# Lesson Plan: Algebra: Formula Substitution using the Wind Turbine Energy Equation

**This is a lesson plan developed by the ARC Centre of Excellence for Climate Extremes (CLEX) and the Monash Climate Change Communication Research Hub (MCCCRH) with contributions by Dr Sanaa Hobeichi and Dr Ian Macadam (CLEX); Tahnee Burgess and Dr David Holmes (MCCCRH); and Dr. Roger Dargaville (Monash University). The lesson plan originated at the "Climate across the Curriculum: Educational Resources for Teachers" workshop at the Australian Meteorological and Oceanographic Society (AMOS) conference held in February 2020 in Fremantle, Western Australia. The workshop was supported by AMOS, CLEX, MCCCRH, the Schools Weather and Air Quality (SWAQ) Citizen Science project, TROP ICSU and the University of Western Australia. A version of the lesson plan tailored for use in Australian classrooms is available at https://www.monash.edu/mcccrh/projects/climate-classrooms.**

As a **high school Mathematics** teacher, you can use this set of computer-based tools to help you in teaching **Formula Substitution** in algebra after introducing **formulas, numbers, variables, and constants**.

Global warming due to fossil fuel emissions, is believed to be one of the causes for climate change. Therefore, there is an increased interest in the use of renewable and cleaner sources of energy. This lesson plan will help improve students' literacy in clean energy sources while enabling them to practice Formula Substitution. It includes resources to teach your students about the **components of formulas**, and **substitution in a formula** using the **energy equation for wind turbines**, to enable them to understand the energy available from wind.

Thus, the use of this lesson plan allows you to integrate the teaching of a climate science topic with a core topic in **Mathematics**.

Curriculum Code (Australia):

- **ACMEM035**: substitute numerical values into algebraic expressions
- **ACMEM036**: substitute given values for the other pronumerals in a mathematical formula to find the value of the subject of the formula

Cross Curriculum Priority (Australia): **Sustainability**

Presumed Knowledge (Australia):

- Arithmetic with real numbers and the use of index notation (ACMNA150, ACMNA153, ACMNA183, and ACMNA154).

- Substitute values into formulae to determine an unknown (ACMNA234).
- Use units of energy to consumption of electricity (ACMEM031)
- Convert from one unit of energy to another (ACMEM034)

Use this lesson plan to help your students find answers to:

- What is wind energy? How can it be harnessed for electricity?
- How can you compute the energy available due to wind?
- What are the advantages and challenges of producing electricity from a wind turbine?

## About the Lesson Plan

**Grade Level:** High School

**Discipline:** Mathematics

**Topic(s) in Discipline:** Formulae and their components: Numbers, Variables, and Constants; Formula Substitution

**Climate Topic:** Energy, Economics and Climate Change; Climate Mitigation and Adaptation

**Location:** Global, Australia

**Access:** Online, Offline

**Language(s):** English

**Approximate Time Required:** 50 min

# 1 Contents

## 3. Video (~2.5min)

A video to introduce the topic of wind power.

This can be accessed at:

https://www.khanacademy.org/partner-content/nova/nova-labs-topic/energy/v/windpower

## 4. Classroom Activity (~5 min + 30 min)

A PowerPoint presentation of a solved word problem to compute wind energy from a wind turbine (using Formula Substitution) followed by solving of textbook questions for independent practice.

The PowerPoint presentation is available as a separate downloadable document.

## 5. Suggested questions/assignments for learning evaluation

- What is wind energy? How can it be harnessed for electricity?
- How can you compute the energy available due to wind?
- What are the advantages and challenges of producing electricity from a wind turbine?

# 2 Step-by-step User Guide

Here is a step-by-step guide to using this lesson plan in the classroom/laboratory. We have suggested these steps as a possible plan of action. You may customize the lesson plan according to your preferences and requirements.

### 1. Topic introduction and discussion

Use the teaching module, 'Formulas' by The Improving Mathematics Education in Schools (TIMES) Project, Australian Govt., to introduce or reacquaint your students with formulas and their components- variables, numbers, and constants. Encourage them to identify the variables, numbers and constants in a set of formulas (e.g. $A = \pi r^2, E = m\,c^2, F = G\frac{m_1 m_2}{r^2}$) given in the text. Ask them to recall examples of formulas they know and identify their elements. Use the solved examples in the text to explain the subject of the formula and how substitution in a formula is done to find its value. Explain what an equation is and how it can be solved by substitution using the given examples.

This can be accessed at:

http://www.amsi.org.au/teacher_modules/Formulas.html

### 2. Initiate discussion

Use the interactive visualization, 'CO2 emissions per capita vs. share of electricity from renewables, 2014' by Our World in Data, to initiate a brief discussion about global warming due to carbon emissions and its effect on climate change. Allow the students to make various country selections on the interactive chart to visualize their contributions to these sectors. Thus, emphasize on the importance of renewable and clean sources of energy as opposed to fossil-fuel based energy.

This can be accessed at:

https://ourworldindata.org/grapher/co-emissions-per-capita-vs-share-of-electricity-from-renewbles

## 3. Introduce the topic of wind power

Use the video, 'Wind Power' by Khan Academy to introduce your students to wind energy as a renewable and clean source of energy. Use this video to explain how wind energy is harnessed for electricity production using wind turbines.

This can be accessed at:

https://www.khanacademy.org/partner-content/nova/nova-labs-topic/energy/v/windpower

Explain to your students that in the ensuing classroom activity, the equation for measuring the wind energy will be used as an example for formula substitution to find the value of total energy harnessed by the wind turbine.

## 4. Apply understanding

Use the PowerPoint presentation, 'A teaching exercise for renewable energy' by Dr. Roger Dargaville, Monash University, to guide your students through a worked example of formula substitution. Use this exercise to show your students how the energy equation for the wind turbine can be used to find out the amount of wind power the turbine receives or is available for it to harness. The working out of the answers appear step-by-step on mouse clicks in the presentation.

The PowerPoint presentation can be accessed as an independent downloadable in this lesson plan.

Following the solved example, encourage your students to independently solve a selection of questions from their textbooks, based on students' abilities and fluency in the topic.

## 5. Questions/Assignments

Use the tools and the concepts learned so far to discuss and determine answers to the following questions:

- What is wind energy? How can it be harnessed for electricity?
- How can you compute the energy available due to wind?

- What are the advantages and challenges of producing electricity from a wind turbine?

# 3 Learning Outcomes

The tools in this lesson plan will enable students to:

- substitute given values for the other pronumerals in a mathematical formula to find the value of the subject of the formula.
- substitute numerical values into an algebraic expression to evaluate the expression.
- explain the advantages and challenges of producing electricity from a wind turbine.
- compute the energy available from wind as a renewable and clean energy source.
- discuss the importance of renewable sources of energy to reduce carbon emissions induced global warming.

# 4 Additional Resources

If you or your students would like to explore the topic further, these additional resources will be useful.

### 1. Video micro-lecture; 'Maths solutions. Algebra- substitution into a formula'

A video to explain the formula substitution can be done to solve for the value of an equation.

This can be accessed at:

https://www.youtube.com/watch?v=C2xJbUlC5AA

# 5 Credits/Copyrights

All the teaching tools in our collated list are owned by the corresponding creators/authors/organizations as listed on their websites. Please view the individual copyright and ownership details for each tool by following the individual links provided.
We have selected and analyzed the tools that align with the overall objective of our project and have provided the corresponding links. We do not claim ownership of or responsibility/liability for any of the listed tools.

### 1. Teaching Module; 'Formulas'

Provided by The Improving Mathematics Education in Schools (TIMES) Project. This resource is prepared by The University of Melbourne on behalf of the International Centre of Excellence for Education in Mathematics (ICE-EM), the education division of the Australian Mathematical Sciences Institute (AMSI).

### 2. Visualization; 'CO2 emissions per capita vs. share of electricity from renewables, 2014'

Provided by Our World in Data.

### 3. Video; 'Wind Power'

By Khan Academy

### 4. PowerPoint Presentation; 'A teaching exercise for renewable energy'

By Dr. Roger Dargaville, Monash University.

### 5. Additional Resources

Leeds University Library