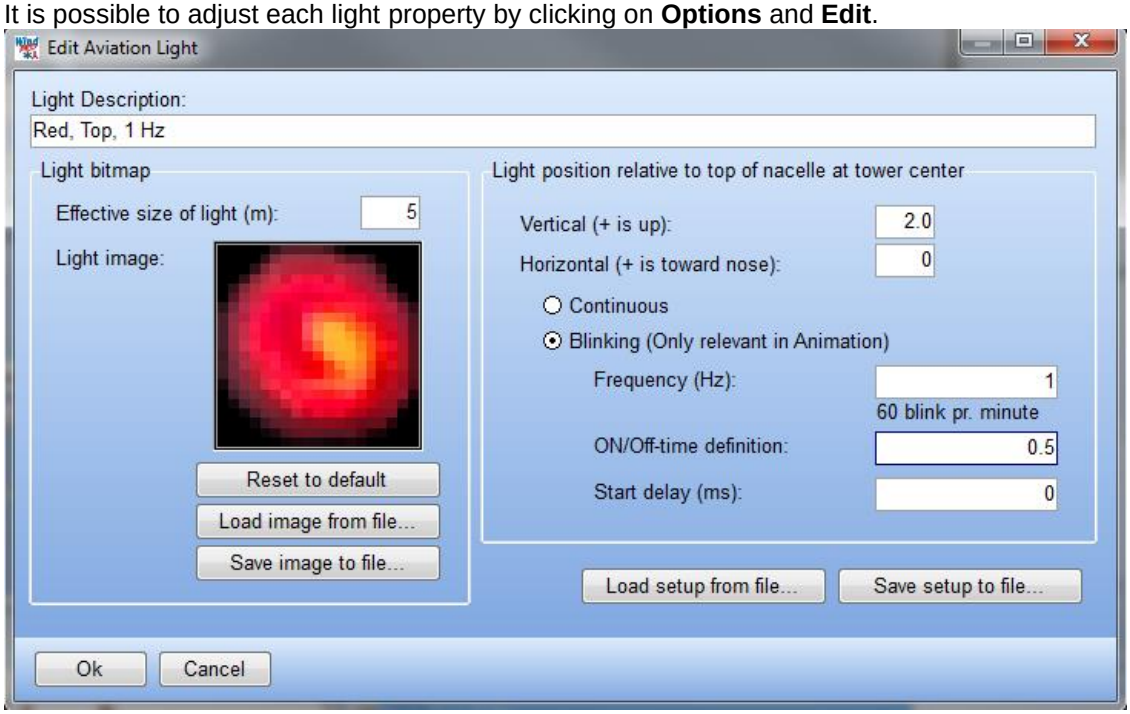
7.1.3.18 Aviation lights integrated in the photomontage

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

By default two types are available as bitmaps.



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

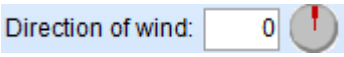


In Edit Aviation light the following properties can be found:

- **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.

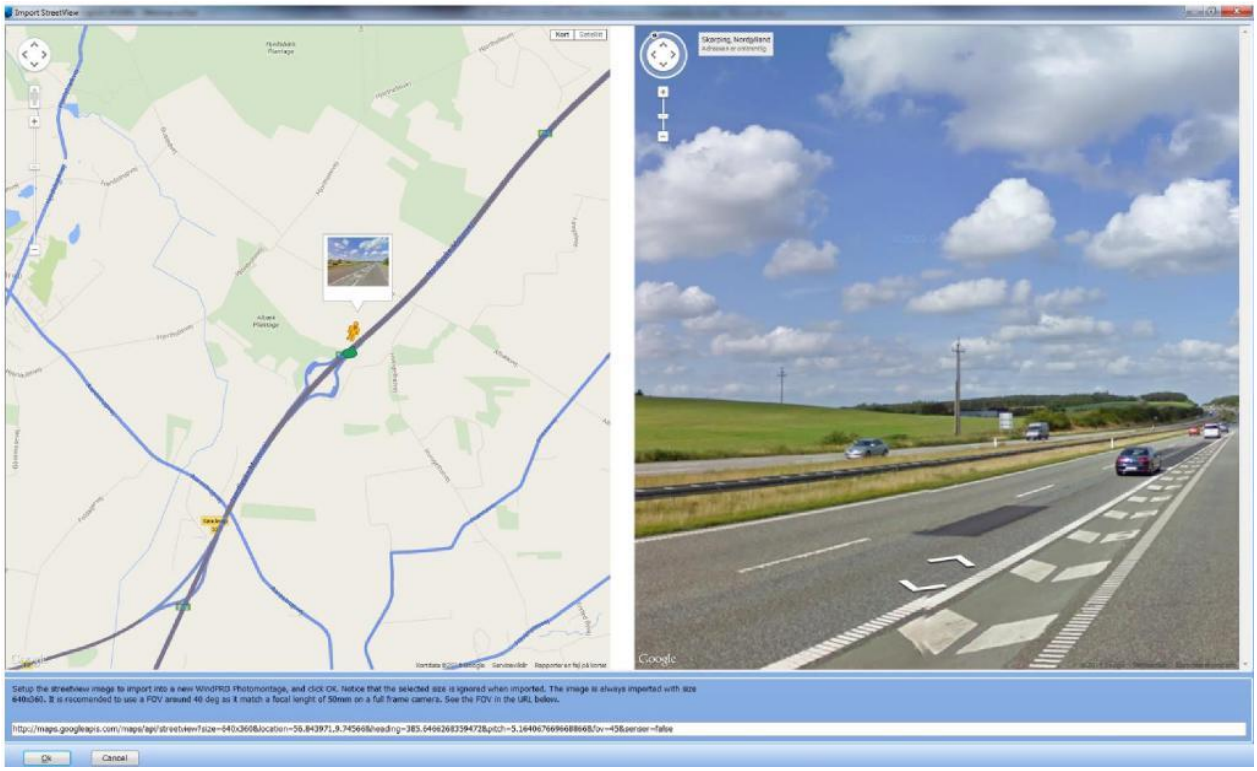
7.1.3.19 Direction of wind



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 Import Google Street view

Google Street view images can be imported to a photomontage. Click on the Google Street View icon from the top bar (the yellow man) or go to Tools and select Import to **Google Streetview in photomontage**. In the Import street view window, the Google map can be seen on the left side. Pick the Goggle Street view icon and drag it to a selected position for which a Google Street view is available (on a road colored in blue). The Google 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 import. Note that the view on the screen does not show the whole imported image. The imported image 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 imported in 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 imported from Google Street view is low (only suitable for presentation on screens).

7.1.4 Photomontage with artificial landscape as background

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

7.1.4.1 Establishment of height contour lines

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

Important when creating the height contour line object:

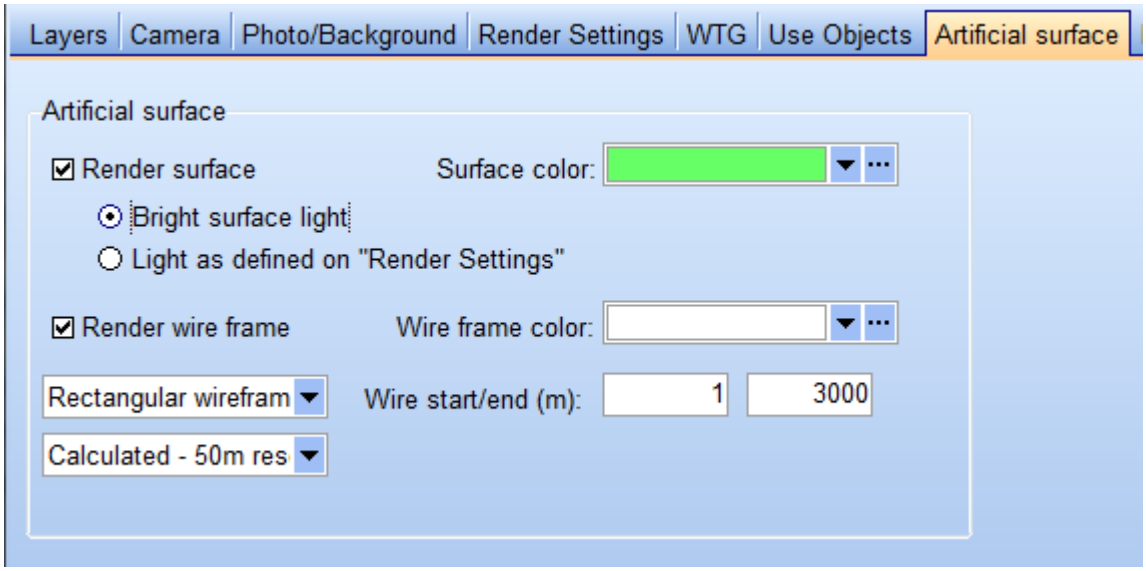
- DHM (Digital Height Model) has to be selected and ticked in the tab sheet **POSITION**.
- The object has to be centrally placed in the area to use.
- Set the TIN-radius under the tab sheet **PRESENTATION** to ensure that the yellow circle, which will appear around the height contour line object, covers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

7.1.4.2 Camera model: Artificial landscape

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

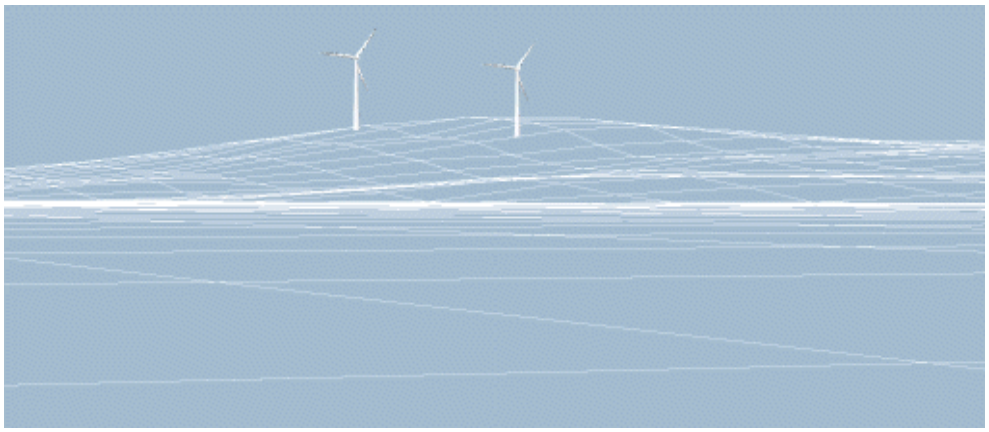
It is not necessary to select a photo (file name) neither to calibrate the model.

Artificial surface is where all the relevant parameters concerning the above are set. The artificial surface can be rendered as a solid surface and/or as a wire grid. The artificial surface is based on the height contours form the line object set for TIN (see BASIS Chapter 2.8).



Render surface
You can choose to render an artificial landscape by ticking the **Render surface** checkbox. The surface can be rendered with a bright light or using the light setup defined in Render settings. In this latter case the shadow of the terrain will be simulated with respect to the sun position. The colour of the surface can be changed.

Render wireframe
You can choose between rectangular or triangular wireframe. The resolution of the rectangular wireframe can be defined. The triangle is based on calculated triangles (TIN) from the DHM and is therefore the fastest and the most accurate one. But based on rectangular grid it is often easier to see the contours of the landscape (see following). The colour of the grid can be changed.

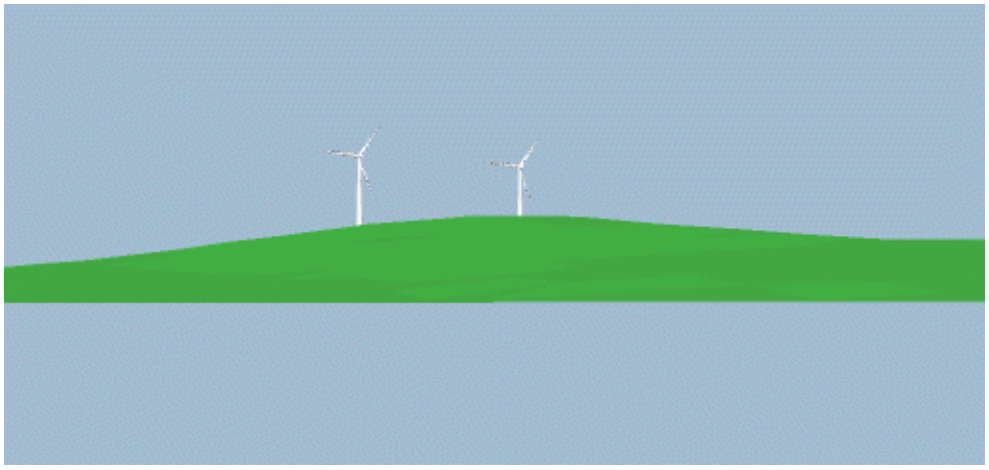


Note: a wire grid model with a landscape photo, as background is very suitable for checking the camera model.

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

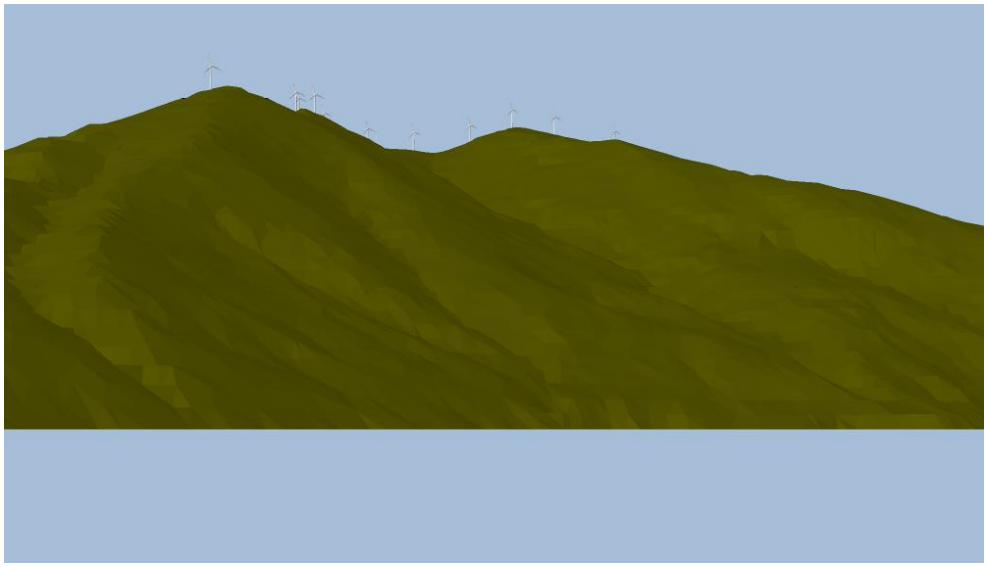
The start point can often and with advantage be set for 1 if the turbine is within a distance of 3 kilometres from the camera. On the contrary, you can utilize the value to give an impression of the waters in front of the turbine by reducing the landscape site to generate. See the following example.

Where the site ends is a more complex matter as it depends on the landscape and the height contour lines for a site. If there is a mountain landscape behind the turbine it might be important to include this though it requires a substantial enlargement of the calculation and data site (TIN radius in height contour object).



The model for generation of an artificial landscape is improved in connection with development of the module 3D-Animator. It is possible to input more landscape details through different objects, see 7.1.4.8.

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



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

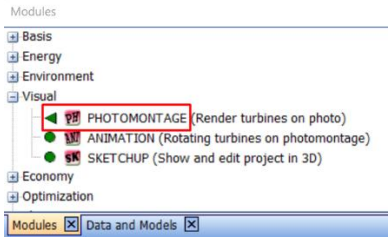
See also: 7.1.3.10 Bitmap elements integrated in the photomontage, which make it possible to build up any landscape you wish.

7.1.5 Exporting the final image

You have the following options as photomontage output: a visual report with many details and relevant information and the photomontage as image file.

7.1.5.1 Visual report

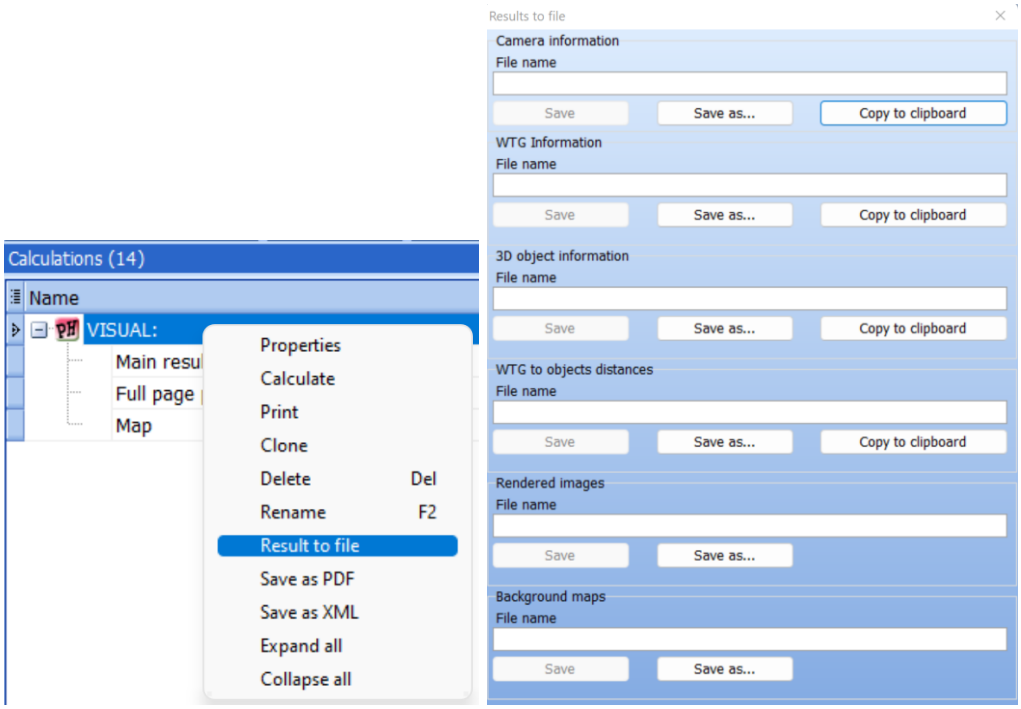
The report is only available for wind turbines. It is generated from a Photomontage calculation. To start the calculation, select PHOTOMONTAGE in the Module list.



Such a report presents the selected photomontages together with relevant information, that is

- 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 hold 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 [m]	Target point Easting	Target point Northing	Target point Z [m]	Photo direction [°]	Clouds	Visibility	Sun	Wind dir. [°]	Image width [pix]	Image height [pix]	Field of view [°]	Vertical field of view [°]	Focal length [mm]
A	305186	6579950	292	304215	6579693	159.076	261.355	Clear sky	Normal	Normal	0	3648	2736	41.3957	14.8361	25

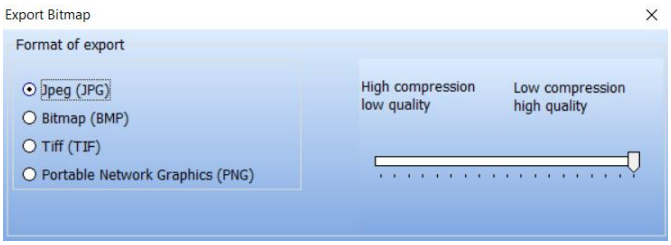
…

Focal length [mm]	Film format width [mm]	Film format height [mm]	Panorama	Image filename	HFOV [°]	VFOV [°]	View Direction [°]	WTGs In View	Visible WTGs Count Tip	Visible WTGs Count Hub	Closest Wtg [m]	Distant WTG [m]	Closest Wtg Description	Distant WTG Description	Camera Agl [m]
25	34.6133	25.96	NO	U:\TRAV\t	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 or the google Earth Icon (right click on the Camera object)

- 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)

7.2 VISUAL – Animation (2D)

Animated visualization consists in rotating the turbine blades in a sequence of renderings called an animation. The animation, which is stored as a file, can then be shown on any 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. By this 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.).

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

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.

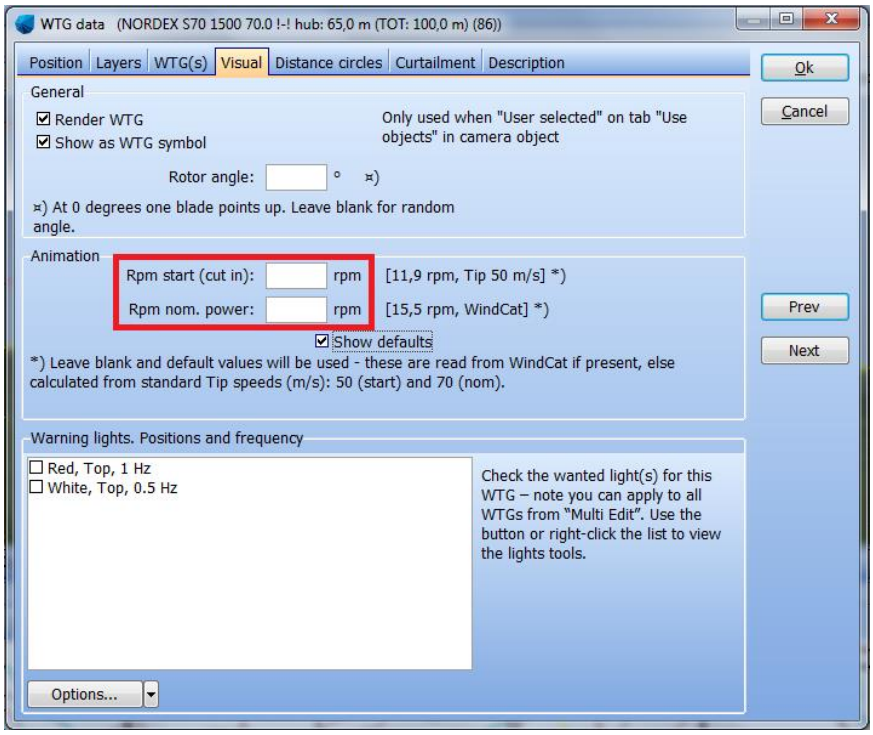
The program automatically creates the necessary number of rendered images for a complete cycle.

The file format and the film player have been developed by EMD on the basis of a once-used but now outdated format for Windows 3.11.

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.

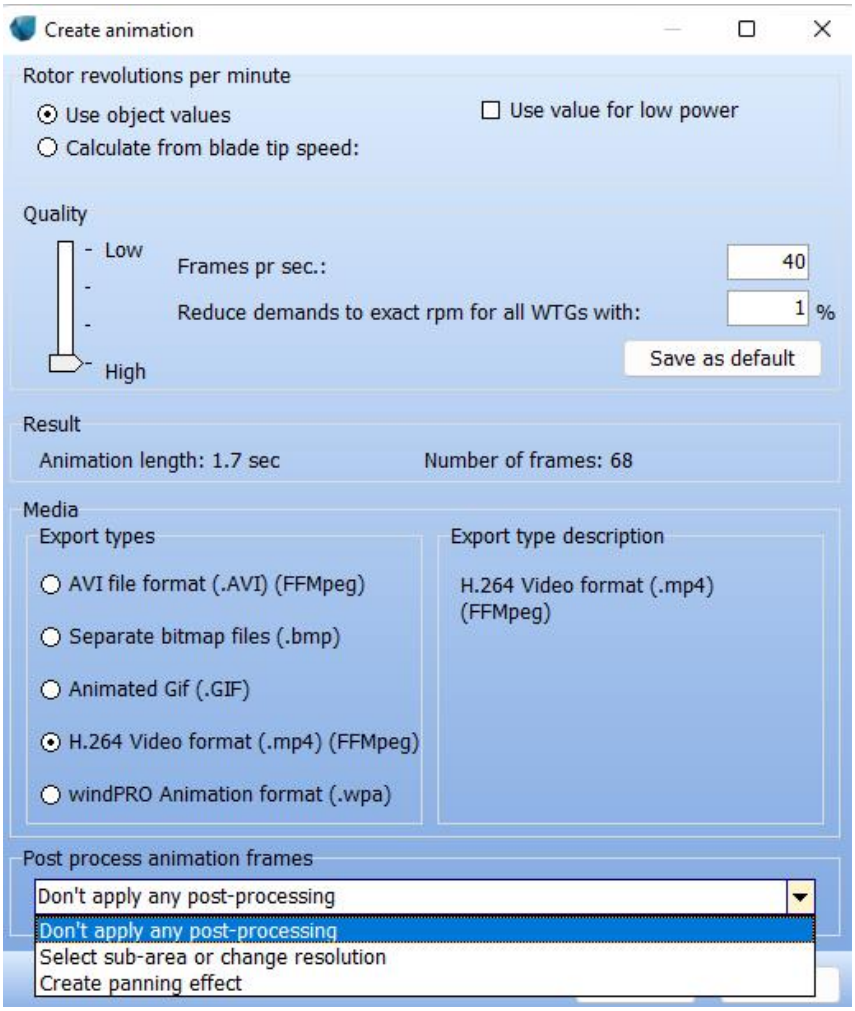
Next, ensure that the rotational speed settings in the WTG Catalogue for the relevant turbines are correct. Alternatively, the rotational speed can be entered together with the turbine data. By default, the input of Rpm for nom. power (revolution-per-minute at nominal power) is used. The Rpm start (cut 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.



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 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 of 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.

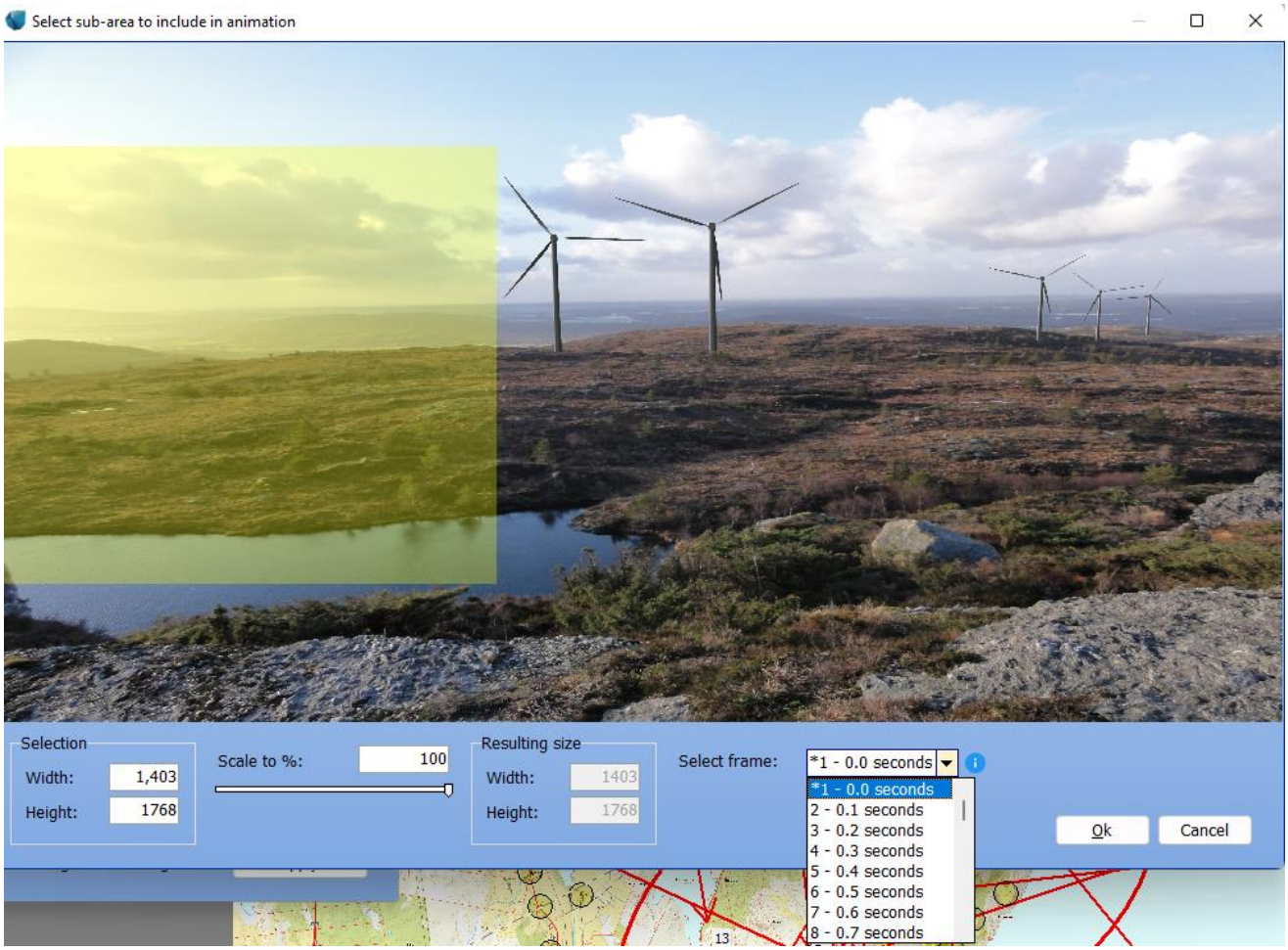
5) H.264 Video format (FFMpeg) where a 30 seconds long animation is made

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 choose the output format of .wpa file the EMD Player application starts automatically. In the EMD Player, it is possible to change the recording speed (but only experimental reasons since it changes the rotational speed of the turbines too, thus resulting in a false, unrealistic animation).

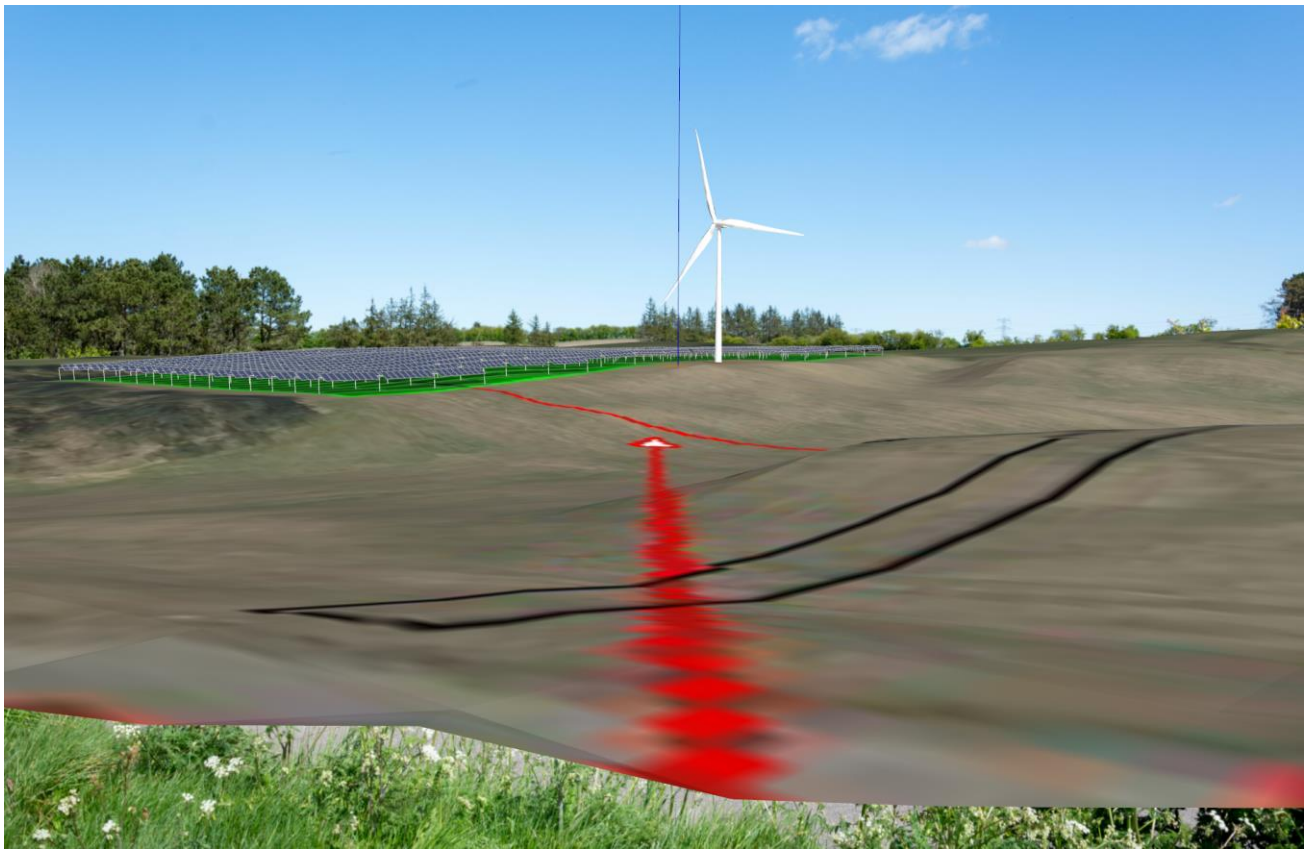
If you want to play the animation on another computer with the EMD Player, you need to copy both the animation file (.wpa) and the animation player EMDplay.exe both found in the folder: Program Files\EMD\windPRO3.x\

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

7.3 VISUAL – SketchUp Integration

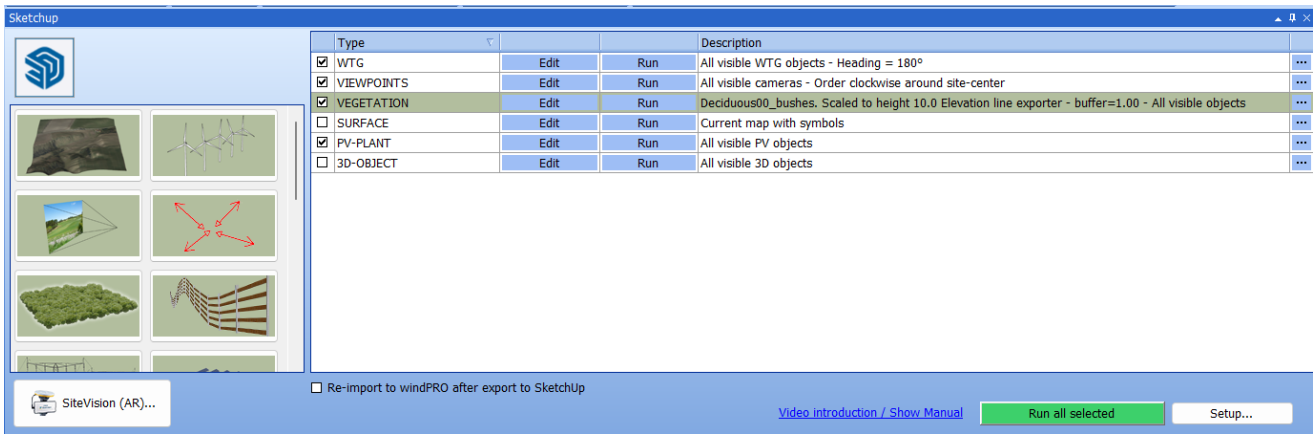
The SketchUp Integration tool makes it possible to export elements from windPRO to SketchUp and from SketchUp to windPRO. Making the bridge between these two powerful softwares gives access to benefit from the strength of each one. Both SketchUp and/or windPRO users will find advantages in the Integration tool, for example:

- Create a SketchUp project with any of the many background maps, elevation sources supported by windPRO worldwide, and work in a real-world GIS coordinate system
- Add vegetation and/or fences around the PV or wind farm areas in photomontage
- Visualize power transmission masts and lines in a photomontage with a great level of details and accuracy
- Use the huge SketchUp 3D warehouse and bring models back into windPRO to get these visualized in Photomontage.
- Visualize Photomontages directly in SketchUp, with very high accuracy compared with existing SketchUp tools
- Visualize shadows correctly from rotating WTG's or from PV panels
- Edit Solar PV layouts directly in 3D
- Export Solar PV models to Google Earth
- Show and edit a windPRO project in 3D, show result layers as 3D volumes and get access to the world of VR and AR.



7.3.1 SketchUp Integration - Main interface

Open the tool using this button: 



With the SketchUp integration tool, the workflow consists in creating “exporters” which then will have to be run. An exporter is an element that can be exported to SketchUp such as:

- Terrain surface
- WTGs, Solar PV areas
- Photomontages
- Camera points
- Vegetation, Fence, transmission lines
- Buildings
- Shape files, DWG, dxf files
- 3D objects
- Text objects, Line objects, Obstacles
- Coordinates system information
- Result layers, Resource maps, CFD maps

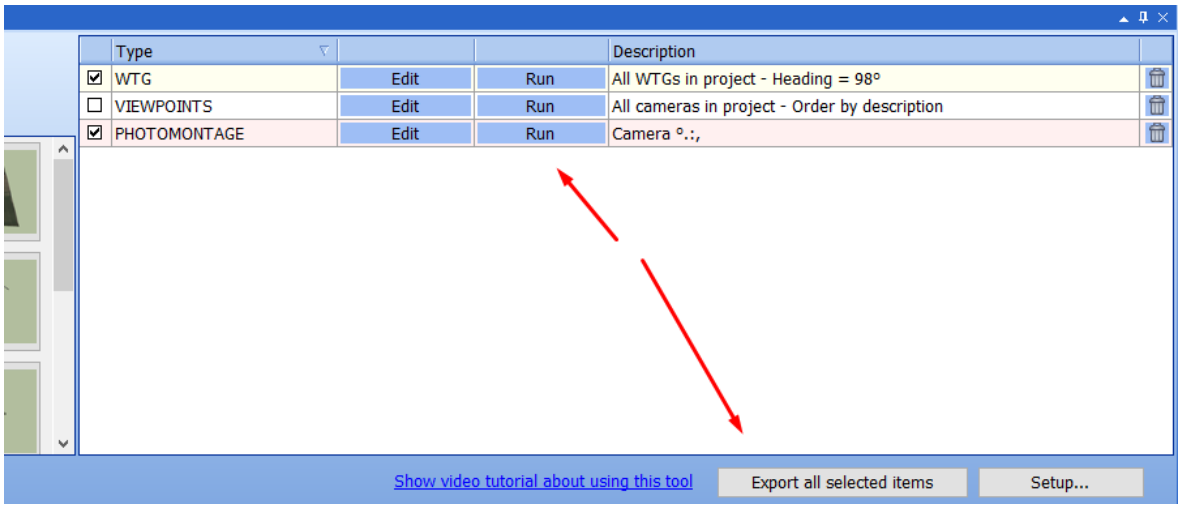
In the main interface, each line corresponds to a created exporter. The same exporter can be run multiple times, alone or together with other exporters. It can also be edited and deleted.

Before running an exporter, SketchUp must be loaded by windPRO:

If SketchUp is not installed or found by windPRO, go to the next chapter, and read how to set it up.

When SketchUp is loaded, the following message (can be disabled) should appear.

It is then possible to run the exporters by using the individual “run” button or the **Export all selected items** button at the bottom:

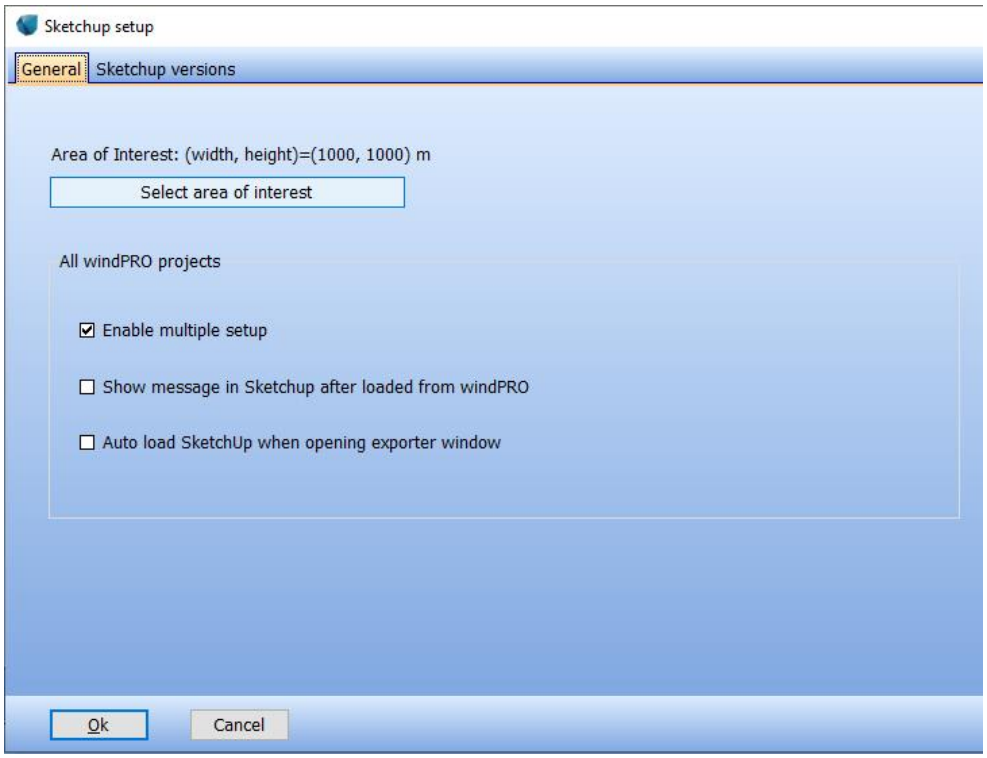


From the main interface it is also possible to re-import automatically to windPRO (See 7.3.5).

7.3.2 SketchUp setup

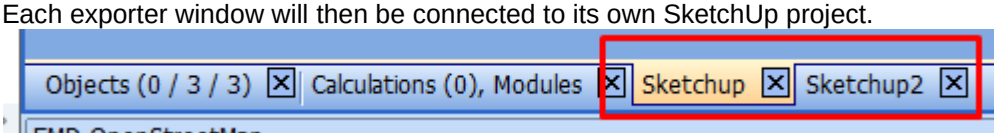
Pressing the **Setup…** button in the main interface opens the SketchUp Setup dialog.

7.3.2.1 General setup



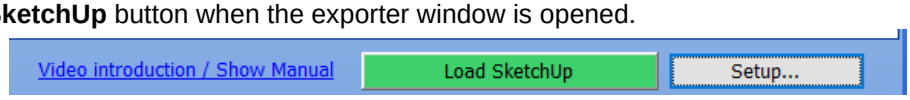
Area of interest: It is possible to define an area on the map, that can later be used from the individual exporters. This can be useful if wanting to export the exact same area from different exporters.

Enable multiple setup: Check the option to have more than one exporter window open in each windPRO project. Each exporter window will then be connected to its own SketchUp project.

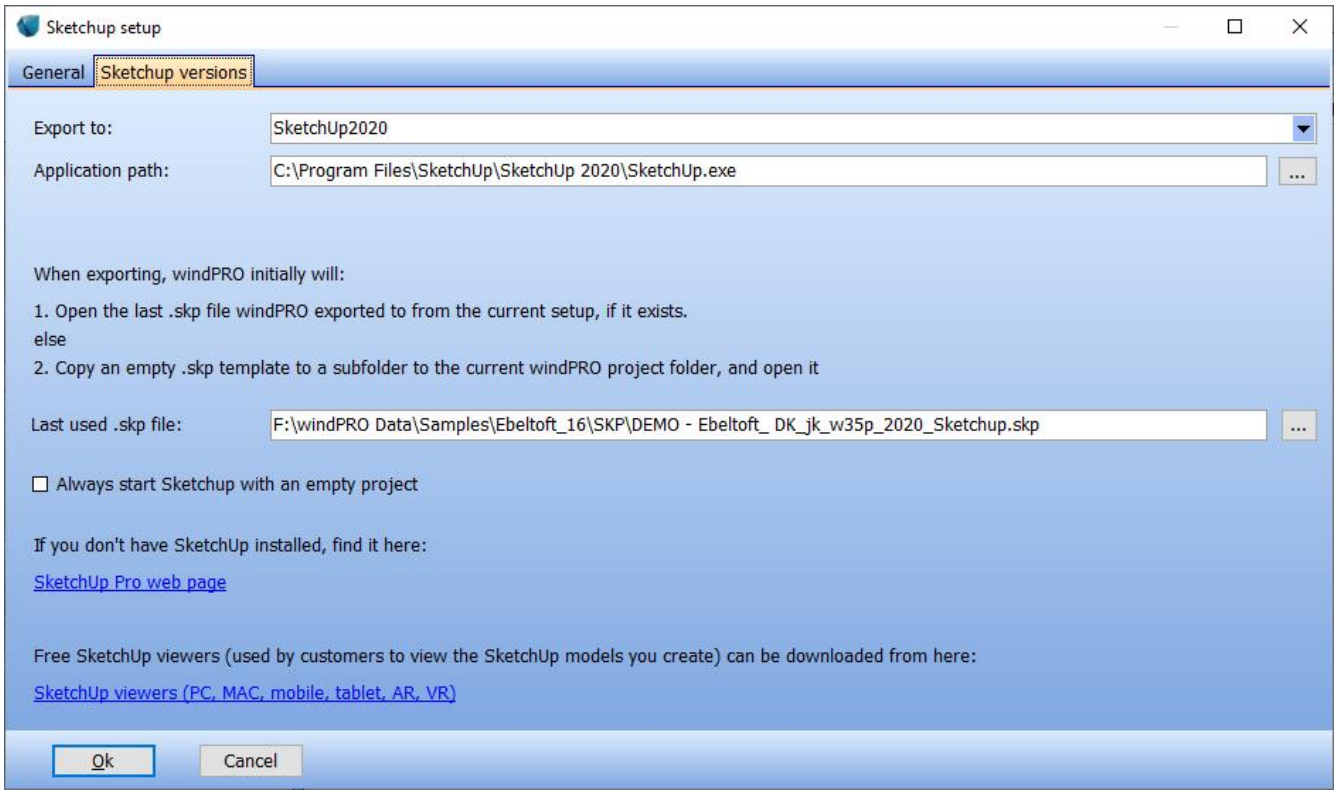


Show message in SketchUp after loaded from windPRO: This defines if this message should be shown when SketchUp is loaded from windPRO

Auto load SketchUp when opening exporter window: With this option, windPRO will automatically click the **Load SketchUp** button when the exporter window is opened.



7.3.2.2 SketchUp version



Export to: To select which version of SketchUp to use. windPRO has preselected the expected paths to the SketchUp.exe files, but if they are installed in different folders, it must be set manually.

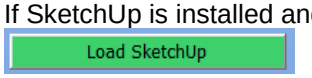
Application path: If SketchUp is not installed in the default installation folders, then it must be selected here where it is located.

Last used .skp file: To define the SketchUp project associated with this exporter setup. If it is blank, as it is first time, then windPRO will copy a template project to a subfolder to the current windPRO project and use this file. It can be changed manually to a different filename. If a SketchUp project has been loaded by windPRO and then saved to a different name, then windPRO will use this new name.

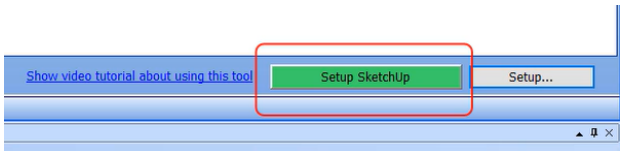
Always start SketchUp with an empty project: Check this to bypass the *Last used .skp file* and start with an empty project.

7.3.3 SketchUp installation

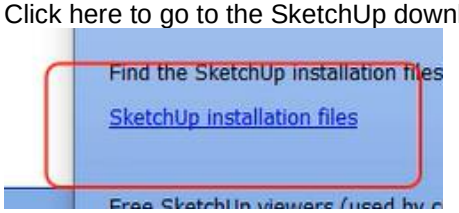
If SketchUp is installed and the button **Load SketchUp** is displayed, then you can skip this chapter.



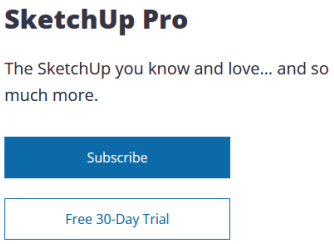
If SketchUp is *not* installed, or if windPRO cannot find the SketchUp installation, a setup must be performed. Click the “Setup Sketchup” button:



Click here to go to the SketchUp download page:

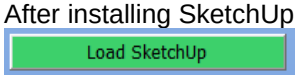


If you do not have a SketchUp subscription, you need to sign up or get a trial version:

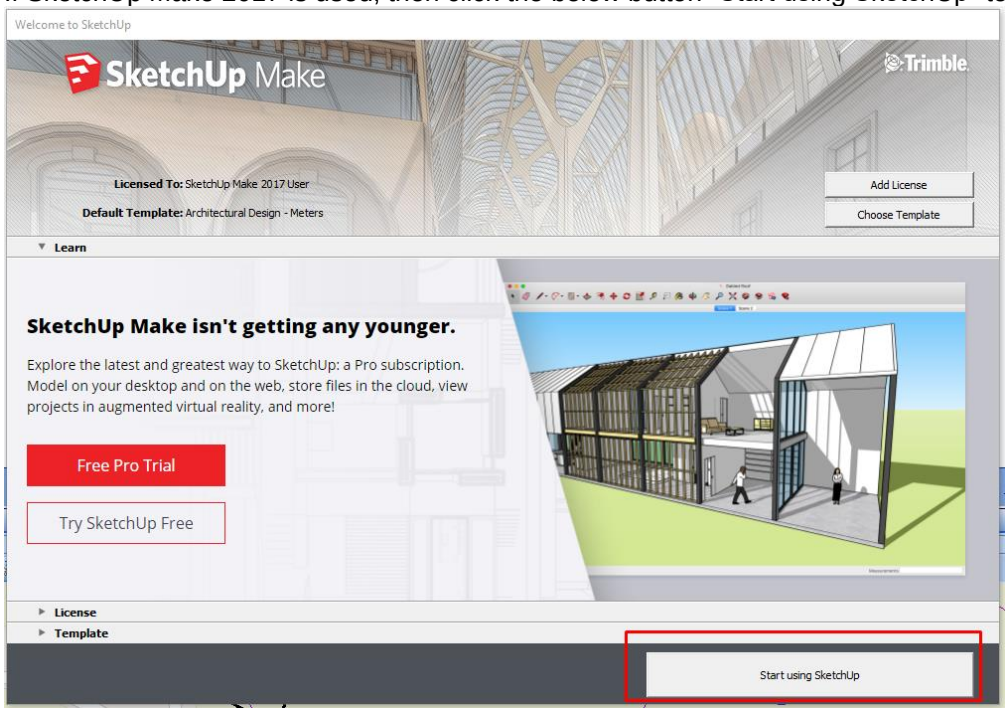


If you already have one, then you can download SketchUp here:
https://www.sketchup.com/download/all

After installing SketchUp this button appears. Click it to start SketchUp.



If SketchUp Make 2017 is used, then click the below button “Start using SketchUp” to get started:



7.3.4 Exporters to Sketchup

In the following sections, each type of Exporter is explained.

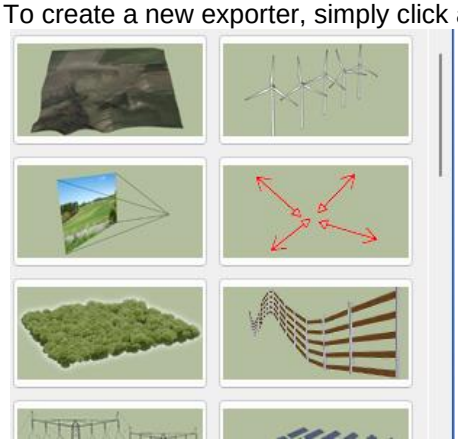
Common features for all types of Exporters:

1) **Description:** the description text is shown in the list of created exporters and also used as *Layer* name in SketchUp. When the description is not used as a Layer, it will be specified.

2) When Exporters are related to objects, they can be selected in three possible ways:
   - All objects from visible layers
   - All objects in the project
   - All selected objects (just before clicking *Run*)

3) Which object are exported to SketchUp is not determined by when the exporter is edited, but rather when the exporter is *run.*

To create a new exporter, simply click an item in the left list:



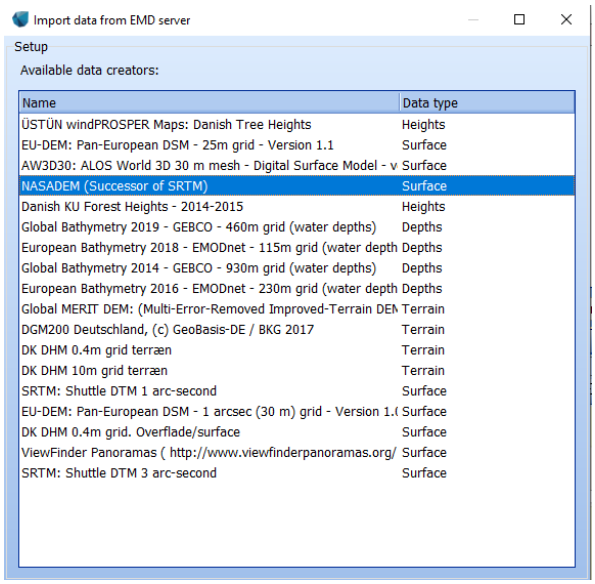
7.3.4.1 Surface Exporter

Video tutorial link
This exporter can export an elevated windPRO background map to SketchUp.

Export an elevated windPRO background map to SketchUp.

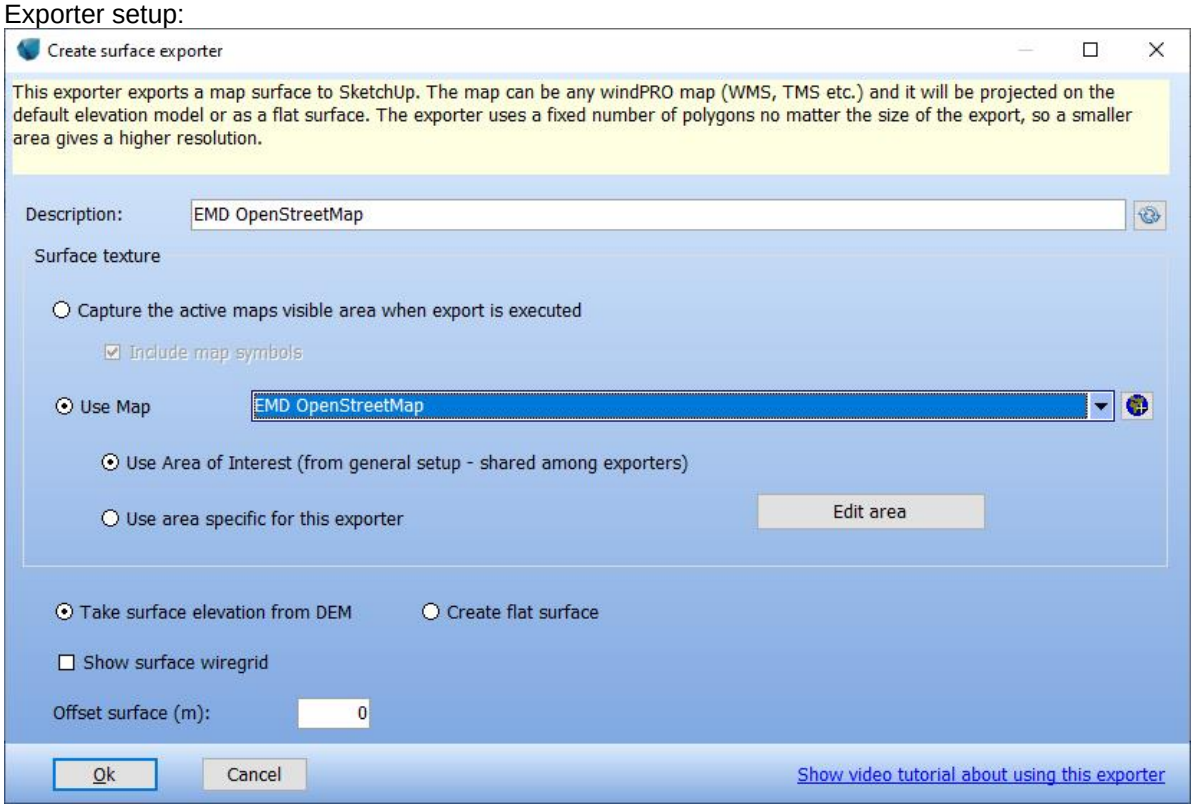
There will always be used a maximum 10.000 points to create the surface map. This means the resolution in meters depends on the size of the exported area.
Any of the maps used in windPRO can be used. This gives access to a wide range of maps for the whole world including Open Street Map, user defined WMS/TMS maps, scanned maps, screenshots, world files and overlays from Google Earth.
Link to windPRO help about background maps

The map exporter uses the default elevation model from the windPRO project. windPRO has access to a wide range of global and local maps. The list of available elevation data sources depends on the project location:



Also, elevation data can be loaded from many file formats, including Surfer Grid, GeoTiff, xyz and Shape format.
Link to windPRO help about grid elevation data (recommended)
Link to windPRO help about line elevation data

Exporter setup:

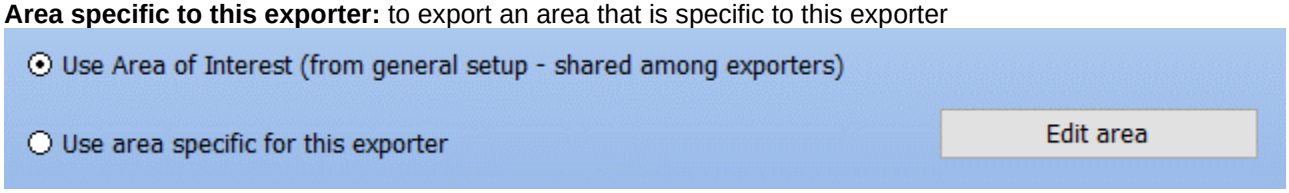


Capture the active maps visible area when export is executed: Use this option to export the part of the map that is visible at the time the exporter is run

Include map symbols: Select if the map symbols should be rendered on the exported map too. This way result-layers can be exported to SketchUp in a simple way.

Use Map: Use this option to select a fixed map and area for the surface export. The map can be selected from the drop down dialog. This would produce a higher quality map.

Use Area of Interest (from general setup): If this is selected, then the area to export is taken from the general setup that is shared with other exporters
Area specific to this exporter: to export an area that is specific to this exporter



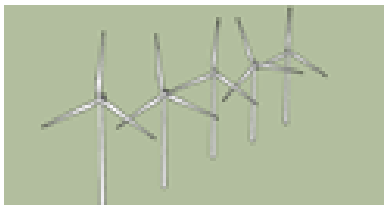
Press “Edit area” to define the selected area

Create flat surface: Use this option to create a flat map, and not use the elevation model. This can be useful when drawing new 3D objects on the surface where it is a lot easier when the surface is flat. Objects created on a flat surface can later be moved vertically to the correct vertical position.
Also it can be useful when exporting result layers.

Show surface wire grid: Check this to let the lines in the surface be visible in SketchUp. This can also be edited inside SketchUp after the export.

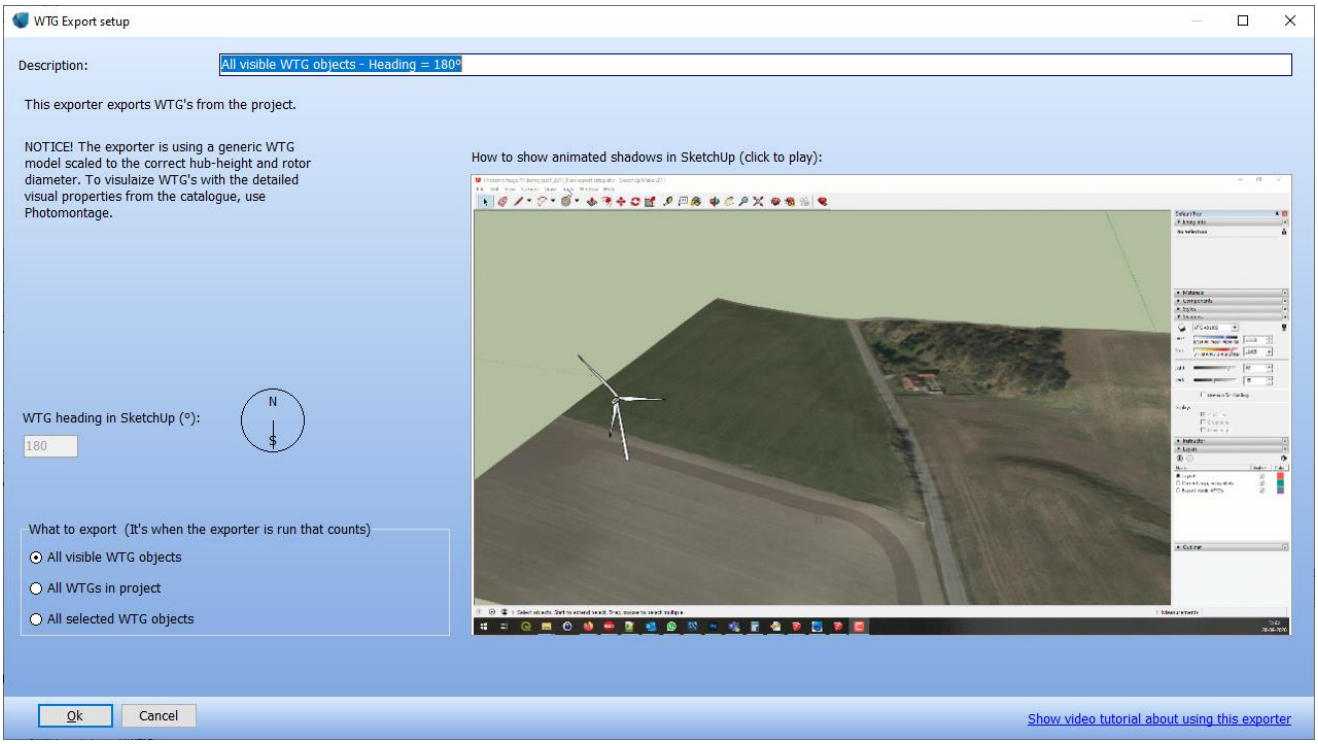
Offset surface: If surface level is taken from DEM, then this value is added to the DEM. If exporting a flat surface then it will use this level.

7.3.4.2 WTG Exporter



Video tutorial link

Use the WTG exporter to export WTGs from the project to SketchUp.
In the setup it can be selected which direction the WTGs should face, and which WTGs to export.

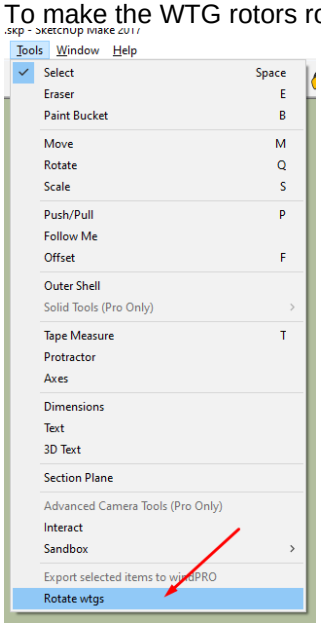


It is at the time the exporter is *run* that it is determined which WTGs to export, *not* when the exporter is edited.

The size of the WTGs is picked up from the WTG object properties (hub-height and rotor diameter), but the model itself is generic, and the same one used for all WTG types. To visualize WTGs with the correct visual properties, use windPRO PHOTOMONTAGE module.

Make the WTG rotate

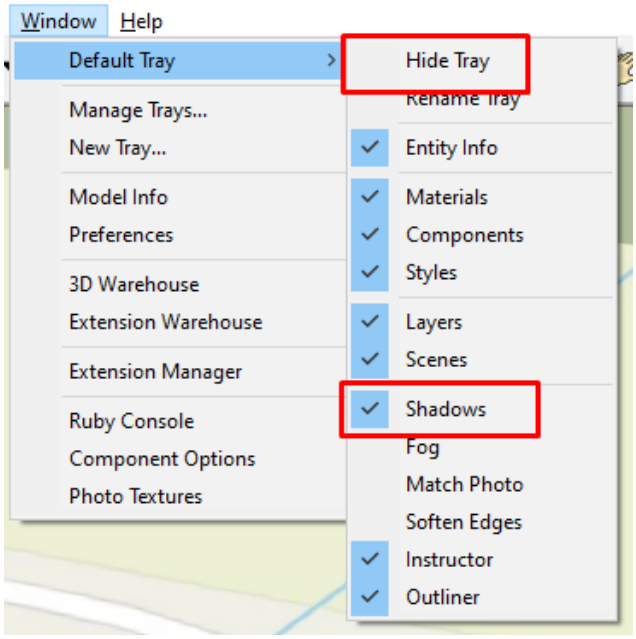
To make the WTG rotors rotate in SketchUp, select this option in the Tools menu:



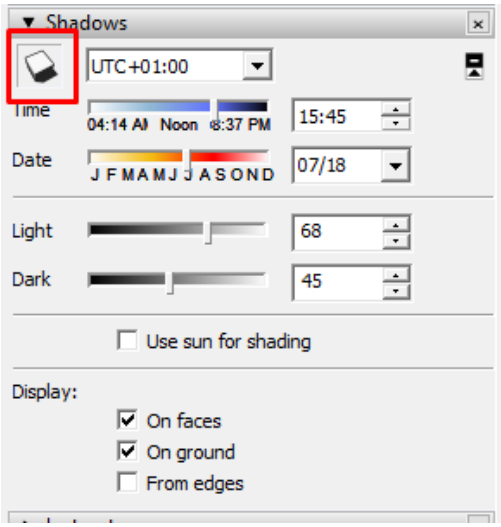
This can be quite resource intense for the computer, so do not activate rotation while editing the SketchUp model. Strange things may happen.
Rotating WTGs only work when SketchUp is started from windPRO.

Show WTG shadows

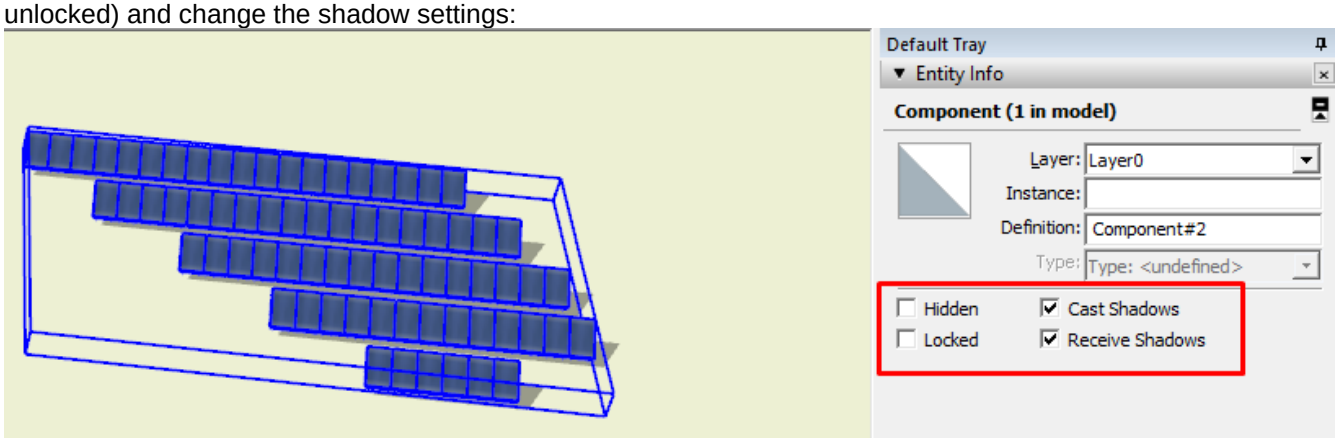
The Video tutorial link also demonstrates how to show shadows of WTGs in SketchUp.
Make sure the default tray is not hidden, and the Shadows toolbar is turned on:



Then this setup should appear in the user interface:

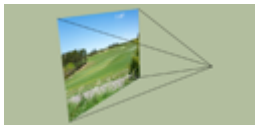


Turn shadows on by pressing the button in the upper left side. Then the sliders can be used to adjust the light. If showing shadows is not visualized smooth and the computer has problems keeping up the speed, then it can be changed what elements that should cast and receive shadows. Select an element (make sure it is unlocked) and change the shadow settings:



Switching off irrelevant elements often has a great influence on performance.

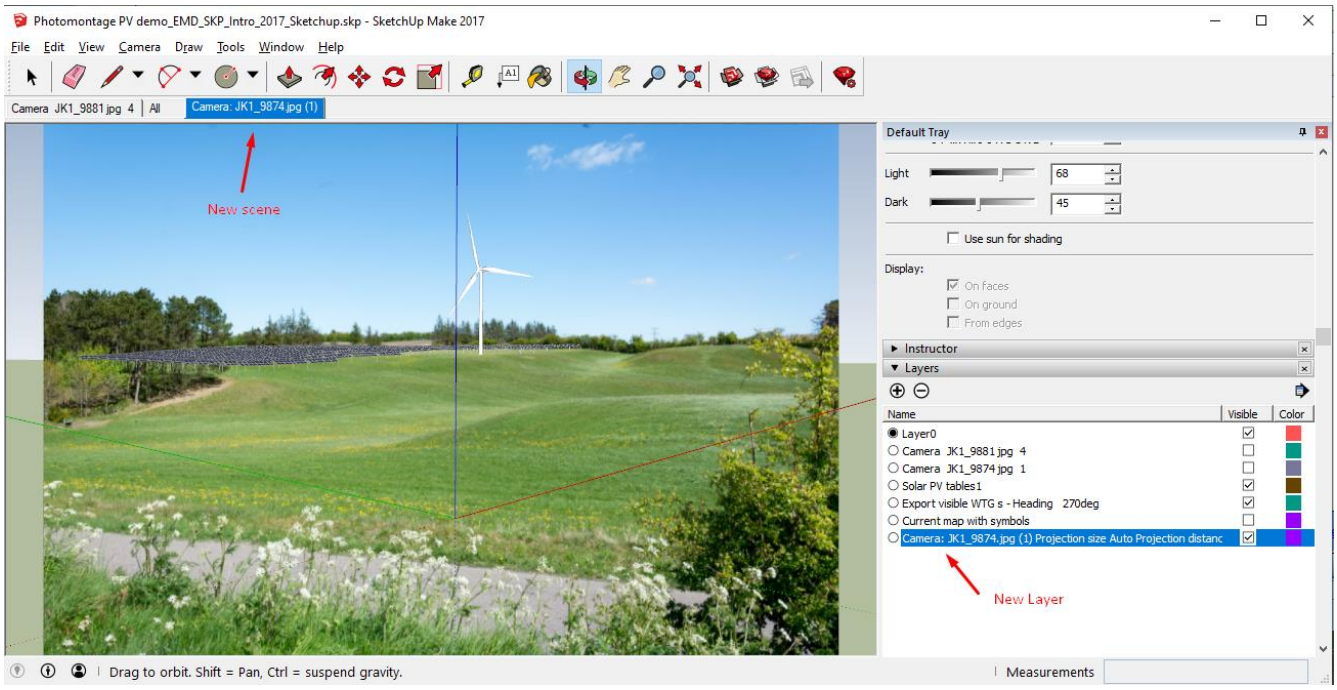
7.3.4.3 PHOTOMONTAGE Exporter



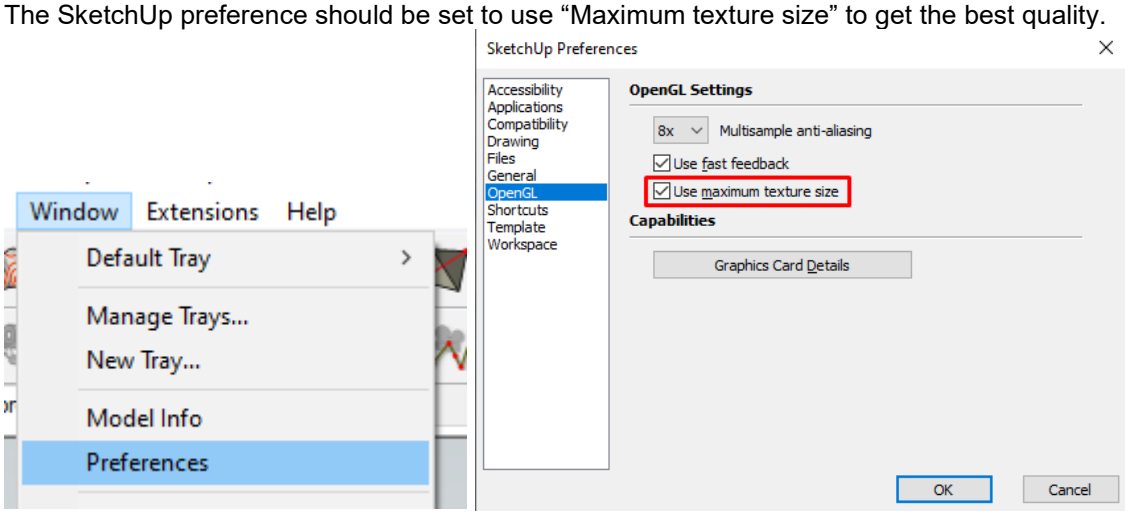
Video tutorial link

With the PHOTOMONTAGE Exporter photo-matching can be performed with unseen precision in SketchUp. PHOTOMONTAGE is a tool created for rendering 3D models correctly on a photo, primarily WTGs and Solar PV areas in windPRO, and it has a long list of tools available for calibrating the camera model. When the camera is calibrated correctly the photo and/or the camera viewpoint can be exported to SketchUp, and objects in the SketchUp project can be visualized on the photo with great precision.

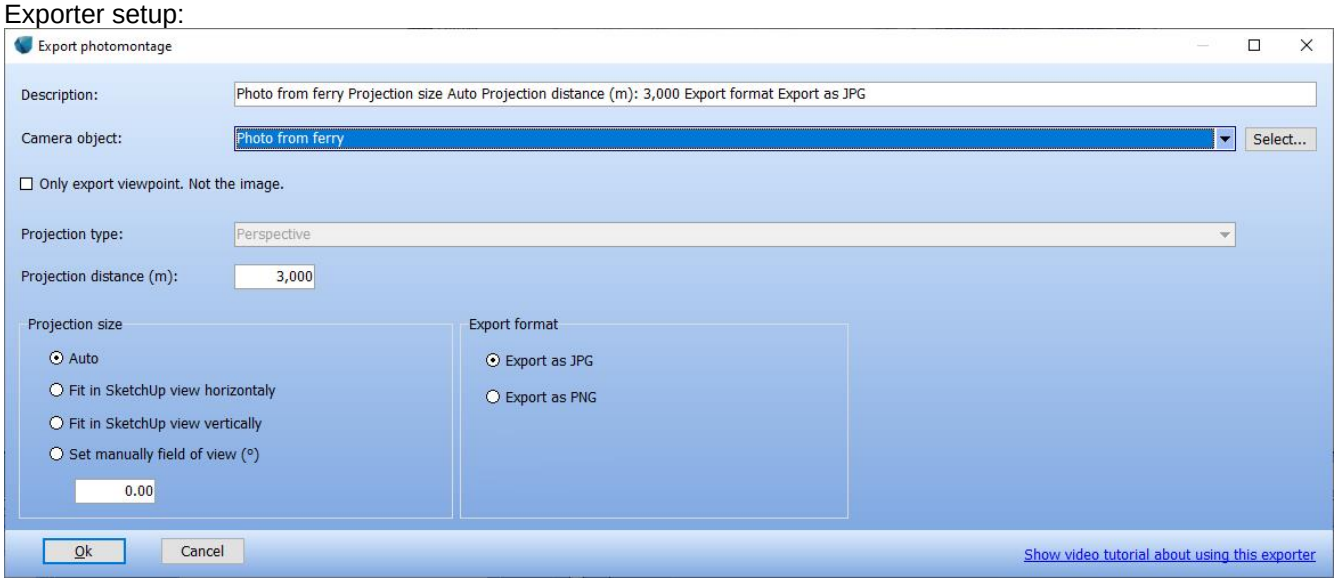
After exporting a PHOTOMONTAGE image to SketchUp it is placed floating in the 3d space and it is put on its own layer. A new *Scene* is created. When this scene is selected, the camera is moved to the correct position to view the photo correctly.



The SketchUp preference should be set to use “Maximum texture size” to get the best quality.



Exporter setup:



Camera object: the wanted camera object is selected. Before using a camera object, it must be calibrated in the PHOTOMONTAGE module. The object description is used as Scene name in SketchUp.

Projection type: perspective projection is used with a normal photo, or cylindrical with a Panorama.

Projection distance: indicates the distance from the camera position to the image position in SketchUp. Normally the distance should be large enough to put the image “behind” any other objects in the model. It should not be extremely large or small. If it is very small then the precision of the visualization can suffer.

Projection size: Normally it is preferable to use a zoom that makes the image fill out the screen, but still not being truncated (auto). Often this would lead to blank spaces at either the sides or the top/bottom:

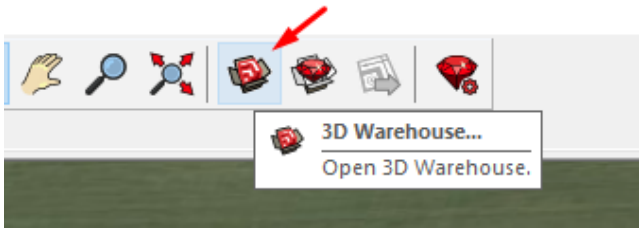
In this case, setting Projection size to “Fit in SketchUp view vertically” would make the image fill out the screen, but then the sides would then be truncated.
Use “Set manually field of view (°)” to set the zoom to an user defined value.

Export format: .jpg format is the most efficient choice. However, it can be worth considering .png if creating a “mask” layer. A mask layer can be used together with the normal PHOTOMONTAGE export, just on the near side of objects to visualize. A .png layer can be edited to be partly transparent. This illustrates the idea:

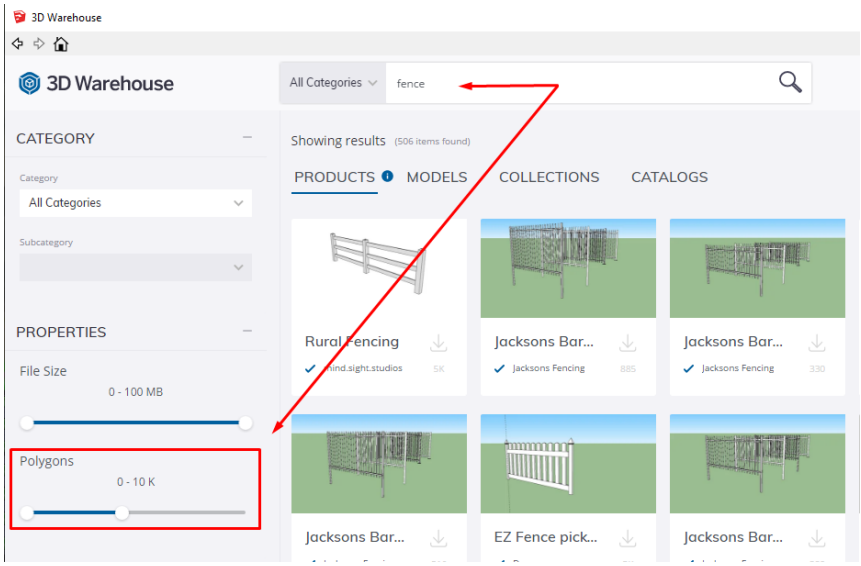
Use 3D warehouse to bring items into windPRO photomontage

SketchUp has a huge collection of freely available 3D models that can be downloaded and used inside SketchUp as well as in windPRO Photomontage.

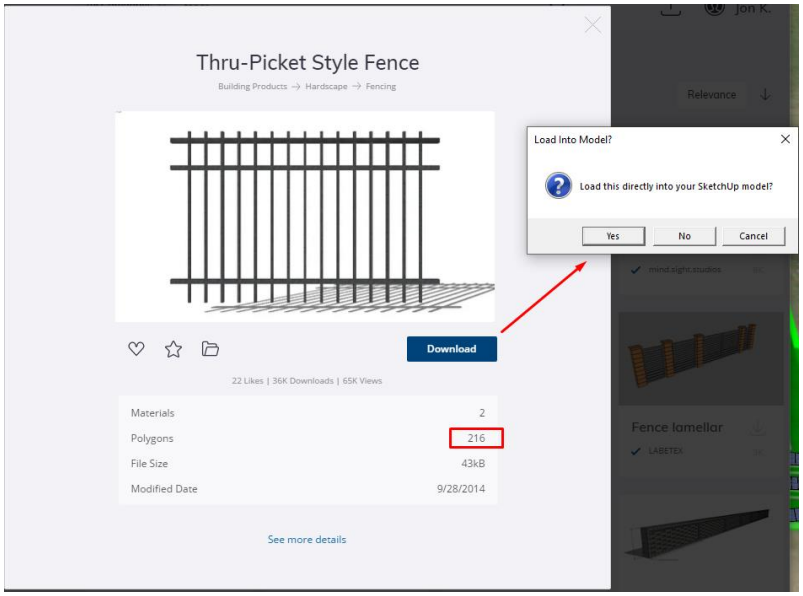
Go into 3D Warehouse using this button in the toolbar:



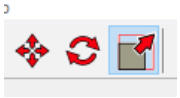
Inside the 3D Warehouse, it is possible to search and filter. It is recommended to set a maximum of polygons to 10 K (10.000), because some models have way too many polygons slowing down the whole process. Here is a search for fences:



Select a model and download it into SketchUp. Remember that the number of polygons should not be too high.

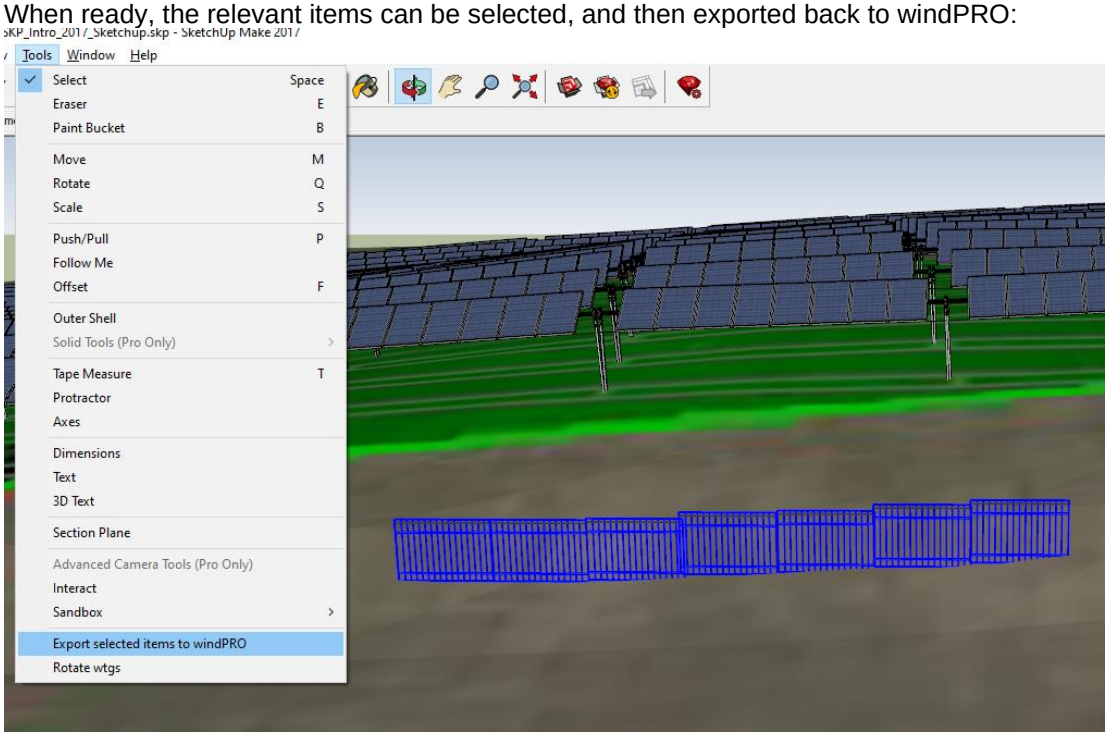


After downloading, the fence can be moved, rotated, scaled and copied using the basic SketchUp tools:

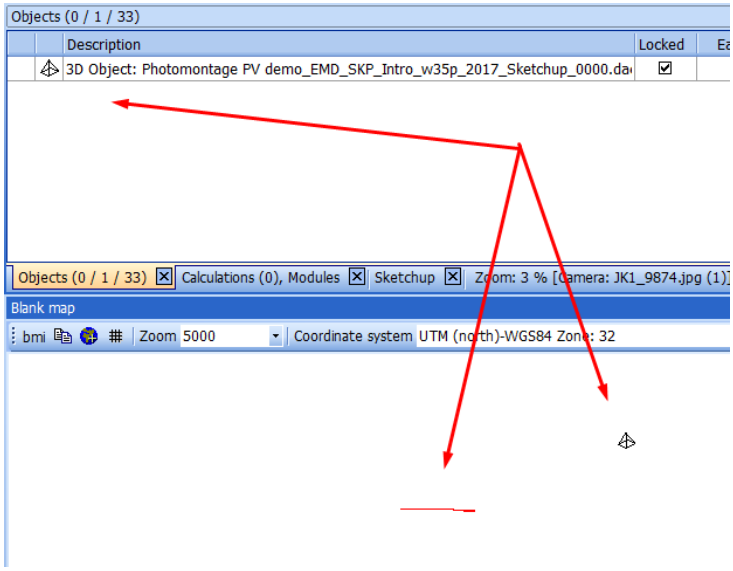


If holding Ctrl down while using these tools, the object will be *copied*. If pressing the arrow keys on the keyboard while using these tools, the action will be locked to a specific axis. Most useful is arrow up (blue axis).

When ready, the relevant items can be selected, and then exported back to windPRO:



The object will then show up as a 3D object in windPRO, and it can be visualized in Photomontage:

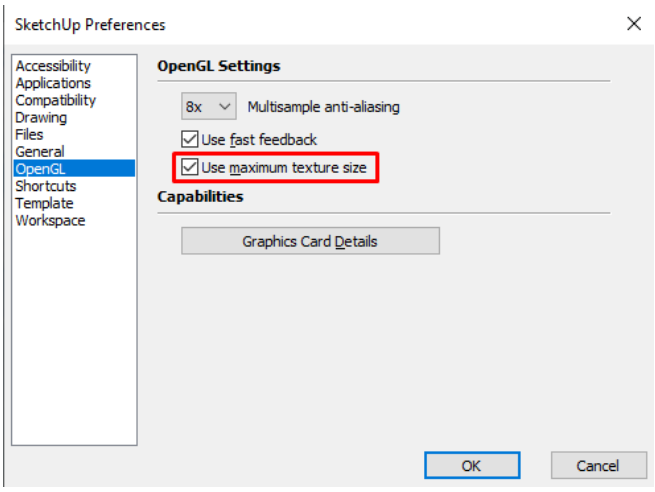


To avoid the shift between the position of the windPRO 3D object and of the resulting 3D structure (in red), the dae file should be placed in SketchUp at the Origin of the coordinate system before export to windPRO.

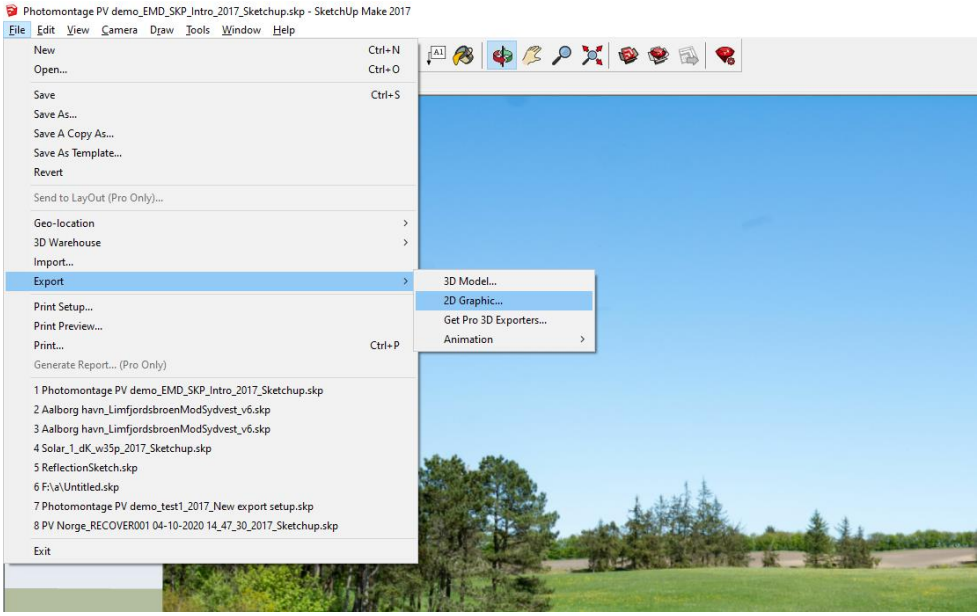
Postprocessing images in Photoshop

When adding images to SketchUp using the Photomontage exporter, and visualizing objects on the photo, it is often necessary to post edit the visualizations in an image editor like for instance Photoshop.
Below some recommendations when using Photoshop, but many other tools can do it in a similarly.

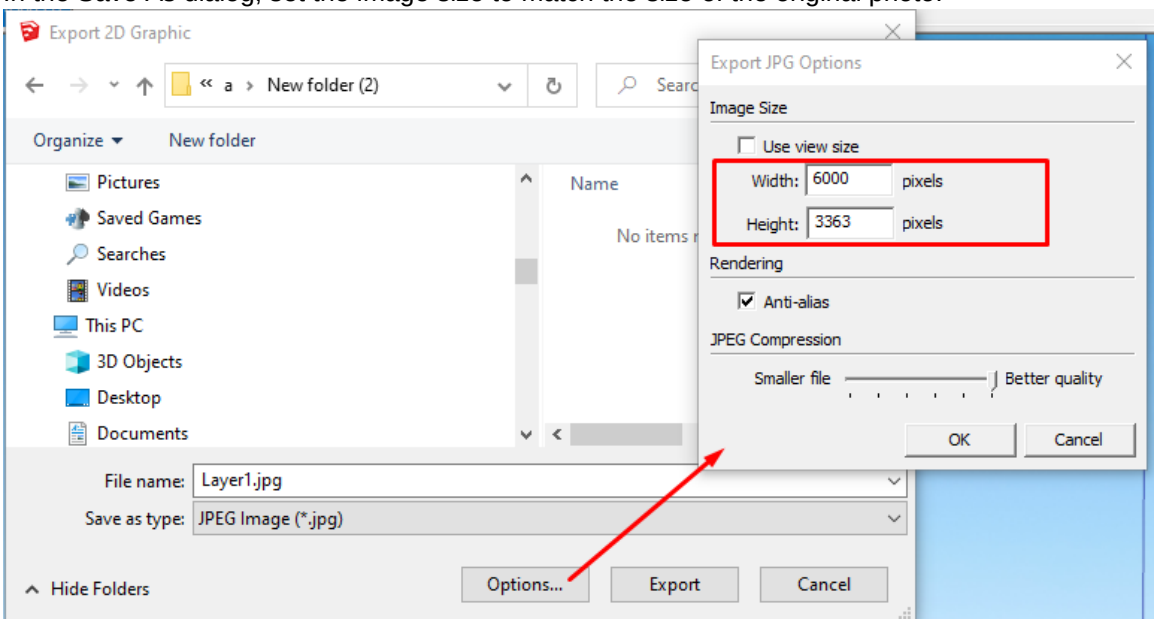
1. Make sure that “Use maximum texture size” is selected in SketchUp:



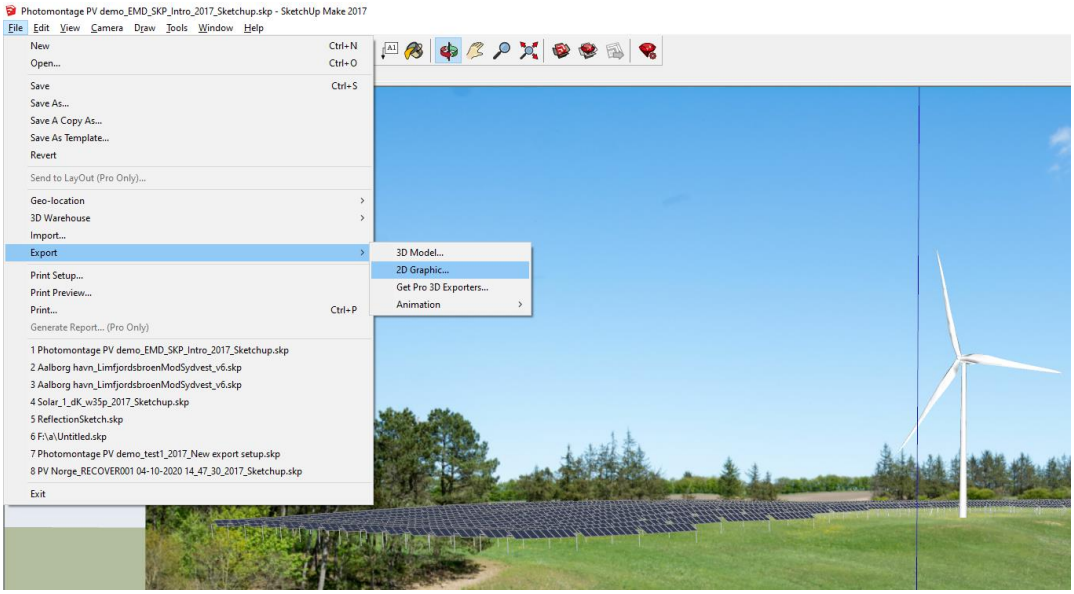
2. Hide all layers except the layer with the photo to export the image with *no objects* as a jpg file:



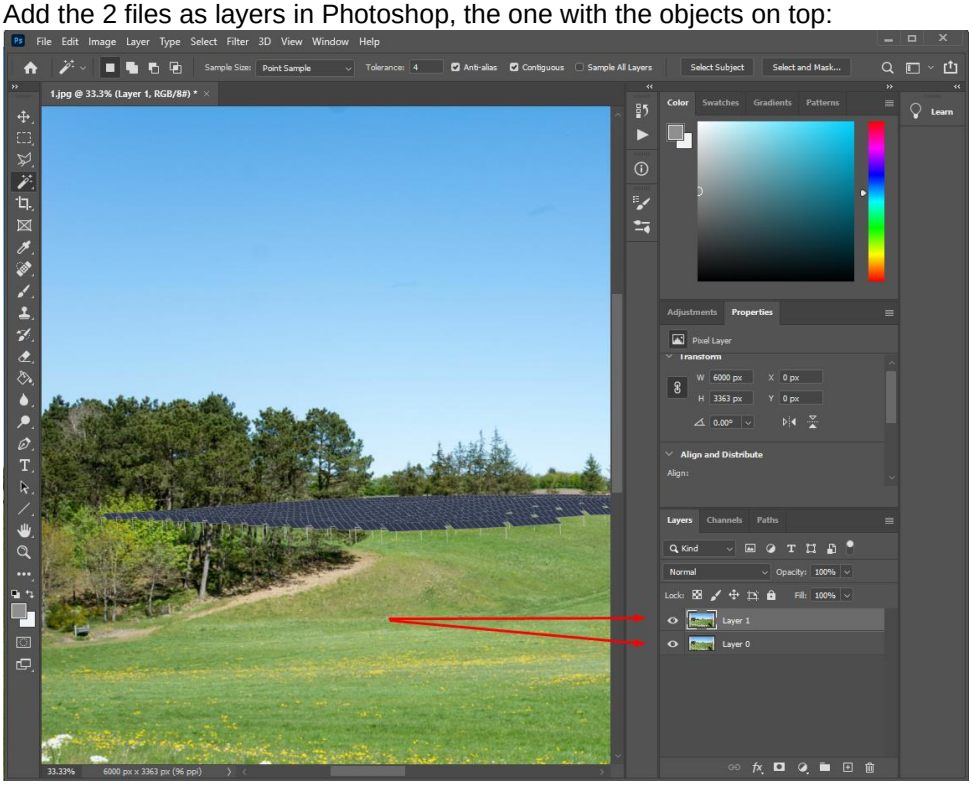
3. In the Save As dialog, set the image size to match the size of the original photo:



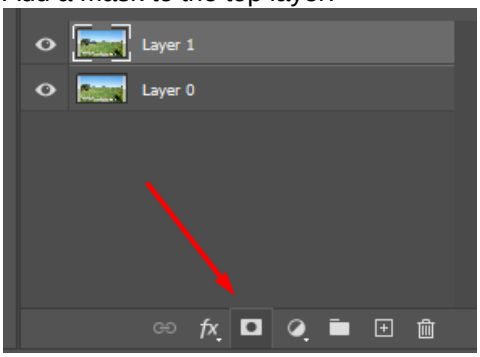
4. Then export the image *with* objects as a 2D graphic jpg file:



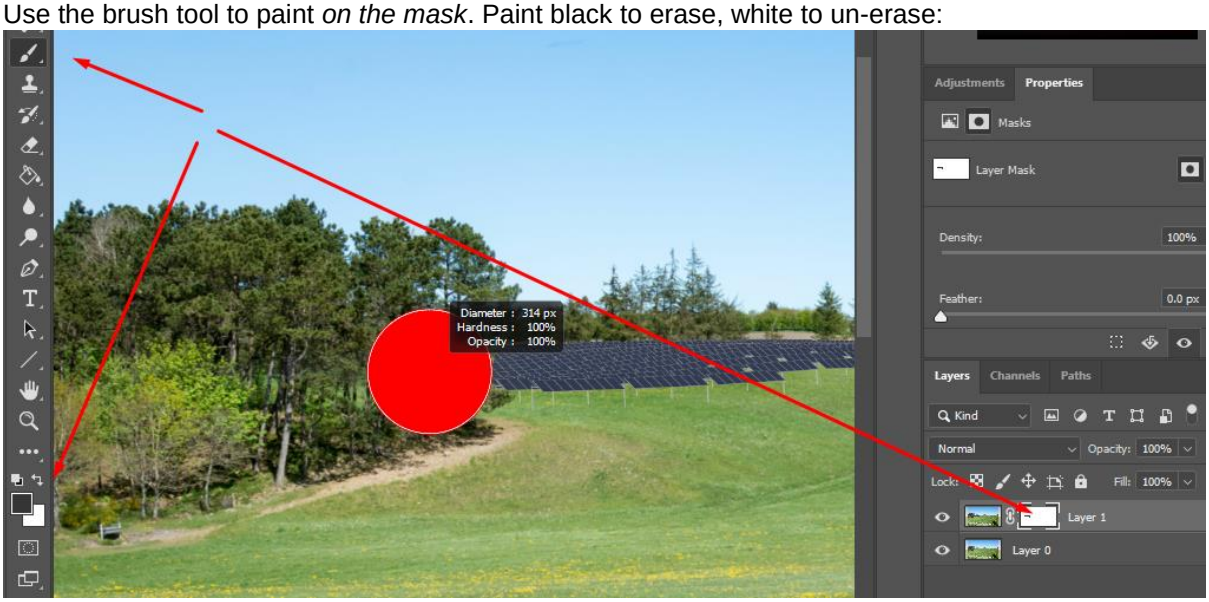
5. Add the 2 files as layers in Photoshop, the one with the objects on top:



6. Add a mask to the top layer:



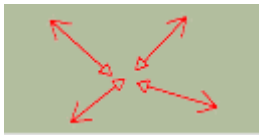
7. Use the brush tool to paint *on the mask*. Paint black to erase, white to un-erase:



Many other Photoshop tools can be used when painting on the mask, e.g. the magic wand selection tool or paint brushes.

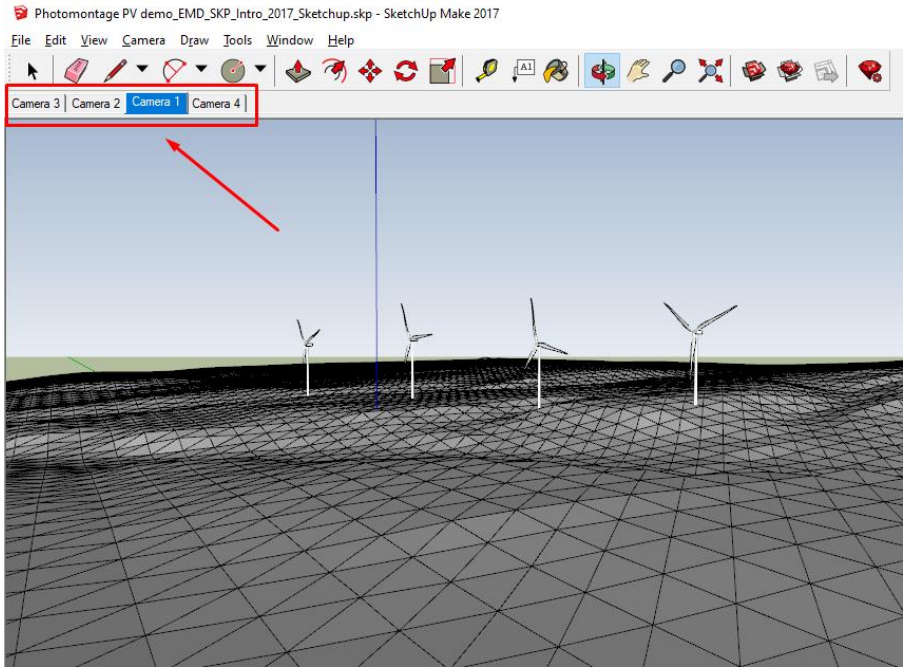
8. Use Save As, to save the result as a jpg file.

7.3.4.4 Viewpoint Exporter

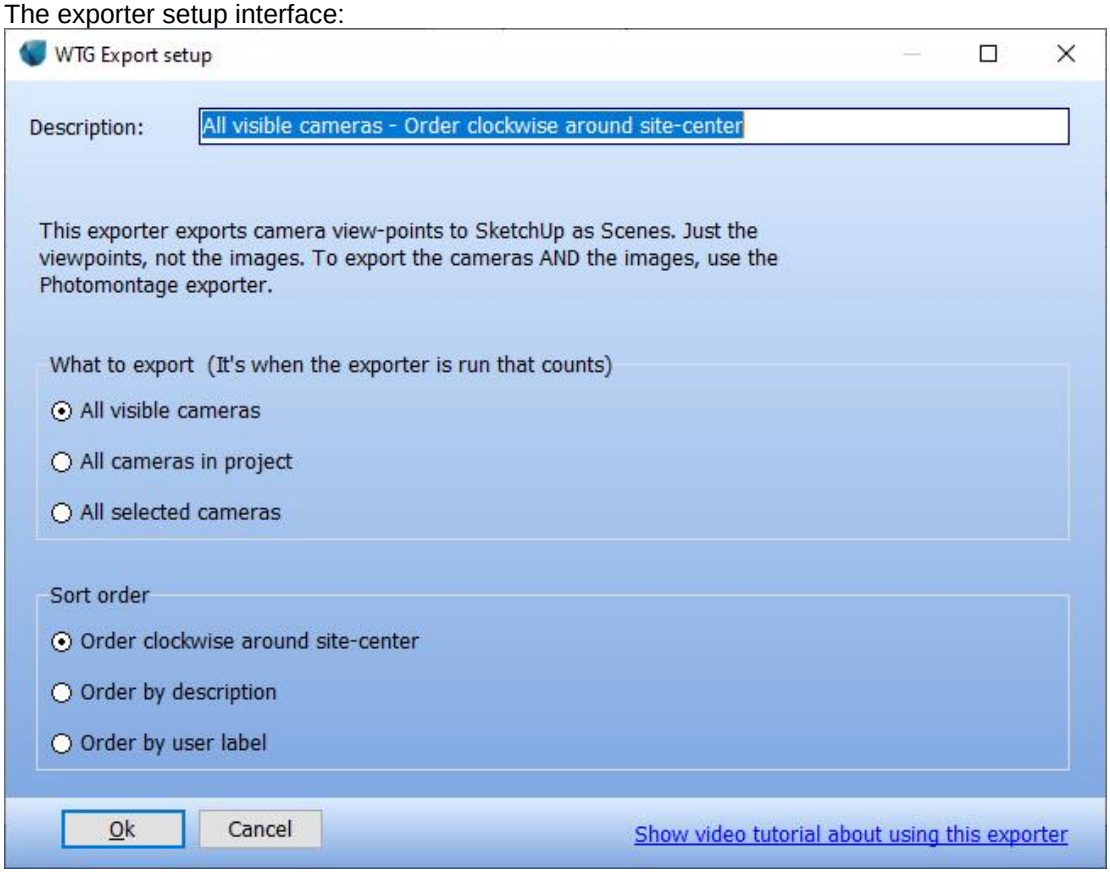


Video tutorial link

This exporter is similar to the PHOTOMONTAGE exporter, except that it only creates “scenes” in SketchUp and not the layers and the photos. It can export multiple cameras. This is useful when making visualizations purely artificial and/or to show the model from specific positions. It can also be used to setup viewpoints for a SketchUp animation.
Each exported camera position is exported as a new scene:



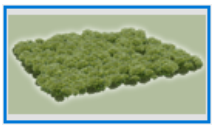
The exporter setup interface:



It can be selected what order the scenes (cameras) should have in SketchUp:

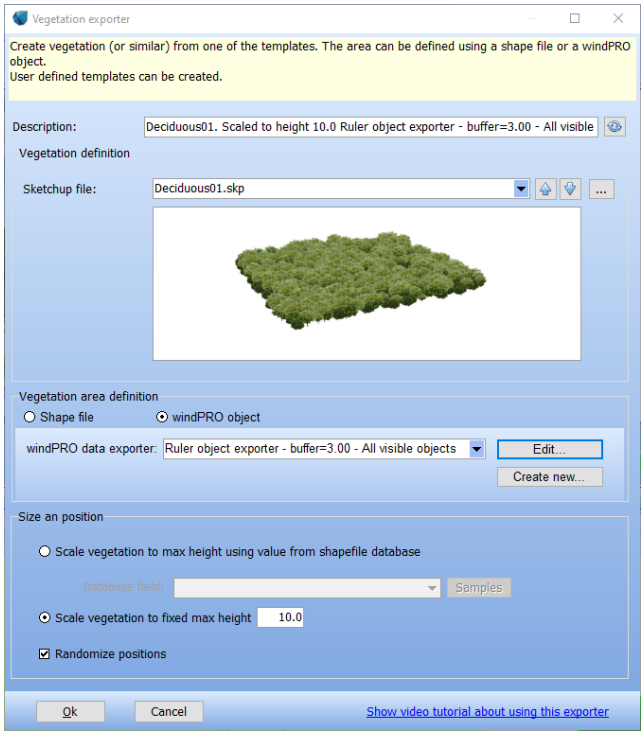
- ***Order clockwise around site-center (default):*** refers to the direction the camera would move when going from one scene to the next in SketchUp.
- Order by alphabetical order from description name or user label

7.3.4.5 Vegetation Exporter



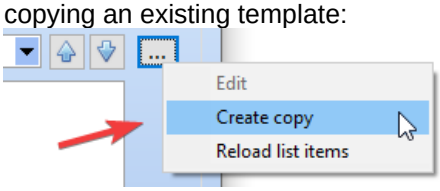
Video tutorial link

This exporter can export a collection of 3D objects into a predefined area. This can be trees and bushes, but also many other things. The vegetation can then be re-imported and rendered in a Photomontage.
This is the exporter setup:

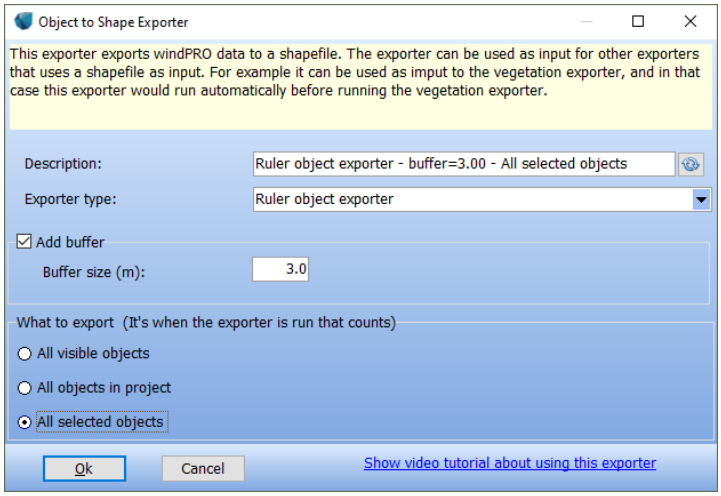


SketchUp file:
Select This is the template containing what to export. windPRO has a predefined set of templates. Also Tthe up down arrows can be used to change the template:

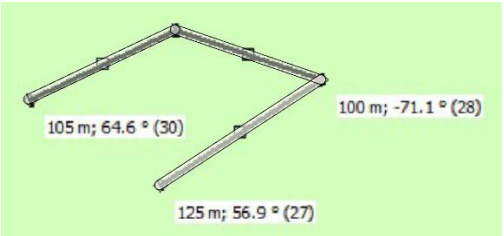
Use the menu to create a user defined template by copying an existing template:



Vegetation area definition is the same setup as for other exporters. Here a shape file can be used, or a windPRO object can be used. When using a shape file, the filename must be given. When using a windPRO object, a windPRO to shape file exporter must be created:

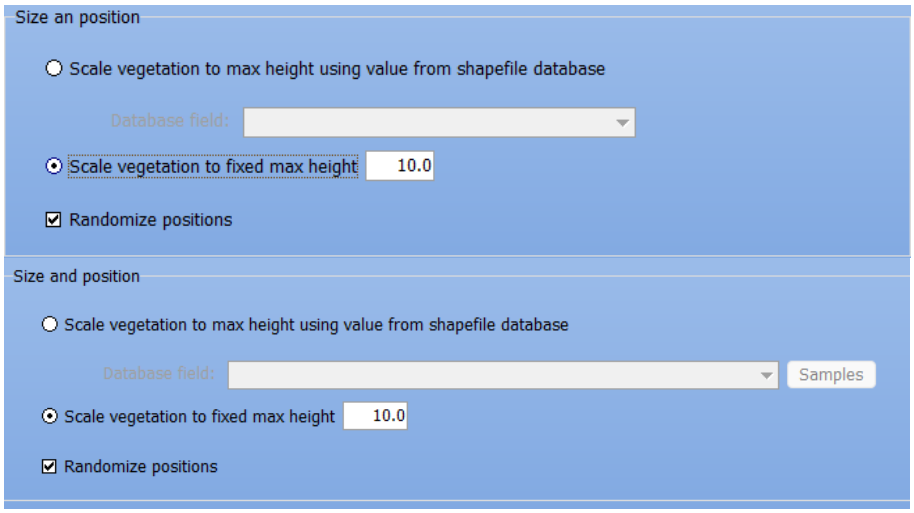


Here is an example of a windPRO to shape exporter that uses Ruler objects is shown below. Since the vegetation exporter needs a shapefile containing areas and not lines, a buffer must be specified. Using a buffer of 3 meters will create a 6-meter-wide area following the selected rulers:



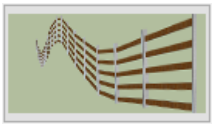
This shape file is not exported to SketchUp, but just used to define where to export vegetation. To export the shape file itself, then use the Shape file eExporter (see **Error! Reference source not found.**).

The final setting in the vegetation exporter is the **Size and position.**



windPRO opens the template and finds the object with the maximum height, and then finds how much it must be scaled to match the setting specified above. Then all objects are scaled with this factor.
If the shapefile used for the export contains a database field containing the height, this field can be used. If a windPRO object exporter is used than there would be a Height field when exporting Obstacles or Area objects.

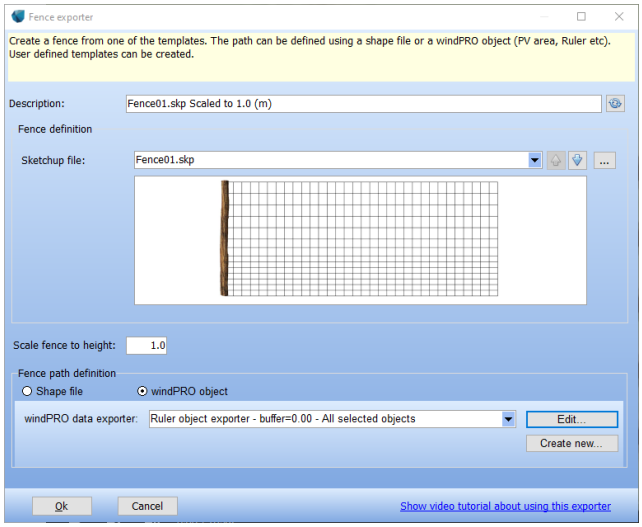
7.3.4.6 Fence Exporter



Video tutorial link

This exporter can export a fence following a specified path. The fence can then be re-imported and rendered in a Photomontage.

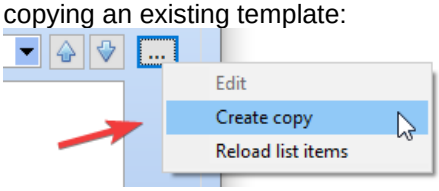
This is the exporter setup:



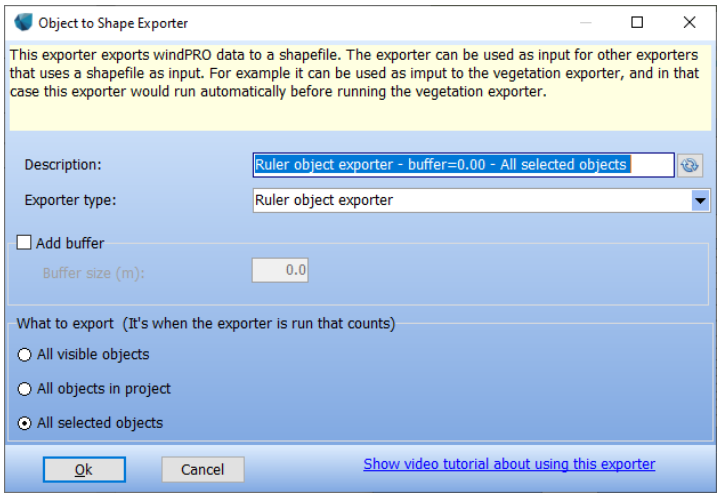
SketchUp file

Select the template containing what to export. windPRO has a predefined set of templates. The up down arrows can be used to change the template: 

Use the menu to create a user defined template by copying an existing template:



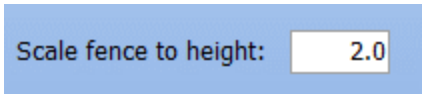
Fence Path definition is the same setup as for other exporters. Here a shape file can be used, or a windPRO object can be used. When using a shape file, the filename must be given. When using a windPRO object, a windPRO to shape file exporter must be created:



The example above shows a ruler object exporter selected as a windPRO object. It will create a line for each selected ruler for which the selected Fence will be created.

Note that the shape file itself is not exported. To export the shape file itself, then use the Shape Exporter (see **Error! Reference source not found.**).

The final setting in the Fence Exporter is the desired height defined in **Scale fence to height**.:



windPRO opens the template and finds the object height and then scale it to above height.

7.3.4.7 Transmission Lines Exporter

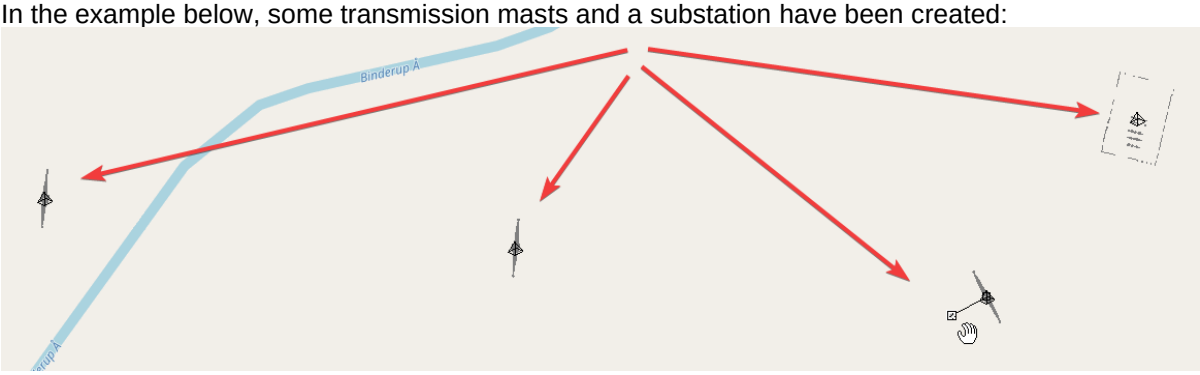
Video tutorial link

This exporter can export 3D objects  and connect them with wirelines following a catenary (hyperbolic cosine) curve. The towers and transmission lines can be re-imported and rendered in a Photomontage.

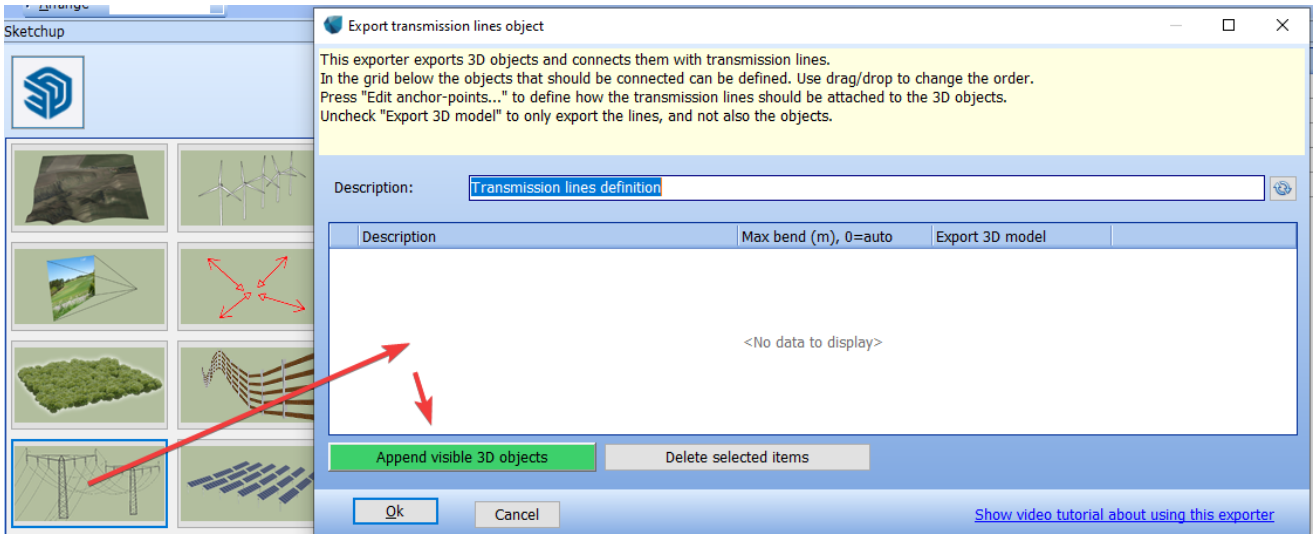
The procedure is the following:

1. Insert 3D objects  where the transmission masts should be. It can also be substations or similar. Use the same .dae file for each 3D object if they are the same, that makes it easier. If the objects are imported from SketchUp they should be imported one at the time!
2. Define how many transmission lines should connect the objects, and where they should be attached.

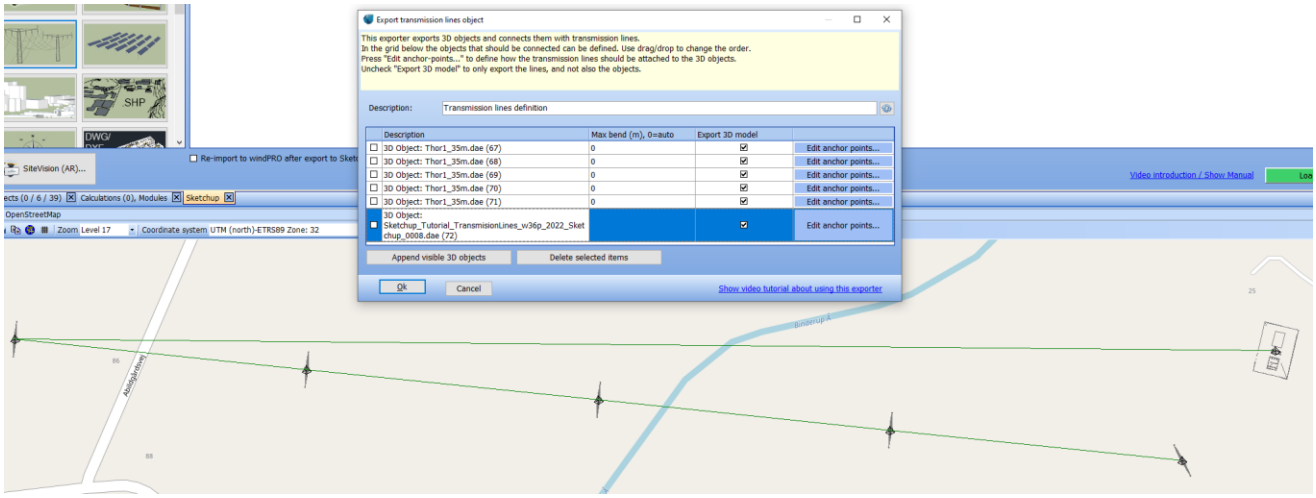
In the example below, some transmission masts and a substation have been created:



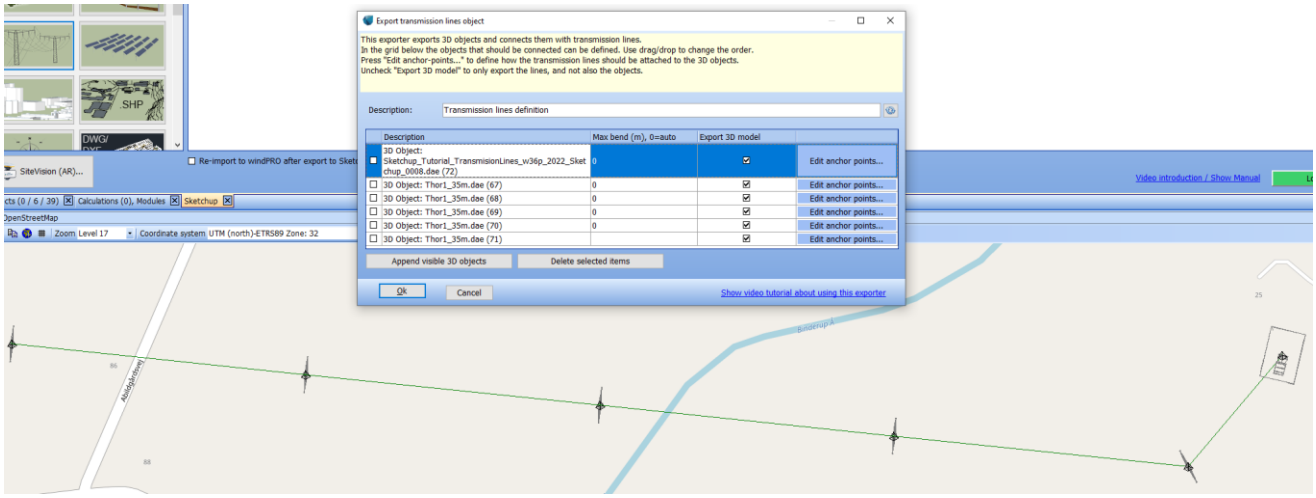
When the 3D objects are selected, they can be rotated using the handle. The objects above are rotated as wanted, and now the transmission lines exporter can be created:

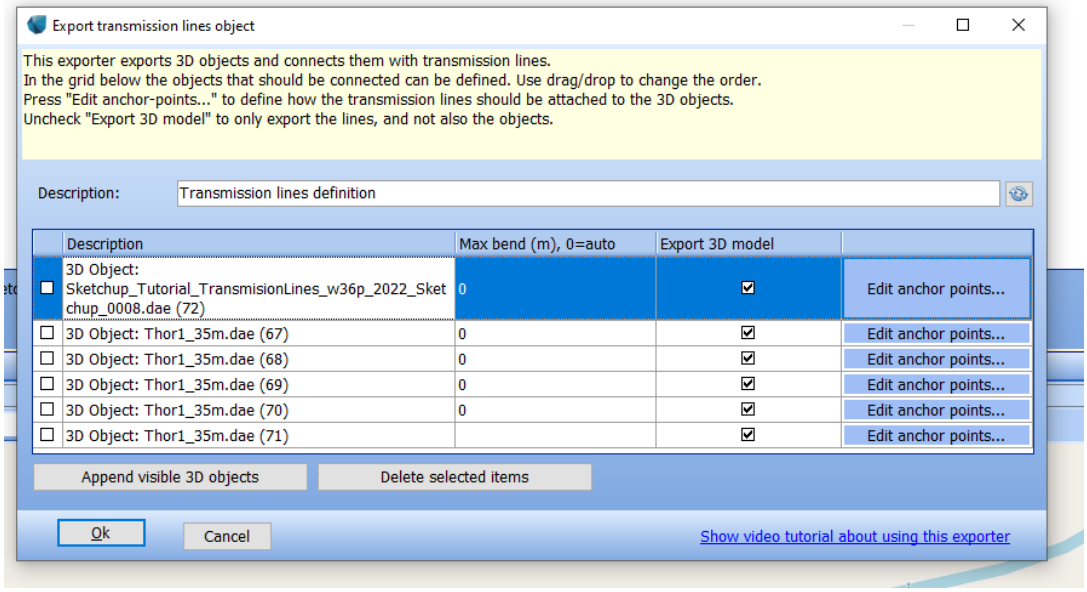


Press the append button to add the visible 3D objects to the list. When they are added to the list, it is shown on the map how they are connected. Here you can see that the substation is added to the leftmost mast, but it should be added to the rightmost.

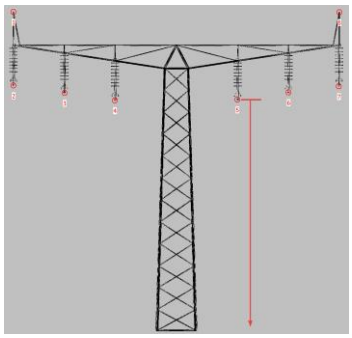


The problem is solved by dragging the substation in the list from the bottom to the top:

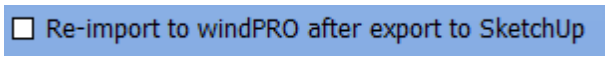




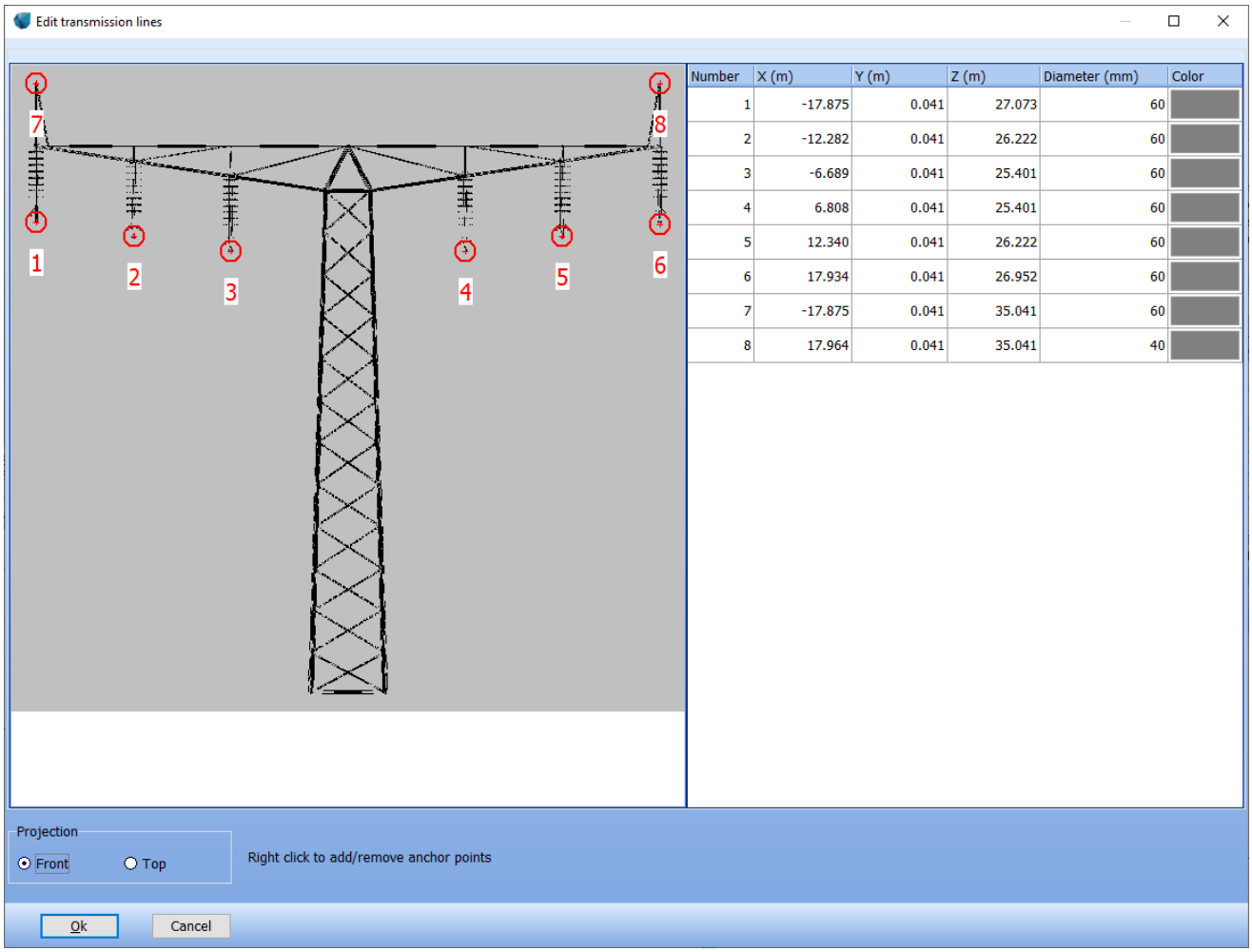
Max bend is used to define how much the transmission lines are bending down. The value corresponds to the vertical distance between the line and the straight line connecting two masts (at same anchor points). The value is applied at the middle of the line. Set to 0, the bend will automatically equal half (the distance marked below in red and corresponding to) the distance between the lowest anchor point and the ground.



Export 3D model: when checked, both the 3D model and the transmission lines are exported to SketchUp when running the exporter. To create only the transmission lines into windPRO, uncheck this box and then check the Re-import to windPRO after export to SketchUp:



Edit anchor points: from this button, it is possible to define where the transmission lines should be attached to the 3D model:

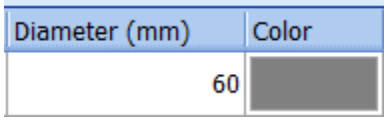


Anchor point 1 is connected to point 1 in the next an previous 3D model, and the same with point 2, 3 etc. If there are more points in one 3D model than in the next, the missing ones is not created.

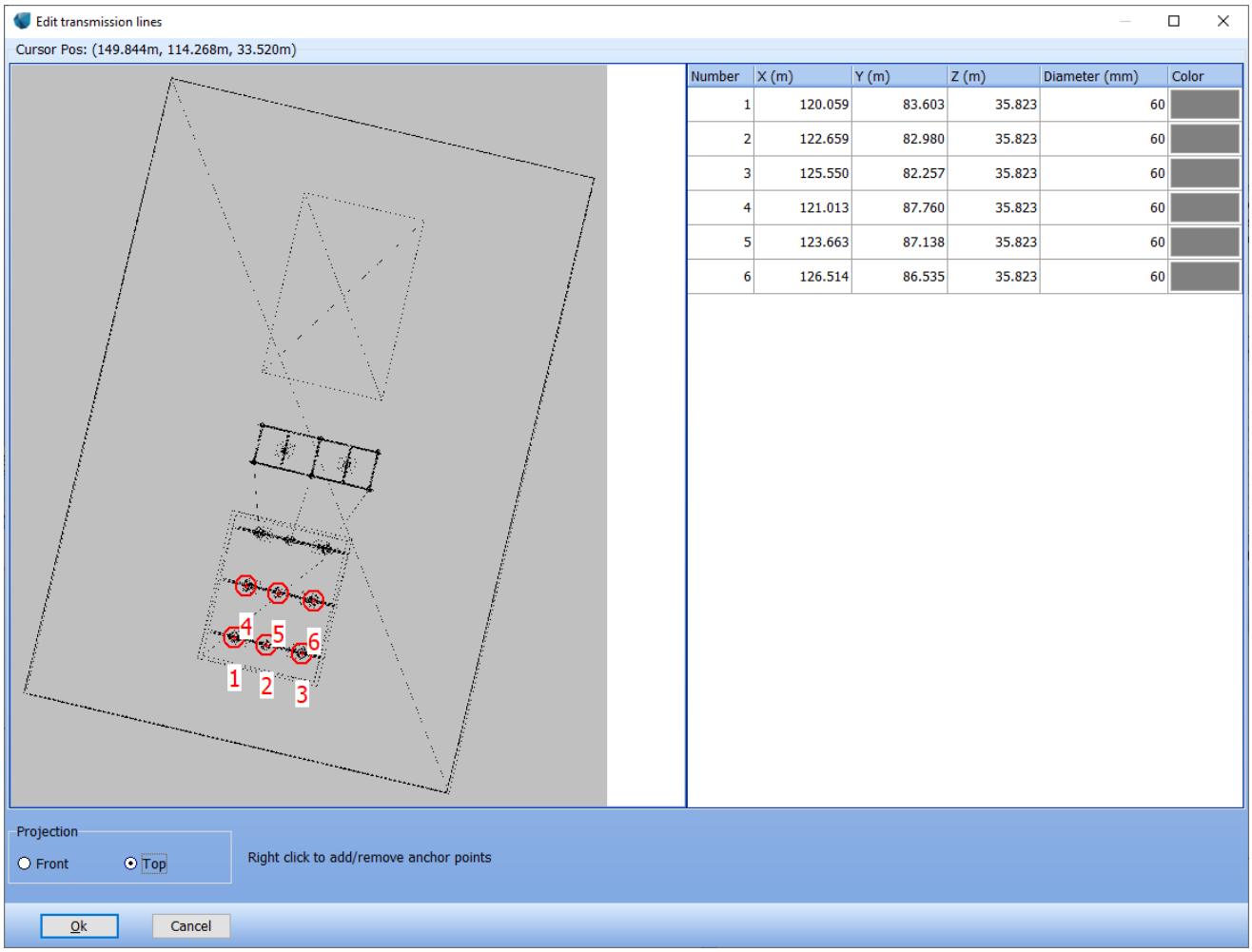
Mouse Scroll: Zoom in out
Mouse drag: Move image or drag existing points
Right-click: Create/Delete anchor points

Change the viewing **Projection** to ensure that the anchor points are placed correctly in all dimensions:

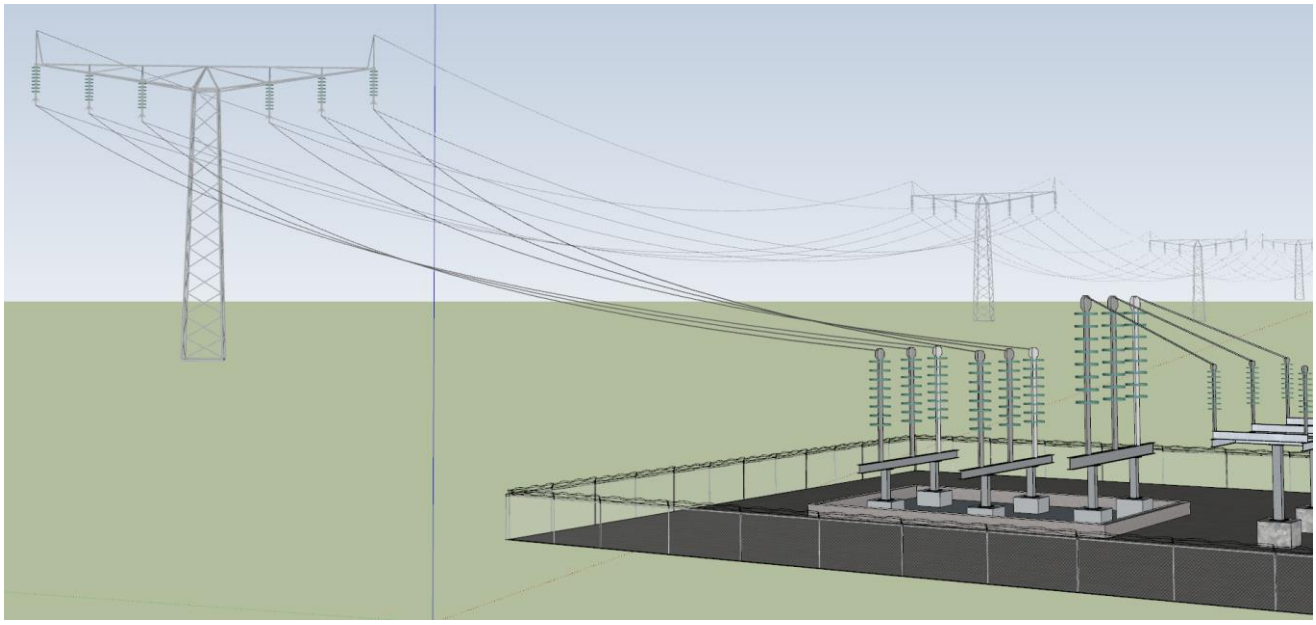
Diameter and color of the lines can be changed here:



An example of substation anchor points seen from top is shown below:



Run the exporter and the transmission lines (and optionally the masts and substation) are created in SketchUp. To re-import in windPRO for Photomontage see 7.3.5.

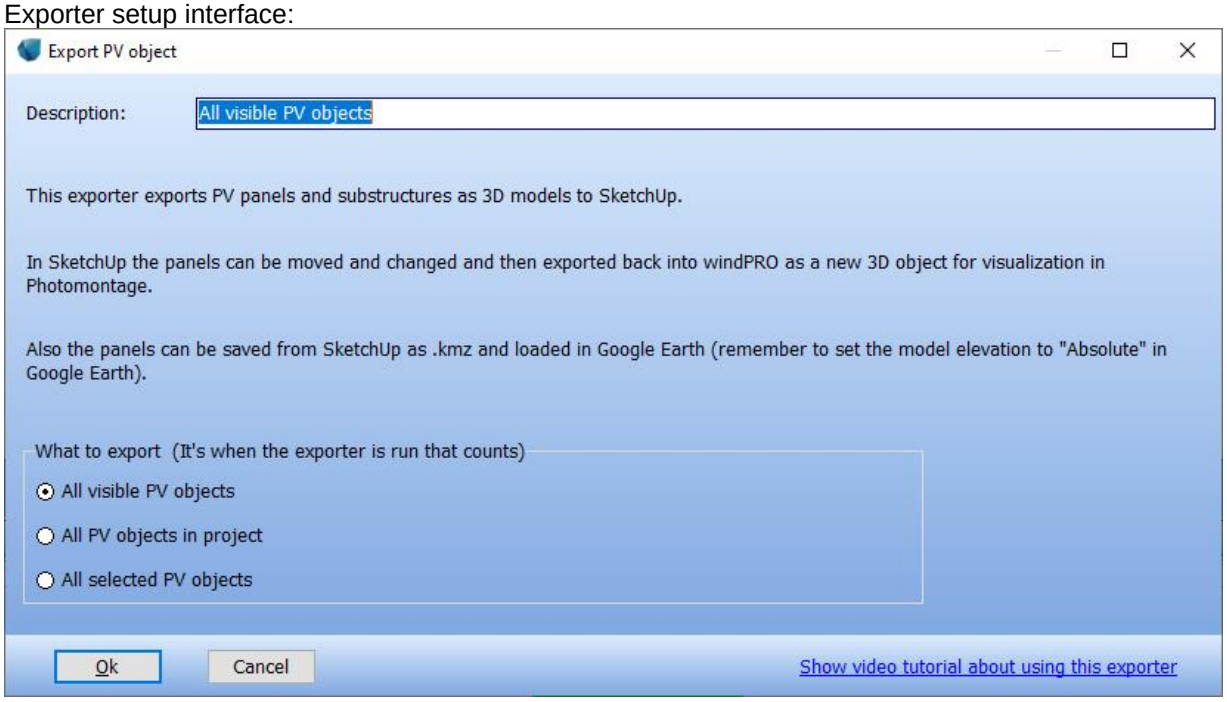


7.3.4.8 Solar PV Exporter

Video tutorial link

Use this exporter to export a Solar PV area. This can be useful to manually move/edit the panels before visualizing in Photomontage or to export as 3D models to Google Earth.

Exporter setup interface:

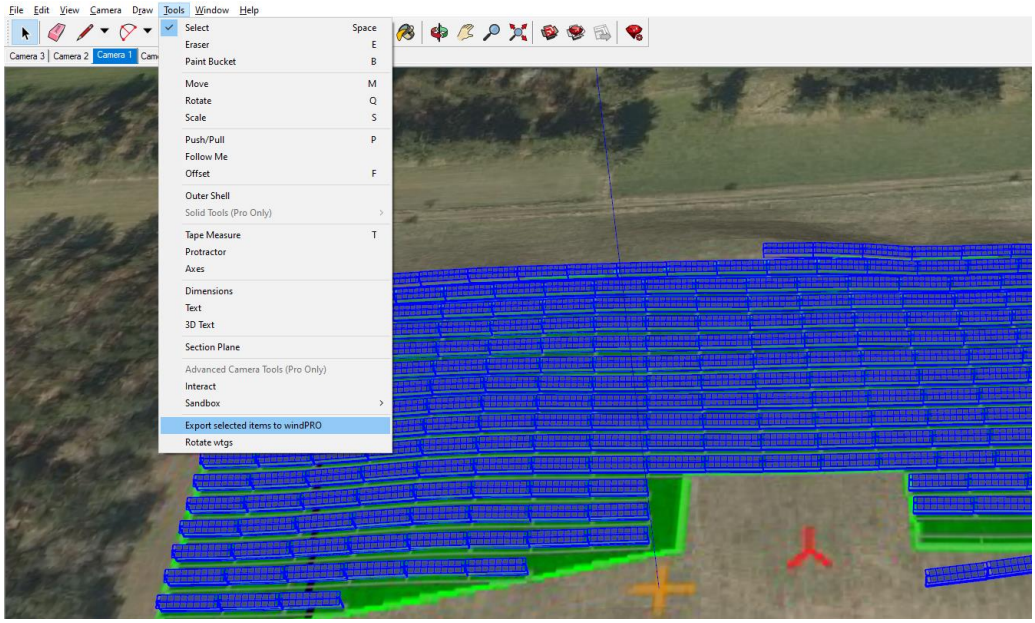


There are three ways to select what PV objects to export

All from visible layers
All in the project
All selected

It is at the time the exporter is *run* it is determined what PV objects to export. It is *not* when the exporter is edited.

After exporting, the PV panels shows up in SketchUp. Besides just visualizing it in the model, it can be modified and exported back to windPRO like this:



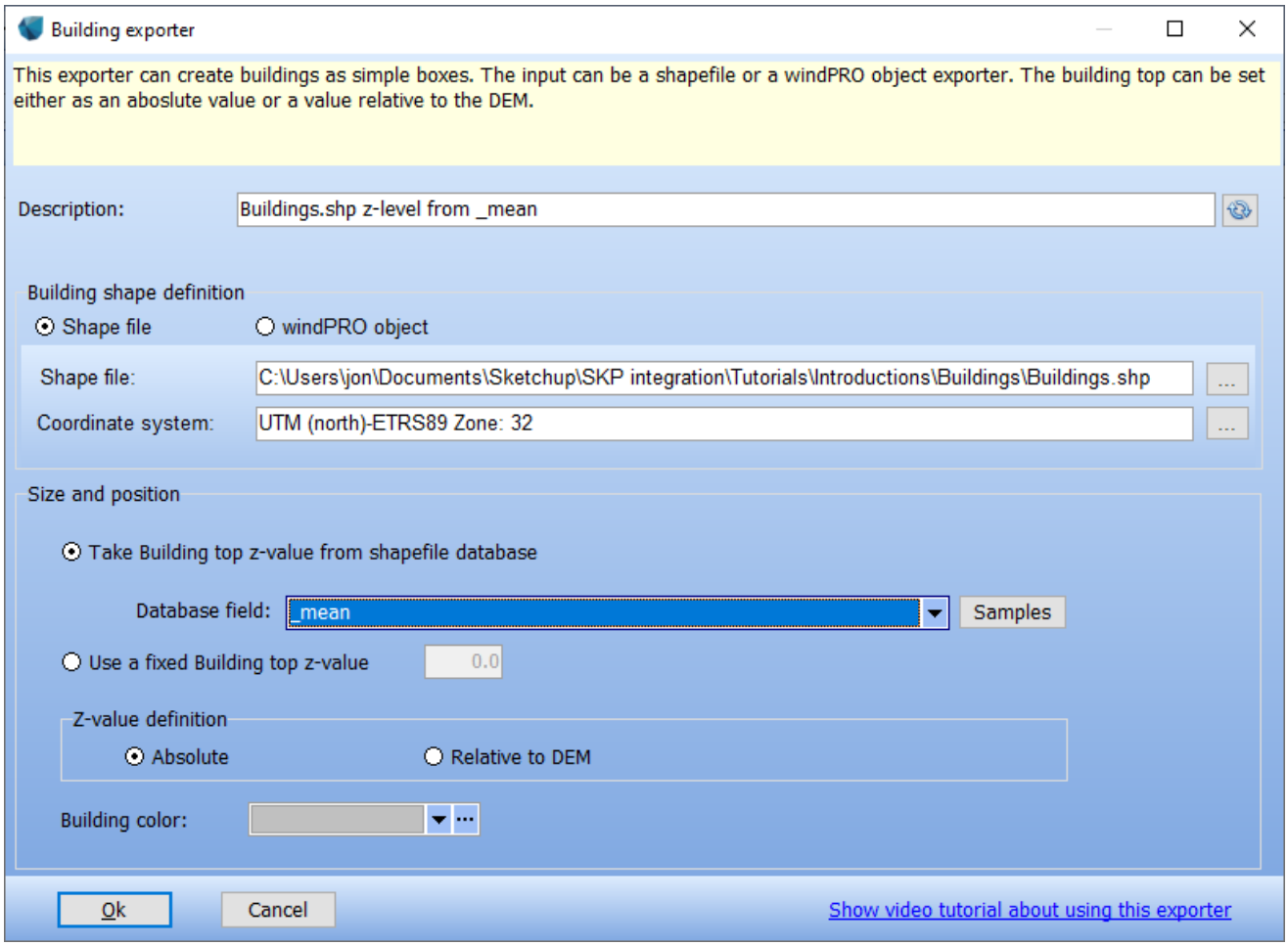
This would create a 3D object in windPRO with a copy of the selected items. This 3D object can then be visualized in Photomontage in replacement of the PV panels objects in windPRO. This way this tool can be used to override the layout created by windPRO, but it would not have any effect on the energy calculations!

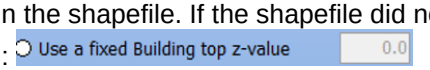
7.3.4.9 Building Exporter

Video tutorial link

This exporter allows to create building like blocks from a shapefile or windPRO objects.

Exporter setup:

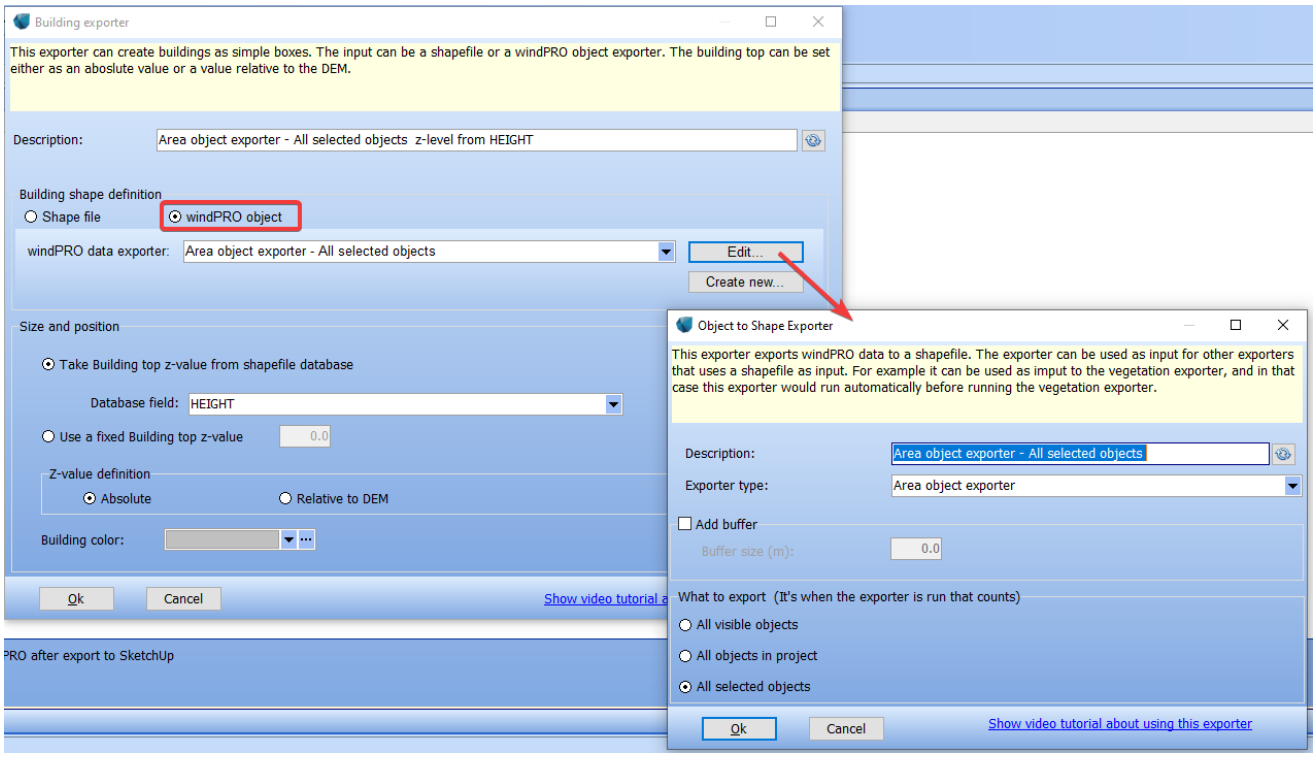


In the example above, a shapefile is selected. The shapefile has a field "_mean" that contains the height of the buildings in the shapefile. If the shapefile did not have a building height then a fixed building height must be given with: 

The **z-value definition** relates to the bottom of the building. It can either be available as "Absolute" (Above sea level) or "Relative to DEM" (Above ground level) as specified from here:

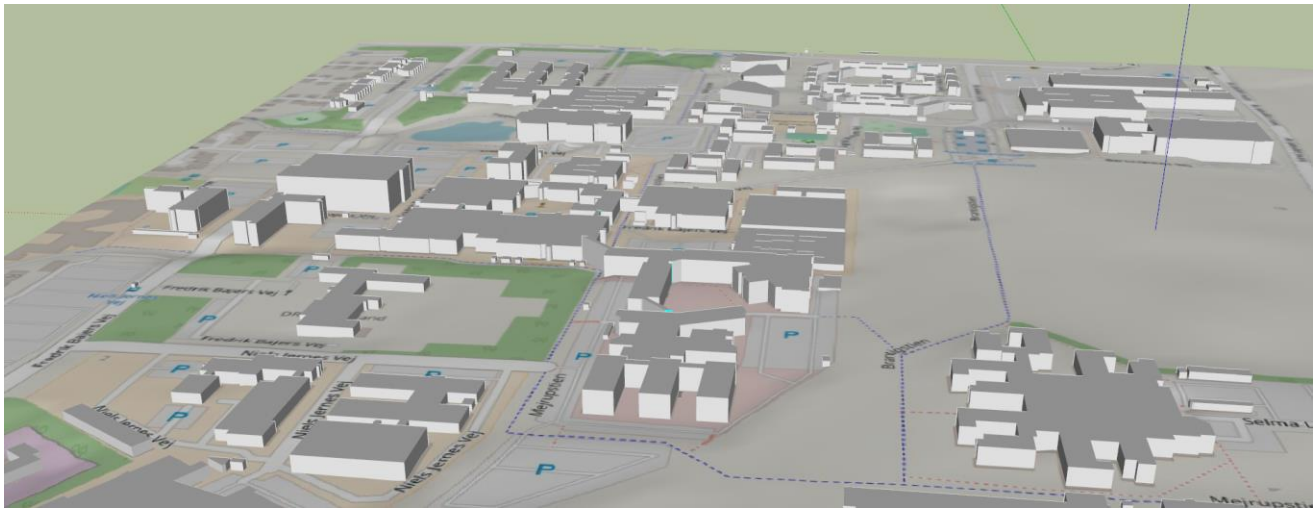
Finally, the wanted color can be defined: 

Instead of using a shapefile, windPRO object(s) can be used:



In the example above, “All selected Aare objects” is used, and the field “Height” from the areas is used for getting the building heights.

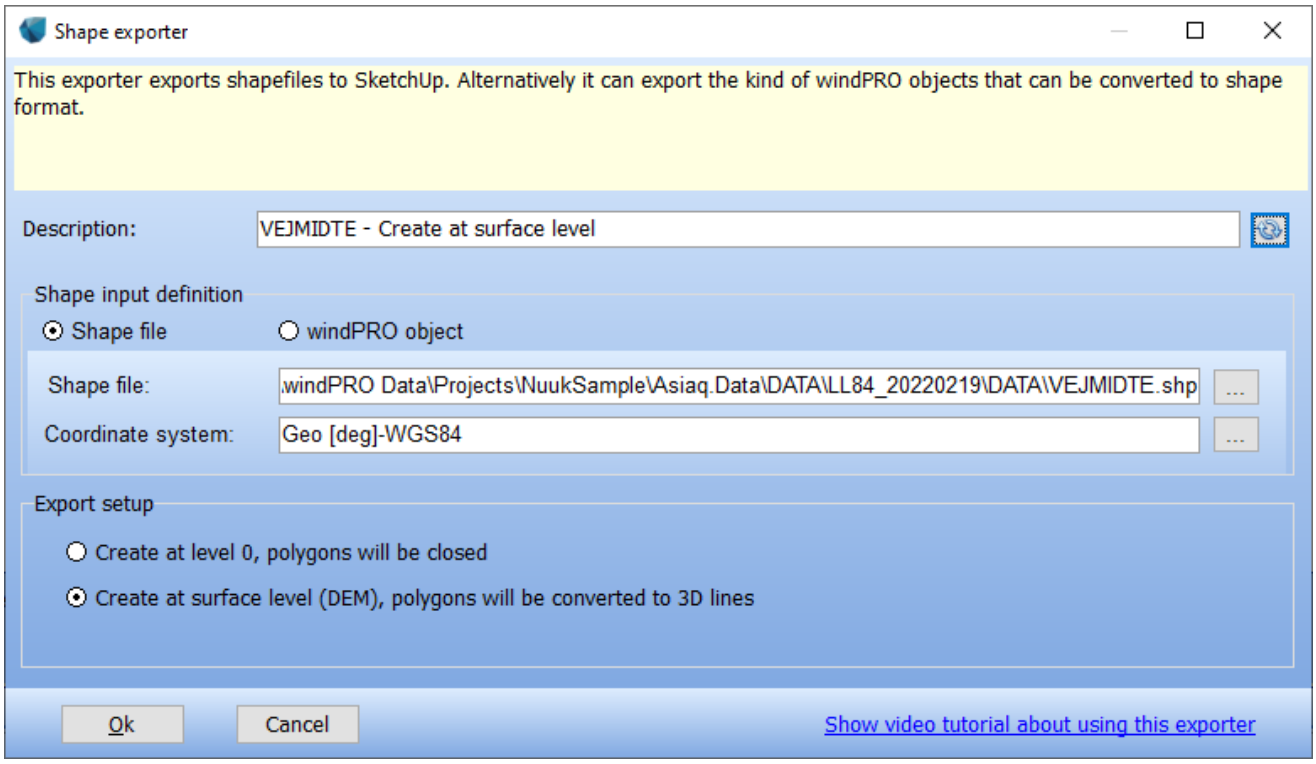
When running the exporter, the buildings are created in SketchUp like this:



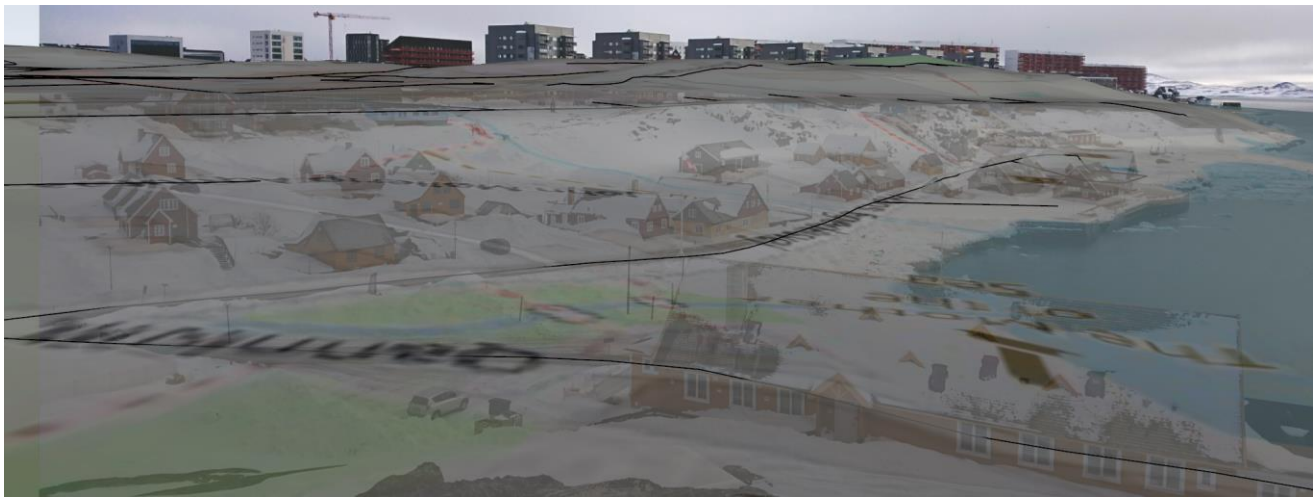
7.3.4.10 Shape Exporter

Video tutorial link

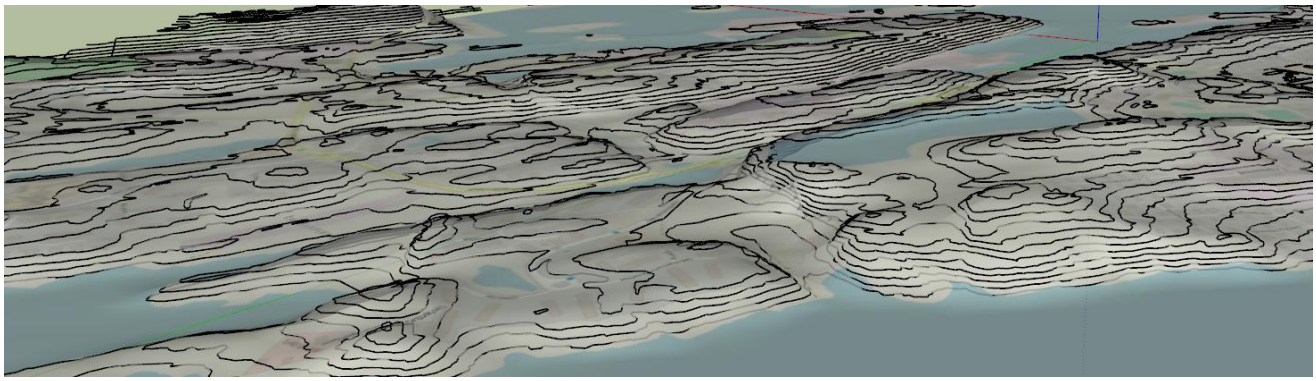
The shapefile exporter can export shapefiles, or windPRO objects as shapefiles, to SketchUp.
Here is a setup for exporting the roads for a small city:



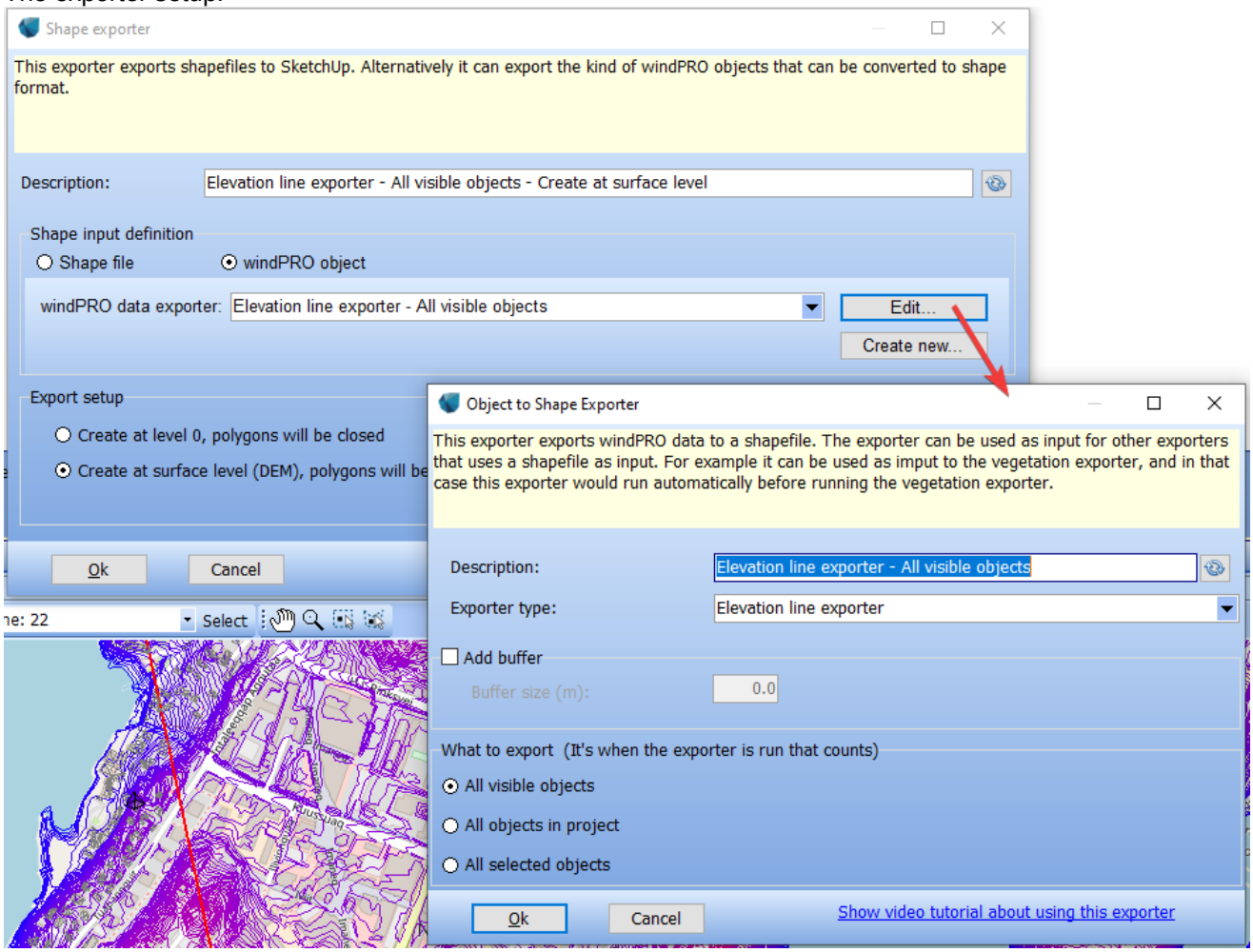
In this case a shapefile containing roads is selected, and the used coordinate system is specified.
Export setup is used to specify where to place the lines vertically. In this example, surface level is selected.
windPRO 3.6 does not support 3D shapefiles that contains a z coordinate for each point.
This is how the export looks in a SketchUp project containing a Photomontage export and an Open Street Map surface that is made semi-transparent:



In the example below, the elevation lines object in windPRO has been exported for the same project:



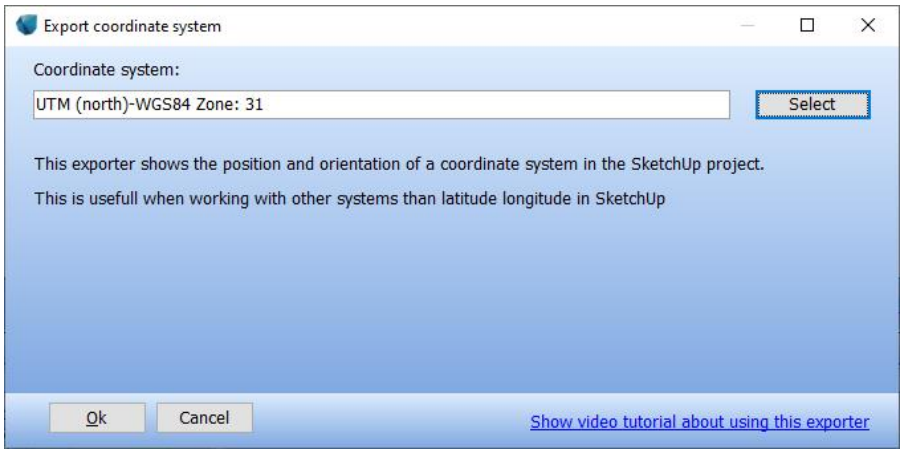
The exporter setup:



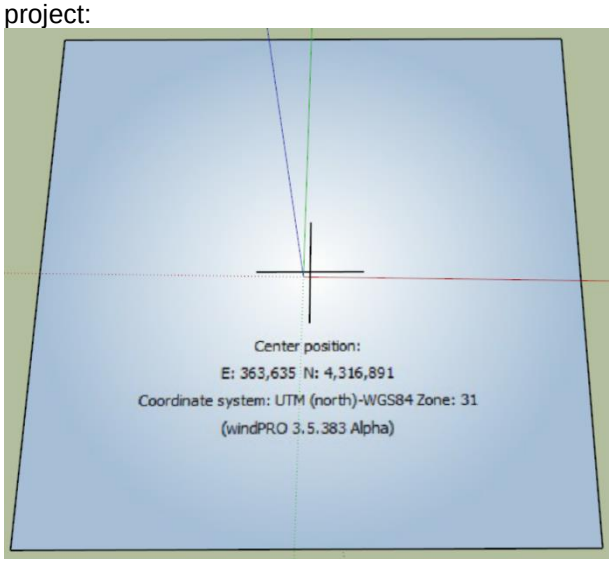
7.3.4.11 Coordinate system setup/exporter

Video tutorial link

Everything is exported to SketchUp in a cartesian coordinate system where the red axis is pointing at true north at the centre position. The project is automatically geo-located, so shadows are correctly calculated, and it can be correctly exported to Google Earth.
Any other coordinate system can be selected and exported to SketchUp:

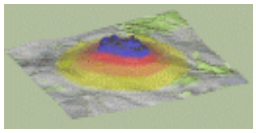


When running the exporter, coordinates system information is shown close to the center of the SketchUp project:



The coordinate system information is shown with a centre point and axis directions. This is enough to establish a connection between any point in SketchUp and this coordinate system. The reason, it is not right at the centre, is simply that it is shown without decimals.
The export is a group, and a group can have a local coordinate system. If using the selection tool and double clicking on the coordinate informer, the group is opened, and then the local coordinate system is activated. The axes are now aligned to the coordinate system. Also, the tape tool is now showing points positions in the local coordinate system, except that the centre offset needs to be added.
SketchUp is not suitable for creating very large GIS projects covering many kilometres, because of Earth's curvature!

7.3.4.12 Result layer Exporter

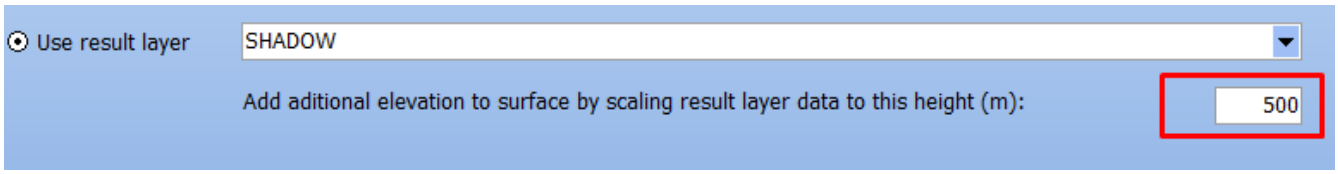


Video tutorial link

This exporter can export a result layer as a 3D volume to SketchUp

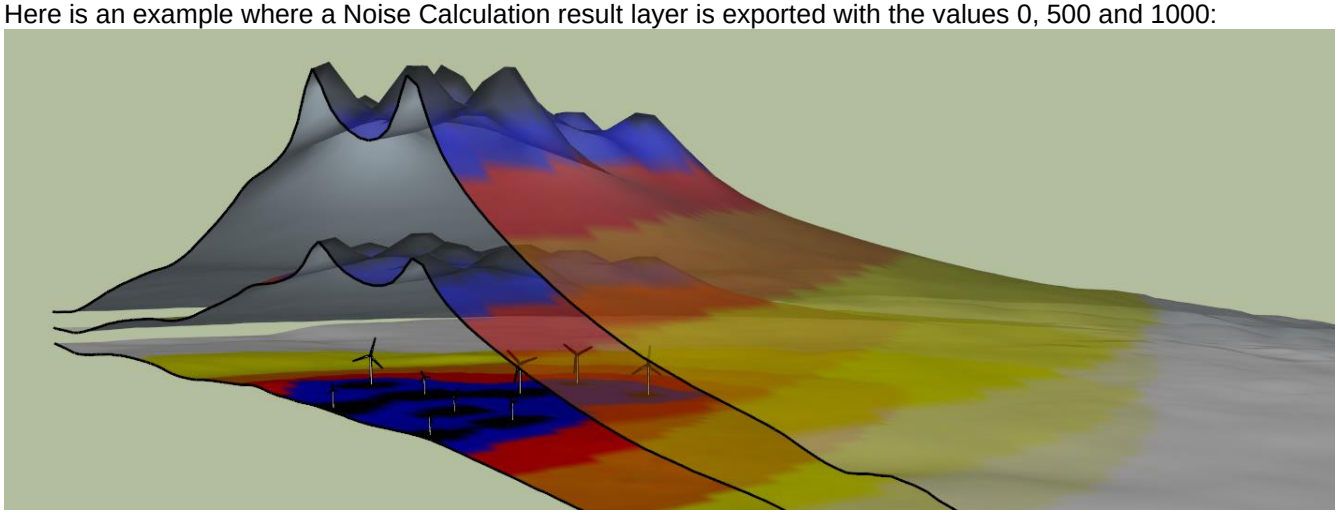
Export a result layer as a 3D volume to SketchUp

The result layer exporter shares many options with the background map exporter. It exports a result layer as a 3D volume, where the data in the result layer is scaled to a height:

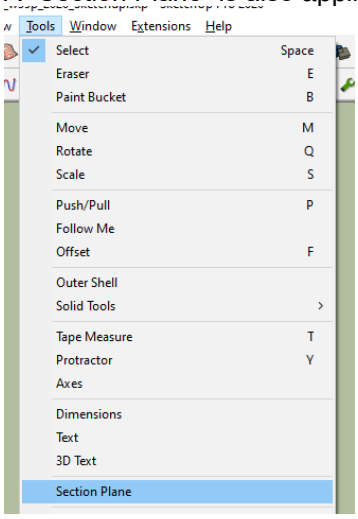


In above case the lowest result layer value is given the height 0m and the highest is given the height 500m and the rest is scaled linearly. This height is added to the surface height. The surface can be the DEM or a flat surface. See the background map exporter description for details.

Here is an example where a Noise Calculation result layer is exported with the values 0, 500 and 1000:

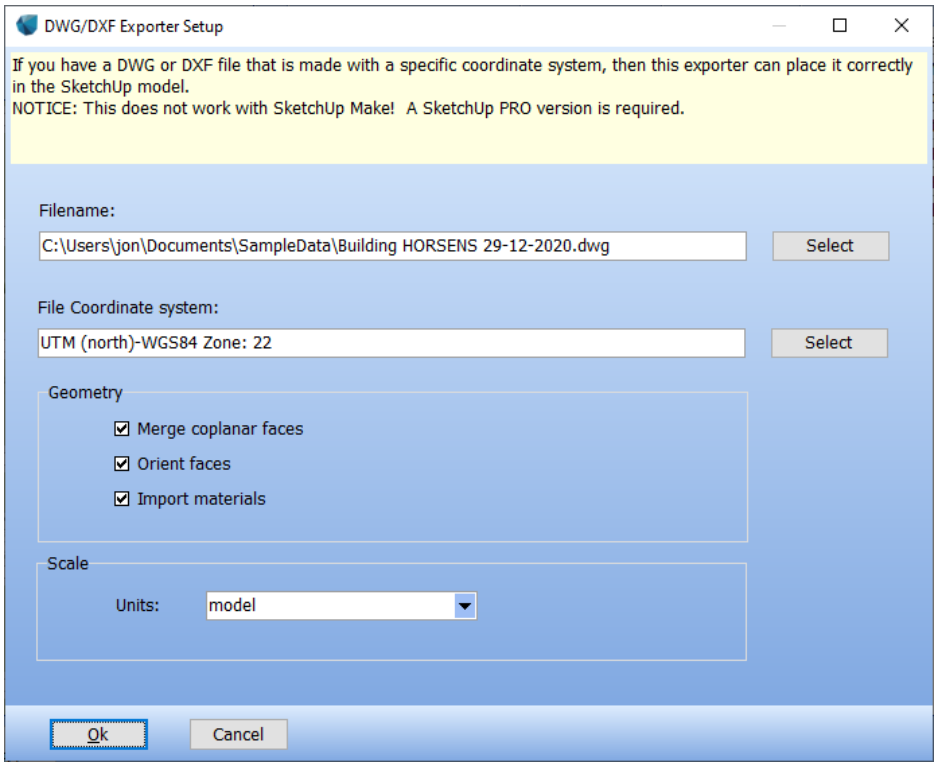


A “Section Plane” is also applied:



7.3.4.13 DWG/DXF Exporter

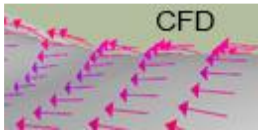
From applications like Revit or AutoCAD, 3D models can be exported to DWG, and sometimes this is done using a specific coordinate system. If such a DWG file is imported normally in SketchUp it must be positioned manually in the model, but if thanks to the DWG/DXF Exporter, the model is placed correctly in the SketchUp project.
You simply select the .dwg file, specify the coordinate system, and the import options:



Apart from the filename and the coordinate system, the other parameters are a copy of the import options from SketchUp and the meaning can be found in the SketchUp manual:

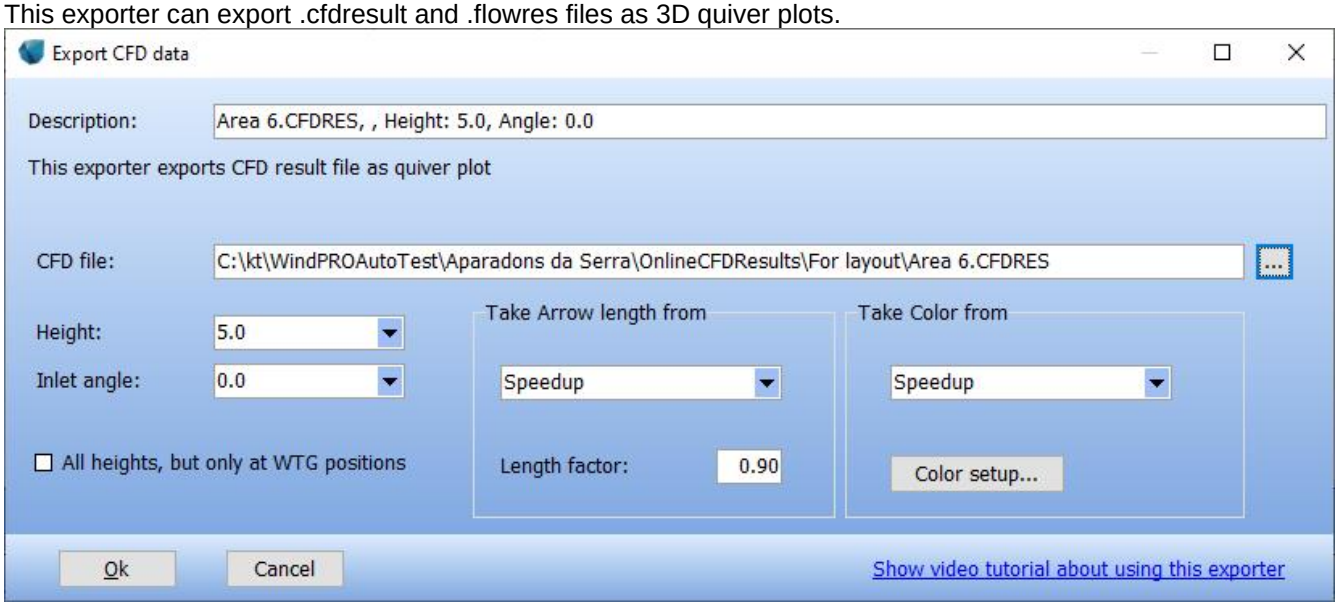
https://help.sketchup.com/en/sketchup/importing-and-exporting-cad-files#import-cad

7.3.4.14 CFD exporter



Video tutorial link

This exporter can export .cfdresult and .flowres files as 3D quiver plots.



CFD file: can be either a .cfdres or a .flowres file

Height: the available height values are read from the file. Only a single height can be exported at the time, except if just exporting at WTG positions.

Inlet angle: the available inlet angles are read from the file.

All heights, but only at WTG positions: all heights are shown for each WTG position. Values are interpolated to get the exact position.

Take arrow length from: the length of the arrows in the quiver plot is taken from this value. Available values are read from the file.

Length factor: the arrow length is scaled by this value. If the value is 1 then the longest arrow in the export, has the length of a data cell. Sometimes the dataset can contain a few extreme values, and all other arrows will be very short. In this case it makes sense to use a higher scaling value.

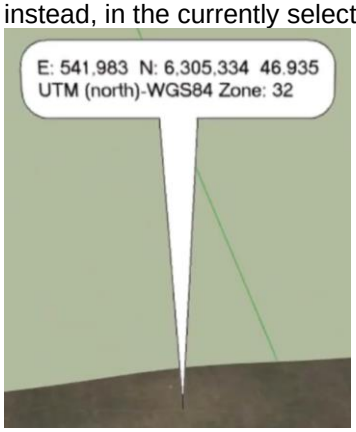
Take color from: to define where the arrow color should come from. It can be the same as the length, or it can be different.

The export can be viewed in Google Earth as well. See the video tutorial for more information: Video tutorial

7.3.4.15 Text object Exporter

Video tutorial link

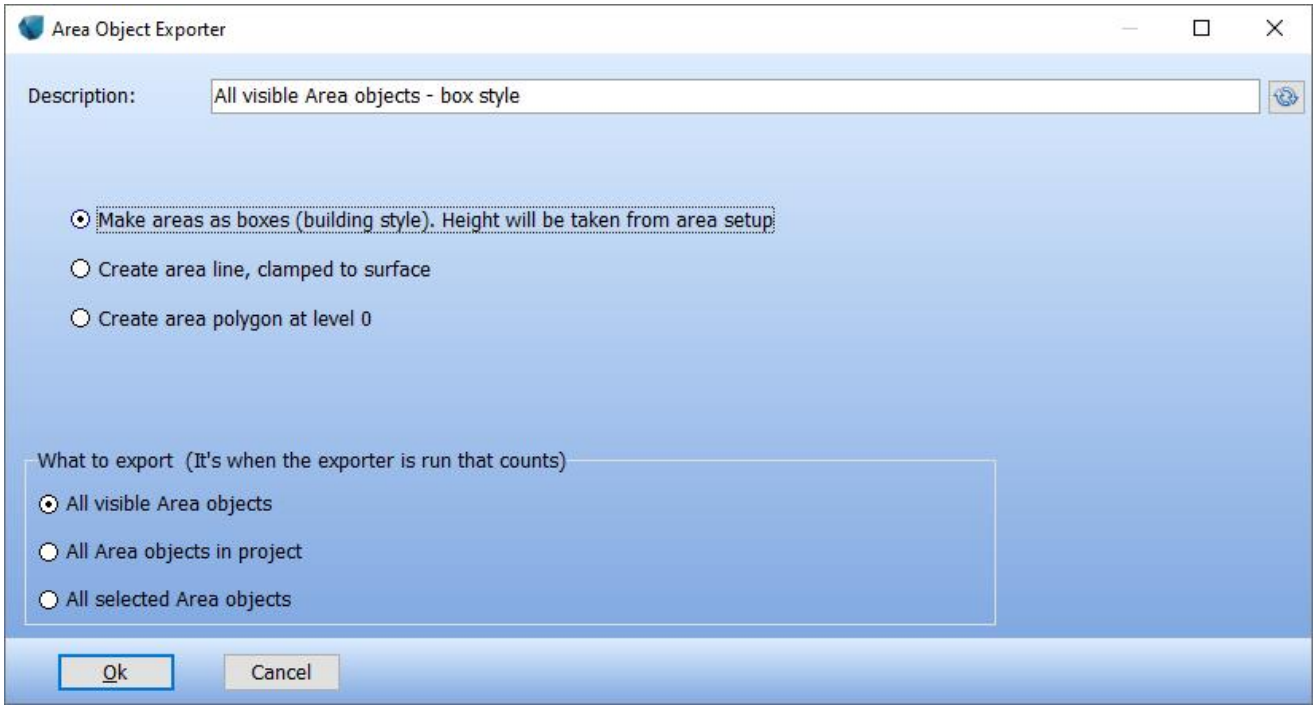
The text object exporter can export a text object to SketchUp. It can be useful for showing geographical information or highlight specific coordinates. If exporting a text object with no text, then the coordinate is shown instead, in the currently selected coordinate system:



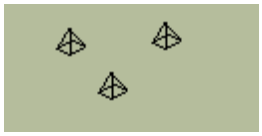
This is the exporter setup:

7.3.4.16 Area Object Exporter

This exporter is a combination of the building exporter and the shape object exporter, just only working with area objects. It is made for making it easier/more understandable for users who is used to the area object.



7.3.4.17 3D object exporter

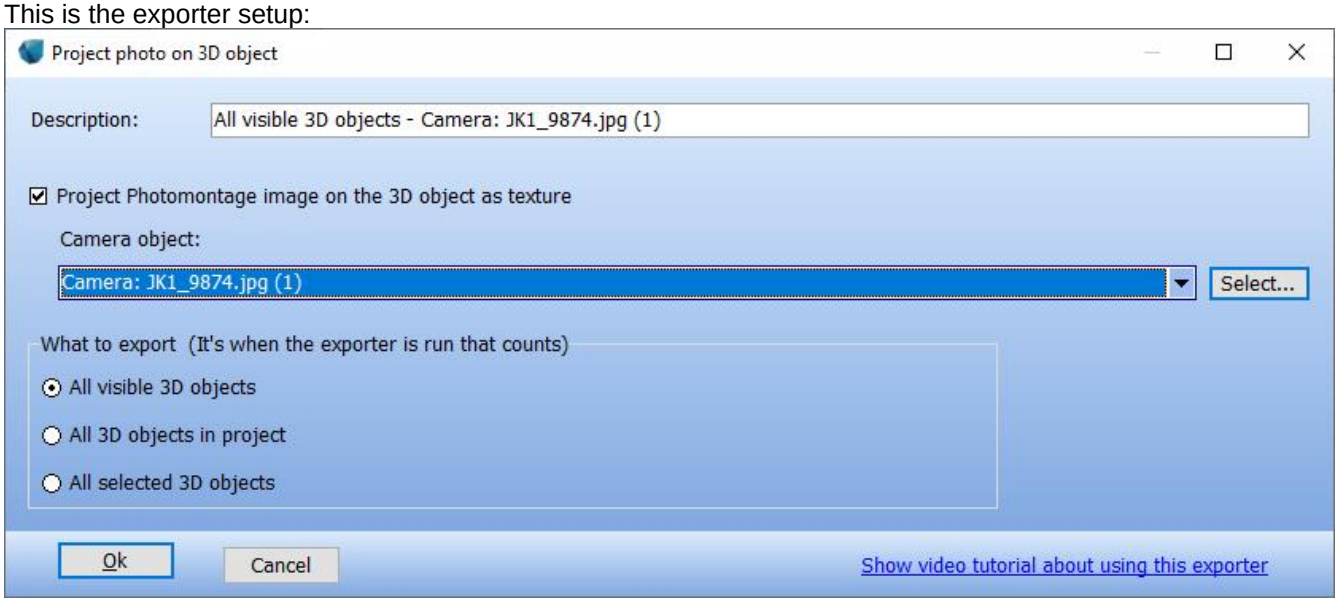


Video tutorial link

The 3D object exporter can export 3D objects to SketchUp at the positions they are in windPRO, but more importantly they can be exported with *textures from a photomontage*. This is very useful, because it means

that any object created in SketchUp can be exported to windPRO and then exported back with a texture from a Photomontage image. See the video tutorial for more details.

This is the exporter setup:

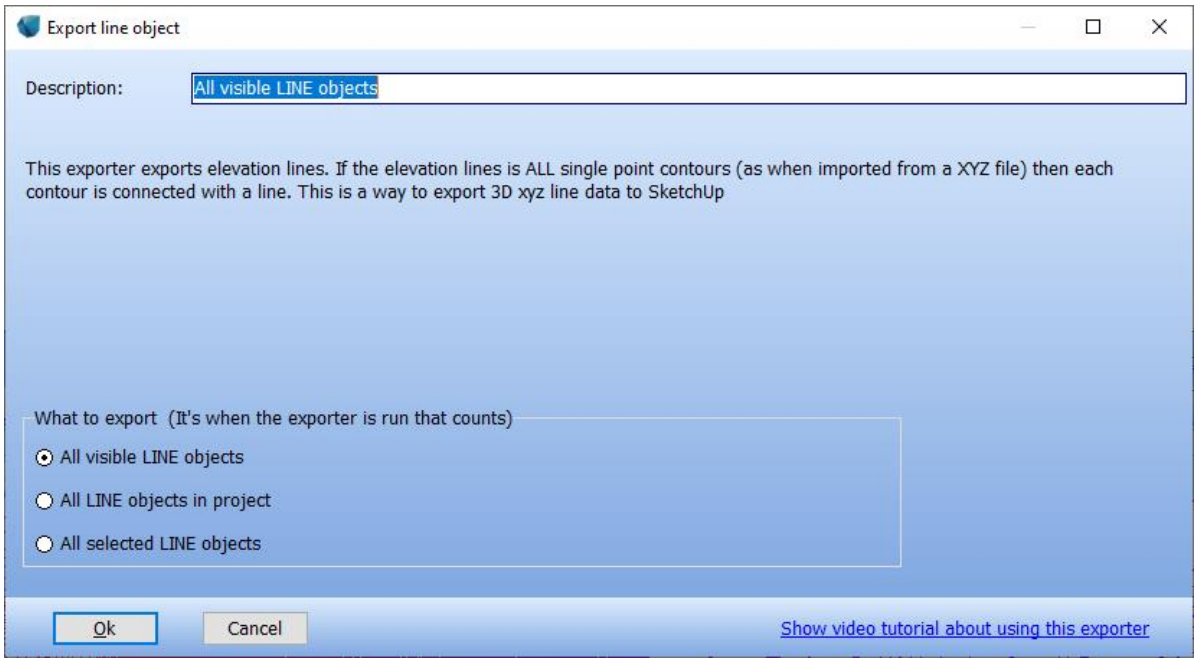


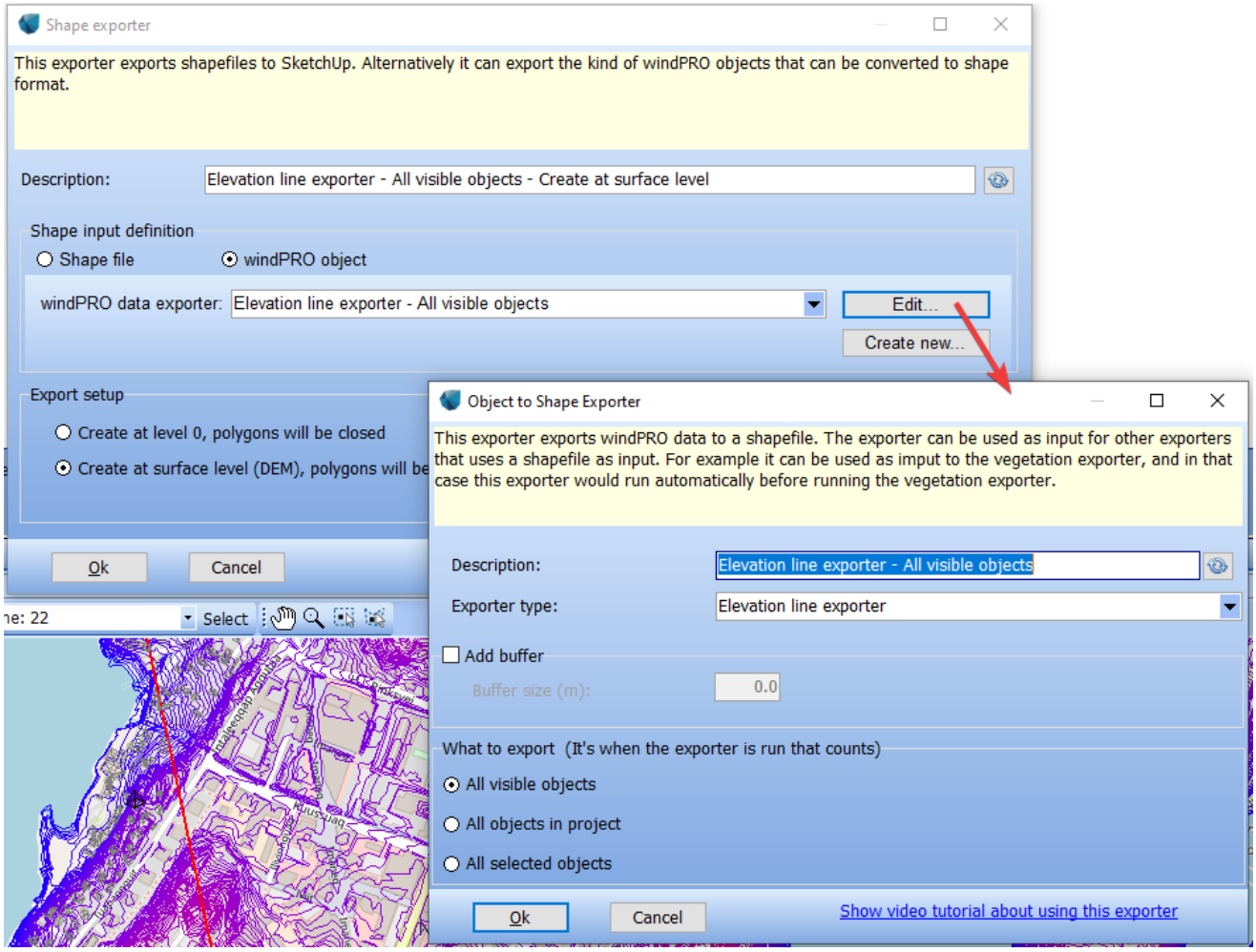
Project Photomontage image on the 3D object as texture: with this option, the objects texture is replaced with a projection of a Photomontage image.

7.3.4.18 Line Object Exporter

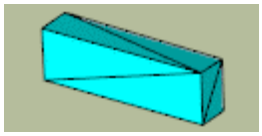
Video tutorial link

The line object exporter can export *elevation* ISO lines object to SketchUp. Currently it is not possible to export other line object properties.





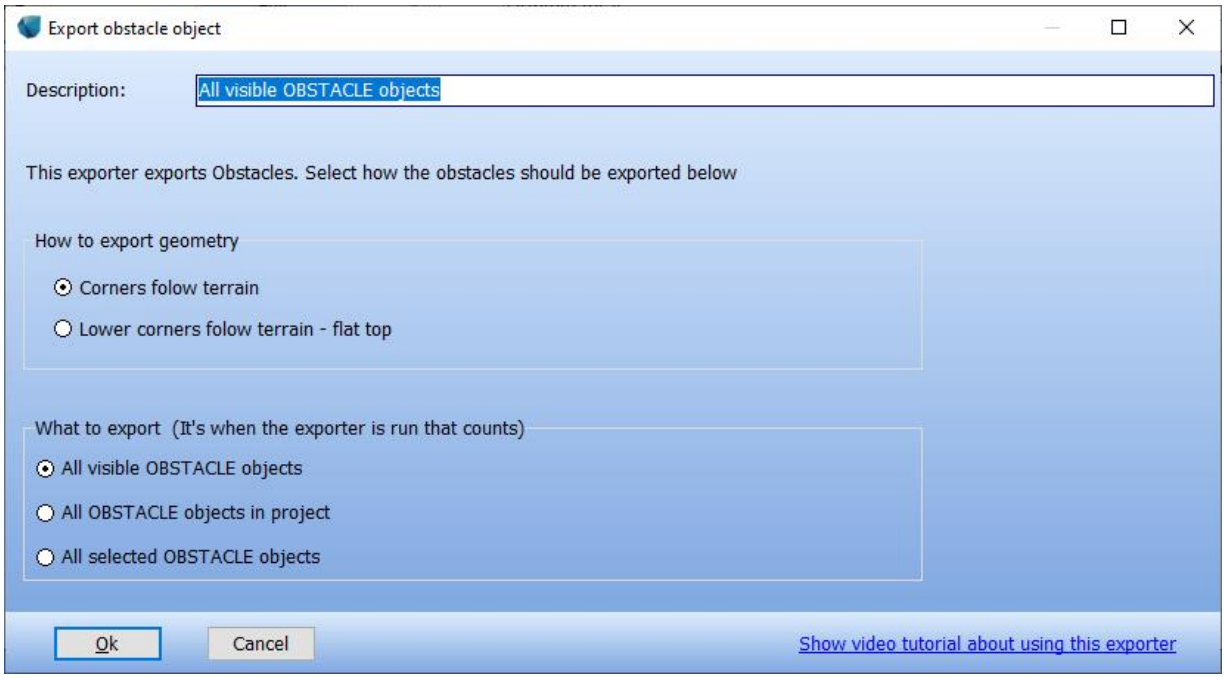
7.3.4.19 Obstacle Object Exporter



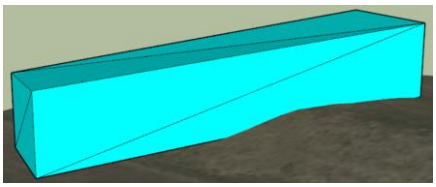
Video tutorial link

The object object exporter can export Obstacles SketchUp at the positions they are in windPRO.

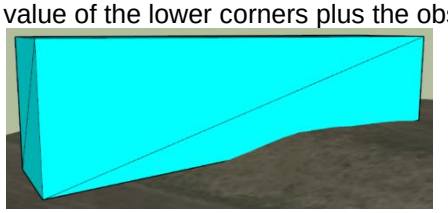
This is the exporter setup:



Corners follow terrain: the lower corners follow the terrain and the top corners are all offset the height of the obstacle from the lower corners.



Lower corners follow terrain – flat top: the lower corners follow the terrain and the top corners are set to the highest value of the lower corners plus the obstacle heights.

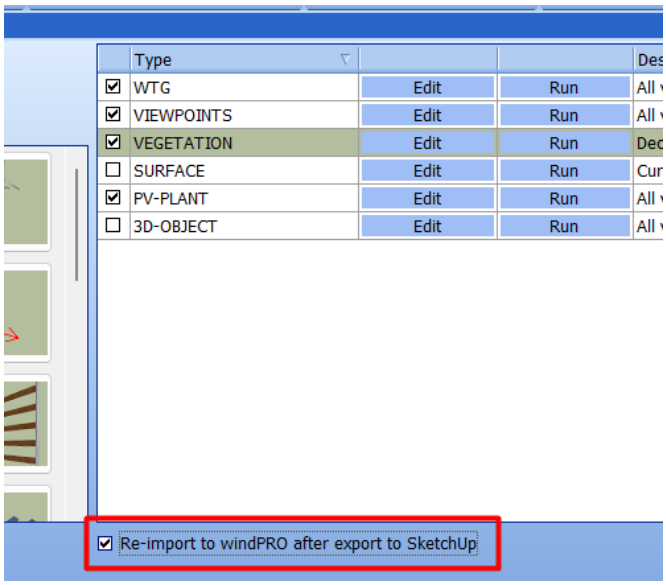


7.3.5 From SketchUp to windPRO

Any object in SketchUp can be exported to windPRO, as long as they are correctly defined in the coordinate system. Therefore, it is an advantage to create the SketchUp project from windPRO, with a surface export for example. Objects exported from SketchUp are imported in windPRO in a 3D object .

There are 2 options to export from SketchUp to windPRO:

1) with the automatic **Re-import to windPRO after export to SketchUp** , selected from the main window. This option can be used when no manual adjustment needs to be made in SketchUp. It is especially relevant for Vegetation, fences, and transmission lines.

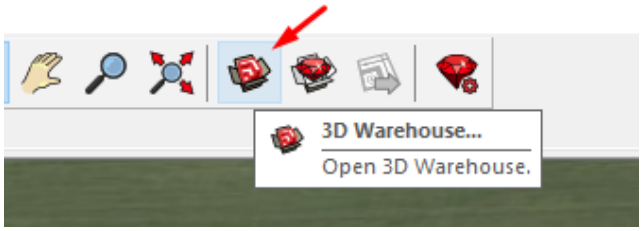


2) from SketchUp, after selecting the object, go to **Tools** and click on **Export items to windPRO**

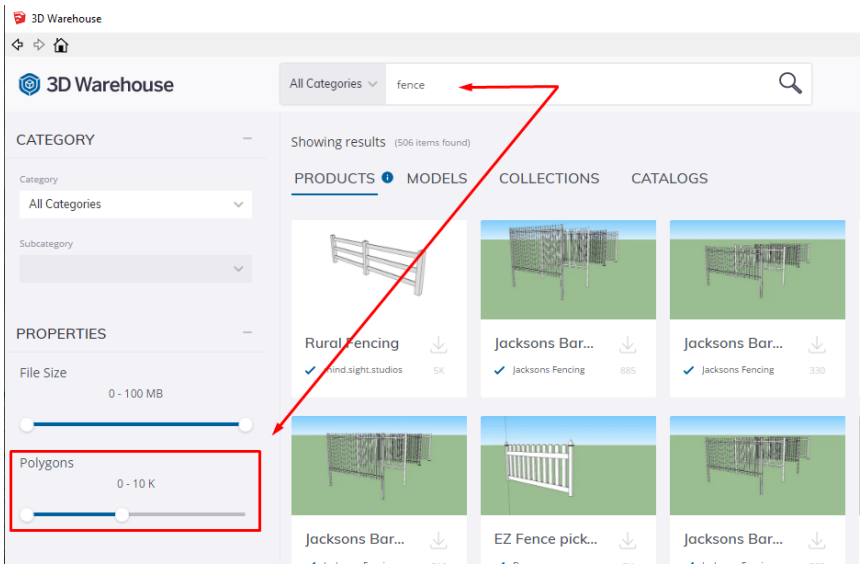
Use 3D warehouse to bring items into windPRO photomontage

SketchUp has a huge collection of freely available 3D models that can be downloaded and used inside SketchUp as well as in windPRO Photomontage.

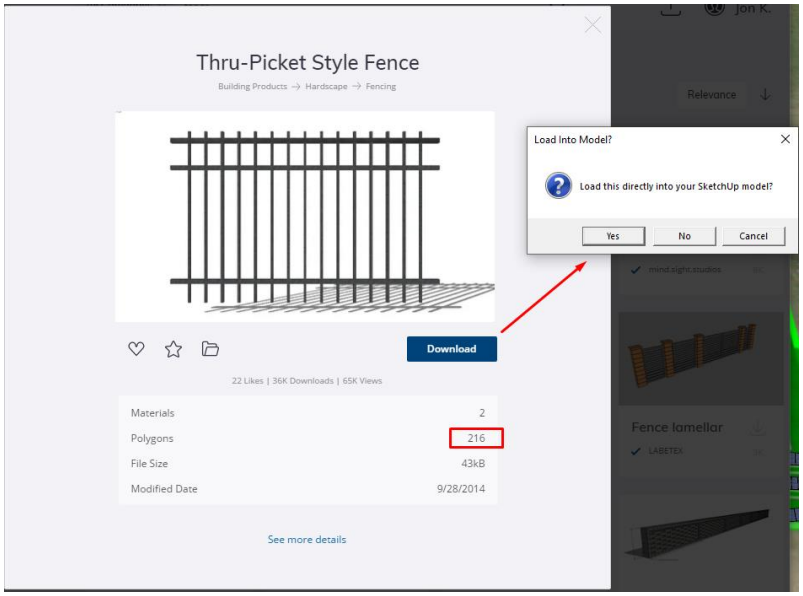
Go into 3D Warehouse using this button in the toolbar:



Inside the 3D Warehouse, it is possible to search and filter. It is recommended to set a maximum of polygons to 10 K (10.000), because some models have way too many polygons slowing down the whole process. Here is a search for fences:

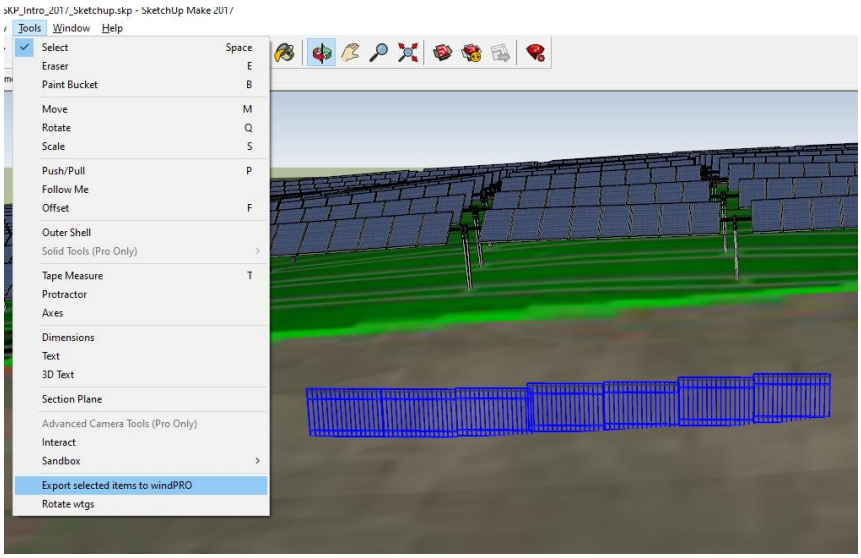


Select a model and download it into SketchUp. Remember that the number of polygons should not be too high.

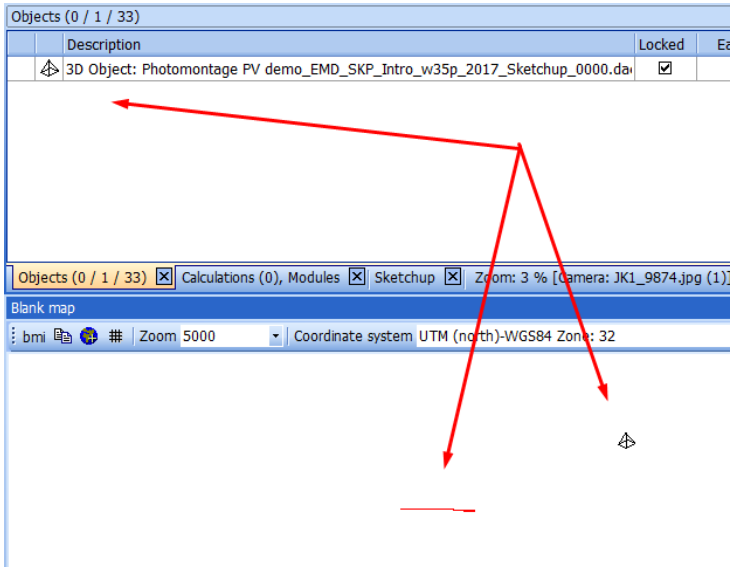


After downloading, the fence can be moved, rotated, scaled and copied using the basic SketchUp tools:

If holding Ctrl down while using these tools, the object will be *copied*. If pressing the arrow keys on the keyboard while using these tools, the action will be locked to a specific axis. Most useful is arrow up (blue axis).
When ready, the relevant items can be selected, and then exported back to windPRO:



The object will then show up as a 3D object in windPRO, and it can be visualized in Photomontage:



To avoid the shift between the position of the windPRO 3D object and of the resulting 3D structure (in red), the dae file should be placed in SketchUp at the Origin of the coordinate system before export to windPRO.

7.3.6 Sketchup tips

7.3.6.1 Sketchup viewer

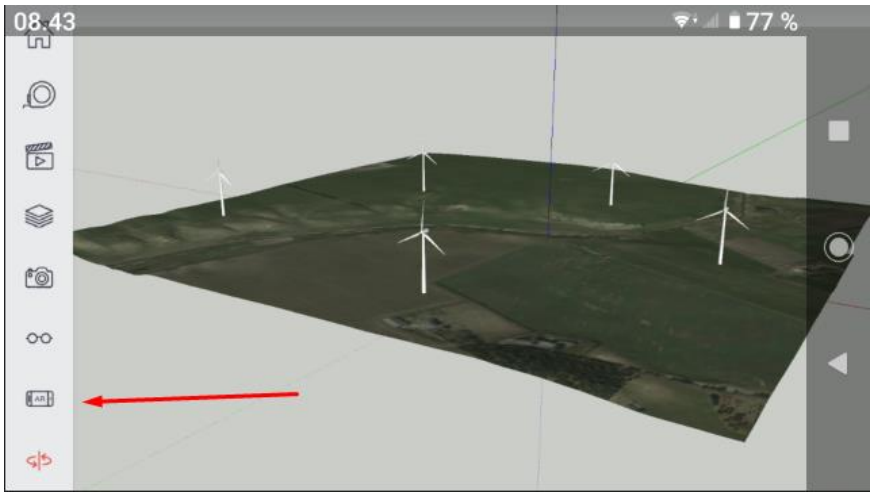
Trimble has developed (free) viewers for many different platforms that makes it possible to view a SketchUp project, and as a result also a windPRO project, on a PC, Mac, mobile phone or VR glasses (not free).
The different viewers can be downloaded from here:
https://www.sketchup.com/products/sketchup-viewer/downloads

For Android: https://play.google.com/store/apps/details?id=com.trimble.buildings.sketchup
For iPhone: https://itunes.apple.com/us/app/sketchup-mobile-viewer/id796352563?ls=1&mt=8

With the AR feature of the SketchUp app the model can be placed on a floor,a table (or any smooth and horizontal surface), and it is possible to walk around/inside the project:

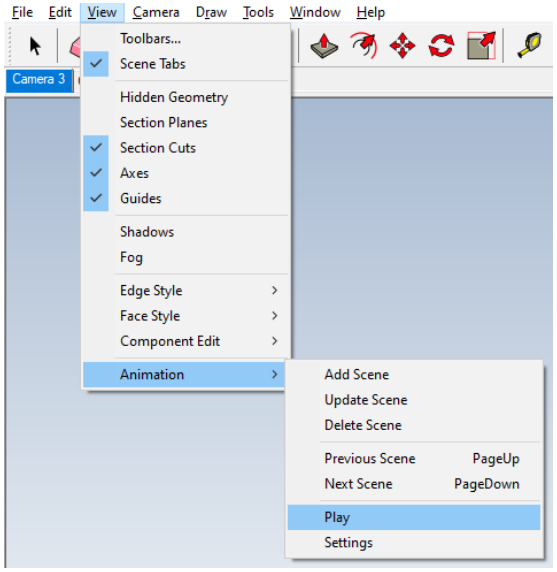
Here is a demo video made from a screen capture on an Android phone: Video
Note that the AR feature is not free but costs $9.99 USD/yr (June 2021).

When the project is loaded, the AR feature can be started from this button:

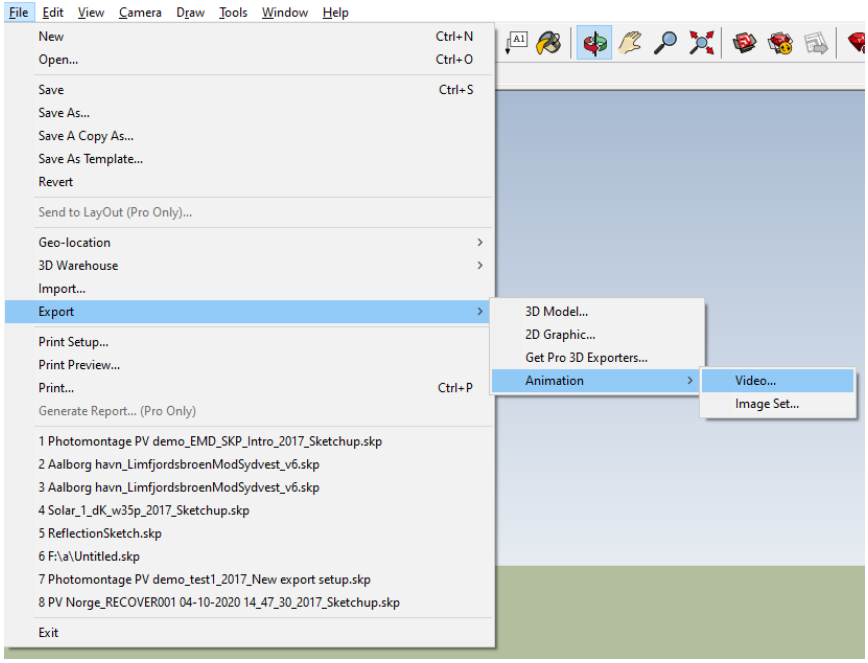


7.3.6.2 Creating animation in SketchUp

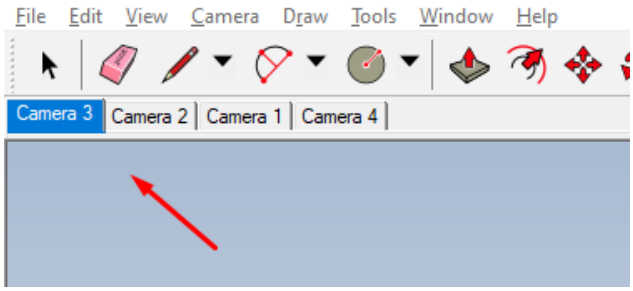
SketchUp can export animations to video. First the animation can be set up and played from this submenu:



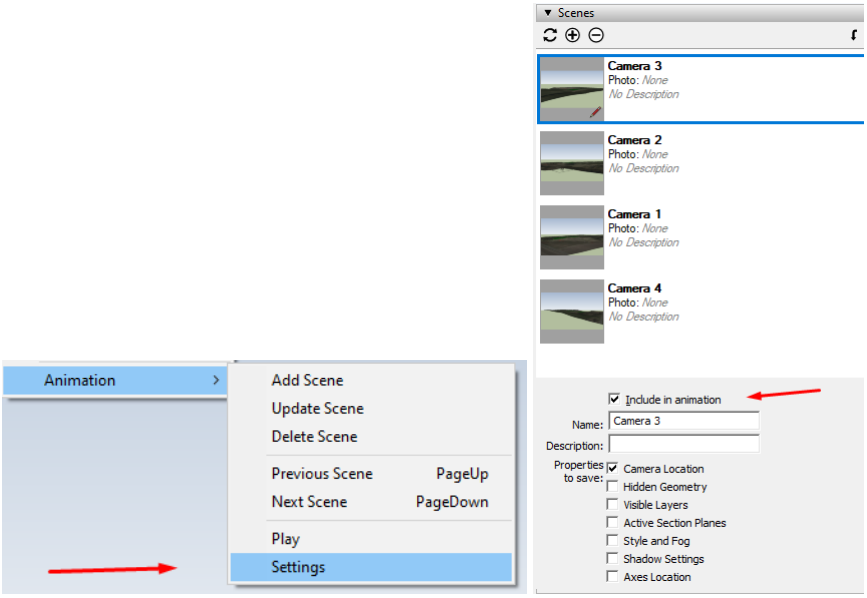
And then the export itself can be initiated from here:



The main principle in an animation, is that SketchUp moves the camera from scene to scene:



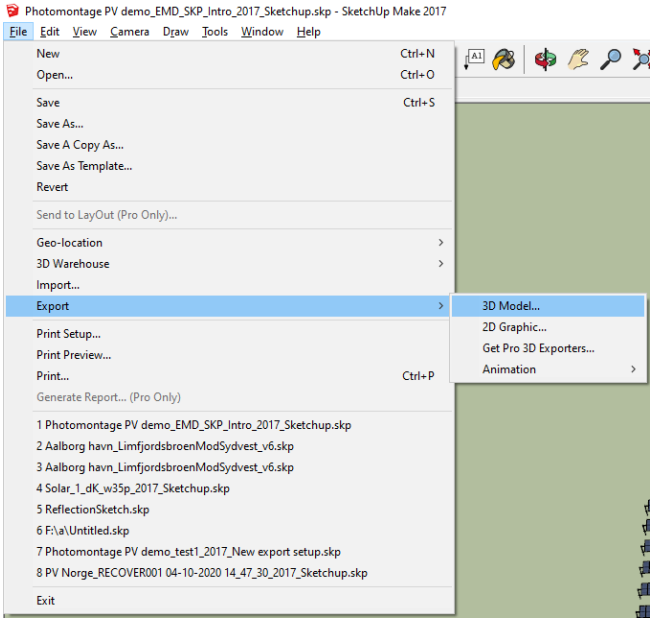
Based on the settings in the animation submenu, and the scene setup:



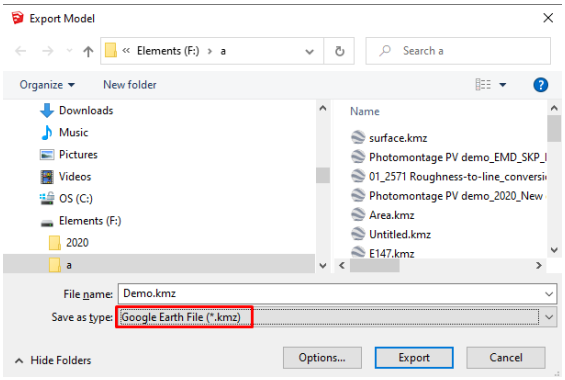
This means that the project needs to include scenes to create an animation. To do more advanced animations, not based on scenes, this plugin offers many possibilities: https://sketchucation.com/plugin/1839-animator

7.3.6.3 Exporting to Google Earth

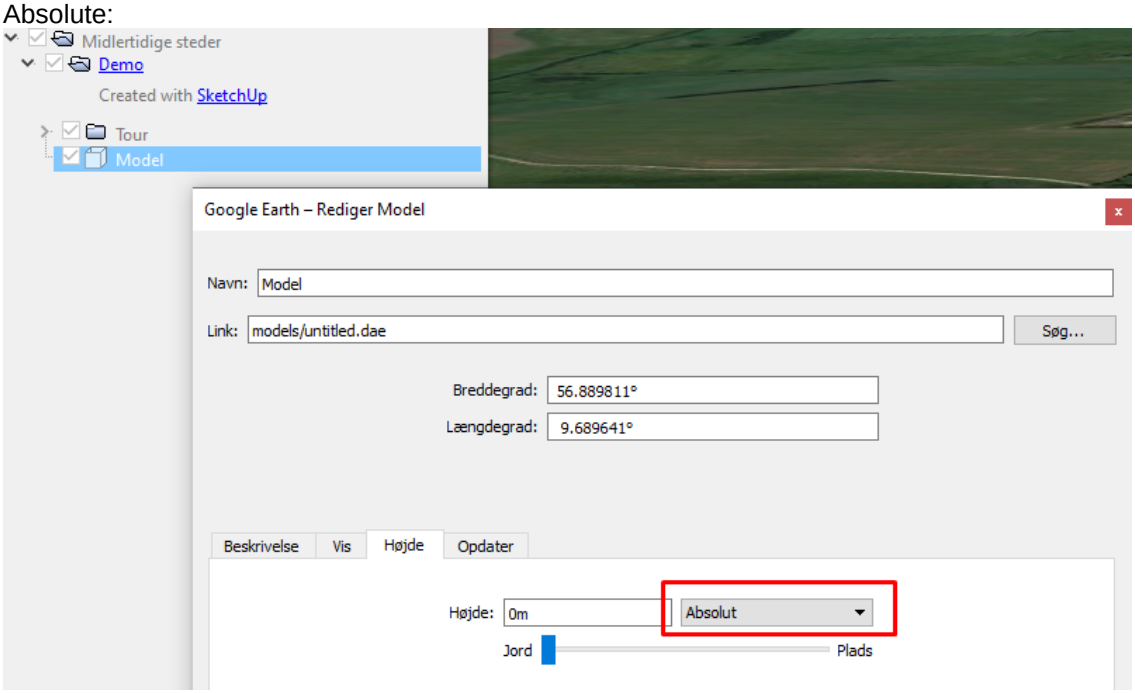
The visible items can be exported to Google Earth. Select Export 3D Model:



Select .kmz format



After opening in Google Earth right click on model, go to Properties, and change model height from Relative to Absolute:



7.3.6.4 SiteVision

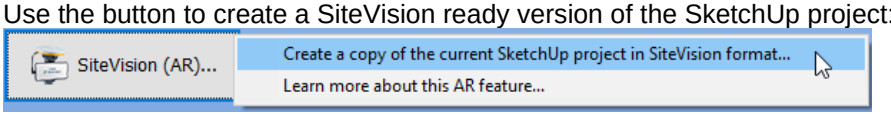
Video tutorial link

SiteVision is an outdoor augmented reality system that allows to visualize 3D data live in the environment from a smart phone or a tablet. SiteVision has been developed by Trimble (https://sitevision.trimble.com).

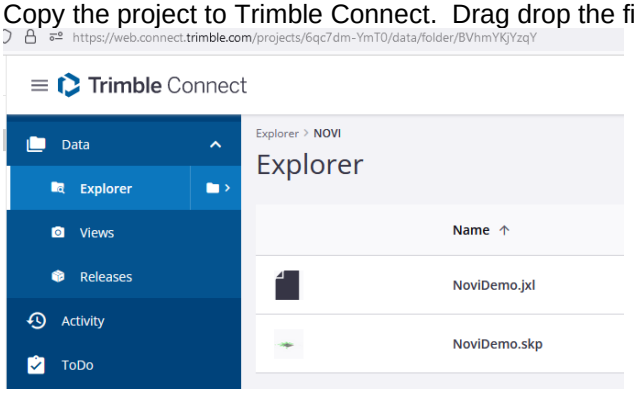
SiteVision button can be used to convert the active SketchUp project to a format that SiteVision can understand. It means that the SketchUp project is converted to UTM WGS84 and its current zone. A file is also created with the same name as the SketchUp project, but with a .jxl extension. This file contains information about the used coordinate system, and if this file is present together with the SketchUp file, then SiteVision can read it and place the model correctly.

To transfer the SketchUp project to the SiteVision app:

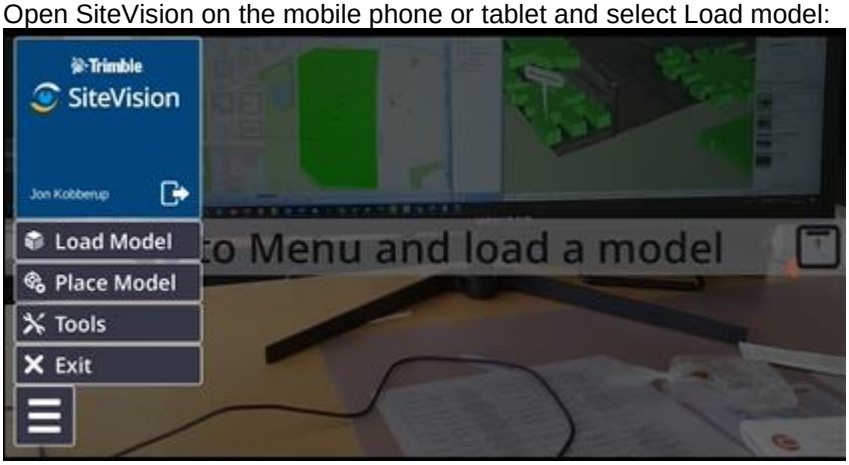
1. Use the button to create a SiteVision ready version of the SketchUp project:



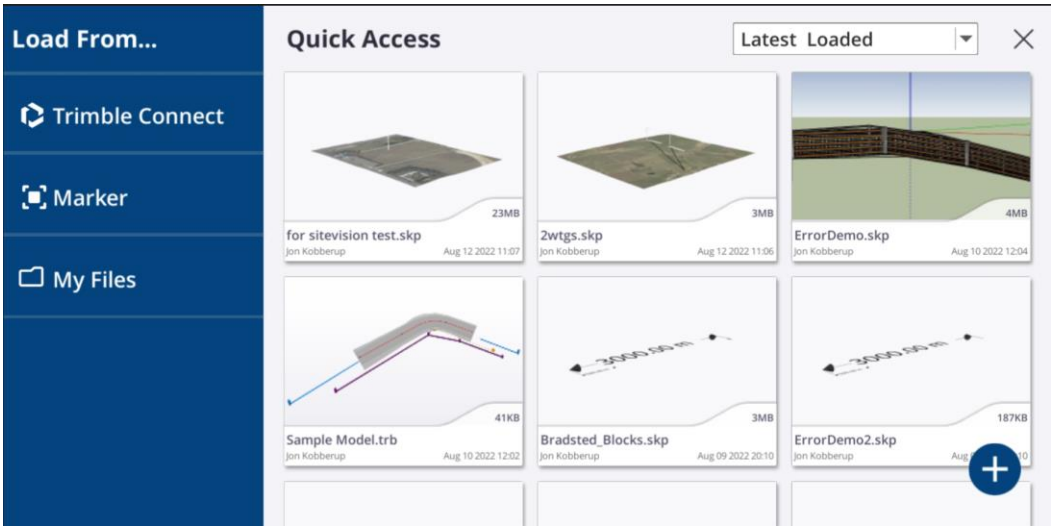
2. Copy the project to Trimble Connect. Drag drop the files to the wanted folder:



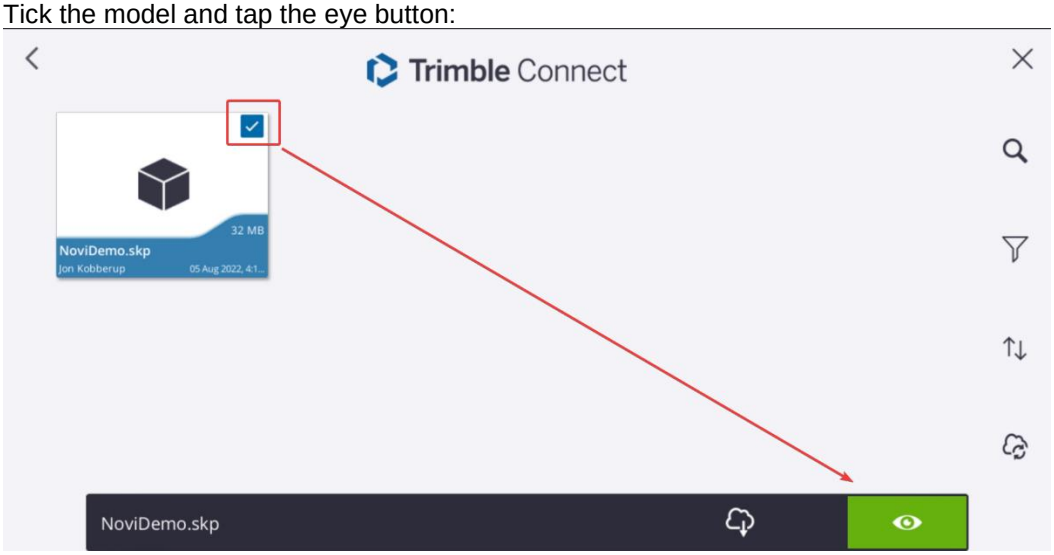
3. Open SiteVision on the mobile phone or tablet and select Load model:



4. Select Trimble Connect:



5. Tick the model and tap the eye button:



This should open the project on SiteVision, and it should now be positioned correctly.