

NUCLEAR POWER & CAREER PATHS



Agenda

- Our Path to Nuclear Power
- Electricity Basics and the Grid
- Nuclear Power & Safety
- Used Nuclear Fuel and Reprocessing
- Break
- Careers & Education
- Education Pathways
- Q&A
- Tour Reminders



Julie Weber

- Mechanical Engineering Degree from Cal Poly Pomona, CA
- 2007 – Probabilistic Risk Assessment Engineer
 - San Onofre Nuclear Power Plant (CA)
- 2009 - Probabilistic Risk Assessment Engineer
 - Monticello Nuclear Power Plant
- 2013 - Control Room Supervisor at the Monticello Nuclear Power Plant
 - Senior Reactor Operator License
- How did I choose nuclear power for a career?



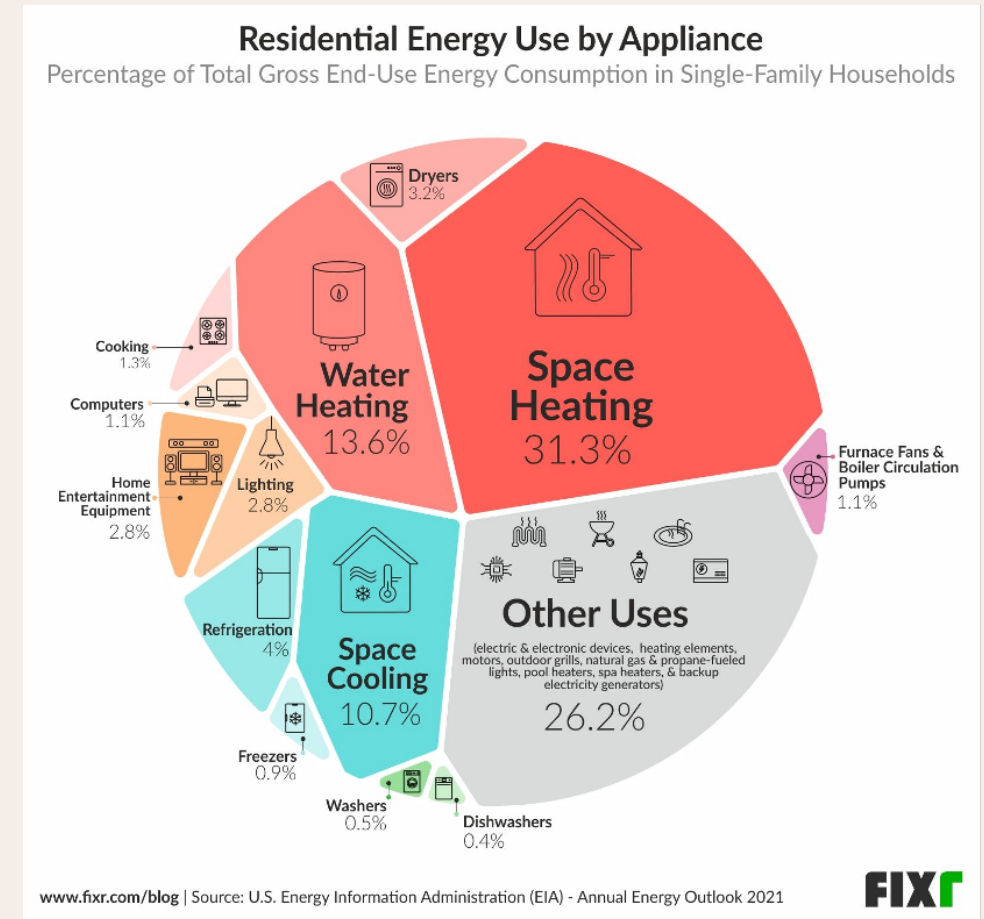
Judy Gutridge

- B.S. Degree in Ecology & Water Quality from St Cloud State University
- Teaching Licensure, Science 5-12 from St Scholastica, Duluth
- 2019 – Science and Math teacher, grades 5-8
 - St Francis Xavier School, Buffalo MN
- 2024 – Operations Training Instructor
 - SRO Certification (in progress)



Our World Thrives With Electricity

- Take a minute and consider the room you are in right now. How much in it needs electricity to work?
- When we flip the switch or turn on the widget, we expect the power to be there.
- Imagine your morning routine with no electricity.



Making Electricity in Minnesota

Black Dog Generating Station (Natural Gas)



Monticello (Nuclear)



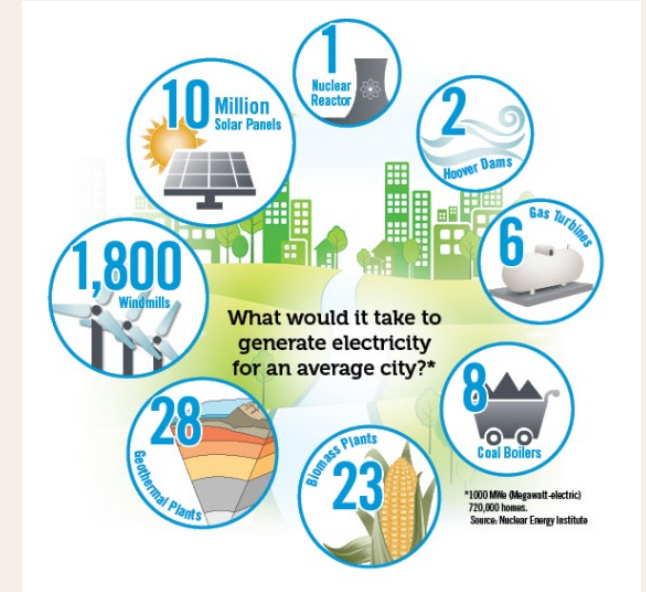
SherCo Generating Station (Solar & Coal)



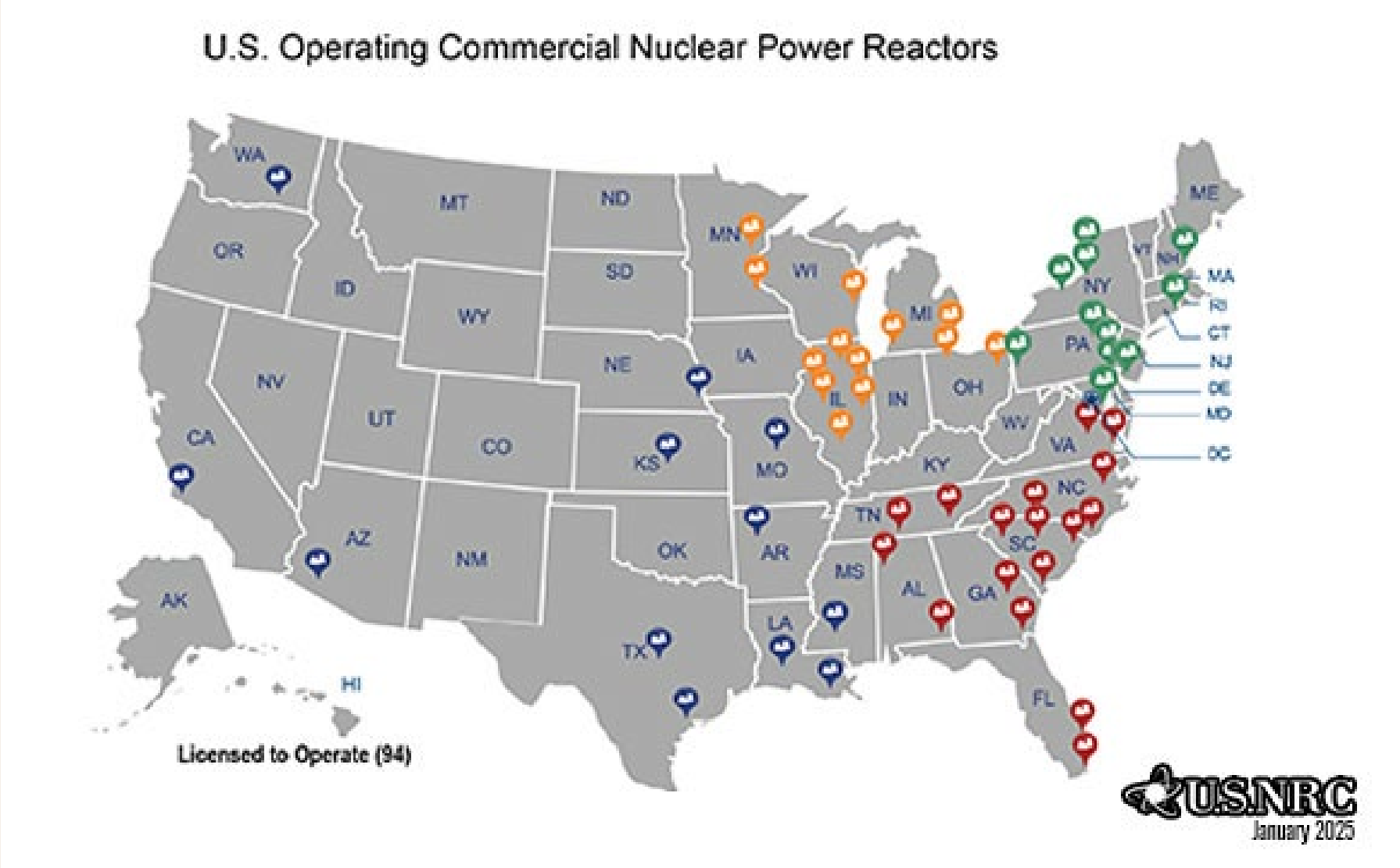
Prairie Island (Nuclear)



Buffalo Ridge (Wind)



Nuclear Power Plants Across the United States



Capacity Factors for US Energy Sources

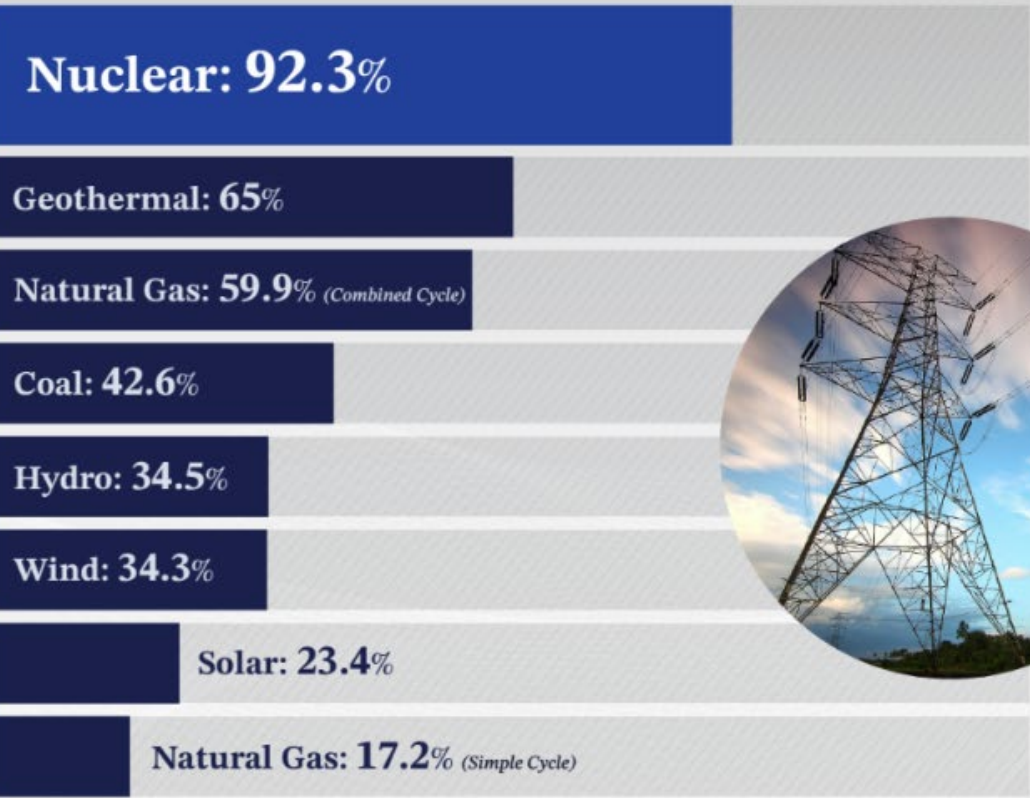
Capacity Factor by Energy Source, 2024

Source: U.S. Energy Information Administration

Capacity factor measures a power plant's actual generation compared to the maximum amount it could generate in a given period without any interruption.

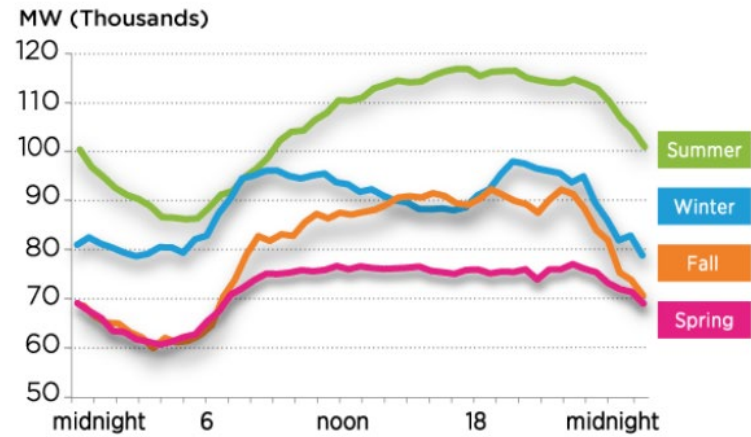


U.S. DEPARTMENT
of **ENERGY** | Office of
Nuclear Energy



energy.gov/ne

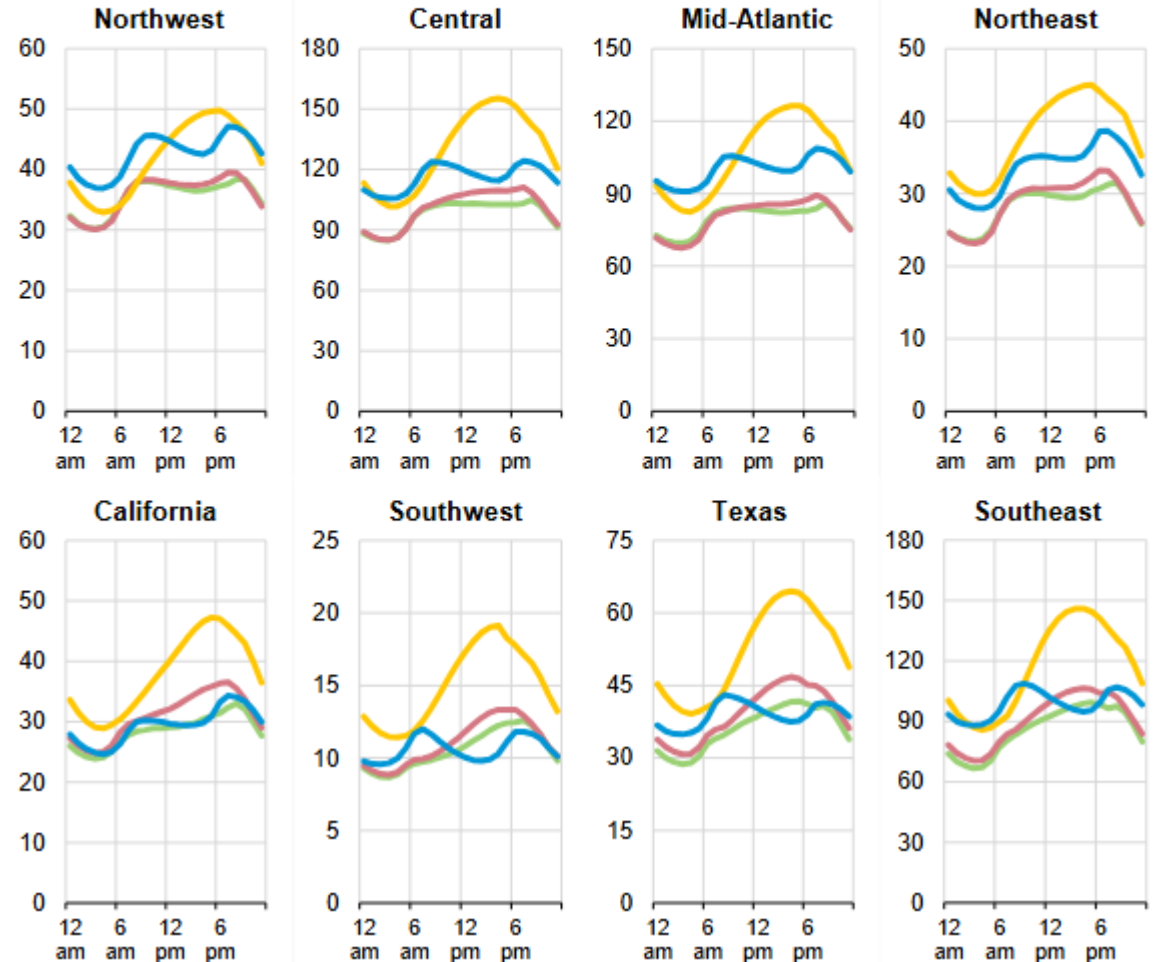
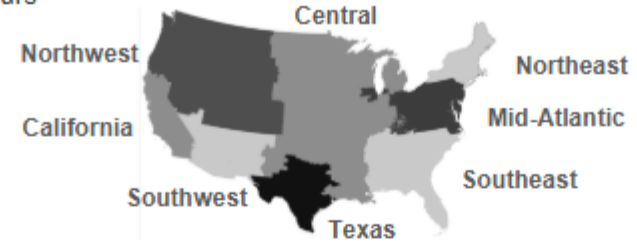
The Grid and Seasonal Changes



2003 North-East Blackout

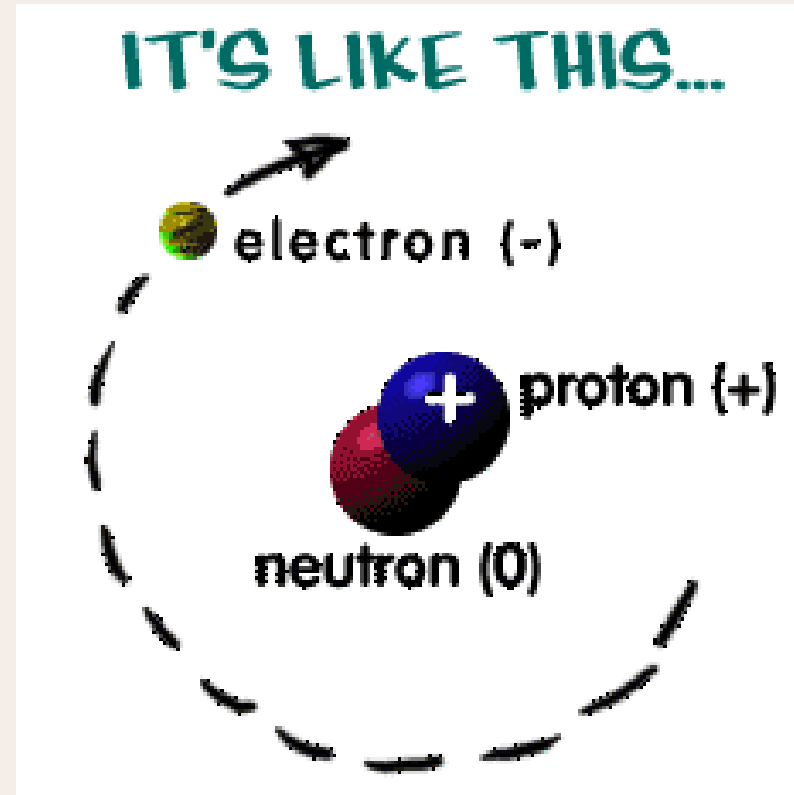


Average hourly electricity load during typical day by region, selected months
million kilowatthours



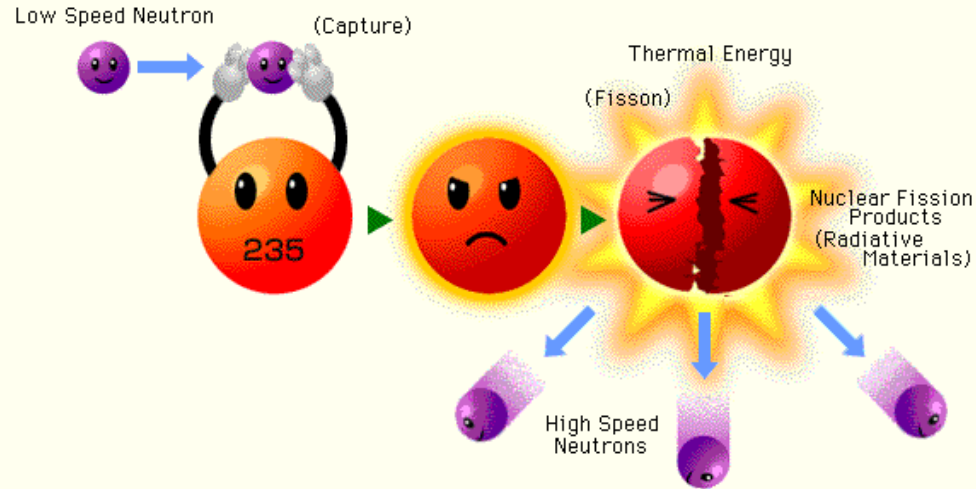
Time to Get Nuclear - Remember the Atom?

- In the middle
 - Protons
 - Neutrons
- On the outside
 - Electron

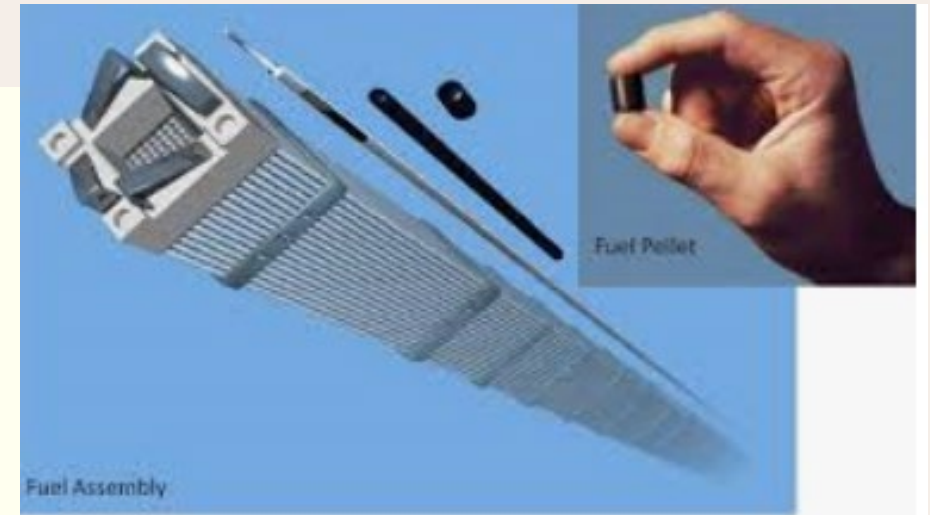


What is Fission?

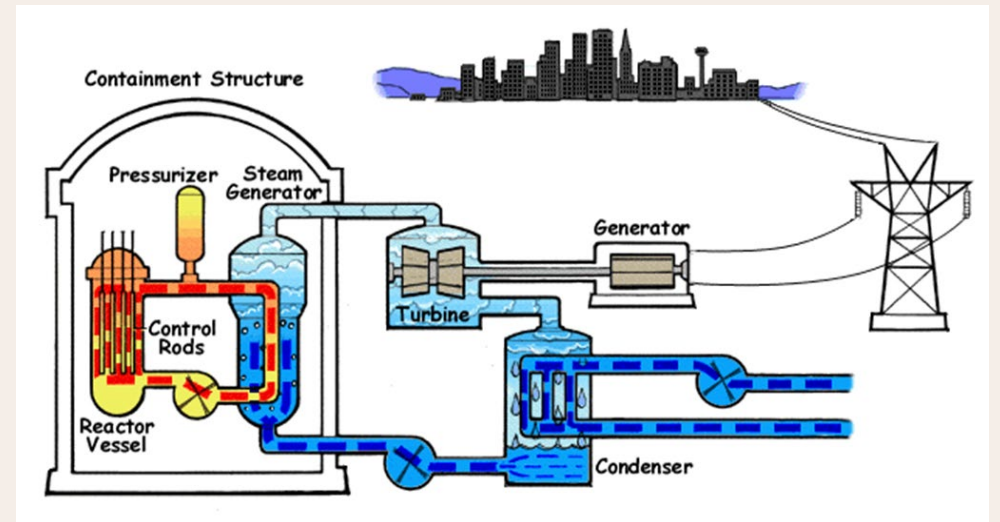
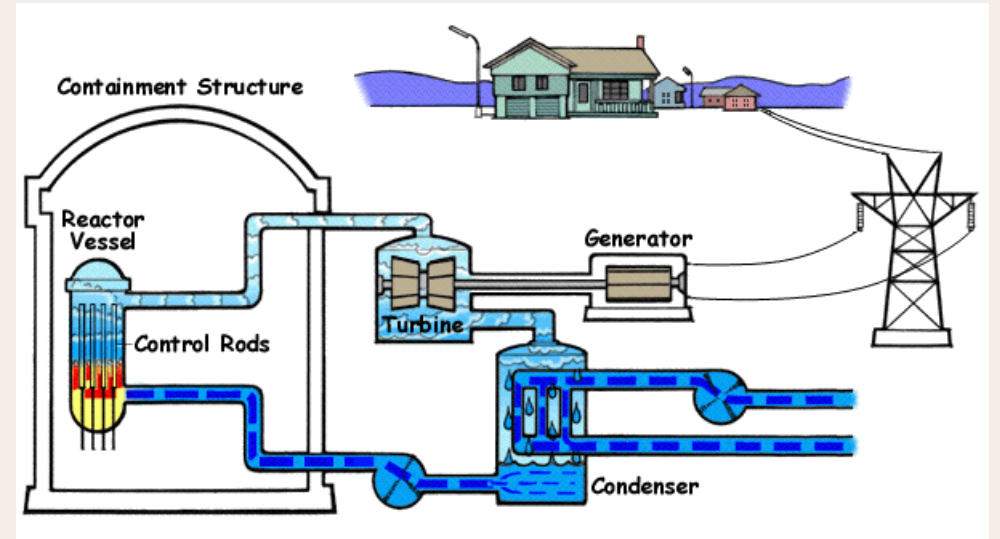
- Neutrons collide with the nucleus of the uranium atoms, which split and release energy in the form of heat.



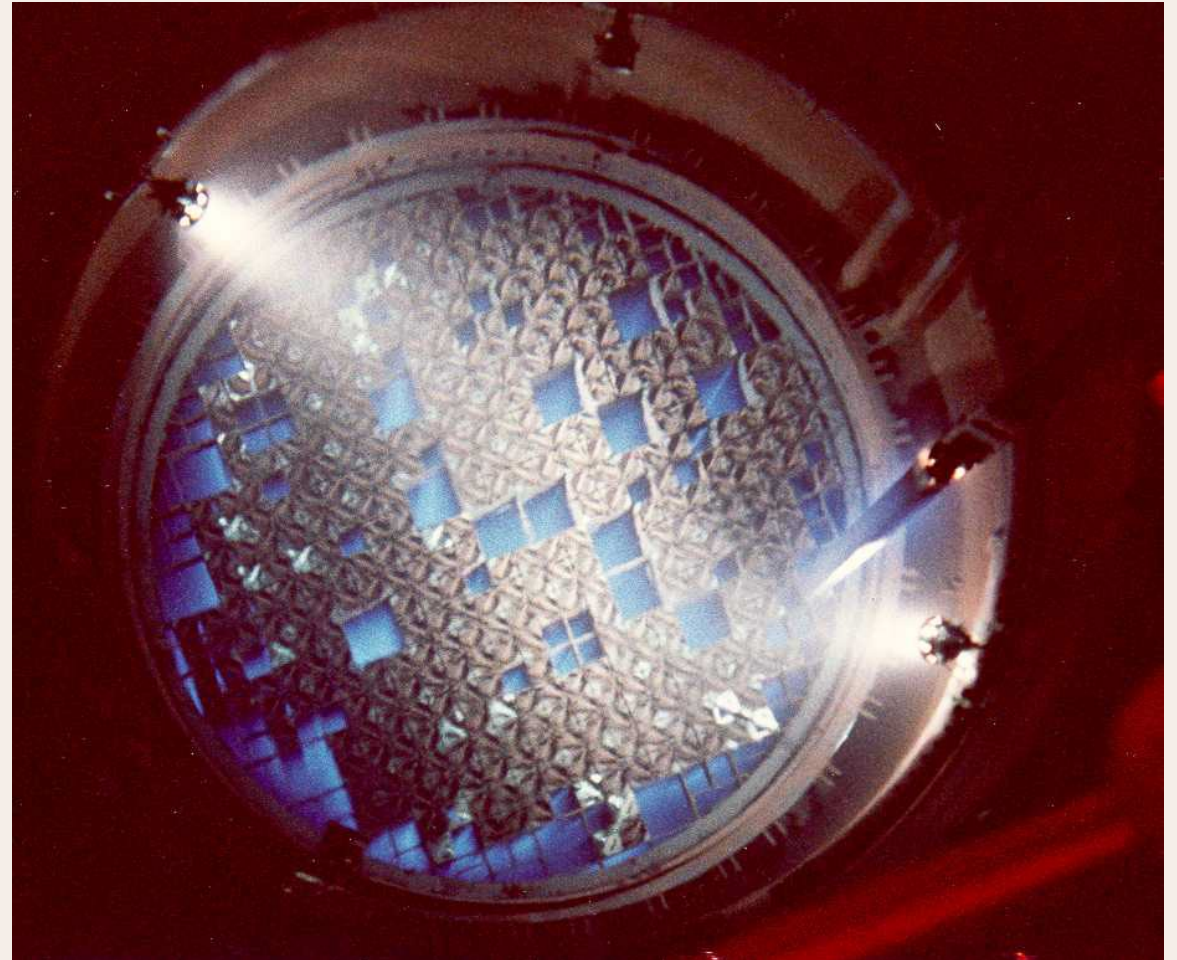
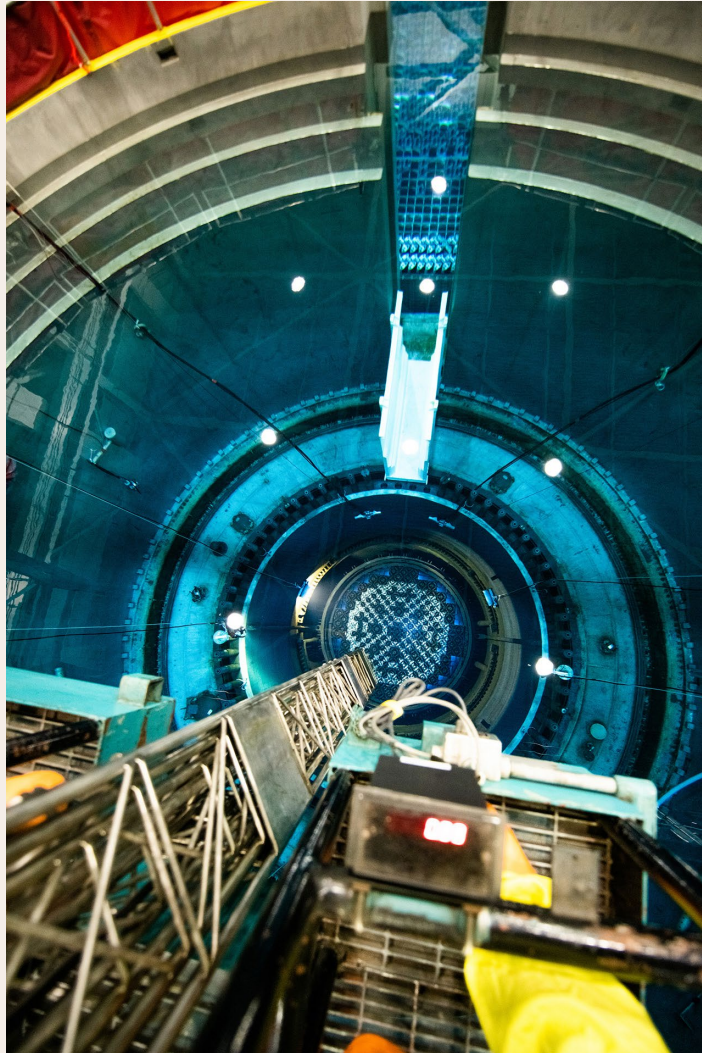
Uranium 235 fissions, giving off energy, fission products, and high energy neutrons.



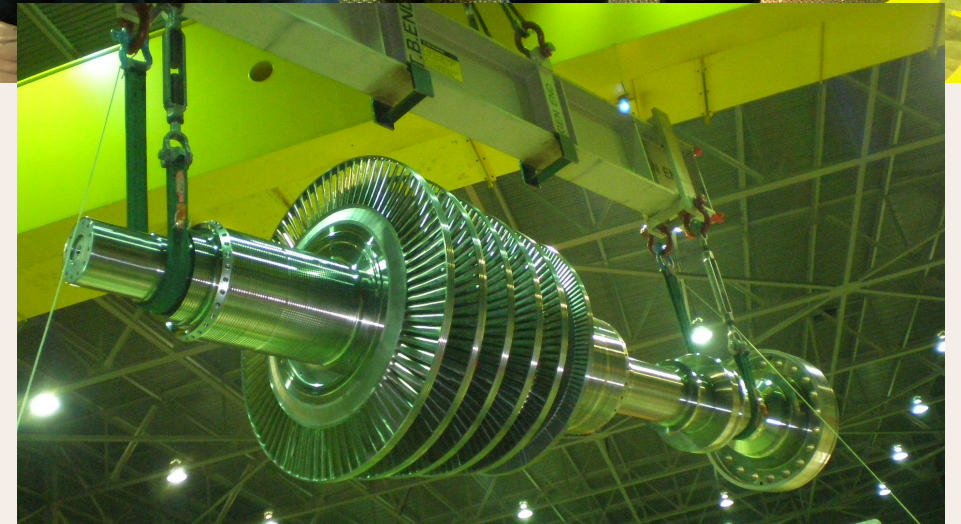
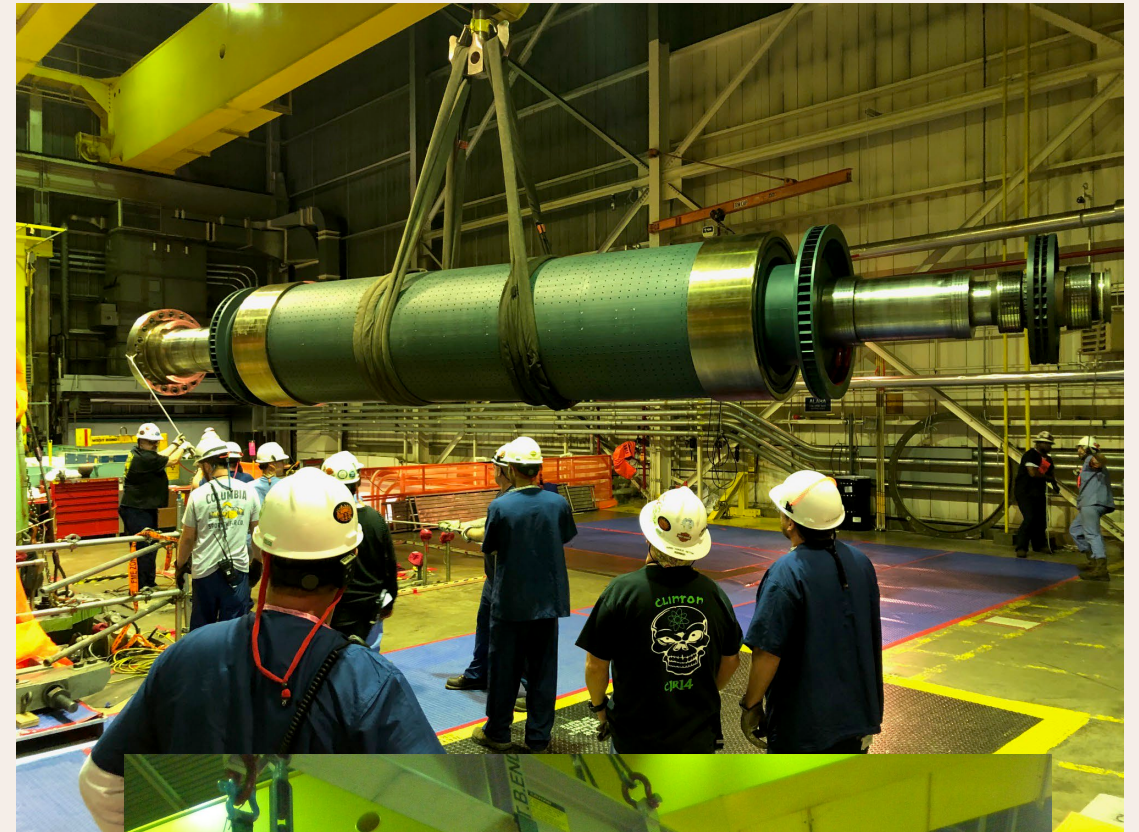
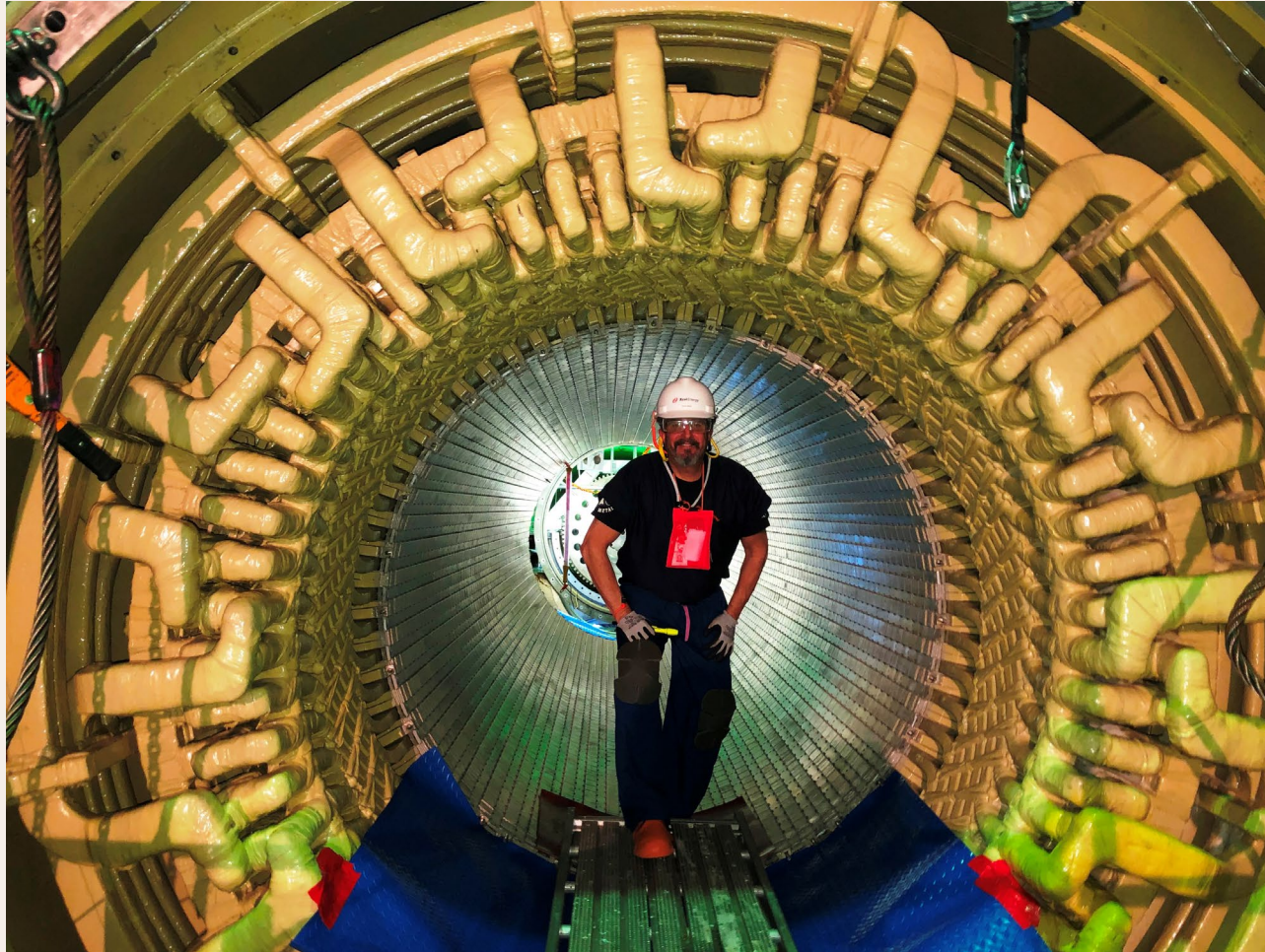
Boiling Water vs Pressurized Water Reactor



Refueling the Reactor & Cherenkov Effect



Generator and Turbine



What is Radiation?

- Radiation is energy that comes from a source and travels through some material or space
- 2 kinds of radiation
 - Non-ionizing – heat, light, radio waves
 - Does not change atoms
 - Ionizing – alpha, beta, gamma, neutron x-rays
 - Excessive amounts can change atoms
- If you can't see, smell, taste or feel radiation - how do we know where it is?



Detecting Radiation

- We detect radiation with Geiger-Mullers

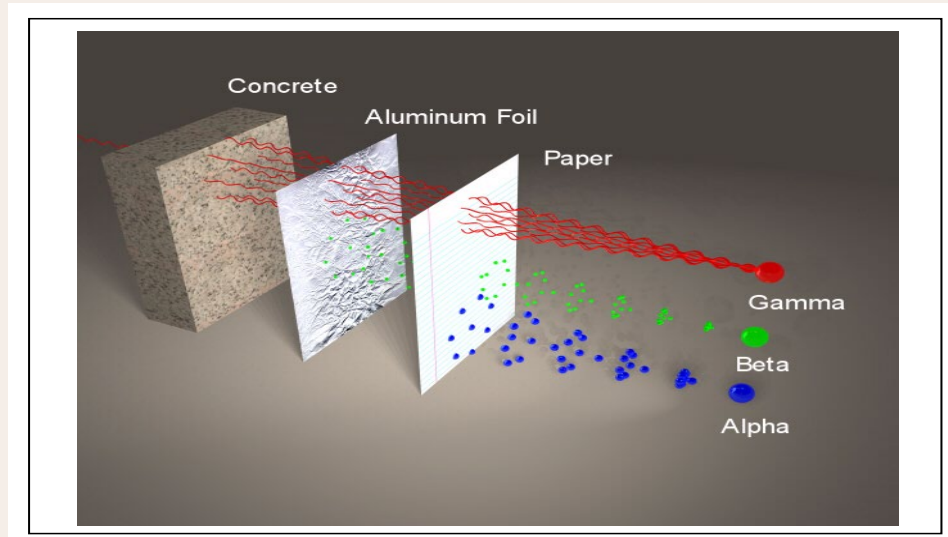


- Do the yellow suits protect against radiation?
 - Nope, they are used for contamination control



Radiation Exposure

- Radiation is often NOT harmful – we are exposed to radiation just by living on earth!
- Known effects above 75,000 mREM, unclear below that number as each body is different.
- People with rapidly dividing cells are impacted more by radiation (babies) vs the elderly.
- Radiation is inevitable. We are all exposed to ~300 mRem of background radiation each year.
- All atoms – people, animals and even materials can be affected by ionizing radiation.





Natural Sources of Radiation Exposure

Background Radiation Sources:

200 mRem/ year from breathing air

40 mRem/year from food – potassium 40 (bananas, carrots, potato, red meat, peanut butter)

- Potassium decay inside our bodies from food causes us to give off 3 mRem/year of radiation.

Where you live matters - @ sea level is 26 mRem/yr while @8,000-9,000 ft above sea level is 96 mRem/yr

YOU are radioactive! A person has about 1.5 micrograms of Carbon-14 ($1/3000^{\text{th}}$ of a grain of sand).

- No Carbon-14 fairies come around after living beings pass away to sprinkle them with Carbon-14

Radiation Exposure in Life

Secondhand smoke – From the Environmental Protection Agency

“Toxic chemicals in tobacco smoke are the main reason cigarettes cause cancer, but radiation also may play a part...Polonium-210 is an alpha emitter and carries the most risk.”

Jet plane travel

0.5 mRem/hr in flight because you are closer to natural cosmic radiation

Medical Radiation Exposure Examples:

Chest X Ray = 10 mRem	Dental X-Ray = 0.5 mRem	Hand X-Ray = 0.1 mRem
Head CT Scan = 200 mRem	Whole Body = 1275 mRem	Hand CT Scan = 10 mRem

Radiation Exposure at Work

Anne and Julie were both Control Room Supervisors when pregnant.

Anne's radiation exposure while pregnant:

- From the plant: 0.4 mrem
- From background radiation: ~300 mrem

Julie's Radiation Exposure when pregnant:

- Radiation exposure from air travel: 13 hrs (MN to west coast twice) + 21 hrs (Europe) = 34 hrs of flight → ~ 17 mRem
- Radiation exposure from year of working at the plant = ~12 mRem
- Background Radiation: ~300 mRem/year



Nuclear Power is Safe

For every 100,000 workers, there are the following number of fatalities (OSHA):

Logging = 100.7

Roofers = 57.5

Fishing/Hunting = 50.9

Helpers in Construction = 38.5

Pilots and Flight Engineers = 35.9

Sales/Truck Drivers = 30.4

Refuse and Recycle Collectors = 22.6

Iron & Steel Workers = 21.3

Misc Agriculture Workers = 20



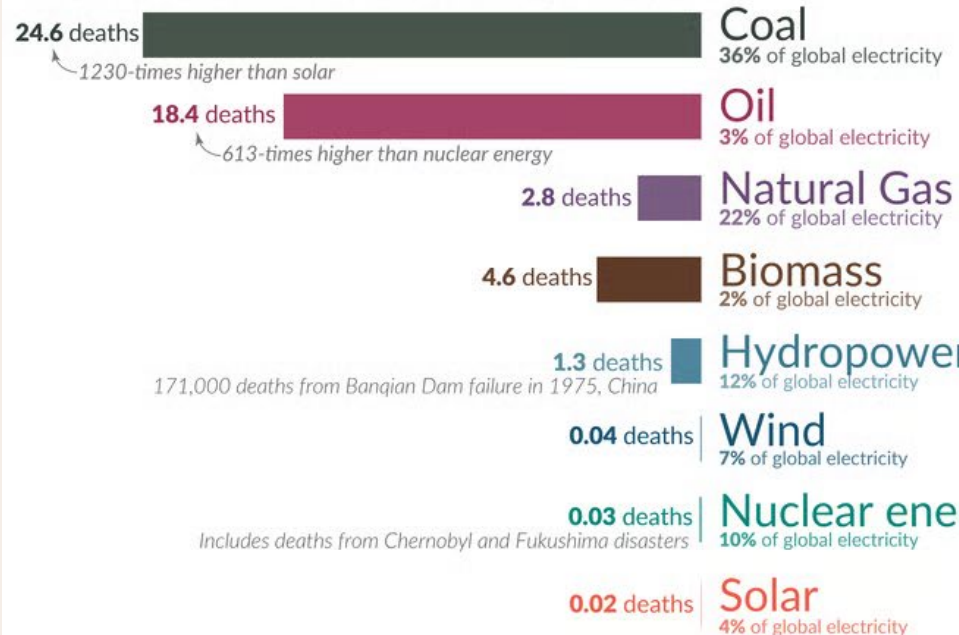
Nuclear Power is Safe

What are the safest and cleanest sources of energy?

Our World
in Data

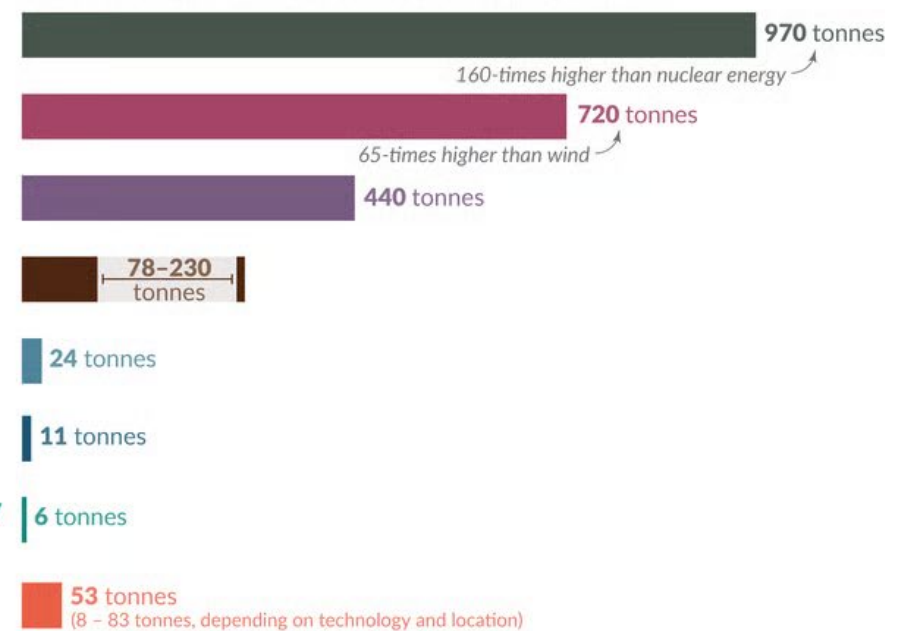
Death rate from accidents and air pollution

Measured as deaths per terawatt-hour of electricity production.
1 terawatt-hour is the annual electricity consumption of 150,000 people in the EU.



Greenhouse gas emissions

Measured in emissions of CO₂-equivalents per gigawatt-hour of electricity over the lifecycle of the power plant.
1 gigawatt-hour is the annual electricity consumption of 150 people in the EU.

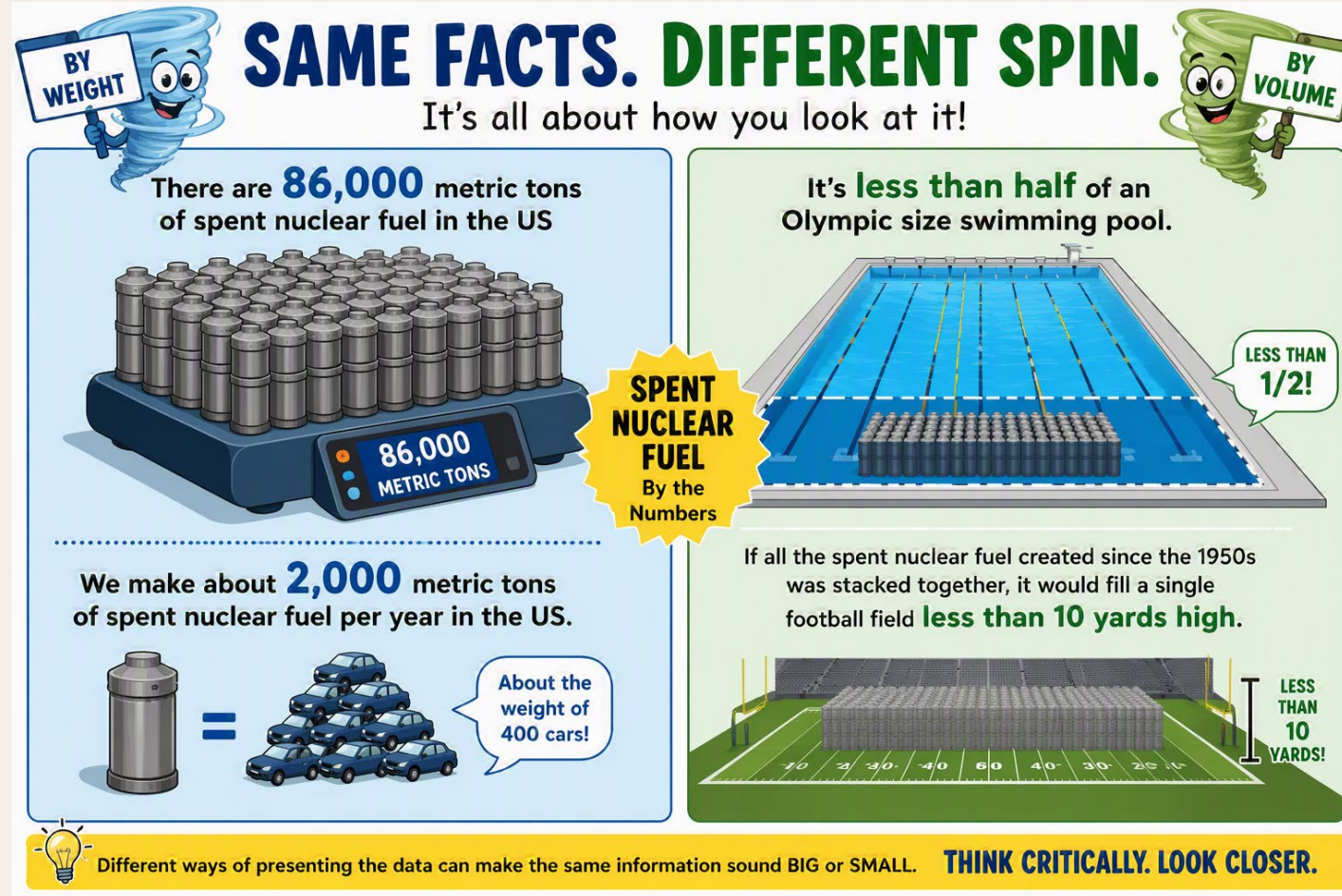


Death rates from fossil fuels and biomass are based on state-of-the-art plants with pollution controls in Europe, and are based on older models of the impacts of air pollution on health. This means these death rates are likely to be very conservative. For further discussion, see our article: OurWorldinData.org/safest-sources-of-energy. Electricity shares are given for 2021. Data sources: Markandya & Wilkinson (2007); UNSCEAR (2008; 2018); Sovacool et al. (2016); IPCC AR5 (2014); UNECE (2022); Ember Energy (2021).

OurWorldinData.org – Research and data to make progress against the world's largest problems.

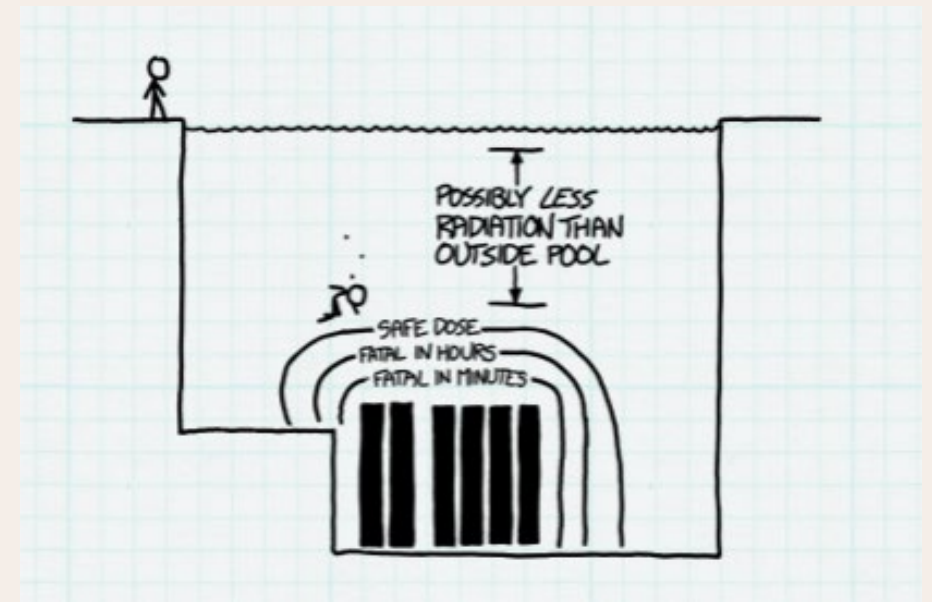
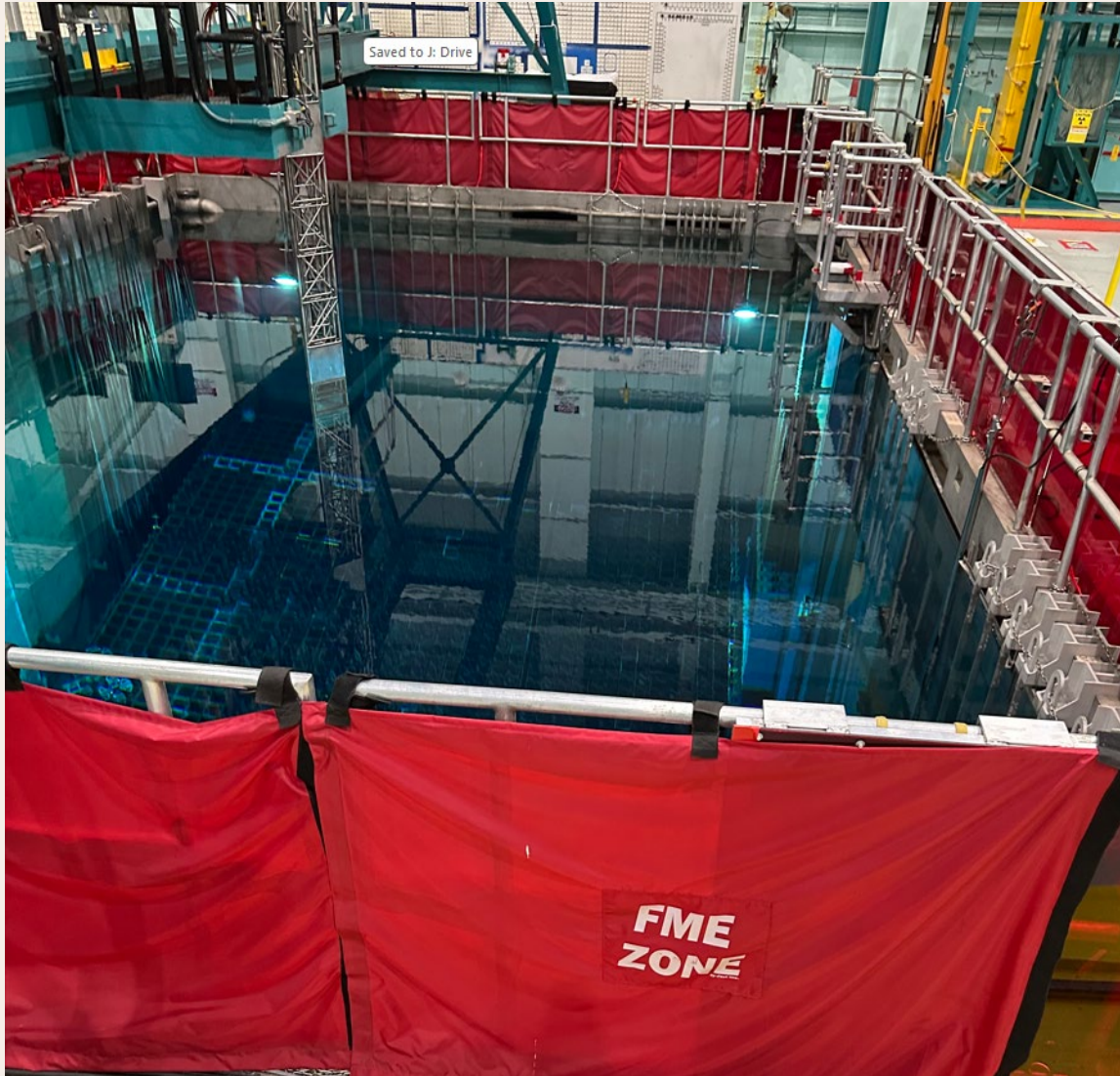
Licensed under CC-BY by the authors Hannah Ritchie and Max Roser.

Spent Nuclear Fuel



The clean energy generated from this fuel would be enough to power more than 70 million homes—avoiding more than 400 million metrics tons of carbon dioxide emissions.

Safe Storage of Spent Nuclear Fuel



Spent Nuclear Fuel - Reprocessing

What is Reprocessing?

Most people think of spent nuclear fuel as "waste," but spent fuel still contains a lot of usable material.

According to a recent Congressional Research Service report, spent nuclear fuel is approximately:

- 95% uranium

- 1% plutonium

- 4% fission products and other materials

Reprocessing is a chemical process that separates the reusable uranium and plutonium from the remaining waste products. The recovered materials can then be made into new reactor fuel.

We don't reprocess in the US for a variety of reasons (federal laws, economic) but it does exist in France, Russia and Japan.

BREAK TIME



Work Expectations

- Alcohol and drug free – random drug testing occurs in nuclear power
- Although legal in MN, marijuana use is not allowed in any amount, at any time during your employment
- Additional medical screening/monitoring for Operators
- We will teach you about the power plant
- Training is ongoing, sometimes there are tests and you need 80% to pass
- Maintenance and Operations can be physically demanding
- Refueling outages requires everyone to work 12-hour shifts, 6 days a week, half the people on night shift



Work Culture

- High standards of work quality
- Work by approved procedures – no tolerance for “I’ll just try it and find out how bad it is”
- Expect employees to ask questions and take the time you need to do the job right the first time
- Troubleshooting may require quick transitions to new tasks
- Heavily rule based and process driven decision making

Careers

Job	Salary	Education
Operator	\$70,000 – \$200,000	2 year degree in power systems or similar, EEl test
Control Room Supervisor	\$160,000 – \$200,000	4 year technical degree + Senior Reactor Operator License (18 months of training given by Xcel Energy)
Engineer	\$80,000 – \$180,000	4 year engineering or engineering technology degree Make sure your school is ABET certified!!!
Maintenance	\$60,000 – \$150,000	2 yr degree in power systems or similar, EEl test
Plant Helper	\$25/hr	High School diploma
Admin Assistant	\$22/hr	High School diploma, 2 year certificate in business or similar subject preferred
Department Manager/ Corporate Manager	\$300,000 and up	4 year technical degree, Masters in business, preferred to have Senior Reactor Operator License

Xcel Energy will support a portion of higher education expenses

Trades – IBEW Union Members

Examples of trade roles:

- Operations
- Plant Helper
- Maintenance – Mechanical, Electrical, Instrumentation & Control
- Chemistry Technician
- Radiation Protection Technician
- Planner

Trades have an apprenticeship program to ensure you learn the skills you need to do your job.

4-year degree is NOT required!!!! Associates degrees in energy programs or energy adjacent programs are enough.

Operations, Maintenance and Plant Helpers will require passing the ‘EEI test’.

EEl Testing Information

The EEI (Edison Electric Institute) Test is a series of pre-employment cognitive and aptitude assessments used by major energy and utility companies to evaluate candidates for roles like line workers, plant operators, and administrative staff.

POSS - Plant Operator Selection System

MASS - Power Plant Maintenance Positions Selection System

Practice tests are available for free - <https://eeitests.org/onlineproducts/Login.aspx>

Once you apply for a job, you will likely get an invitation to take the test.

<https://getintoenergy.org/why-work-in-energy/>

Trades – Operations

Operators run the power plant.

Routine Tasks

- Monitoring equipment by taking data each shift
- Shutting down equipment for maintenance
- Starting equipment after maintenance or for required testing

Non-Routine Tasks

- Car example - If you get a flat while driving, an Operator would be driving the car and get the car to a safe place to have the tire changed.
- Operators keep the plant in a safe condition at all times



Trades – Plant Helper

Make sure all the small things you need to get work done are there when you need it.

- Moving materials from warehouse to plant specific locations.
- Fire watch during hot work (ex: welding)
- Janitorial/lawn/snow removal
- Foreign Material Monitoring
- Decontamination activities
- Confined Space Attendant
- Security escort for visitors



Trades – Mechanic/Electrician/Instrumentation & Controls

Maintain the pieces of the plant - if it moves or needs power, Maintenance takes care of it.

Car Preventive Maintenance Examples

- Oil change, brake pad replacement, fluid flush, tire rotation
- Does your fuel gauge say you have fuel, but the tank is actually empty? (Calibration)

Car Corrective Maintenance Examples

- Air conditioner fluid leak
- Flat tire

Maintenance also does a lot of lifting of heavy equipment with cranes, rigging, forklifts, etc.



Trades – Chemistry

Take samples and monitor various liquid sources around the plant to make sure we follow all industry, state and federal rules.

Plant Systems

- The water in our reactor has very tight chemistry limits.
- Make sure reactor water stays in the places it's supposed to be.

Environmental Monitoring

- The environment should not see that we have a nuclear reactor here.
- The river water comes into our plant, gets warm, then goes back into the river. Nothing else is added to the river.
- Ground water levels rise and falls with natural water table shifts and is not impacted by the sites.



Trades – Radiation Protection Technician

Make sure people work as safely as possible around radiation.

- Use special detectors to measure radiation.
- Control access to areas with higher radiation levels.
- Make sure workers have the right training and tools.
- Monitor and track radiation received by workers.
- Trained to help protect workers, the environment and public in emergencies.

Think of Radiation Protection as a combination of a school nurse, safety officer, and weather forecaster. They continuously monitor conditions, provide guidance before people enter certain areas, and help everyone stay safe while doing their jobs.



Trades – Planner/Scheduler

Does **NOT** require the EEI test.

Write the instructions for a majority of work at the plant and schedule the work at the safest time.

Work plan details include:

- Specific parts needed
- Steps to be performed in the right order
- Notes/reminders from engineering or past maintenance for tricky steps
- Required testing to show the equipment operates at high standards after work is done



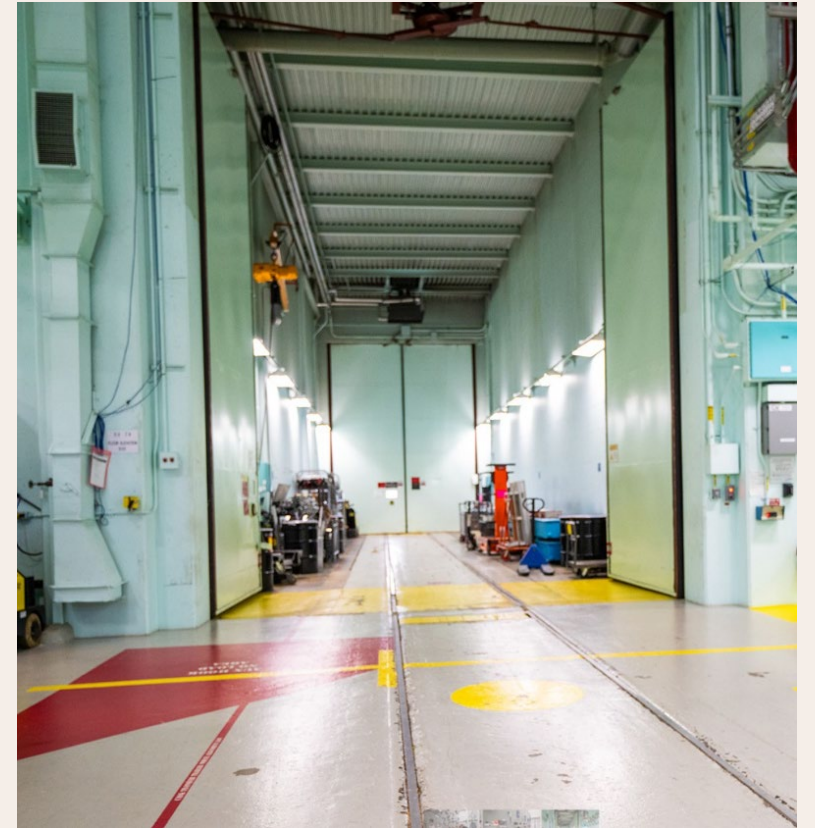
Supply Chain

At your schools, these people would order textbooks, computers, science lab supplies, replacement parts, and arrange for contractors to fix things.

In nuclear power, they would:

- Buy equipment, tools, replacement parts
- Find qualified companies to do specialized work
- Make sure parts follow strict material standards
- Keep track of on hand supplies and material

Does **NOT** require the EEI test. “Expeditor” role only requires a High School Diploma!



Engineering

- ABET vs non-ABET degree programs
 - **THIS WILL IMPACT YOUR PAY FOR YOUR WHOLE CAREER!**
 - Ex: Electrical Engineering vs Electrical Engineering Technology
- Mechanical Engineering & Electrical Engineering are most needed
- Some Nuclear Engineering and Civil Engineering
- Few Chemical or Environmental Engineering
- Bachelors degree is enough!
 - Technical masters are fine, but they won't significantly change your initial career hiring.
 - Masters in Business Administration is likely to be more valuable to move up.

Engineering

Engineers solve problems – sometimes it's a math problem, sometimes it's a “pick the new kind of thing to use” problem.

Multiple Departments within Engineering

- Design plant changes and improvements
- Troubleshoot complex challenges
- Trend and monitor plant performance
- Implement various rules and standards for plant equipment

Engineering roles include desk work and field work – how much of each depends on the department.



Training – Operations and Technical

Training and continuous learning is a BIG DEAL in nuclear power.

Operations:

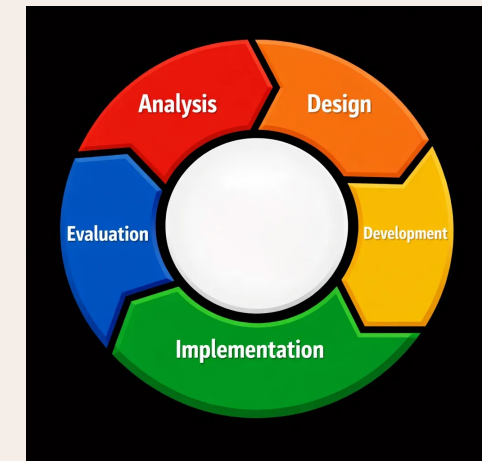
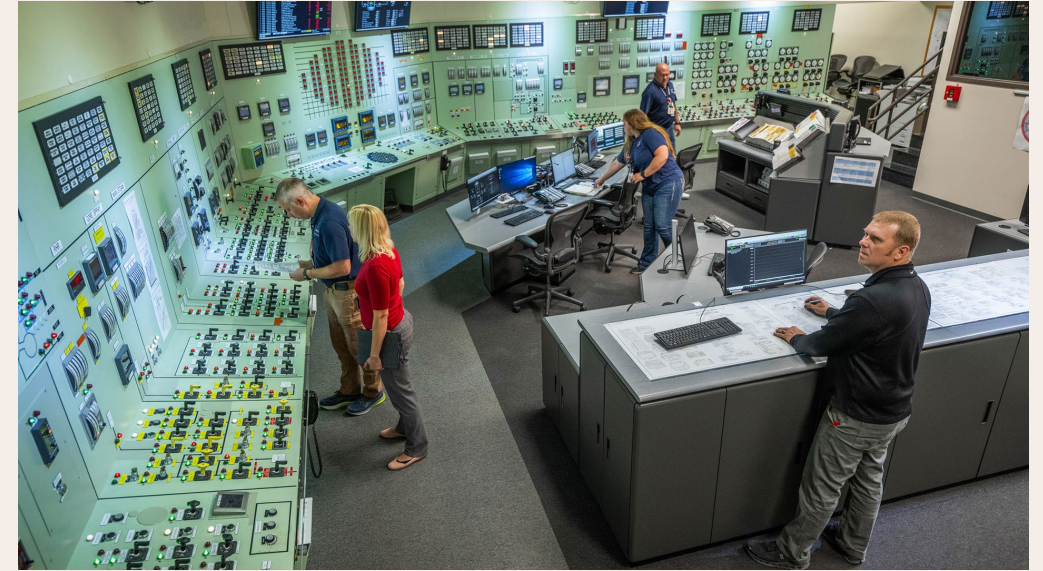
- Continuing training for licensed operators (LOR) and non-licensed operators (NLO)
- Initial License Training (ILT)

Maintenance and Tech:

- Continuing training for all programs

Use the Systematic Approach to Training (SAT) process to create and maintain our training program.

Commercial nuclear power is an excellent post nuclear military path!



Other Career Paths

Xcel Energy Employees

Business or Finance Degree

- Supervision
- Data Management
- Business Metric
- Payroll

Project Management

- IT Software Implementation
- Plant Building/Infrastructure Improvements
- Plant Modifications

Contract Employees

Westinghouse

- Construction Laborers
- Scaffold Builders
- Specialty Maintenance

Allied Universal Security Services

- Security

Commercial nuclear power is an excellent post nuclear military path!

If a Power Plant was a Puzzle...



Women in Nuclear Member Visits to Your Class

This program is sponsored by Xcel Energy and our Women in Nuclear Chapter.

If you'd like Xcel Energy Women in Nuclear members to visit your school or to set up a field trip to our Prairie Island or Monticello Training Center for your students, please email

XEWomenInNuclear@xcelenergy.com

Visits to your schools are a lot easier to coordinate timing wise as we mainly need to coordinate around school schedules.

Visits to our Prairie Island or Monticello Training Center require coordination around our training programs in addition to school schedules. It is common to have a day or less of availability per week for tours around our training needs. Please reach out early if you are looking to visit us.

Tour Reminders

Valid ID (the actual card) and your social security number (not the card) are required. This is a non-negotiable with security.

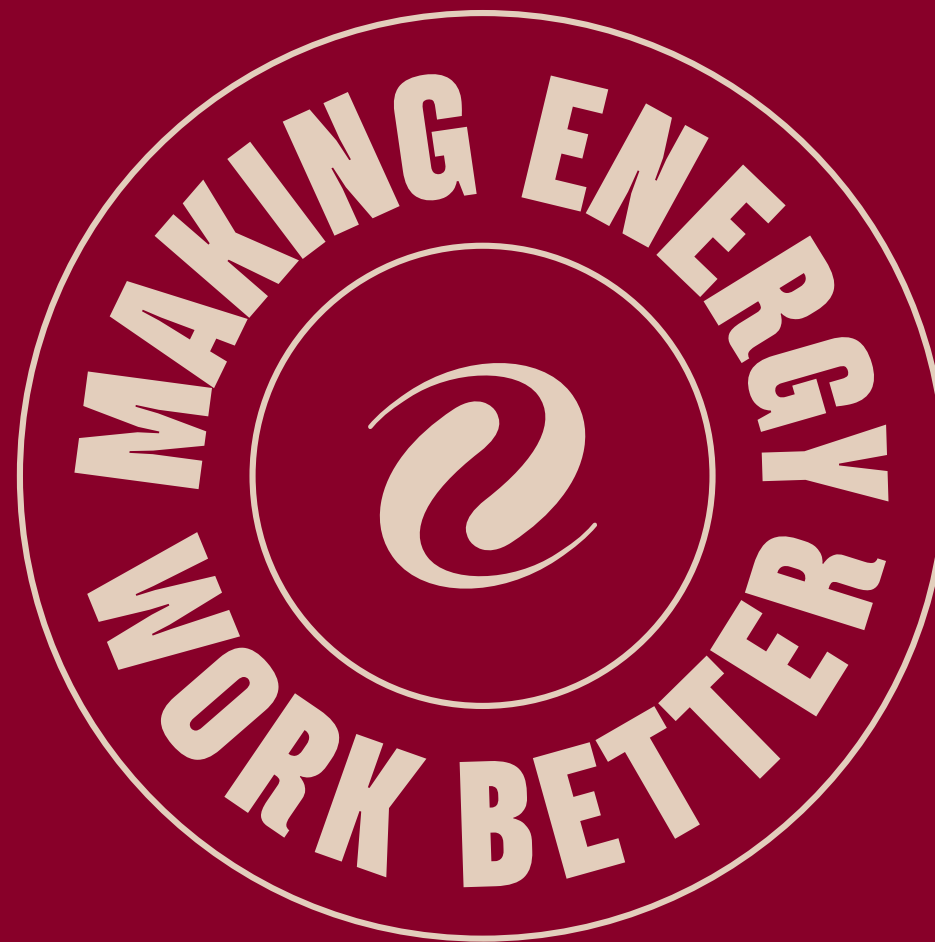
100% cotton clothes and sneakers are recommended. The plant will be warm. Expect to be a little sweaty by the end of your tour.

Review your email for items NOT to bring.

We will provide light refreshments and water.



THANK YOU.



[xcelenergy.com](https://www.xcelenergy.com)

