



## **American Nuclear Society Nuclear Energy Classroom Presentation**

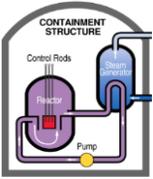
This PowerPoint deck is intended for presentation to students in middle- and high school. It is based on the [Nuclear Energy](#) lesson in Navigating Nuclear: Energizing Our World. You can find the lesson and the accompanying Educator Guide on the ANS website. Navigating Nuclear also includes a virtual field trip of the Palo Verde Generating Station in Arizona; you may want to share it with the classroom teacher.

Following is a slide-by-slide overview of the presentation, their animations and presenter notes. The presentation notes include suggestions for activities to make the presentation interactive for students.

Materials you may wish to bring to your presentation are a set of 28 dominos and enough copies of ANS's Radiation Dose Calculator for each student to have one.

The slides include many animations, so we recommend you review the deck in Slide Show mode to get acquainted with it before presenting.

For more information, contact [Janice Lindegard](mailto:jlindegard@ans.org) (jlindegard@ans.org).

Slide	Notes
 <p><b>Nuclear Energy</b></p> <p>American Nuclear Society</p>	<p>This title slide is followed by a customizable presenter slide</p>
<p><b>FACT OR MISCONCEPTION</b></p> <p><b>TRUE FALSE</b></p> <p><b>Claim 1</b>    A nuclear reactor can explode like a nuclear bomb.</p> <p><b>Claim 2</b>    Nuclear power plants don't emit greenhouse gases or air pollutants.</p> <p><b>Claim 3</b>    Nuclear power releases dangerous amounts of radiation into the atmosphere.</p> <p><b>Claim 4</b>    Nuclear power plants are some of the safest and most secure workplace facilities in the U.S.</p> <p>ANS</p>	<p>Prior to beginning presentation, place students into teams and have them get out a piece of paper. Ask them to write down their guesses on a sheet of paper as you reveal the claims. Go through all the claims before revealing the answers. These slides are animated to show the claims until all four are revealed. The answers will be revealed in the following slides.</p>
<p><b>Claim 1</b> <b>FALSE</b></p> <p><b>A nuclear reactor can explode like a bomb</b></p> <p>It is impossible for a nuclear reactor to explode like a nuclear weapon.</p> <p>Nuclear reactors and nuclear weapons contain different materials and use different systems.</p> <p>Nuclear reactors generate energy through a chain reaction that is carefully controlled.</p> <p>In nuclear weapons, the chain reaction is not controlled.</p>  <p>Pressurized Water Nuclear Reactor</p>  <p>Teller-Ulam design hydrogen bomb</p> <p>ANS</p>	<p>Ask students how many thought the statement was true and how many thought it was false. They can do this by raising hands.</p> <p>Before reading the statements, ask the students if they notice differences in the two illustrations. Review the statements, pointing out features like control rods as well as lack of control in the bomb. Note that fusion is happening in the bomb as well as fission, another difference from a reactor. If students ask, explain that creating the conditions that allow a fusion is much more difficult when the fusion must be sustained.</p>

**Claim 2**  
**Nuclear plants don't emit green house gasses or air pollutants**

**TRUE**

The "smoke" you see rising from NPPs is water vapor—the same as steam or even a cloud.

Nuclear power plants do not burn fuel for heat, so they don't create gasses or particulates when they create electricity.



Palo Verde Generating Station



Continue as before, asking students if they thought the statement was true or false.

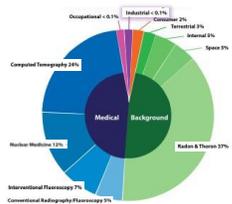
The photo is of Palo Verde Generating Station. Ask students what they think the "smoke" arising from the power plants is before revealing the supporting statements. Point out some of the structures visible in the photo. You may wish to point out that ANS has a virtual field trip of the Palo Verde Generating Station at <https://www.ans.org/nuclear/navigatingnuclear/virtualfieldtrips/#paloverde>

**Claim 3**  
**Nuclear power releases dangerous amounts of radiation into the atmosphere**

**FALSE**

Nuclear reactors are built with multiple layers of shielding to contain the radioactive substances.

If you lived within 50 miles of a nuclear power plant, you would receive an average radiation dose of about 0.01 millirem per year. A chest x-ray dose is about 10 millirem.



Sources of Radiation Exposure  
 Source: National Council on Radiation Protection & Measurements, Report No. 160



Before revealing the answer, ask students which portion of the pie they think nuclear power falls into. It isn't labeled as such. Nuclear power plants are listed in with industrial exposure. That portion of the pie will glow when the slide is advanced.

**Claim 4**  
**Nuclear power plants are some of the safest and most secure workplace facilities in the U.S.**

**TRUE**

Nuclear power plants are built and maintained to strict standards overseen by the Nuclear Regulatory Commission.

The U.S. Bureau of Labor reports that it is safer to work at a nuclear power plant than at a fast-food restaurant or grocery store.



Palo Verde Generating Station, generator floor



Point out that NPPs are regulated and overseen by the Nuclear Regulatory Commission and that such standards are set for worst case scenarios. Note that the people in the picture are not wearing hazmat suits because they are not in a high-exposure area. They are wearing head protection and safe shoes. They are also wearing ear protection, which can't be seen in the photograph.

**NUCLEAR ENERGY IS GREEN ENERGY**

- Nuclear power makes up 60% of our low-carbon energy
- Nuclear power plants take up less land
- Nuclear reactors can make electricity night or day, no matter the weather
- Nuclear is reliable—available 24/7



The above statement points out how nuclear energy compares to other green energy sources. You may also wish to point out that nuclear energy is available right now at significant capacity.

**AWIND FARM NEEDS 235 SQ MILES**  
to produce the same amount of electricity as a 1,000 megawatt  
**NUCLEAR POWER PLANT DOES IN <1%**  
of the same area

**ONE HALF INCH**  
URANIUM NUCLEAR FUEL PELLETS  
CREATES AS MUCH ENERGY AS:

**149**  
GALLONS OF OIL

**17K**  
CUBIC FEET OF NATURAL GAS

**ONE**  
TON OF COAL ORE

Energy Equivalents

Ask the students their thoughts about these statements. You may ask one or more to read the statements and have the class comment on the comparisons.

**It's good to be dense**

Uranium contains immense amounts of energy released through nuclear fission, not combustion

One kilogram of **uranium** is about the size of a **golf ball** - it could run a light bulb for **162 years**

One kilogram of **coal** could run it for **four days**

One solar panel could light it for less than **four hours**

YOU AND YOUR DESCENDANTS' LIFESPANS COMPARED TO A LIGHTBULB RUN ON 1 KILOGRAM OF URANIUM

This is a complicated slide. It contains numerous animations that demonstrate the advantage of uranium's density.

The lightbulb timeline will appear in stages, starting with the bulb turning on, then the first person. Each person is followed by another, the yellow timeline bar grows with each additional person until it goes out after 182 years.

The timeline is based on a 100-watt bulb glowing continuously. Lifespan of each individual is 80 years, and each has a child at 30 years of age.

Ask the students if they are surprised at the amount of time any of the energy sources can keep the bulb lit.

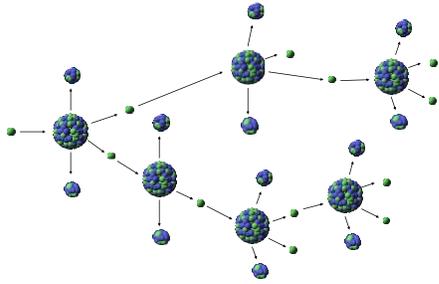
**Nuclear Fission**

- The nucleus vibrates and splits.
- A neutron strikes the nucleus of a heavy and unstable isotope.
- A nucleus being split results in fission.
- Heat energy is produced.
- The nucleus becomes unstable.

The statements in this slide are out of order. Ask the students if they can figure out, based on the illustration, what order the statements should be in. Give the students about 30 seconds to write down what they think is the proper order. Students are more likely to do this in groups.

When the students are ready, ask the groups to tell you what should go first. Then click to reveal the answer. Continue in the same way until all of the answers have been revealed. You can ask students if any of them got the whole order correctly.

### The Chain Reaction



This slide is animated. The title and a single uranium atom will appear, followed by a single neutron that strikes the atom. You will need to click through to complete the chain. You can use the following description to explain the chain reaction.

Neutrons are released in the reactor core. The neutrons released strike other uranium atoms, causing them to fission. This fissioning continues in a chain reaction, like dominos falling.

### ACTIVITY BREAK

At this point, you may wish to demonstrate a chain reaction with dominos. Make a domino chain and ask a student to start the reaction. All the dominos should fall. Rebuild the chain, then challenge students to control the chain, making it stop or slow. Give the students about a minute to consult and figure out a solution.

Afterwards, explain how fission is controlled in a reactor. You may use the following explanation.

Neutrons are fast, so a moderator is used. The moderator slows neutrons to ensure they strike  $^{235}\text{U}$  atoms, continuing the chain reaction.

Control rods keep the reaction in check. Reactor operators raise or lower them depending on the need.

When the reaction is self-sustaining, the reactor has achieved criticality.

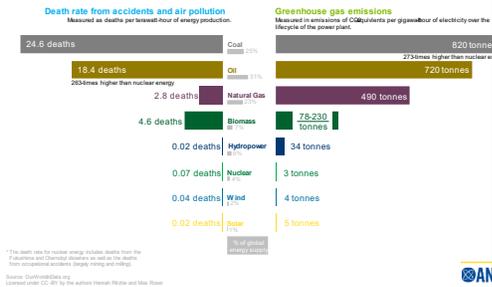
### What happens in a nuclear reactor?



There is a video embedded in this slide. It is an mp4 format that will play on a Mac or PC. The video explains what happens in the reactor core as well as what happens to the steam created in the core.

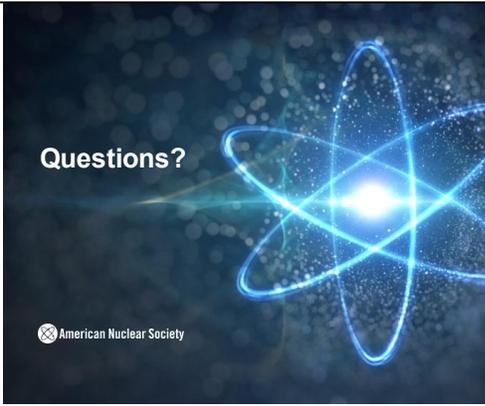
Note that the water that circulates in the reactor core is completely isolated from the water outside the core.

## What are the safest and cleanest sources of energy?



This slide is animated. First, it will show the percentage of energy world-wide generated by source. Then, it will show the rate of deaths caused by each source, followed by the number of emissions per source. This is a slide using global data, so tons is spelled tonnes.

Before proceeding to reveal safest sources, ask students to predict what the safest and most dangerous might be. Do the same with emissions per source.



Take students questions. If time permits, use the ANS Radiation Dose Calculator to calculate each students' annual radiation dose. You may also leave copies with students to use later.