Science Stage 5 Physical world

## Going nuclear

Students are guided in completing a short investigation into the considerations of siting a nuclear power station and submitting a brief report and reflection.

Stage 5, PW4 Energy conservation in a system can be explained by describing energy transfers and transformations.

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| Guiding question:  | Where could a nuclear power plant be sited in Australia?  |
| What are your students going to learn? (Objectives) | PW4d - discuss viewpoints and choices that need to be considered in making decisions about the use of non-renewable energy resourceWS8 Students solve problems by:1. describing strategies to develop a range of possible solutions to an identified problem

WS9 Students communicate by:1. presenting scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations for specific audiences
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| How are they going to learn it? (Resources and Strategies) | Students will explore the considerations for planning the site for a fission nuclear power plant in NSW. Taking into account the needs and concerns of relevant stakeholders to create a balanced proposal for their suggested location. |
| Target date for completion | 3 lessons. |
| How are you going to know that they learned it? (Success criteria) | In the submitted report students can:* Address the selection criteria for siting a nuclear power plant
* Clearly articulate their investigation
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| Collecting evidence of student learning (Verification) | Students will produce a concise report outlining the process undertaken and the results obtained. This report could be submitted via e-mail, Google Classroom or Microsoft Teams to the teacher for feedback. |
| Differentiation including HPGE | Adapting product – students can explore the 1969 proposal of a nuclear power plant in Jervis Bay ACT and the considerations around site selection and eventual rejection as a suitable site in 1971. Creating a balanced presentation of the economic, cultural, environmental and social implications of this specific proposal. |
| Feedback (Evaluation) | Teachers can provide feedback via the submission pathway (e-mail, Google Classroom or Microsoft Team) to students on their progression towards the learning outcomes. An example [rubric for the Working Scientifically Skills](https://schoolsequella.det.nsw.edu.au/file/bebc596d-7e55-4bf2-83dc-be16daabe9fd/1/science-s45-rubricskills.docx) can be found on the Science Curriculum Support website. |
| Communication | Students and teachers can interact either synchronously (Google Hangouts, Microsoft Teams) or asynchronously (email) to provide ongoing feedback and support to students for their learning. |

### Resources:

* YouTube - [how do nuclear power plants work?](https://www.youtube.com/watch?v=R7WPEYGr1Vs) (duration 8:06) is a short TedEd video which clearly describes the process of nuclear fission power.
* [AEMO interactive map](https://www.aemo.com.au/aemo/apps/visualisations/map.html) is an online map for the Australian Energy Market Operator showing the main electrical infrastructure for Australia.
* [IAEA Managing Siting Activities for Nuclear Power Plants](https://www.iaea.org/publications/8804/managing-siting-activities-for-nuclear-power-plants) is a publication which describes in significant detail the site requirements for nuclear power plants.
* [General site suitability criteria for nuclear power stations](https://www.nrc.gov/docs/ML1218/ML12188A053.pdf) is the United States Nuclear Regulatory Commission information on the site selection for nuclear power plants.
* [Siting Consideration for Nuclear Power Plant: A Review](https://osjournal.org/ojs/index.php/OSJ/article/view/1078) is an article reviewing a range of international processes used for selecting sites for nuclear power plants.
* [Australian Bureau of Statistics](https://www.abs.gov.au/) has reliable statistical data which can be used for demographic data to select and provide evidence for a suitable site.
* [Bureau of Meteorology](http://www.bom.gov.au/climate/data) has reliable statistical data which can be used for meteorological data to select and provide evidence for a suitable site.
* [Geoscience Australia](https://www.ga.gov.au/) has reliable data which can be used for geological and geomorphic hazard data to select and provide evidence for a suitable site.
* [Australian Disaster Resilience Disaster Mapper](https://knowledge.aidr.org.au/disasters/) has reliable data which can be used for natural and man-made disaster data to select and provide evidence for a suitable site.
* [Jervis Bay nuclear power plant proposal](https://en.wikipedia.org/wiki/Jervis_Bay_Nuclear_Power_Plant_proposal) has some brief introductory information for the 1969 proposal.

### Lesson sequence

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| Session | Learning Sequence | Evidence of learning |
| 1 | Students can watch the introductory video [how do nuclear power plants work?](https://www.youtube.com/watch?v=R7WPEYGr1Vs) (duration 8:06)This will help gain a few insights to the site requirements for the nuclear power plant. Following this, students can consider the generalised requirements of nuclear power plants, such as:* the need for a supply of water for the turbine condenser and other cooling needs
* reasonable proximity to a main electrical grid
* reasonable access to source of skilled labour, equipment, supplies, etc.
* Seismicity of the area
* Meteorology of the area
* Potential external events - both natural and man-made
* Population distribution
* Land and water use
* Special environmental features
* Historical and cultural features
* Proximity to international border

Requirements vary in each country, Australia does not currently have our own due to the legal ban on constructing nuclear power plants. Examples of international sources for these requirements can be found at:* [IAEA Managing Siting Activities for Nuclear Power Plants](https://www.iaea.org/publications/8804/managing-siting-activities-for-nuclear-power-plants)
* [General site suitability criteria for nuclear power stations](https://www.nrc.gov/docs/ML1218/ML12188A053.pdf)
* [Siting Consideration for Nuclear Power Plant: A Review](https://osjournal.org/ojs/index.php/OSJ/article/view/1078)

Using the [AEMO interactive map](https://www.aemo.com.au/aemo/apps/visualisations/map.html) and adding the “Transmission Lines” layer to the map (under the Electricity Network, Transmission Infrastructure menu) students can see where the main electricity grid runs across NSW to inform their site selection.Other requirements for the nuclear power plant may require the use of several data sources such as:* [Australian Bureau of Statistics](https://www.abs.gov.au/)
* [Bureau of Meteorology](http://www.bom.gov.au/climate/data)
* [Geoscience Australia](https://www.ga.gov.au/)
* [Australian Disaster Resilience Disaster Mapper](https://knowledge.aidr.org.au/disasters/)

Students can review the data which supports their decision of an appropriate site and include this as evidence for their selection. | Students select a site which they feel best suits the needs of a potential nuclear power plant in NSW and produces a report using appropriate data to justify their selection. |
| HPGE | Students can explore the 1969 proposal of a nuclear power plant in Jervis Bay ACT and the considerations around site selection and eventual rejection as a suitable site in 1971. Creating a balanced presentation of the economic, cultural, environmental and social implications of this specific proposal. Some resources for students to use in addition to the above resources:* [Jervis Bay nuclear power plant proposal](https://en.wikipedia.org/wiki/Jervis_Bay_Nuclear_Power_Plant_proposal)
* [YouTube - Fortress Australia](https://www.youtube.com/watch?v=JZ6mV6QbvJ4&feature=youtu.be&t=5m28s)
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### Student handout:

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| Steps to follow |
| 1. Watch the introductory video [how do nuclear power plants work?](https://www.youtube.com/watch?v=R7WPEYGr1Vs) (duration 8:06).This will help you gain a few insights to the requirements of a site for a nuclear power plant.
 |
| 1. Consider the generalised requirements of nuclear power plants, such as:
	* the need for a supply of water for the turbine condenser and other cooling needs
	* reasonable proximity to a main electrical grid
	* reasonable access to source of skilled labour, equipment, supplies, etc.
	* Seismicity of the area
	* Meteorology of the area
	* Potential external events - both natural and man-made
	* Population distribution
	* Land and water use
	* Special environmental features
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	+ [General site suitability criteria for nuclear power stations](https://www.nrc.gov/docs/ML1218/ML12188A053.pdf)
	+ [Siting Consideration for Nuclear Power Plant: A Review](https://osjournal.org/ojs/index.php/OSJ/article/view/1078)
 |
| 1. Using the [AEMO interactive map](https://www.aemo.com.au/aemo/apps/visualisations/map.html) and adding the “Transmission Lines” layer to the map (under the Electricity Network, Transmission Infrastructure menu) you can see where the main electricity grid runs across eastern Australia to inform your site selection. Other requirements for the nuclear power plant may require the use of several data sources such as:
	* [Australian Bureau of Statistics](https://www.abs.gov.au/)
	* [Bureau of Meteorology](http://www.bom.gov.au/climate/data)
	* [Geoscience Australia](https://www.ga.gov.au/)
	* [Australian Disaster Resilience Disaster Mapper](https://knowledge.aidr.org.au/disasters/)
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| 1. From your investigations into the various factors that need to be considered when siting a nuclear power plant, select an appropriate site for Australia’s first nuclear power plant. Select a presentation format which best communicates the data to justify your choice of location.
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| HPGE students: You can review the 1969 proposal of a nuclear power plant in Jervis Bay ACT and the considerations around the site selection and eventual rejection as a suitable site in 1971. Creating a balanced presentation of the economic, cultural, environmental and social implications of this specific proposal. Some resources for you to use in addition to the above resources:* [Jervis Bay nuclear power plant proposal](https://en.wikipedia.org/wiki/Jervis_Bay_Nuclear_Power_Plant_proposal)
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