NPRE 442
Radioactive Waste Management

Prof. W. R. Roy



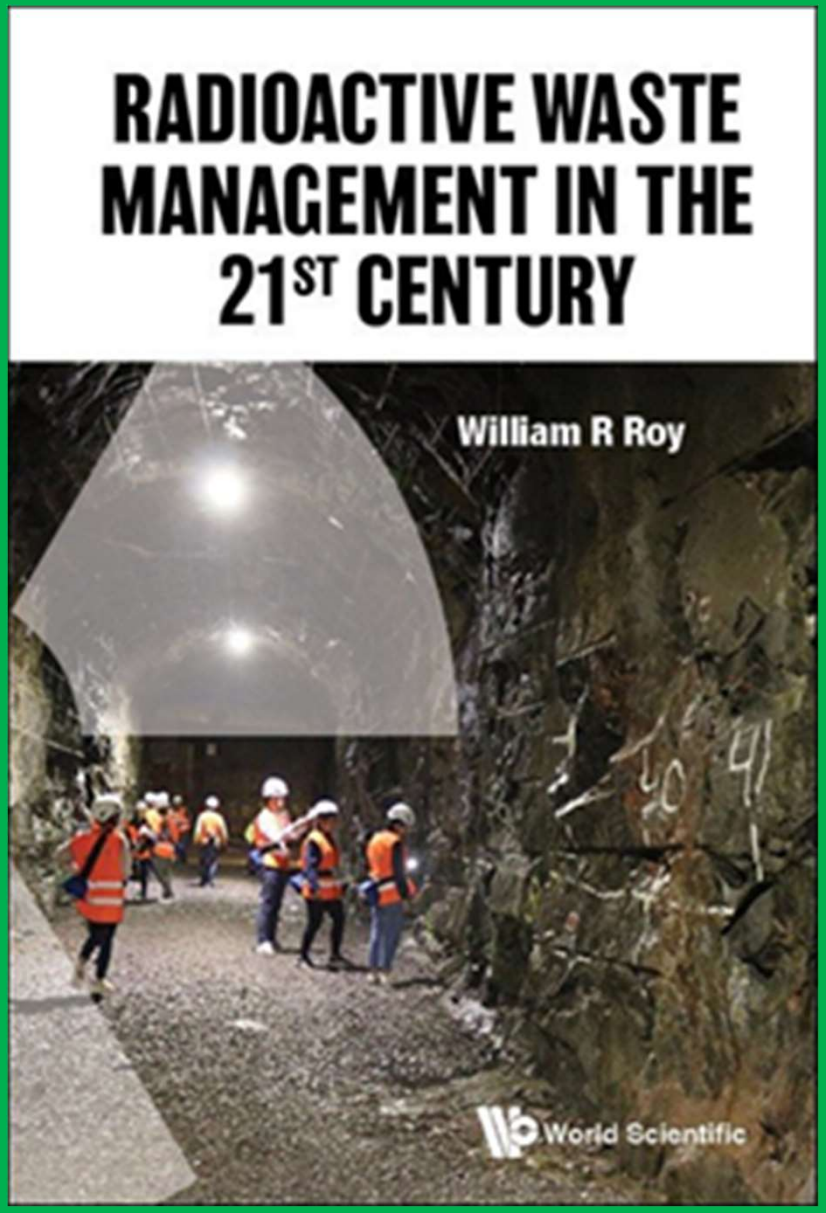
“He had no idea of the journey we were about to take.”
—Henry Lawson in “Journey to the Center of the Earth” by Jules Verne.

Welcome to NPRE 442!

The goal of this course:

Connect a group of engineering- and science-oriented students with the current and future issues resulting from the management of radioactive, hazardous, and mixed wastes created by nuclear energy, research, medicine, industry, and by defense activities.

Textbook for NPRE 442



Course Website

http://wiki.cites.illinois.edu/wiki/display/NPRE442sp12/Home

Home

Created by Unknown User (suelb), last modified by Roy, William R on Dec 13, 2021

Nuclear, Plasma, and Radiological Engineering, NPRE 442

Radioactive Waste Management

Spring 2022 in 3018 Campus Instructional Facility

About this course:

While some students will seek waste-management occupations when they graduate, it would be beneficial to all advocates of nuclear energy to have some unbiased knowledge about how radioactive wastes are managed. Students in geology and environmental engineering will also benefit from taking this course because many of the options for managing both low-level and high-level radioactive wastes overlap with site geology, groundwater impacts, air-quality issues, environmental impact assessments, and environmental restoration. The public generally fears anything radioactive, and has no real understanding about exposure and risk. The content of the course will attempt to convey to the students that there *are* solutions to the problems of managing radioactive wastes in an environmentally benign matter, and that some of these solutions have been successfully used in other countries for decades. A wide range of topics will be covered as they relate to managing wastes. The instructor makes a strong effort to keep current on waste-management issues. Some issues literally are evolving weekly. Whether or not the renaissance in nuclear energy continues to move forward may, in part, depend on what decisions are made with respect to waste management. *Come join us.*

What is NPRE 442 about?

How radioactivity impacts waste management:

- **Background sources of radiation.**
- **Health impacts of radiation.**
- **Attenuation of radioactivity by solid matter.**

Concepts borrowed from geology and chemistry:

- **Geochemistry of radionuclides and hydrogeology.**
- **Uranium and thorium resources.**

What is NPRE 442 about?

The various radioactive, hazardous and mixed wastes and how they are managed:

Low-level radioactive wastes, used nuclear fuel, U.S. DOE legacy wastes, geological repositories, waste package stability, transportation of radioactive materials, and radiological risk management.

What is NPRE 442 about?

International radioactive waste management

France, Japan, Russia, and in 12 other countries.

And more!

Grading

Midterm Exam 100 points

Final Exam 100

8 End-of-Chapter Questions 160

Total 360

About the instructor of NPRE 442

Prof. W. Roy

Nuclear, Plasma and Radiological Engineering.

B.S., M.A. Geology, Ph.D. Soil Physical Chemistry

Taught NPRE 442 since 2008. 16th year.

Teaches NPRE 481, *Writing on Technology and Security*

Teaches NPRE 498 D, *Decommissioning Nuclear Facilities*

About the instructor of NPRE 442

He is former lecturer for the Swedish Royal Institute of Technology.

He also teaches two on-line courses for the University of Denver: EPM 4465, *Environmental Restoration and Waste Management,* and SMGT 4220, *Hazardous and Radiological Materials Preparedness.*

About the instructor of NPRE 442

He has made the "(Incomplete) List of Teachers Ranked as Excellent by their Students" 26 times while teaching for NPRE.

In 2011 and 2018: American Nuclear Society "Students' Award for Excellence in Undergraduate Teaching." In 2017, 2020, 2021, 2022, and 2023 he was nominated for the College of Engineering Rose Award for Teaching Excellence.

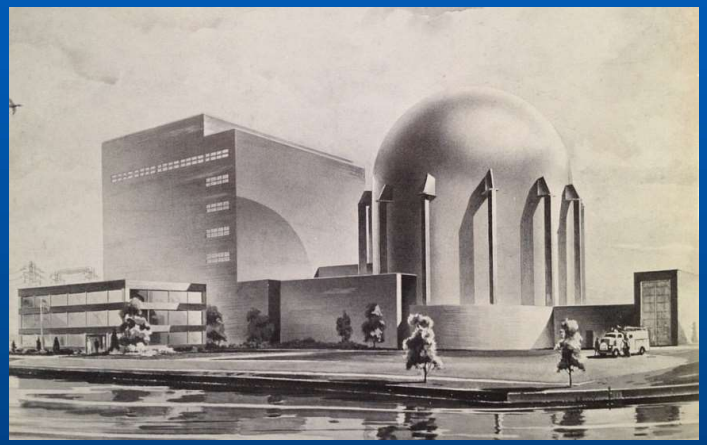
About the instructor of NPRE 442

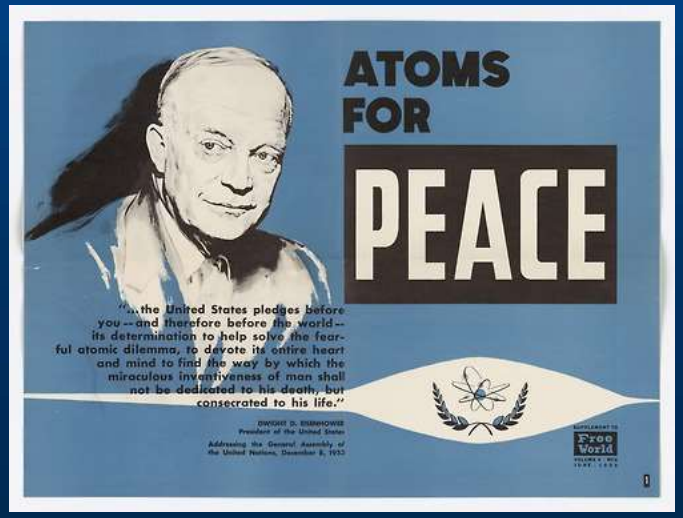
In 2018, NPRE named him "Teacher of the Year." He was appointed to the Academy of Excellence in Engineering Education in 2020. In 2022, he was also nominated for the Campus Award for Excellence in Graduate Teaching.

He is the Environmental Review Lead the Micro-Modular Reactor Project.

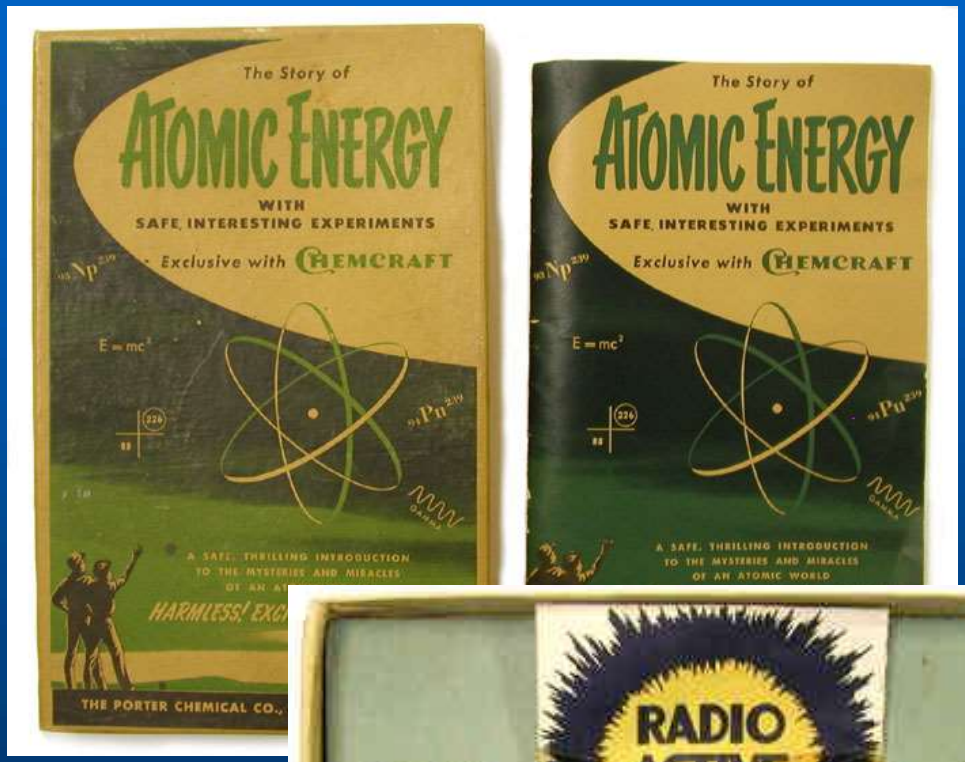
Introduction: Nuclear Energy in the Past

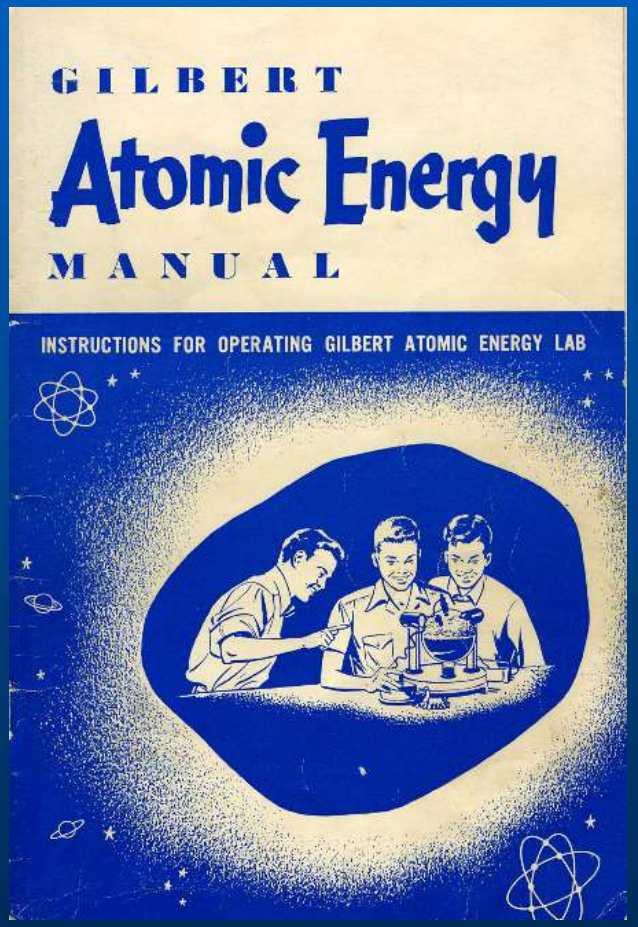
In the 1950s, "atomic energy" was regarded as the key to the future.





Atomic Energy for Youth






ATOMIC ENERGY LAB
ATOMIC CLOUD CHAMBER with PROJECTOR ILLUMINATOR
See the vapor trails of alpha and beta particles, and of cosmic rays.
SPINTHARISCOPE – Shows exploding atoms.
ELECTROSCOPE – Measures background radiation and tests sample sources.
SAFE RADIOACTIVE MATERIALS Alpha source in handy container and Uranium Ore.
FULL INSTRUCTIONS COVER USE AND THEORY
FUN
EASY
EXCITING

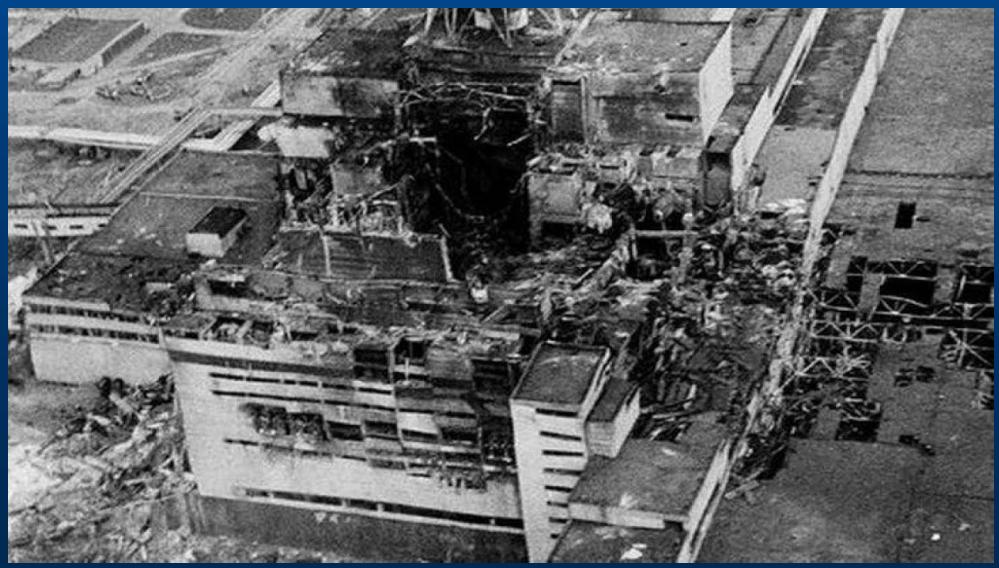

No. U-238
ATOMIC ENERGY LAB
PERFORMS OVER 150 EXCITING EXPERIMENTS!
FOR THE JUNIOR SCIENTIST
MOST MODERN SCIENTIFIC SET EVER CREATED!
SEE PATHS OF ALPHA PARTICLES SPEEDING AT 12,500 MILES PER SECOND!
WATCH ACTUAL ATOMIC DISINTEGRATION—RIGHT BEFORE YOUR EYES!
PROSPECT FOR URANIUM WITH GEIGER-MUELLER COUNTER!
EXPLORE THE SECRETS OF THE ATOM!
Model of Alpha Particle Made with Nuclear Spheres
CONTENTS
$10,000.00 REWARD
ALL SAMPLES OF RADIOACTIVE MATERIALS ARE COMPLETELY HARMLESS!
Exciting! Safe!
ANOTHER GILBERT HALL OF SCIENCE PRODUCT
GILBERT
ATOMIC ENERGY LAB.
DEIONIZER
GILBERT
CLOUD CHAMBER
ELECTROSCOPE
THE A.C. GILBERT CO.

But, in the decades that followed. . .

The cost of building new power plants increased.

Three Mile Island accident in 1979.

Chernobyl Nuclear Power Plant 1986.



2011, Fukushima

The events at the Fukushima plant in Japan were a public relations nightmare.

New safety reviews and studies were launched on a global scale. Concerns about nuclear plants in earthquake zones.

At the same time, it highlighted the lack of a national policy for managing used nuclear fuel.

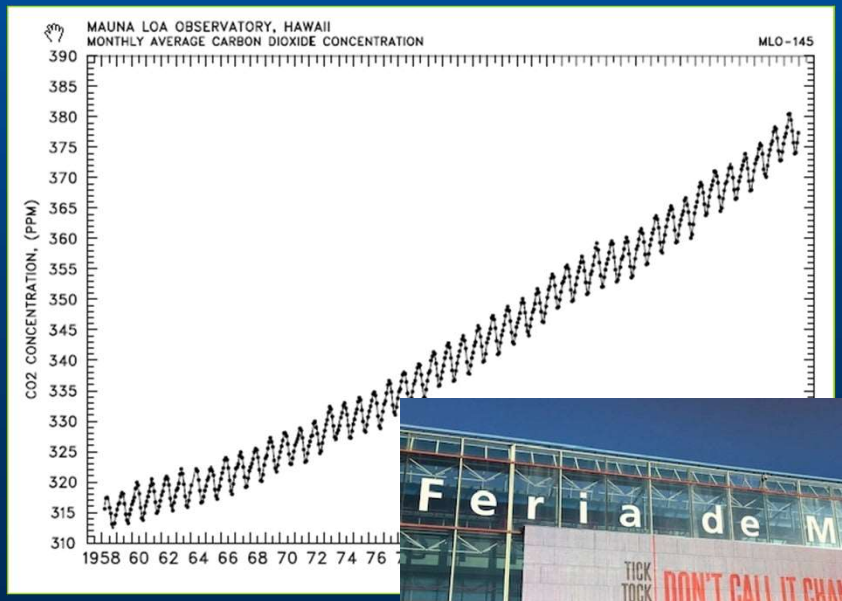
The future of nuclear energy

Beginning in the late 1980s, there was a *de facto* moratorium on building new nuclear power plants in the U.S.

***Until now* . . .**

In about 2000, the concept of climate change was gaining attention. A lot has happened in 20+ years!

Climate change is now a major political issue today



To reduce the emissions of green house gases by fossil fuels. . .

Many advocate greater use of alternative sources of energy: wind, hydroelectric, geothermal, ocean wave energy, solar, and . . .

Nuclear! Nuclear energy is "green energy source" because it does not generate carbon dioxide. Carbon-free energy is now a global objective.

Nuclear reactors in the U.S.

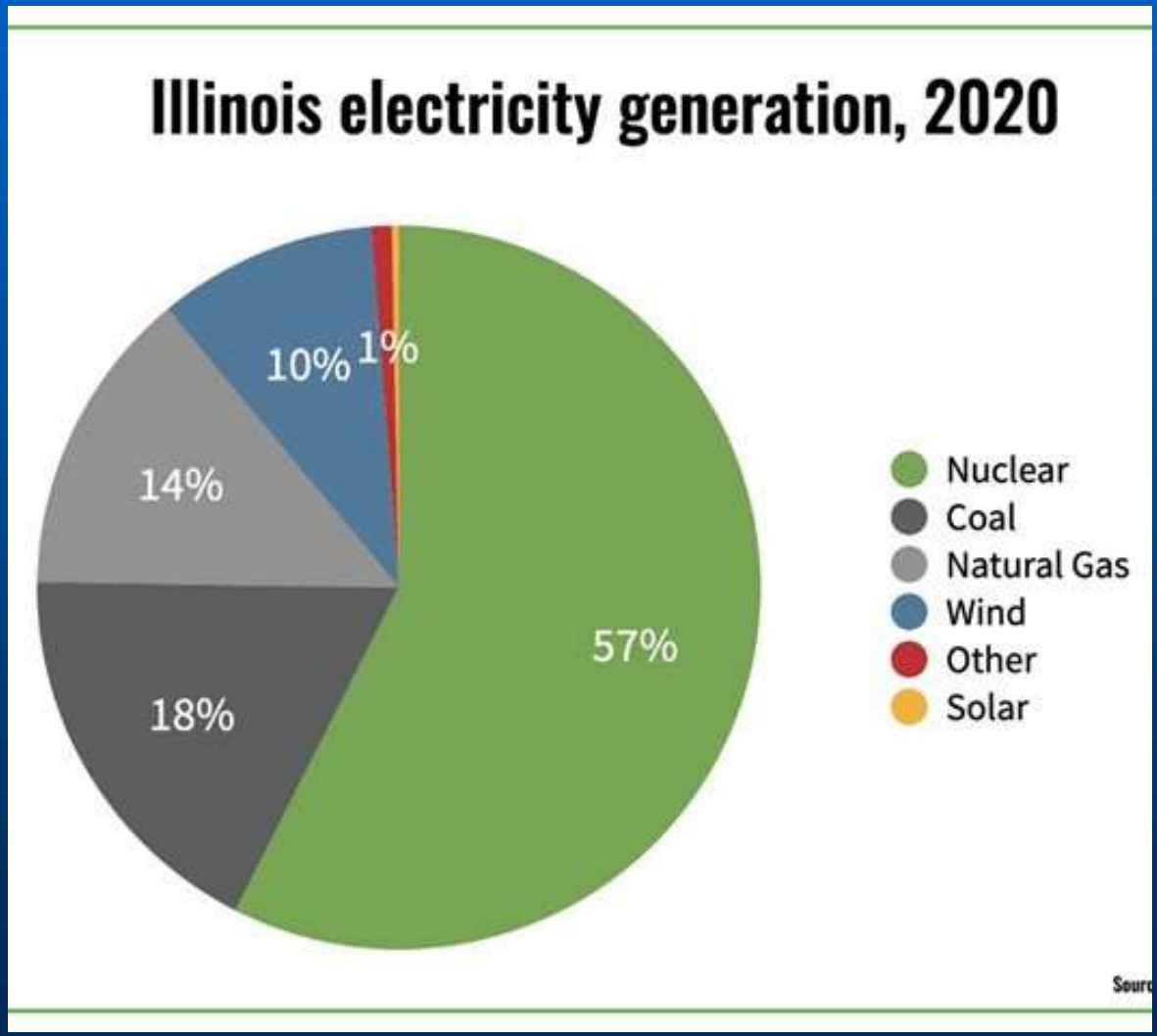
At the end of November 2022, the U.S. had 92 operating commercial power nuclear reactors. Two new reactors under construction. 41 reactors are currently shutdown.

On a global scale

Today there are about 437 nuclear power reactors operating in 32 countries plus Taiwan, with a combined capacity of about 400 GWe. About 60 power reactors are currently being constructed in 18 countries, notably China, India, Russia and Turkey.

From the World Nuclear Association,
Plans For New Reactors Worldwide (2022).

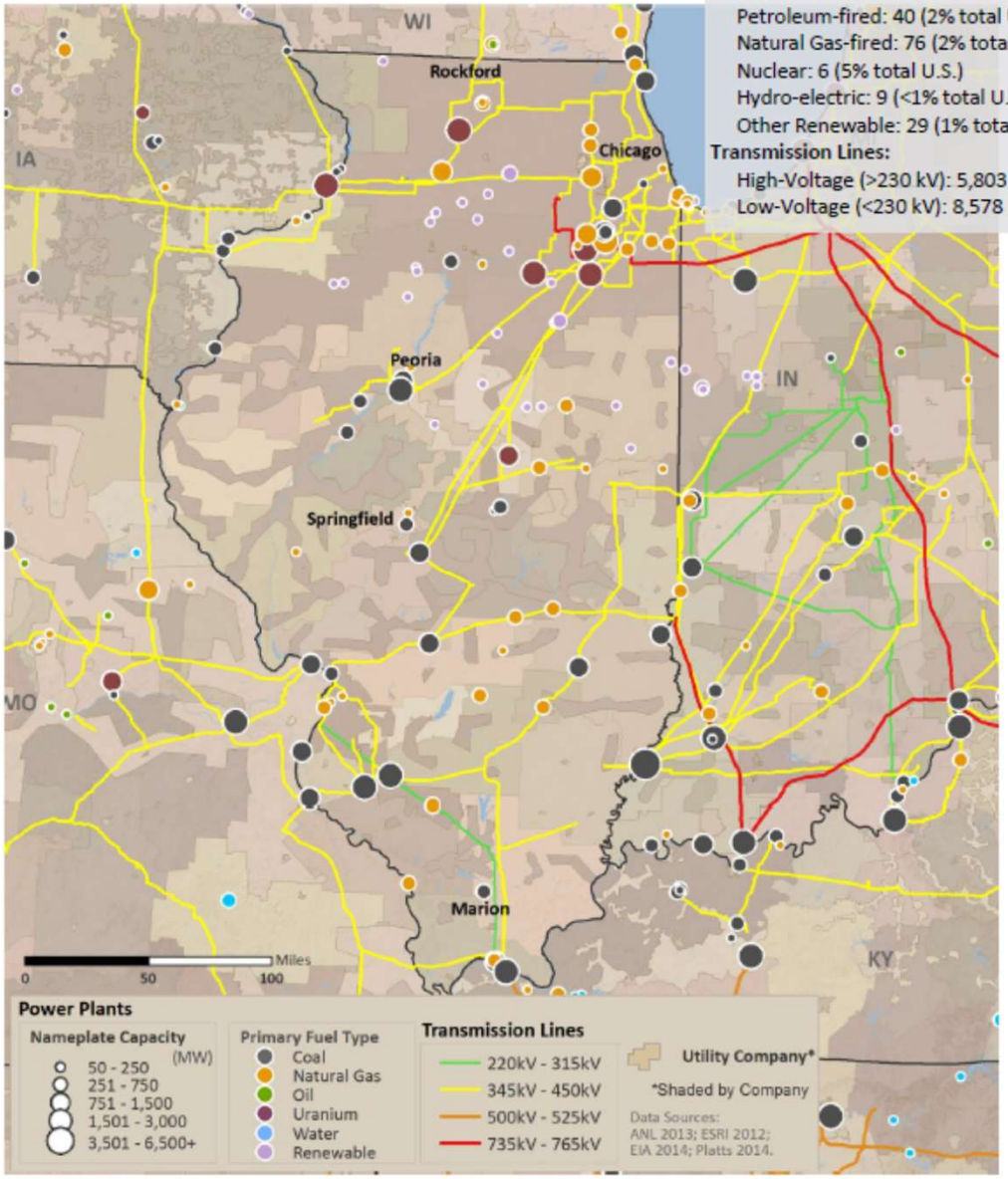
Illinois has most nuclear power plants in the U.S.



ELECTRIC

Electric Power Plants: 187 (1% total U.S.)
- Coal-fired: 27 (2% total U.S.)
- Petroleum-fired: 40 (2% total U.S.)
- Natural Gas-fired: 76 (2% total U.S.)
- Nuclear: 6 (5% total U.S.)
- Hydro-electric: 9 (<1% total U.S.)
- Other Renewable: 29 (1% total U.S.)

Transmission Lines:
- High-Voltage (>230 kV): 5,803 Miles
- Low-Voltage (<230 kV): 8,578 Miles



The U.S. nuclear energy renaissance has slowed down

Why?

Cheap natural gas prices.

New power plants are expensive. Many proposed projects have been cancelled. Operating license of older plants are being extended. Small nuclear reactors may invigorate the renaissance. But . . .

Unsolved issues with respect to the management of radioactive wastes!

But what about radioactive wastes?

If world goes nuclear, where will waste go?

By ANGELA CHARLTON
Associated Press Writer

BEAUMONT-HAGUE, France — Thousands of canisters of highly radioactive waste from the world's most nuclear-gized nation lie ...

safety record and the 26,000 environmental tests conducted every year as evidence that ... public has nothi... their...

Nuclear waste issue still unsolve

In response to your whole-hearted endorsement of addi-tional nuclear power plants in Illinois (April 25 edito-rial) I have but one ques-tion: Where do we put the waste? You certainly high-lighted some of the positive attributes of nucl... but you did... over th...

...wer,

...ar

and operate a waste ... tory in Nevada, not a ... atom of spent fuel has ... shipped there. Nor do... look likely that one wil... shipped there in the ne... distant future.

It would be highly irre... sponsible of us to pursue ... additional nuclear power ... plants until the back end ... the fuel cycle is functiona... The gorilla we have is leav... ing plenty of waste as it is ... its corner. Let's not help hi... out by building more plants.

JON NADLE...
Mount Zio...

EDITORIALS

Inching forward on nuclear waste disposal issue

It is, we suppose, a sign of progress that the government finally has submitted an application to operate a nuclear waste depository in Nevada. But it will be at least a dozen years before the facility is able to take in the nuclear wastes that have been piling up for decades.

Last week's delivery of the long-awaited application to operate a huge nuclear waste repository in Nevada was called a signifi-cant milestone for the nation's nuclear power industry.

We can only hope so but it's hard not to be skeptical. There are so many scientific, politi-cal and legal roadblocks in the way. Even the Energy Department, which would run the facility and is an advocate for it, says the ear-liest the Yucca Mountain repository could be in 2020. That means that spent ... nuclear waste will ... the Unit-

and, led by Senate Majority Lea... Reid, D-Nevada, has pledged t... Reid has even successfully c... the project. "There is no ch... Mountain is going to be th... nuclear waste," Reid said...

Further, federal offic... overturn a court rulin... prove that Yucca Mo... safely store nuclea... years, a seemingl...

Yucca Mounta... nuclear industr... also to the nat... it's an impor... use of fossi... ing. Once ... and oper... ited for ... age, fi... that ... gas ... cu...

LETTERS TO THE EDIT...

Don't rush back into nuclear power

Exelon's plan for early decommissioning of its Zion nuclear site has renewed the controversy over nuclear waste and power. Rep. JoAnn Osmond's bill to amend the Public Utilities Act (HR2971) by repealing Illinois' morato-rium prohibiting new nuclear reactor construction until a permanent disposal solu-tion is first implemented for their dangerous, long-lived high-level radioactive wastes unnecessarily heightens the controversy.

Why the rush to lift the moratorium when:

1. There still exists no ... al permanent dispos... ity for high... wastes...

...ut ...uclear

...nt. BE... ...windo...

...med too risky ... volatile rocket

The bottom line

Regardless of the future of nuclear energy in the U.S. and the world, there are radioactive, hazardous and mixed wastes from several sources that need to be managed today, and well into the future in a manner that is protective of human health and the environment.

Do we as engineers and scientists know how to manage these wastes?

Welcome to NPRE 442!

The Student Questionnaire:

NPRE 442. Radioactive Waste Management
Spring Semester 2023

Student Questionnaire

Name: _____

What chemistry and geology courses have you had? If geology or chemistry or chemical engineering is your major, just say "many."

Have you had courses that covered any aspect of (*or job experience with*) radiation shielding, reactor fuel management, radioactive wastes, hazardous wastes, decommissioning of power plants, or groundwater monitoring?

Have you been to a nuclear power plant, a nuclear energy facility, or a disposal site for radioactive wastes? If so when and where?

What do you hope to gain from this course? (**Very important!**)

Questions?

If world goes nuclear, where will waste go?

By ANGELA CHARLTON
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