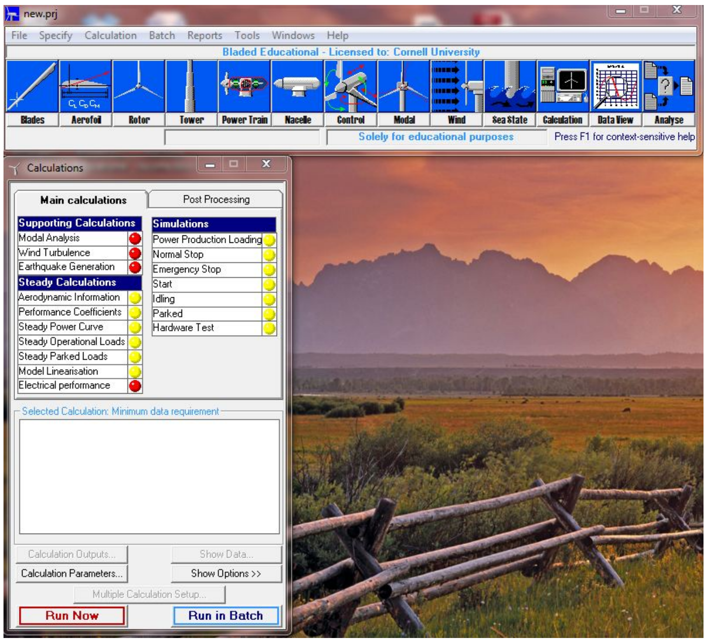
Bladed - Zero Blade Deflection with Steady Wind

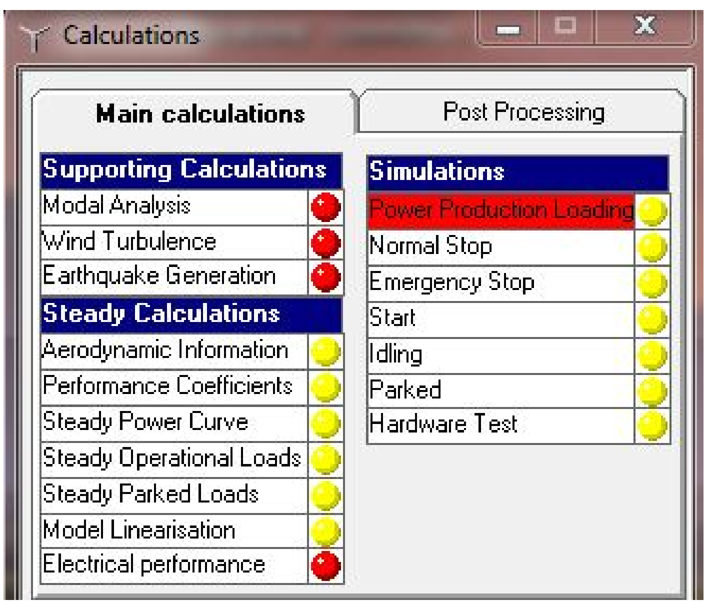
Zero Blade Deflection with Steady Wind

Wind turbine blades typically deflect during operation and this results in reduction in generated electrical power. We will use a steady wind field to examine the effect of blade deflection on generated electrical power.

Start-up

Double click on the Bladed icon to launch GH Bladed.

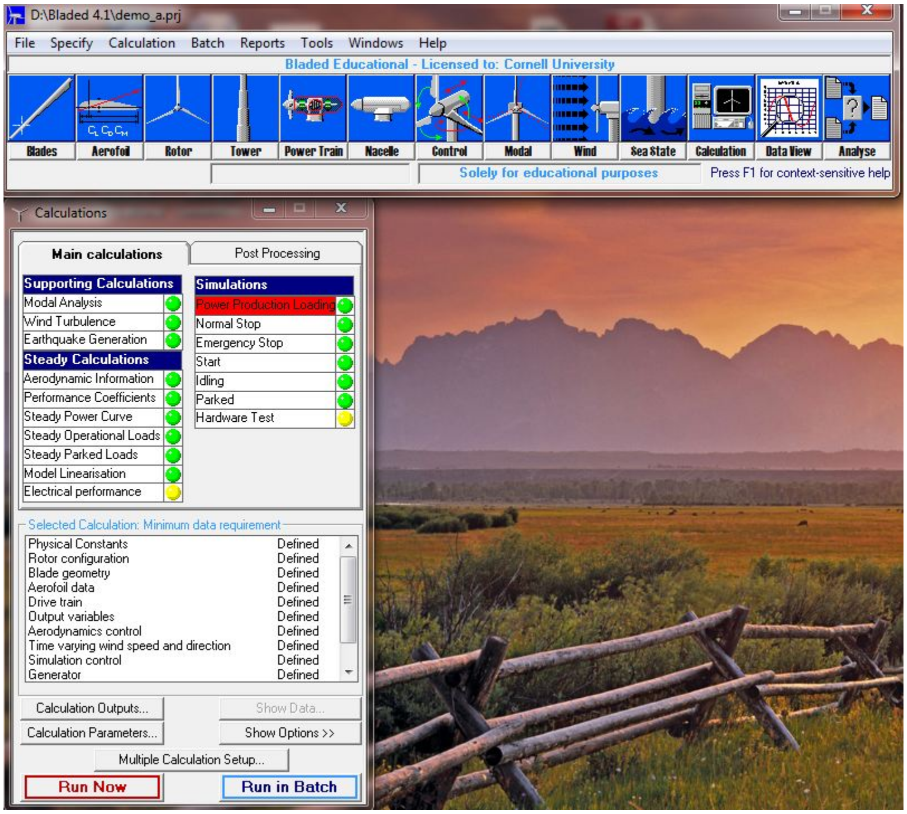




The red circles next to each calculation and simulation in the calculation window indicate none of the required input parameters are defined. The yellow circle indicates that only a part of the required inputs are defined for a given simulation. Green circle indicates all the inputs are fully defined and the simulation is ready to be carried out.

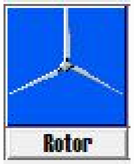
We will fist load a demo project and then adjust the desired parameters. The demo project should be in the Bladed directory. This demo project simulates a 2MW wind turbine.

File > Open Project > ***demo_a.prj***

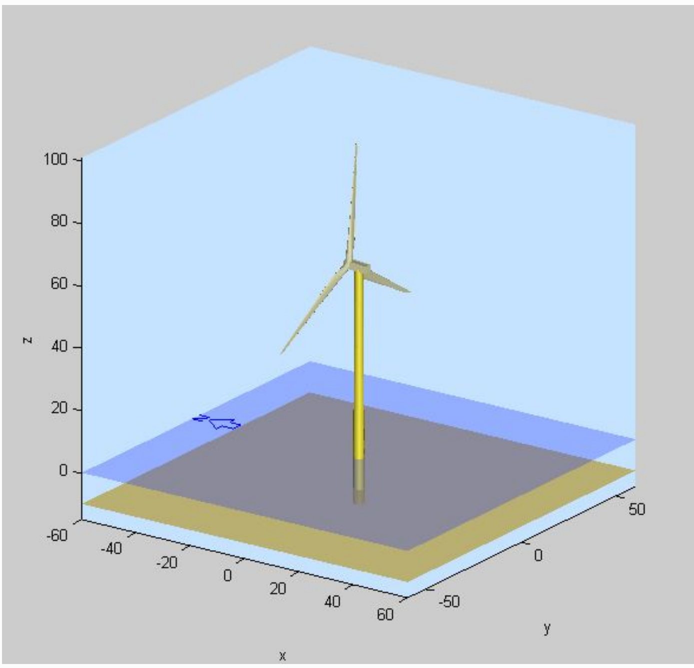

D:\Bladed 4.1\demo_a.prj
File Specify Calculation Batch Reports Tools Windows Help
Bladed Educational - Licensed to: Cornell University
Blades
Aerofoil
Rotor
Tower
Power Train
Nacelle
Control
Modal
Wind
Sea State
Calculation
Data View
Analyse
Solely for educational purposes
Press F1 for context-sensitive help
Calculations
Main calculations
Post Processing
Supporting Calculations
Modal Analysis
Wind Turbulence
Earthquake Generation
Steady Calculations
Aerodynamic Information
Performance Coefficients
Steady Power Curve
Steady Operational Loads
Steady Parked Loads
Model Linearisation
Electrical performance
Simulations
Power Production Loading
Normal Stop
Emergency Stop
Start
Idling
Parked
Hardware Test
Selected Calculation: Minimum data requirement
Physical Constants Defined
Rotor configuration Defined
Blade geometry Defined
Aerofoil data Defined
Drive train Defined
Output variables Defined
Aerodynamics control Defined
Time varying wind speed and direction Defined
Simulation control Defined
Generator Defined
Calculation Outputs...
Show Data...
Calculation Parameters...
Show Options >>
Multiple Calculation Setup...
Run Now
Run in Batch

Wind turbine illustration

One interesting and convenient feature in GH Bladed is the built-in MATLAB model that allows the users to see the wind turbine. This feature is available when all the required physical parameters (blade and tower geometry, nacelle, etc) are fully defined. Since the demo wind turbine is fully defined, we will use this feature to visualize it.

Click on the rotor icon, 

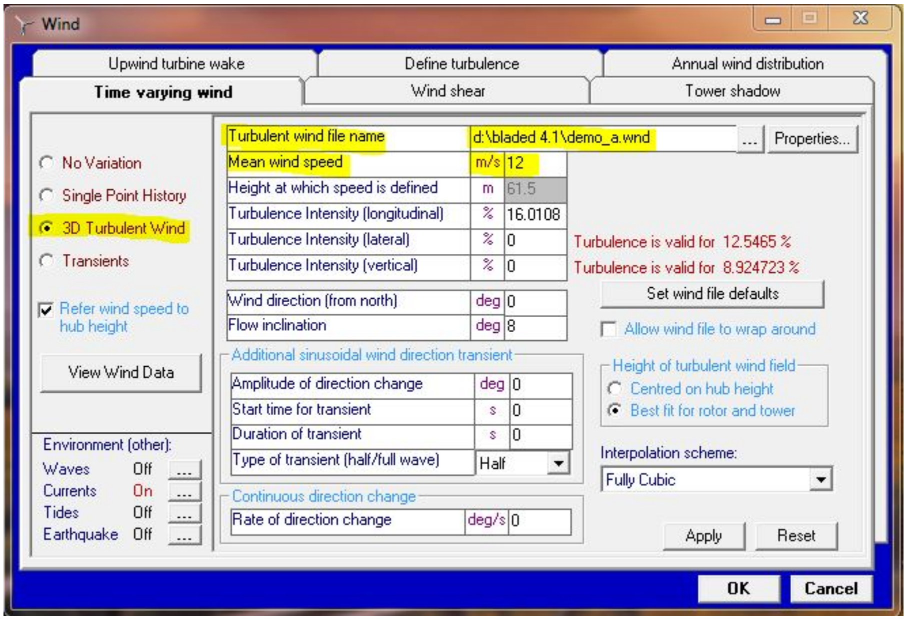
, and select View turbine graphic at the bottom left corner of the Turbine configuration window. GH Bladed will import the physical parameters into MATLAB and generate a 3D plot that illustrates the actual scale of the defined wind turbine.

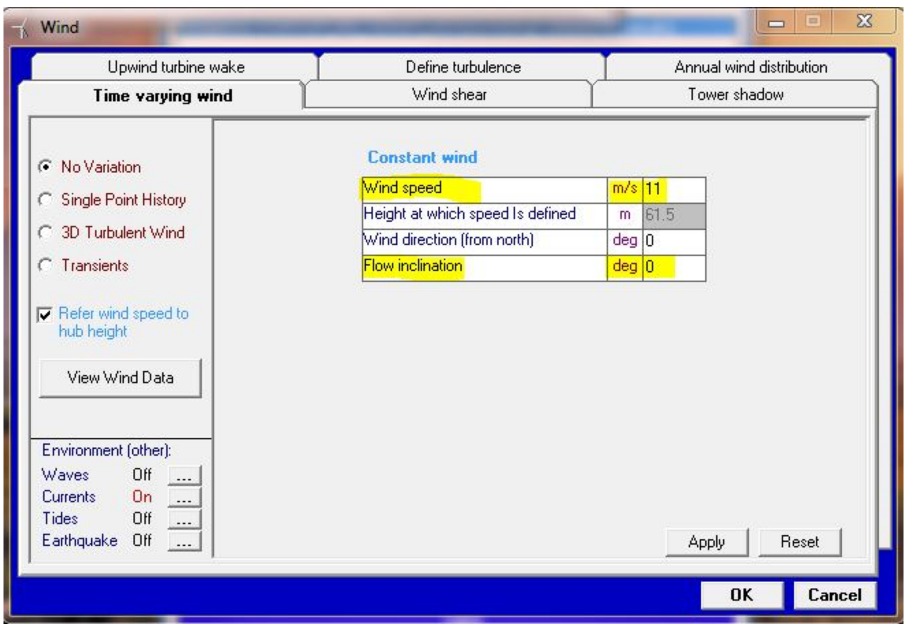


Wind

The demo project uses a pre-defined turbulence wind file. We will change the wind characteristic to steady. Click on 

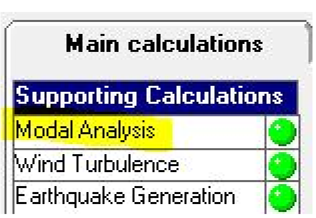
to edit the wind characteristic. The default wind is set to ***3D Turbulent Wind*** with a mean wind speed of 12 m/s. This turbulent wind is defined in the demo wind file. For our case, we will use a steady wind of 11 m/s. Change the option to ***No Variation*** and change the ***Wind speed*** to ***11 m/s***. Change the ***Flow inclination*** to ***0 degrees***. Click on Apply to save the changes.



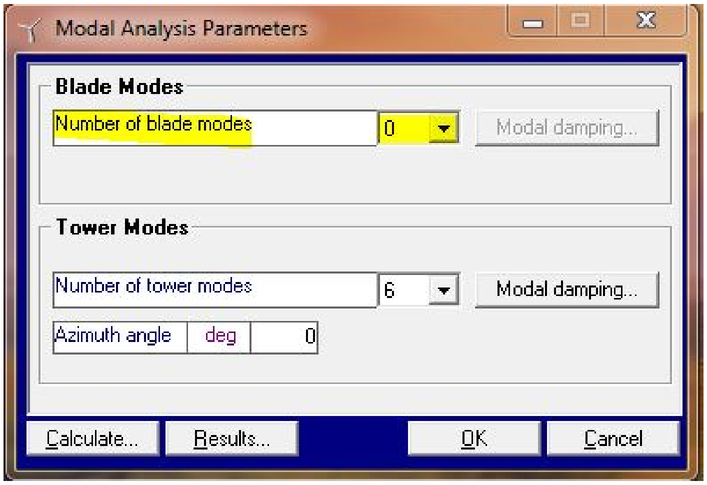


Blade Modes

GH Bladed performs modal analysis based on the defined blade stiffness. The modes are used to predict blade deflection. Thus, we can eliminate the blade modes to simulate zero blade deflection. Double click on ***Modal Analysis***.

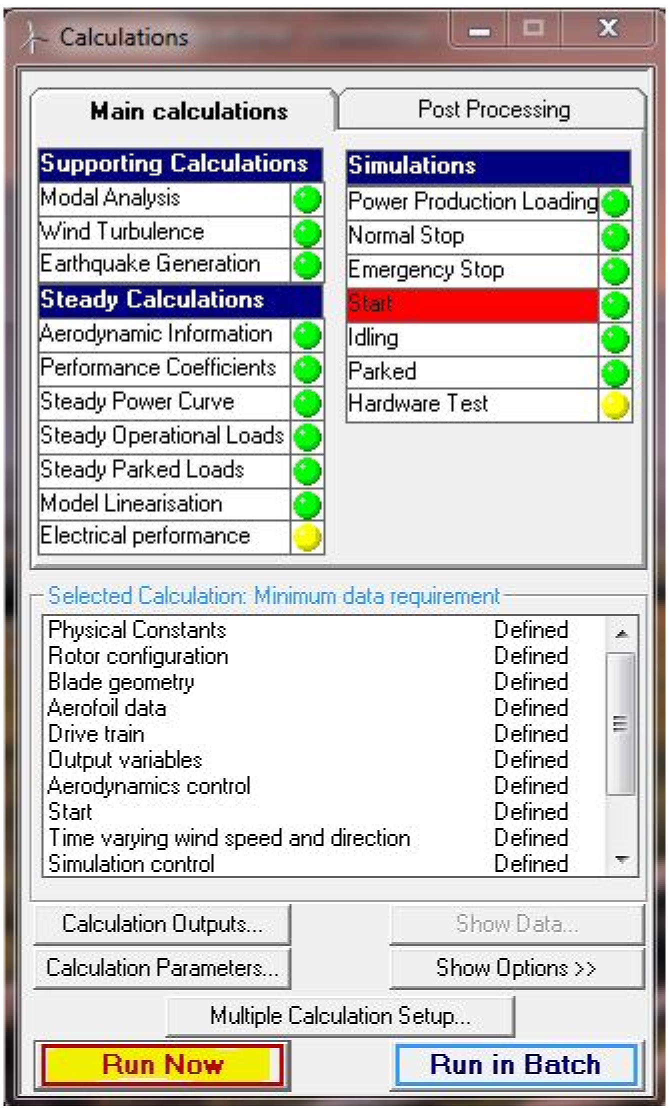


Change the number of blade modes to ***0***. Click OK to close the Modal Analysis Parameters window.

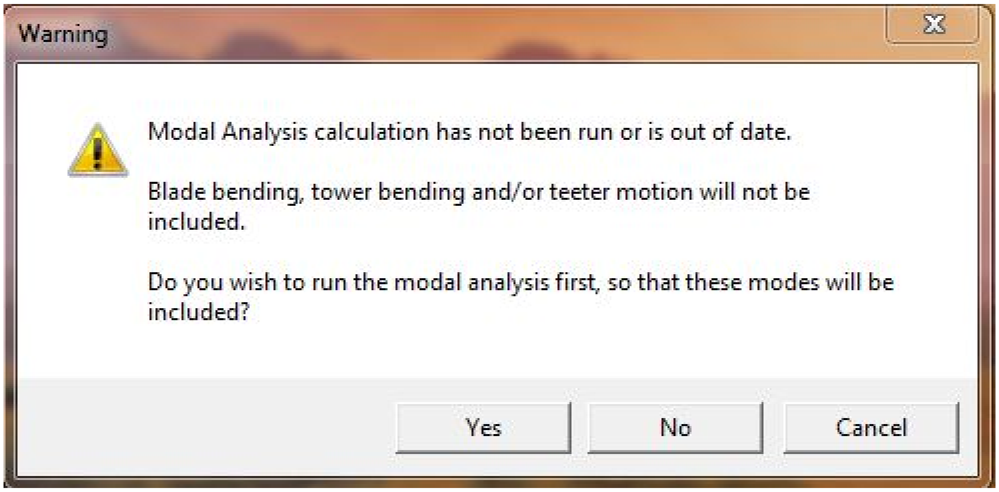


Simulation

We will run ***Start*** simulation because it simulates the start up response of a wind turbine. Highlight ***Start***, and click on ***Run Now***.



A warning message will appear. This message appears because we have changed the blade modes. Click on Yes to update the modal analysis to proceed.



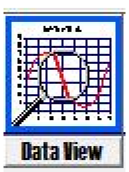
Save the simulation result in the Bladed result folder (bladed 4.1\results). Name it ***startup_no_blade_deflection***. Close the Calculation Progress window when the run is completed.

Results

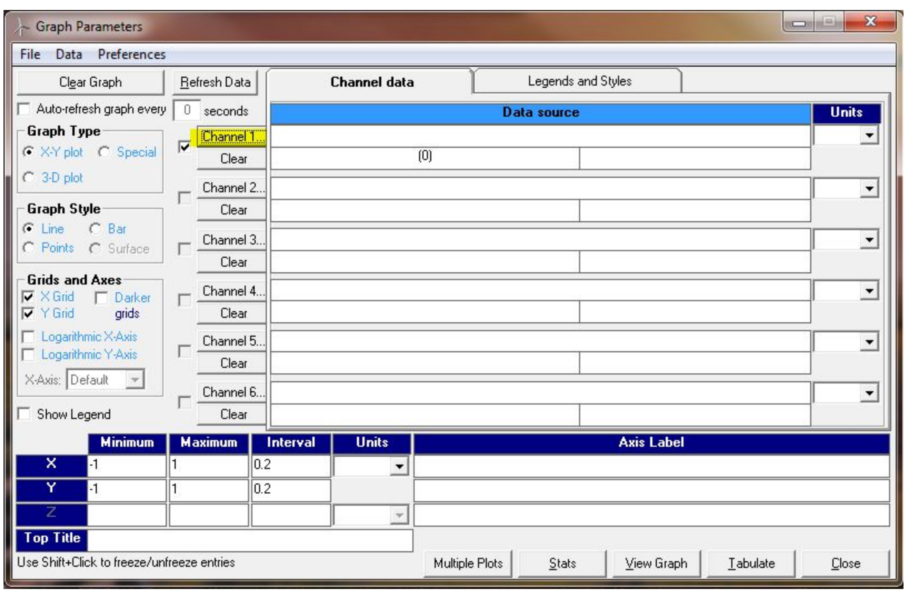
We would like to compare the electrical power output of the demo wind turbine with and without blade deflection. The result for the case with blade deflection (blade mode unchanged) is provided below. It is recommended to download and extract the results folder on the desktop (we will later browse to this folder from within Bladed).

download the result for deflected blade simulation here

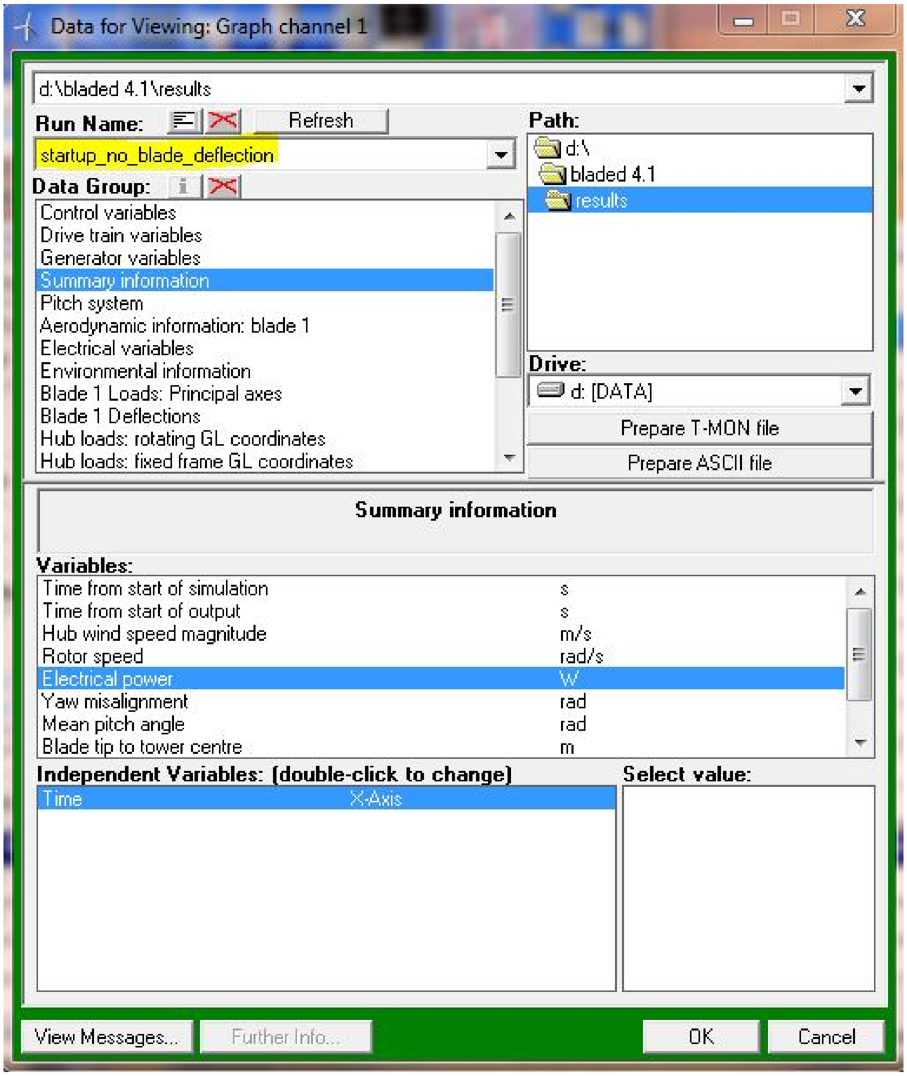
Click on Data View, this is where plots are generated.



In the Graph Parameters window, click on Channel 1 to select data.

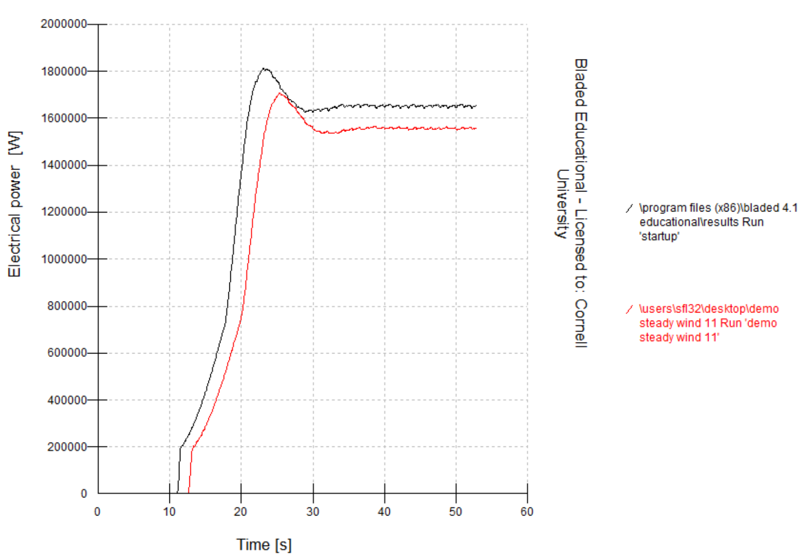


Select "startup_no_blade_deflection" under ***Run Name***. Select ***Summary information*** in ***Data Group***. Select ***Electrical power*** for Variables. The electrical power will be plotted against time. Click on OK to finish data selection.

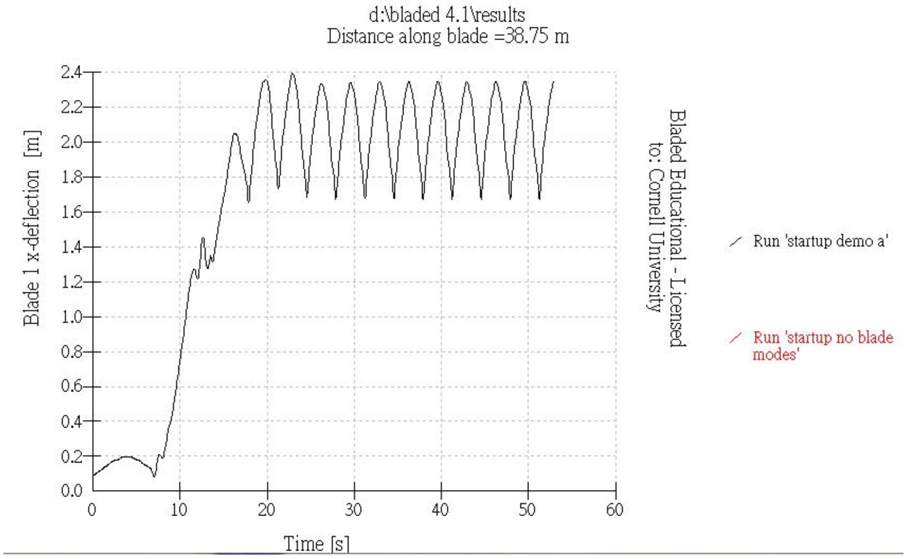


Click on Channel 2 and change the path to the desktop to find "demo_steady_wind_11". Make sure "demo_steady_wind_11" appears under ***Run Name.*** S elect summary information and electrical power, as shown in the previous step.

Channel 1 displays the electrical power produced by the demo turbine without blade deflection. Channel 2 displays the electrical power produced by the demo turbine with blade deflection. Click on ***View Graph***, and you should get something like this:



We can check if the blades in our setup deflect or not for "demo_steady_wind_11" . Select ***Blade 1 Deflections*** in Data Group. Select ***Blade 1 x-deflection*** for Variables. Select ***Time*** for Independent Variables.



Discussion

The results agree with our expectations. Blade deflection does in fact reduces generated electrical power.