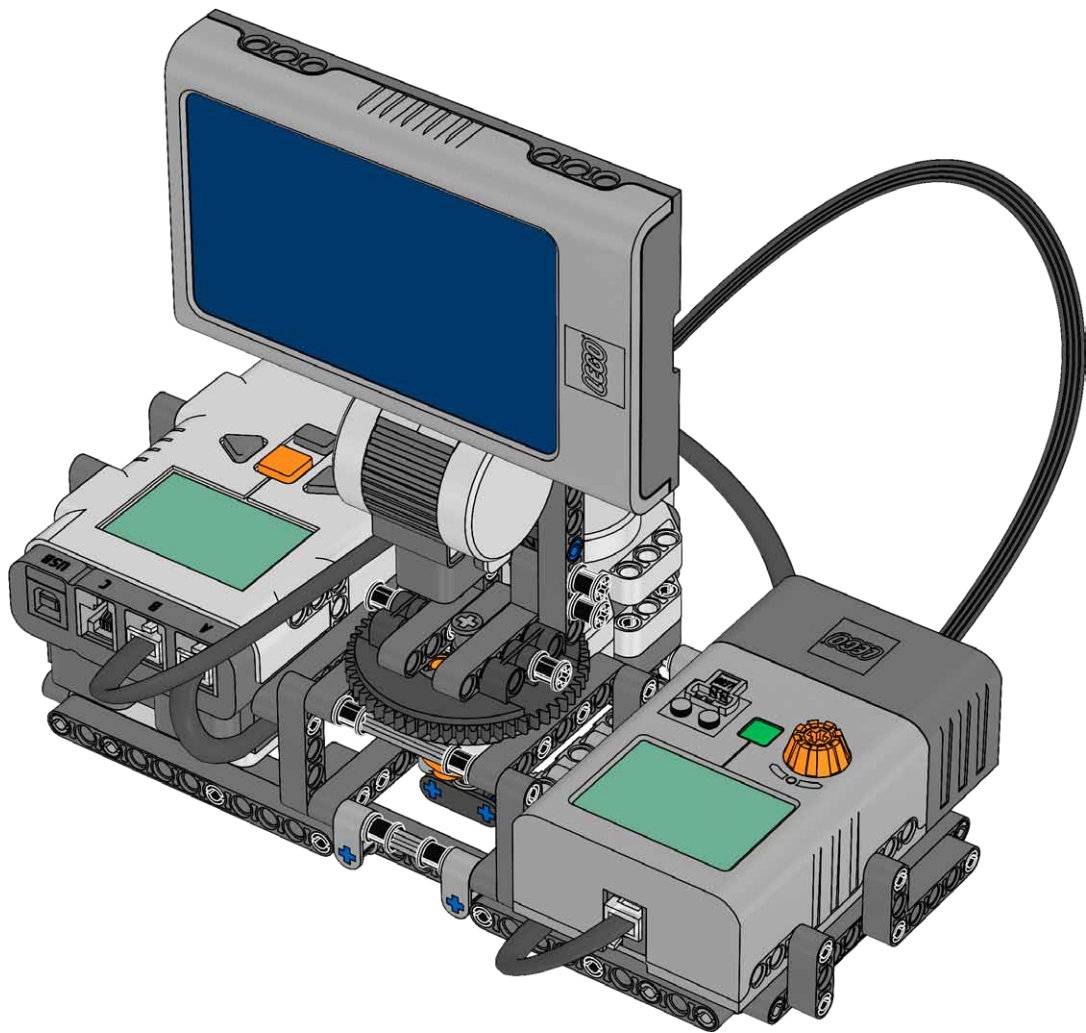


NXT Solar Station





NXT Solar Station

Description

Investigating the NXT Solar Station's ability to generate power by data logging wattage (W) values. Also investigating how a light source turned towards the NXT Solar Station and moving in different directions affects its performance.

Optionally, a fixed NXT Solar Station can be compared to a movable NXT Solar Station by data logging the performance of both.

Objectives

- Building, programming and data logging
- Identifying energy conversion and power
- Interpreting and reading data
- Investigating and evaluating variables

LEGO Materials Required

- 2000080 LEGO® MINDSTORMS® Education NXT Software v2.0 or newer installed
- 9797 LEGO® MINDSTORMS® Education Base Set
- 9648 Education Resource Set or 9695 LEGO® MINDSTORMS® Education Resource Set
- 9688 Renewable Energy Add-on Set

Other Materials Required

- A 60W incandescent light bulb, high performance halogen emitters or any other light source that emits a high amount of IR spectra > 800 nm
- Mobile light source with parabolic reflector
- Ruler or measuring tape

Content of NXT Solar Station zip folder:

- Activity
- Building Instruction
- Element Guide
- Energy Meter Blocks
- Data Logging Programs:
 - Solar Station 1*
 - Solar Station 2*

⚠ Please note that the NXT must have firmware version 1.26 or newer.

Connect



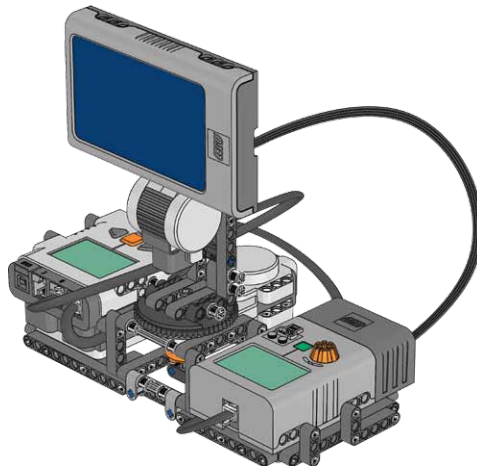
Solar panels have the ability to convert solar energy into electrical energy. How much power a solar panel generates depends on many factors including where it is positioned and how mobile it is. Some solar panels have special control mechanisms that can adjust them to follow the sun.

Build, program and log data to investigate the NXT Solar Station's ability to generate power (W).

Construct

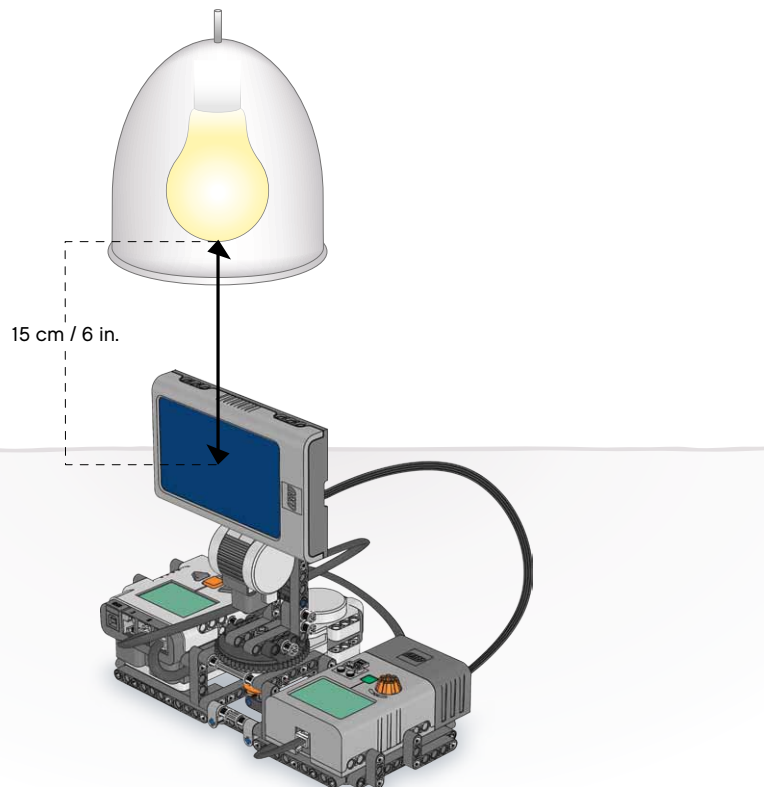
Build the NXT Solar Station

See Building Instruction



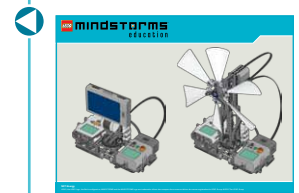
Test setting

- Remember to reset the Energy Meter to 0 J before each investigation by pressing down and holding the green On/Off button for two seconds
- Keep a distance of 15 cm / 6 in. from the center of the solar panel to the light source as illustrated below



Warning!

Heat can damage the solar panel. Keep a distance of at least 8 cm / 4 in. from the solar panel to the light source at all times. Handle light bulbs with great care!



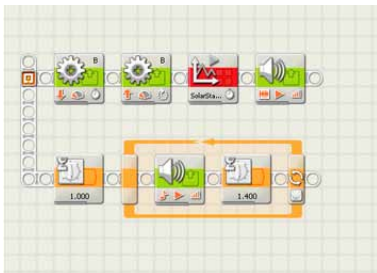
Hint
Important to keep the same distance during all investigations.

Contemplate

Please note that if using the NXT software version 2.0, the Energy Meter Blocks must be imported before you continue.

Light intensity - vertical direction

Data log in wattage (W) how a light source moving in a vertical direction and turned towards the NXT Solar Station, with the solar panel positioned 45 degree from vertical, affects its performance.



Above is a screenshot from the data logging program Solar Station 1 included in the zip folder. This program collects data from the Energy Meter and has a continuous metronome tone, sounding every 1.5 second, lasting the duration of the experiment. Follow the metronome tone's sequence and move the light source approximately 2.5 cm / 1 in. per tone in a vertical direction as illustrated below.

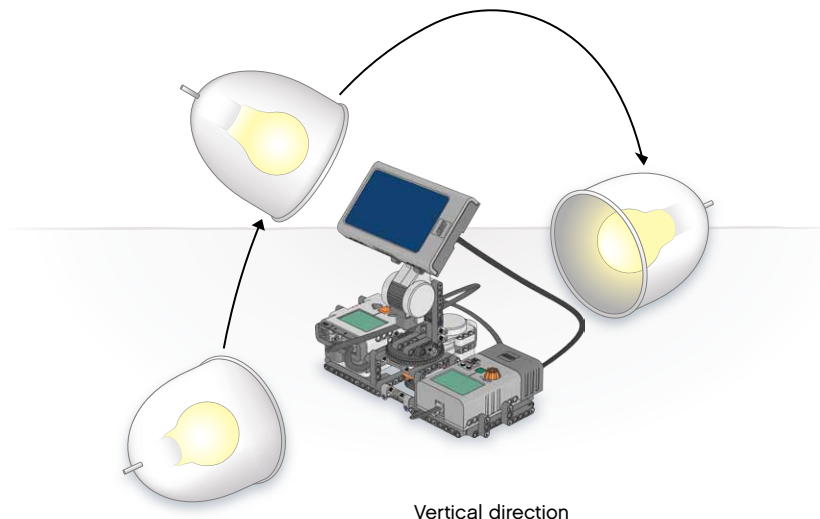
Before opening and running the data logging program Solar Station 1, set up the data logging experiment by following the experiment configurations exactly as written:

- Name: SolarStation
- Click on Sensor drop-down menu, select: Emeter In – W
- Click on Port drop-down menu, select: 3
- Duration: 35 Seconds
- Rate: 5 Samples per Second
- Connects to Port 3 on NXT

Now, predict in wattage (W) values, how the NXT Solar Station will perform.

Then, turn on the light source, open and run the data logging program Solar Station 1 or create an alternative data logging program.

Now analyze data, type annotations, describe observations and write conclusions, explain data and optionally take screenshots using the Data Logging tools. We recommend comparing mean values.

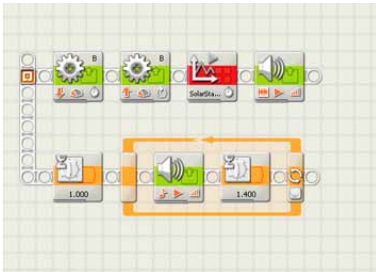


- Hint**
If the Emeter sensor options don't appear, you have NXT software v2.0 and the Energy Meter Blocks have not been imported.
- Hint**
Use 'Prediction Tools' found in NXT software. See the Robot Educator tutorials: 41 and 42
- Hint**
Use 'Analysis Tools' and 'Dataset Table' found in NXT software. See the Robot Educator tutorials: 41

Continue

Light intensity – horizontal direction

Data log in wattage (W) how a light source moving in a horizontal direction and turned towards the NXT Solar Station, with the solar panel positioned 45 degrees from vertical, affects its performance.



Above is a screenshot from the data logging program Solar Station 1 included in the zip folder. This program collects data from the Energy Meter and has a continuous metronome tone, sounding every 1.5 second, lasting the duration of the experiment. Follow the metronome tone's sequence and move the light source approximately 2.5 cm / 1 in. per tone in a horizontal direction as illustrated below.

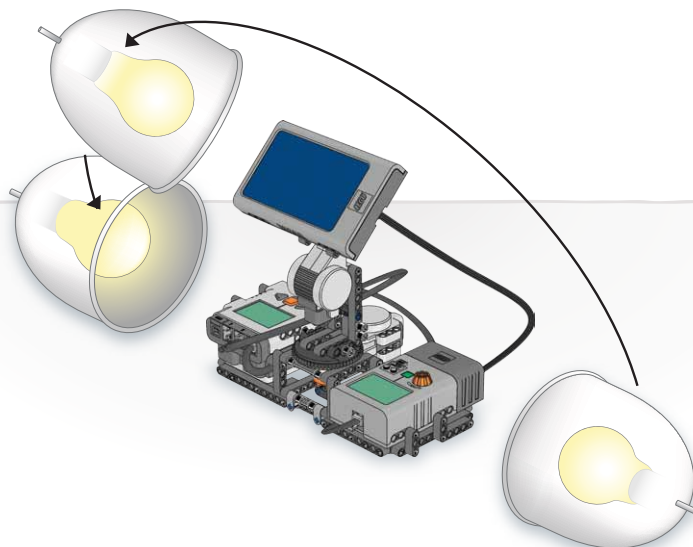
Before opening and running the data logging program Solar Station 1, set up the data logging experiment by following the experiment configurations exactly as written:

- Name: SolarStation
- Click on Sensor drop-down menu, select: Emeter In – W
- Click on Port drop-down menu, select: 3
- Duration: 35 Seconds
- Rate: 5 Samples per Second
- Connects to Port 3 on NXT

Now, predict in wattage (W) values, how the NXT Solar Station will perform.

Then, turn on the light source, open and run the data logging program Solar Station 1 or create an alternative data logging program.

Now analyze data, type annotations, describe observations and write conclusions, explain data and optionally take screenshots using the Data Logging tools. We recommend comparing mean values.



Horizontal direction

Optional

Tracking light intensity

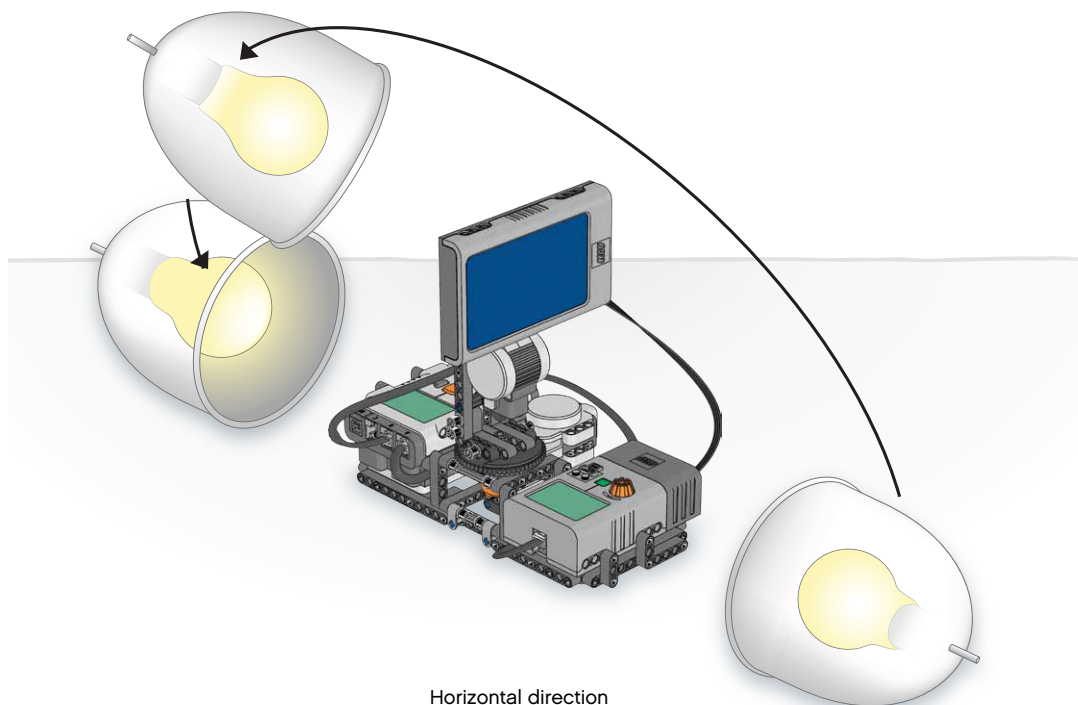
Tracking light intensity optimizes a solar panel's ability to generate power. To increase its input, the NXT Solar Station can be programmed to follow the light, always trying to optimize the position of its solar panel, tracking where the most intense amount of light is.

Data log in wattage (W) how well the data logging program Solar Station 2 tracks the light source.

Open and run the data logging program Solar Station 2. Before you start to move the light source, shine the light directly onto the solar panel for a few seconds so the NXT Solar Station can data log this amount of light intensity. Then keep the light source at a distance of 15 cm / 6 in. as you move the light source from right to left in a horizontal direction as shown below.

NOTE

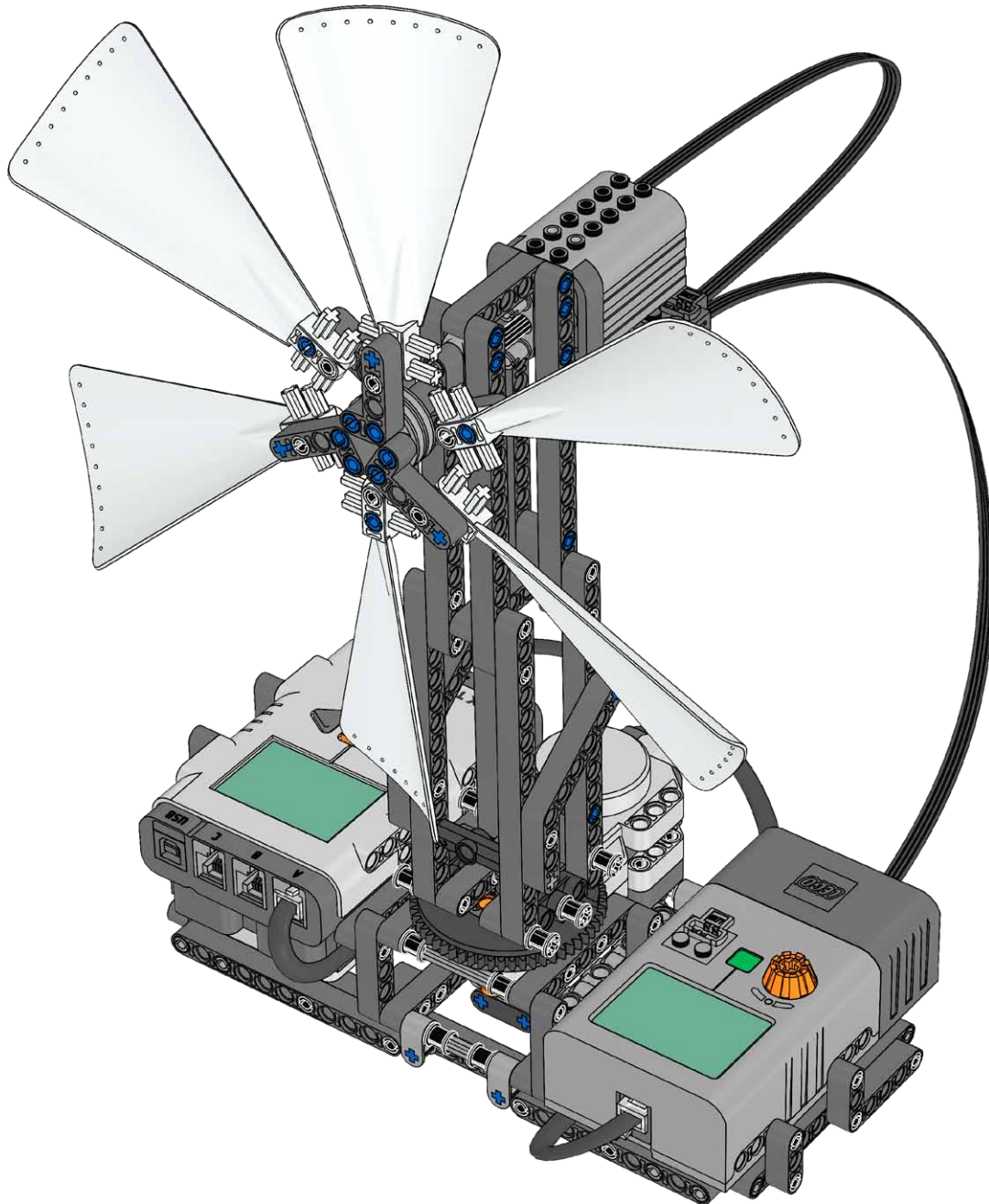
- If the NXT Solar Station doesn't track or falls behind the light source, it might be because the light source is moving too fast or is too far away. Remember to start by shining the light source directly onto the solar panel
- Using the suggested data logging program Solar Station 2, the solar panel must be turned to the side, where the Energy Meter is at the right side of the base of the NXT Solar Station model. See illustration below



Hint
If you wish to change measurement values, select voltage (V) or amperage (A) values using the Sensor drop-down menu: Emeter In - V or Emeter In - A



NXT Wind Turbine



NXT Wind Turbine

Description

Investigating the NXT Wind Turbine's ability to generate power by data logging wattage (W) values. Also investigating how an NXT Wind Turbine facing the fan is compared to an NXT Wind Turbine turned away from the fan by data logging the performance of both. Optionally, specific variables can be altered and their affect investigated.

Objectives

- Building, programming and data logging
- Identifying energy conversion and power
- Interpreting and reading data
- Investigating and evaluating variables

LEGO Materials Required

- 2000080 LEGO® MINDSTORMS® Education NXT Software v2.0 or newer installed
- 9797 LEGO® MINDSTORMS® Education Base Set
- 9648 Education Resource Set or 9695 LEGO® MINDSTORMS® Education Resource Set
- 9688 Renewable Energy Add-on Set

Other Materials Required

- Fan with an effect of at least 40W
- Ruler or measuring tape

Content of NXT Wind Turbine zip folder:

- Activity
- Building Instruction
- Element Guide
- Energy Meter Blocks
- Data Logging Programs:
 - Wind Turbine 1*
 - Wind Turbine 2*

⚠ Please note that the NXT must have firmware version 1.26 or newer.

Connect



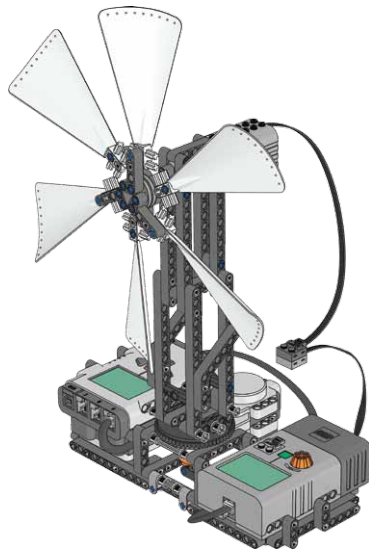
Wind turbines have the ability to convert the wind's kinetic energy into electrical energy. How much power a wind turbine generates depends on many factors including where the wind turbine is positioned and how strong the wind is. Some wind turbines have special control mechanisms that can move them so they can catch more wind.

Build, program and log data to investigate the NXT Wind Turbine's ability to generate power (W).

Construct

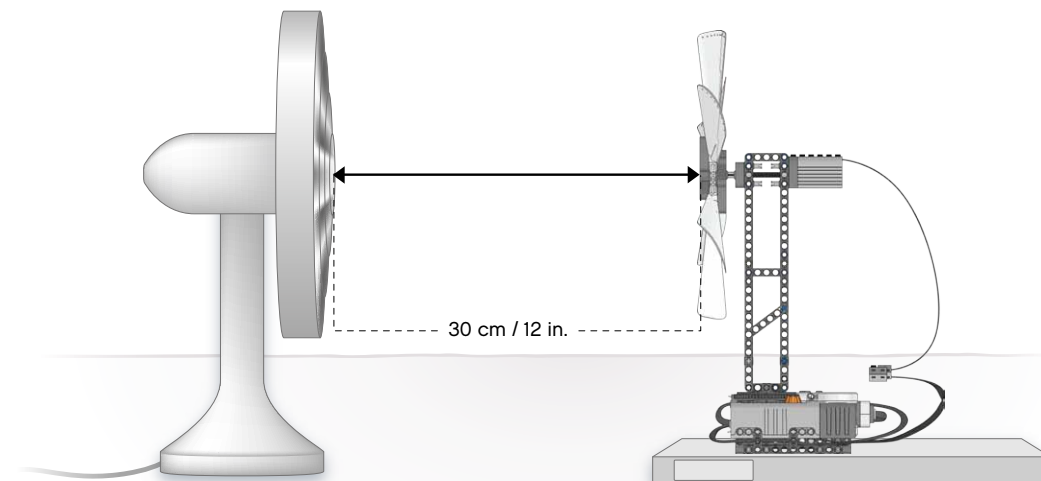
Build the NXT Wind Turbine

See Building Instruction



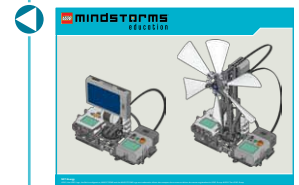
Test setting

- Reset the Energy Meter to 0 J before each investigation by pressing down and holding the green On/Off button for two seconds
- Choose the highest power setting on the fan, the power setting must affect the NXT Wind Turbine so that the Energy Meter's display shows more than 2.0 V on the input reading
- Keep a distance of 30 cm / 12 in. from the fan to the NXT Wind Turbine at all times
- Place fan and NXT Wind Turbine as illustrated below



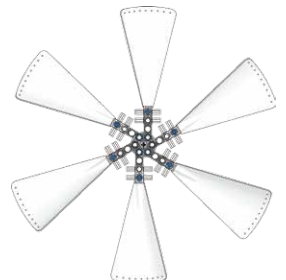
Warning!

Fans are potentially dangerous, handle them with great care!



Hint

Important to keep the same distance during all investigations.

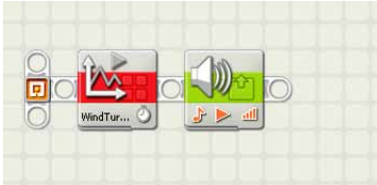


Contemplate

Please note that if using the NXT software version 2.0, the Energy Meter Blocks must be imported before you continue.

NXT Wind Turbine facing fan

Data log in wattage (W) the NXT Wind Turbine's ability to generate power (W) when facing directly towards the fan as illustrated in the test setting.



Above is a screenshot from the data logging program Wind Turbine 1 included in the zip folder. This program collects data from the Energy Meter and has a stop tone when the data logging experiment ends.

Before opening and running the data logging program Wind Turbine 1, set up the data logging experiment by following the experiment configurations exactly as written:

- Name: WindTurbine
- Click on Sensor drop-down menu, select: Emeter In – W
- Click on Port drop-down menu, select: 3
- Duration: 30 Seconds
- Rate: 5 Samples per Second
- Connects to Port 3 on NXT

Now, predict in wattage (W) values, how the NXT Wind Turbine will perform.

Then, turn on the fan, let the NXT Wind Turbine pick up speed before opening and running the data logging program Wind Turbine 1 or create an alternative data logging program.

Now analyze data, type annotations, describe observations and write conclusions, explain data and optionally take screenshots using the Data Logging tools.

Hint
If the Emeter sensor options don't appear, you have NXT software v2.0 and the Energy Meter Blocks have not been imported.

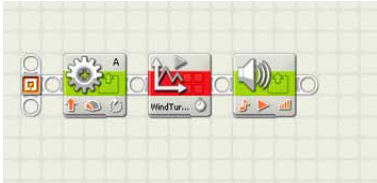
Hint
Use 'Prediction Tools' found in NXT software. See the Robot Educator tutorials: 41 and 42

Hint
Use 'Analysis Tools' and 'Dataset Table' found in NXT software. See the Robot Educator tutorials: 41

Continue

NXT Wind Turbine turned away from fan

Data log in wattage (W) the NXT Wind Turbine's ability to generate power (W) when the NXT Wind Turbines tower is turned at a 45 degree angle away from the fan. See the illustration at the bottom of the page.



Above is a screenshot from the data logging program Wind Turbine 2 included in the zip folder. This program collects data from the Energy Meter, turns the tower 45 degrees and has a stop tone when the data logging experiment ends.

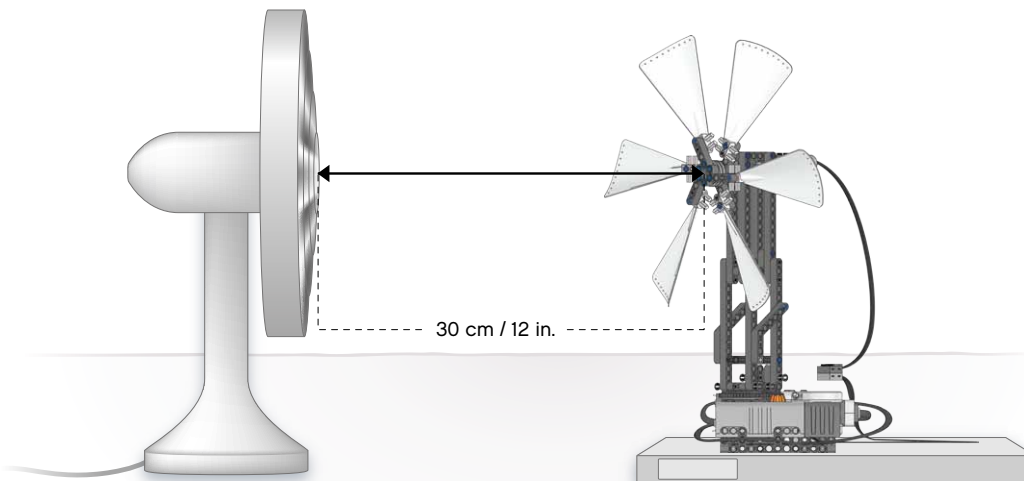
Before opening and running the data logging program Wind Turbine 2, set up the data logging experiment by following the experiment configurations exactly as written:

- Name: WindTurbine
- Click on Sensor drop-down menu, select: Emeter In – W
- Click on Port drop-down menu, select: 3
- Duration: 30 Seconds
- Rate: 5 Samples per Second
- Connects to Port 3 on NXT

Now, predict in wattage (W) values, how the NXT Wind Turbine will perform.

Then, turn on the fan, let the NXT Wind Turbine pick up speed before opening and running the data logging program Wind Turbine 2 or create an alternative data logging program.

Now analyze data, type annotations, describe observations and write conclusions, explain data and optionally take screenshots using the Data Logging tools.



Optional

Changing variables

The earth has large regions of even and uneven terrain that affect the wind near the surface to varying degrees. Different regions have different degrees of unevenness. The correct location of wind turbines is crucial for their ability to generate power, but many other variables affect their performance.

Simulate different landscapes by, e.g., placing a book between the fan and the NXT Wind Turbine, investigating the increase or decrease in the NXT Wind Turbine's ability to generate power.

Or try changing specific variables, e.g., the power setting of the fan, the distance between the fan and the NXT Wind Turbine or try removing some of the blades on the NXT Wind Turbine. Describe the setup, the variable you wish to investigate and your observations.

NOTE

- Choose to create your own data logging program or use one or both of the data logging programs supplied
- Choose an adequate power setting on the fan so the Energy Meter's display shows more than 2.0 V on the input reading

