Nuclear Energy – The Better Energy

An initiative

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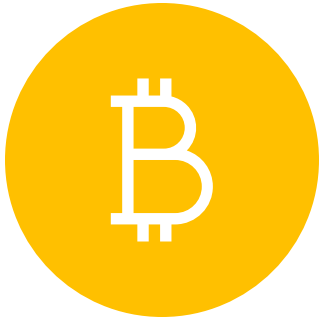
Nuclear Energy – The Better Energy

Why this initiative?

To bridge the gap between my research as a Nuclear Physicist and my responsibilities towards the society.

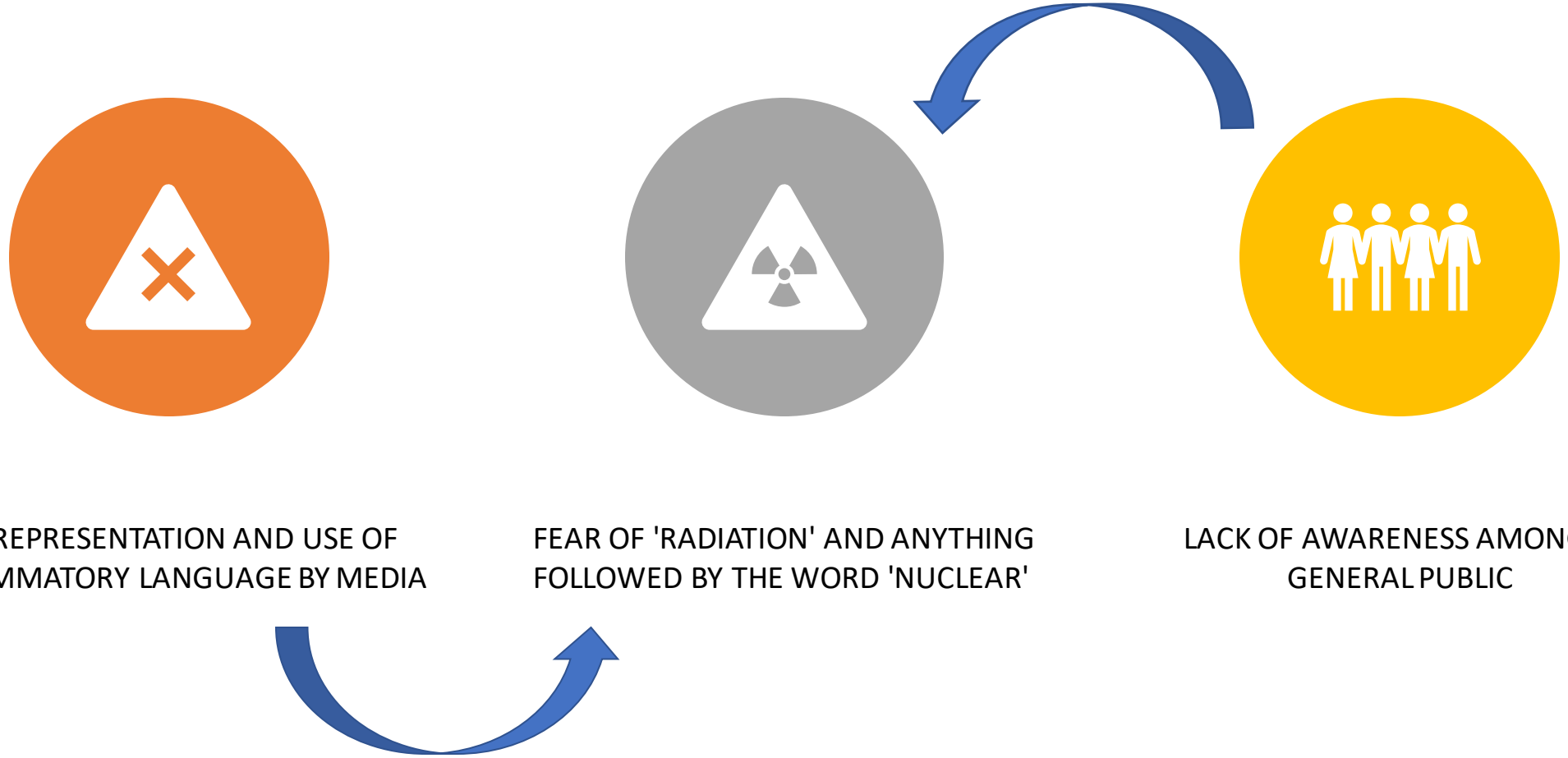
To help the society get rid of their misconceptions and irrational fears about radiation and Nuclear Power.



All safety related fears and apprehensions have become outdated and the Nuclear Energy community has developed enough expertise to provide the world with a low-risk, cheaper and an environment-friendly power.

Use the expertise of specialists in the field to help the public make well-informed and educated decisions about Nuclear power that could eventually help save the world.

Challenges to overcome



Challenges

Effects to linger for decades

By DAVE VON DREHLE
Knight-Ridder Writer

The worst case: Thousands of deaths within days. A rash of miscarriages and birth defects in the cities and towns of the Ukraine. Hundreds of lingering, painful deaths in coming weeks. Contamination of the most fertile soil in the Soviet Union. An epidemic of leukemia six or seven years from now. Thyroid cancers among children hundreds of miles from the Chernobyl disaster — although the symptoms may not emerge for decades.

The best case: Years of uncertainty, as the people of the Dnieper River valley wait to see if this nuclear power plant accident — apparently the worst in history — will cut their lives short.

Scientists say it is too early to know how severe the impact will be from the nuclear power plant explosion near Kiev. The hard facts they need — such as the amount of radioactive material released into the atmosphere — have not been disclosed by the Soviets.

This much is certain, though: The effects of radiation fallout from the Chernobyl plant could last decades, perhaps for [illegible]. That's the way radioactivity works.

"The effects of this will last for years," said Dr. Eugene [illegible], professor of radiology at the University of Cincinnati. "This fallout is blowing all over the place. There's one potful of material being released. And once it gets into the food cycle, it keeps on turning over."

In Sweden, experts are analyzing the radioactive fallout drifting into their country. It includes various amounts of radioactive cesium, strontium [illegible] iodine.

According to Saenger, that's a [illegible] to float, because it's a very heavy element. [illegible] to blow all the way to Sweden, Saenger said, the Chernobyl accident must be a major [illegible] large." In addition, the [illegible] cesium indicates the core was hot enough [illegible] to melt, scientists say.

The [illegible] radioactive fallout will increase closer to the power plant. And at a certain level, exposure to [illegible] of these elements can be fatal.

Contaminated iodine doesn't remain dangerous very long — it loses half of its radioactivity every eight days — but it is very dangerous while it lasts. It collects in the thyroid gland, especially of children, and the damage it does to the cells may not show up for years.

Public health officials in Poland have ordered special iodine treatments for all children in that country to saturate their thyroid glands so that contaminated iodine won't be absorbed.

MEDIA FRENZY

SCIENTISTS TERM RADIATION A PERIL TO FUTURE OF MAN

Even Small Dose Can Prove Harmful to Descendants of Victim, Report States

A SAFETY LIMIT IS URGED

Exposure Check of All Asked —Curb Backed on Dental and Medical X-Rays

MISREPRESENTATION

PROVOCATIVE LANGUAGE

"Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less"

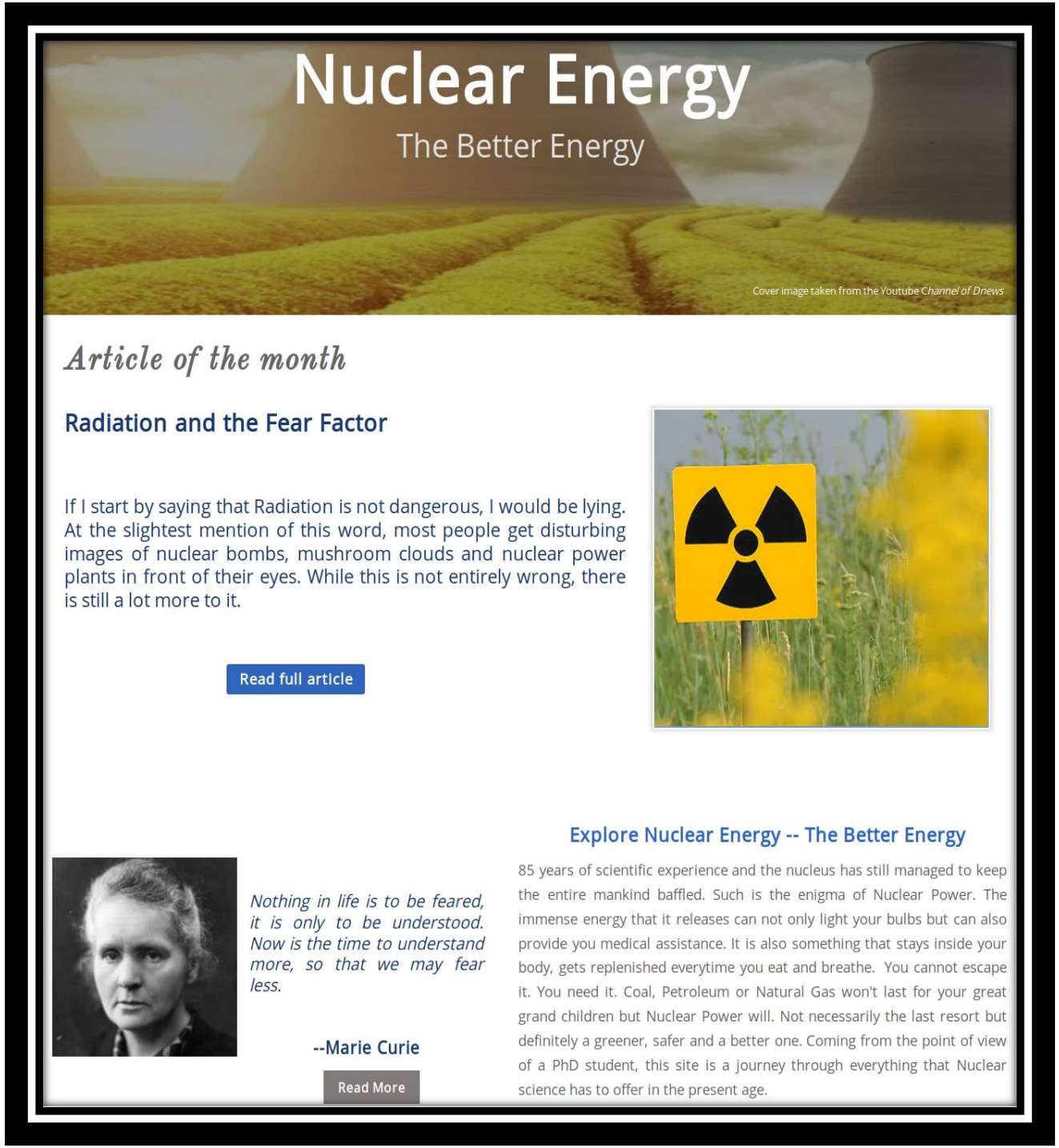
-- Marie Curie

Nuclear Energy – The Better Energy

Where did we start?

Needed a program that serves as an easy-to-approach resource.

It should be clear, accurate, credible and interesting.



WEBSITE

- Designed a user-friendly and easy to understand website for general public
- *thebetterenergy.net*
- Educational/Informational resource for anyone over the age of 15
- Linked website to a Facebook page of the same name

SECTIONS

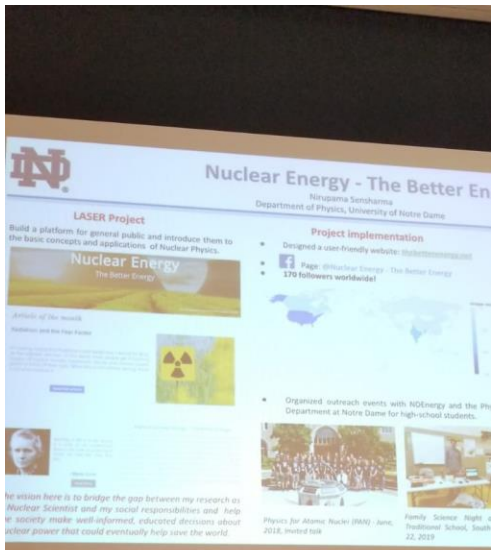
Divided website into five major sections:

- Health Impacts of Radiation
- Nuclear Power Generation
- Nuclear Reactor Safety
- The Indian Nuclear Policy
- Fun Quizzes

Also linked to the US Nuclear Regulatory Commission

IMPLEMENTATION

- Organized outreach events for primary and middle school students to introduce them to the concepts of Nuclear physics through demonstrations.
- Delivered lectures to high school students about working of nuclear power plants and their safety features.
- Organized a platform to interact with parents and answer their questions about radiation and nuclear safety.



Before we start:

Motive of this talk is to open a platform for dialogue about Nuclear science amongst specialists in the field and the general public

Concepts of Nuclear science need to be explained in a non-specialist way

Time for pop quiz # 1

Question. Which do you think leads to a greater average annual radiation dose?

A) Living within 50 miles of a Nuclear Power Plants

B) Living within 50 miles of a Coal Power Plants

C) Employee at the Grand Central Station, NYC

Time for pop quiz # 1

Question. Which do you think leads to a greater average annual radiation dose?

Living within 50 miles of a Coal plant adds 0.03 mrem to the average annual radiation dose of a person while living within 50 miles of a Nuclear plant adds only 0.009 mrem. However, if you are an employee at the Grand Central Sation at NYC, your average annual radiation dose is increased by 120 mrem. It is attributed to the high uranium content of its granite walls.

C) Employee at the Grand Central Station, NYC

Why Nuclear?

Availability of fuel

The amount of energy produced by 1kg of Uranium is the same as that from burning 2,750 tons of coal.

According to the US Energy Information Administration (EIA) estimates, we have enough Uranium to last for 500 years. With reprocessing techniques, we can convert Nuclear energy into a renewable source of energy.

It must also be remembered that electricity generation is not the sole purpose of coal. It also needs to be preserved for some other industries like steel and fertilizer.

Why Nuclear?

Environmental Effects

Fossil fuels emit greenhouse gases and lead to global warming and environmental pollution

The burning of uranium produces no carbon dioxide or any other greenhouse gases.

The only carbon dioxide that Uranium burning releases is during the mining phase.

All the radiation generated in a nuclear power plant is safely contained by thick lead and concrete shielding called a containment structure.

Why Nuclear?

Accident Statistics

Fuel	No. of Fatalities	Affected Persons
Coal	18,000	Workers
Natural Gas	1,000	Workers and public
Hydro	30,000	Public
Nuclear	31	Fire-fighting workers

Challenges

Have you ever heard of terms like "deadly radiation" or "lethal radioactivity"?

Have you ever heard of terms like "lethal electricity" or "lethal natural gas"?

Thousands die every year due to electrocution and suffocation accidents.

All nuclear accidents combined – 31 direct deaths

Bhopal Gas Tragedy - 2,259 direct deaths, 558,125 injuries, including 38,478 temporary partial injuries and approximately 3,900 severely and permanently disabling injuries (Figures from 2006 Govt. Affidavit).

Why Nuclear?

Lifetime & Land requirement

The designed life-time is 40 years and above for nuclear power plants whereas for thermal power plants, it is limited to 30 years.

Life extension is not be possible for thermal power plants due to factors like corrosion and erosion. However with better choice of materials and good maintenance practices, an extension of 10 to 15 years is usually possible for nuclear plants.

For thermal power plants, the land requirement is about 0.5 to 1.2 acres per MWe. However, for nuclear power plants this is just 0.20 to 0.25 acres per MWe.

A 1 km radius is usually required for the construction of a nuclear power plant. However, the actual plant occupies only a small percentage of this area. In the remaining area, agriculture and common human activities can go on as usual.

What is Radiation?

RADIATION IS THE EMISSION OR TRANSMISSION OF ENERGY IN THE FORM OF WAVES OR PARTICLES THROUGH SPACE.

WHY DON'T WE WORRY ABOUT ANY EXPOSURE THAT WE RECEIVE BY SAY SITTING UNDER A LIGHT BULB FOR 12 HOURS OR LISTENING TO RADIO ALL NIGHT LONG OR HEATING OUR FOOD IN A MICROWAVE?

THERE IS A SUBCATEGORY THAT ANY KIND OF RADIATION CAN BE DIVIDED INTO – IONIZING AND NON-IONIZING.

IONIZING - ALPHA, BETA, GAMMA **RAYS AND X-RAYS**

NON-IONIZING - RADIO WAVES, MICROWAVES AND VISIBLE LIGHT

Radiation Exposure - Why and How?

- First nuclear explosion - Trinity nuclear test (Manhattan Project) at US in 1945.
- First nuclear power plant to be connected to the power grid - Obninsk, Russia in 1954.
- Did human life start to get affected by radiation only after these events?

- The answer is NO!

- Radiation has been a part of human life since the beginning of time.
- Two sources of radiation emission -

(i) Natural sources of radiation (Background radiation)

(ii) Artificial sources of radiation

Cosmic Rays

Terrestrial Radiation

Internal Radiation

Natural sources of Radiation

Natural sources of Radiation

Cosmic Rays

- Immensely high-energy radiation, composed primarily of protons and alpha particles.
- These interact with O_2 and N_2 in the atmosphere - produces a cascade of lighter particles falling down on the surface of Earth.
- Av dose from cosmic radiation is 0.04 rem/yr.

Consequences of Radiation from Cosmic Rays

Annual Jet Travel – 10 mrem

Read: ***Radiation and the Fear Factor (thebetterenergy.net)***

- Flying through long trans-continental flights increase the risk of radiation exposure.
- This is due to the exposure from cosmic rays which increases with altitude.
- The longer you are on a flight, the more radiation you receive.
- The higher you are in altitude, the higher the dose of radiation.

Natural sources of Radiation

Terrestrial Radiation

- The Earth that we live on is in itself a source of radiation.
- U, Th and their decay products occur naturally in rocks, soil, water and vegetation.
- Av dose from terrestrial radiation is 0.2 rem/yr (differs for different parts of the world).

Consequences of Terrestrial Radiation

Radon accumulation in basements – 200 mrem/year

Read: ***What's in your home? (thebetterenergy.net)***

- Radon is a radioactive gas that is the decay product of Uranium and Thorium.
- Since both U and Th are found in rocks and soil, radon is released in the environment from these sources.
- Radon can enter buildings or houses through openings in floors, walls or through construction joints and can get trapped if enough air circulation is not possible.
- Radon accumulation mostly occurs in basements and enclosed spaces within buildings.
- Radon poisoning accelerates if the person is a smoker.

Consequences of Terrestrial Radiation

Drinking water – 5 mrem/year

Read: ***What's in your home? (thebetterenergy.net)***

- Drinking water in our homes usually come from rivers and lakes.
- Radiation can enter the water stream from rocks and soil.
- In the United States, the levels of radiation in drinking water is very low.
- The average annual radiation dose received by a person varies from place to place

Natural sources of Radiation

Internal Radiation

- All living beings on Earth have ^{40}K, ^{14}C and ^{210}Pb in them from the time of their birth.
- Radioactive elements absorbed by body which replenish over time.
- Av dose received by Internal radiation is about 0.03 rem/yr.

Sitting next to a person – 0.03 rem/year

Read: ***What's in your home? (thebetterenergy.net)***

- Just by sitting next to a person would expose you to radioactivity arising from the internal radiation emitted from that person's body.

- ^{40}K, ^{14}C and ^{210}Pb arise in a person's body from consumption of food, drinking water or simply inhaling air containing radioactive elements.

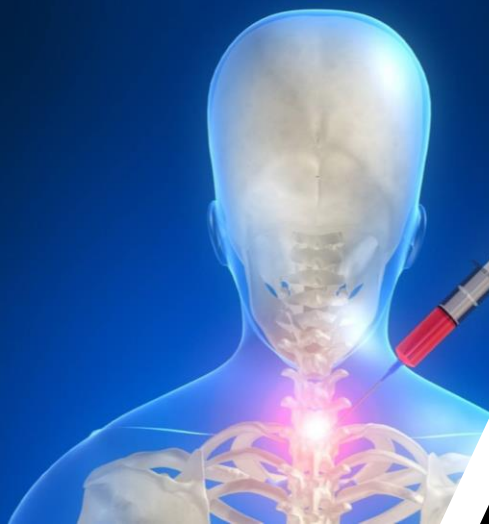
- These elements are absorbed by the tissues and bones in our bodies and keep getting replenished over time by simple processes like ingestion and inhalation.

Nuclear Medicine

Consumer Products

Nuclear Fuel Cycle

Artificial sources of Radiation



Artificial sources of Radiation

- The most radiation exposure received by the general public from man-made sources is by medical procedures such as X-rays, radiation therapy and medical imaging.
- The effective doses can range from 0.006 - 3.7 rem for a non-specific tumor imaging procedure.
- A typical chest X-ray exposes you to about 0.002 rem while a chest CT-scan can result in a dose of 0.2 rem.

Nuclear Medicine



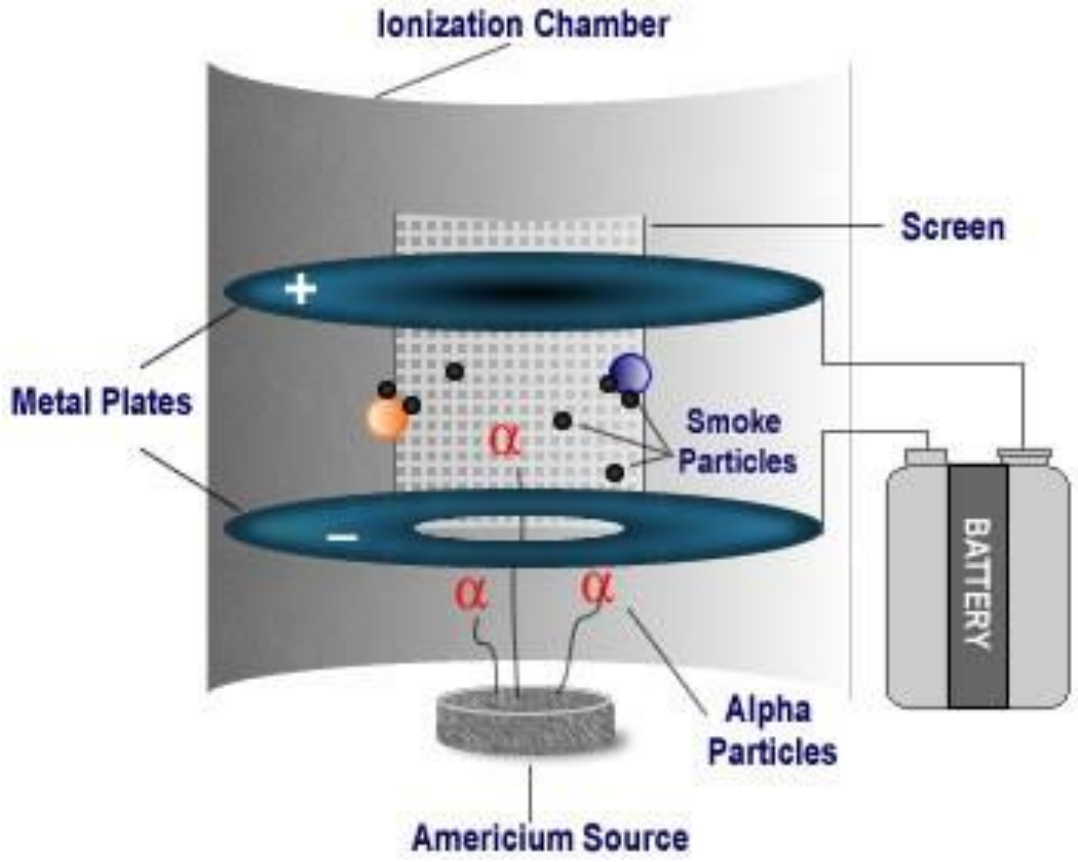



Artificial sources of Radiation

Consumer Products

Smoke Detectors – 0.008 mrem/year

Read: ***What's in your home? (thebetterenergy.net)***



Radiation from Consumer Products

Building materials and soil – 7 mrem/year

Read: ***What's in your home? (thebetterenergy.net)***

- Sandstone, brick, concrete, gypsum and granite contain naturally occurring radioactive elements like radium, uranium and thorium and act as sources of radiation.
- Radiation dose from building materials largely depend on the type and amounts of material used.
- However, the level of radioactive materials in such building materials is very low and does not pose any threat to human health.

Smoking (Use of Tobacco) – 1.3 rem/year

Read: ***Smoking Kills…..it really does! (thebetterenergy.net)***

- Tobacco has a property to absorb radon from the atmosphere.
- Smoking increases the chances of radon accumulation in the human body substantially.
- The gaseous radon enters the respiratory tract of the smoker and soon decays into solid radioactive products.
- These solids can then get stuck in the respiratory tract and lungs and stay there for a very long time continuously decaying into other radioactive products.
- Over the years, this accumulation can prove seriously dangerous and often times fatal.

Orange Fiesta ware

Read: ***Radiation and the Fear Factor (thebetterenergy.net)***

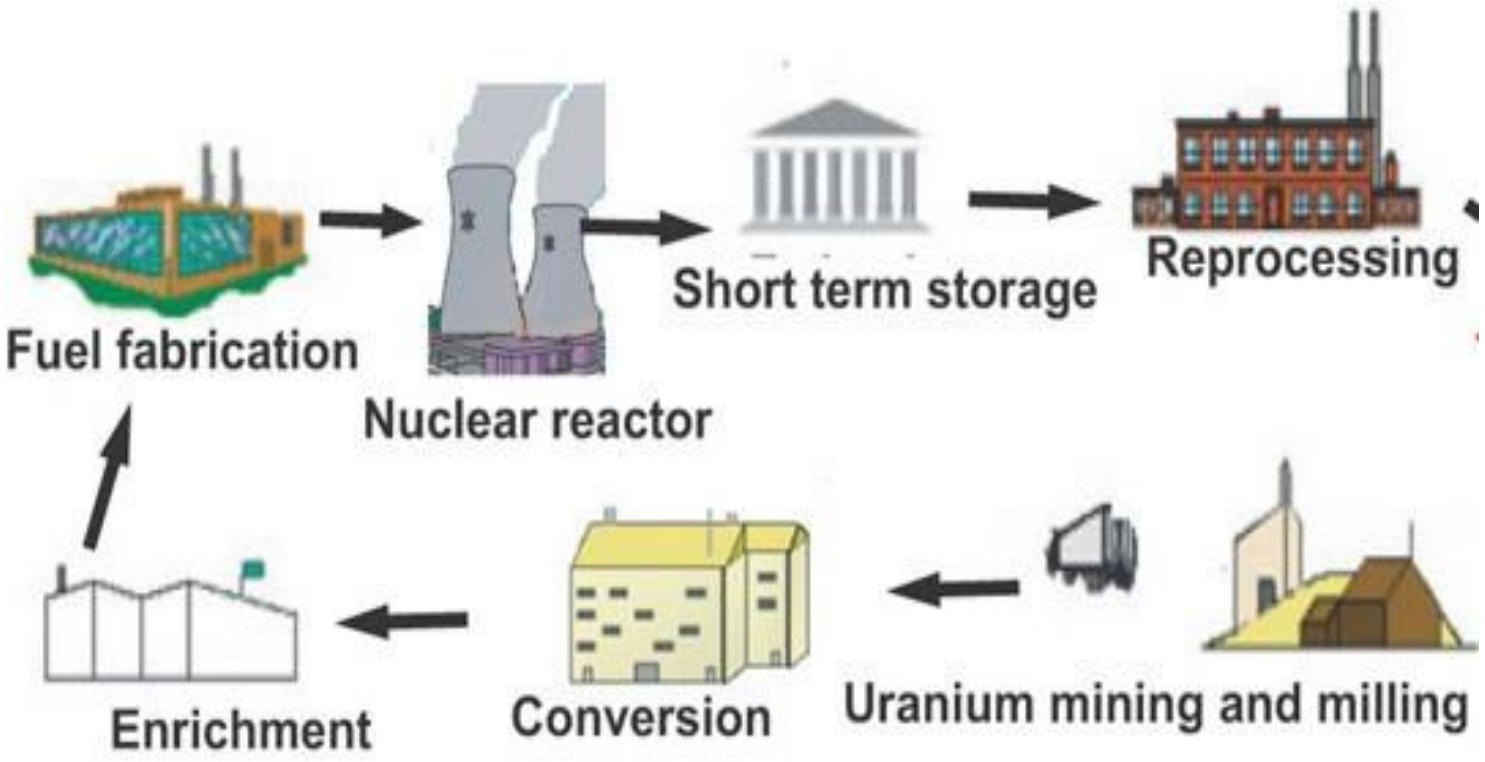
- During the 1960s and 1970s, the famous Fiesta ware manufactured bright orange-red colored dinnerware.
- Back in the day, that special orange-red color was derived from Uranium oxide.
- Researchers estimate that one such plate would have contained approximately about 4.5 grams of uranium.
- If you ate off that dinnerware daily, you would have almost 0.21 grams of uranium ingested per year.
- Fiesta ware manufactured after 1972 is not radioactive

Radiation from Consumer Products

Old Television sets – 1 mrem of X-rays/year

Read: ***What's in your home? (thebetterenergy.net)***

- If you still use your old television set, the cathode ray tube in the machine exposes you to about 1 mrem of X-ray radiation per year.
- The FDA monitors all TV sets sold in the U.S. to be tested to make sure they do not exceed a safe level of X-ray emission.
- Flat-screen TVs and computers don't produce X-rays. Any guesses, why?



Nuclear Fuel Cycle – 0.05 mrem/year

Read: ***Radiation and the Fear Factor (thebetterenergy.net)***

Artificial sources of Radiation

- Nuclear fuel cycle is one of the least contributing factors of radiation dose as received by general public.
- The entire procedure involved in a Nuclear fuel cycle, right from the mining of Uranium to power production exposes the general public to an average dose of only about 0.05 mrem/yr.

The controversial Banana

- A typical banana contains about 0.5 gram of natural potassium of which 0.012% is ^{40}K.
- That amounts to a radiation dose of roughly 0.01 mrem.
- **FUN FACT:** The radioactivity from a truck full of bananas can cause false alarms when passing through a radiation detection device setup to check on the smuggling of radioactive elements!!

Time for pop quiz # 2

Question. Bananas are radioactive! Eating how many bananas would be equivalent to the amount of radiation dose you receive from living within 50 miles of a nuclear power station?

A) 1 – 100

B) 1,000

C) 10,000

D) 100,000

Time for pop quiz # 2

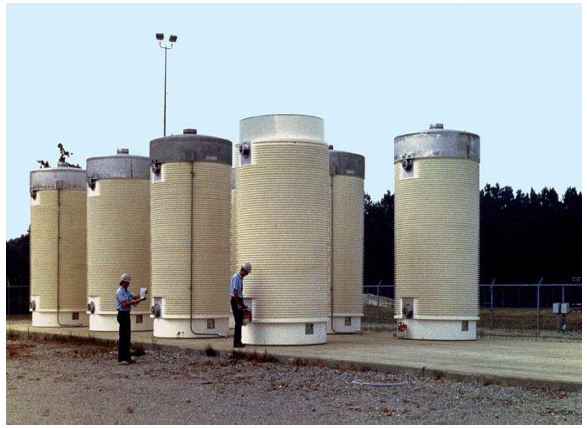
Question. Bananas are radioactive! Eating how many bananas would be equivalent to the amount of radiation dose you receive from living within 50 miles of a nuclear power station for a year?

A) 1 – 100

A typical banana contains about 0.5 gram of Potassium amounting to an activity of about 15 Bq and a corresponding radiation dose of about 0.01 mrem.
So yes, if you have lived near a Nuclear power plant for a year, you have only received as much radiation as from eating at most 100 bananas; low enough for your body to take care of it, naturally.

Time for pop quiz # 3

Question. Which of these is a greater contributor of radiation to the environment?



A) Fly ash produced by Coal Power Plants

B) Nuclear waste shielded via water and dry cask storage

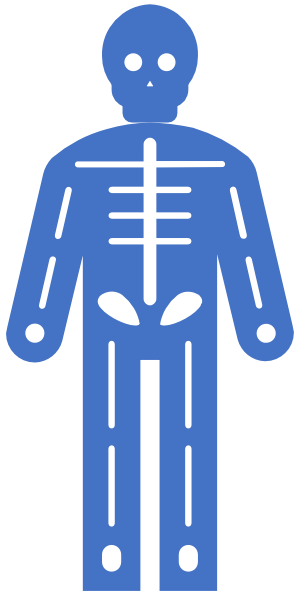
Time for pop quiz # 3

Question. Which of these is a greater contributor of radiation to the environment?

A) Fly ash produced by Coal Power Plants

Coal has radioactive uranium and thorium in trace amounts. When coal is burned into fly ash, uranium and thorium are concentrated at up to 10 times their original levels and leach into the soil and water surrounding a coal plant. In fact, fly ash carries about 100 times more radiation in the surrounding environment than a nuclear power plant producing the same amount of energy.
Source - www.scientificamerican.com

US NRC Personal Annual Radiation Dose Calculator



- The annual average dose per person from all natural and man-made sources is about **350 mrems.**

- But it is not uncommon for any of us to receive more than that each year (largely due to medical procedures).

- The U.S. Nuclear Regulatory Commission (NRC) has established standards that allow exposures of up to **5,000 mrem per year for those who work with and around radioactive material**, and **100 mrem per year for members of the public (in addition to natural background radiation)**.

US NRC Personal Annual Radiation Dose Calculator

Where You Live

1. Cosmic radiation (from outer space) at sea level (26 mrem)
2. Select your elevation from sea level (in feet)
   up to 1000 ft. (2 mrem)

   See also the USGS Elevations of the 50 Largest U.S. Cities EXIT
3. Select your area of residence (for terrestrial radiation from the ground)
   anywhere else in the U.S. (46 mrem)
4. ☑ Select if you live in a stone, brick, or concrete building (7 mrem)

What You Eat, Drink, and Breathe

5. Radiation in your body (240 mrem)**
   From food and water (40 mrem)

   From radon in the air (200 mrem)

Other Sources

6. Weapons test fallout (1 mrem)***
7. Miles of travel by jet plane annually:
   8,000 miles (8 mrem)

US NRC Personal Annual Radiation Dose Calculator

Select from the following if you . . .

8. ☐ Have porcelain crowns or false teeth (0.07 mrem)
9. ☐ Use gas lantern mantles when camping (0.003 mrem)
10. ☐ Wear a luminous wristwatch (LCD) (0.006 mrem)
11. ☐ Use luggage inspection at airports (using typical x-ray machine) (0.002 mrem)
12. ☐ Watch TV (1 mrem) ***
13. ☐ Use a video display terminal (1 mrem) ***
14. ☐ Have a smoke detector (0.008 mrem)
15. ☐ Wear a plutonium-powered cardiac pacemaker (100 mrem)
16. ☐ Have had diagnostic x-rays (e.g., upper and lower gastrointestinal, chest) (40 mrem)**
17. ☐ Have had nuclear medical procedures (e.g., thyroid scans) (14 mrem)**
18. ☐ Live within 50 miles of a nuclear power plant (pressurized water reactor) (0.0009 mrem)
19. ☐ Live within 50 miles of a coal-fired electrical utility plant (0.03 mrem)

Calculate Annual Dose

US NRC Personal Annual Radiation Dose Calculator

- My personal dose came out to be ~ 330 mrem < 350 mrem (annual dose as approved by Govt. from natural and man-made sources for general public).

- This calculator shows that everyone living on this planet receives a radiation dose, albeit the number might vary depending on your lifestyle and other natural factors.

"The reduction in life expectancy from a dose of 1 mrem is about 1.2 minutes. This is equivalent to the reduction in life expectancy from crossing the street three times, taking three puffs on a cigarette, or consuming 10 extra calories (for a person who is overweight)."

Back to the beginning...

The idea is to not get scared but to gain better understanding of what radiation is & how it affects our day-to-day lives

Clear examples of Bananas and Trans-continental flights

The point is that the human body has been subjected to radiation ever since it came into existence

Depending on where we live and our lifestyle, the amount of radiation that we receive might vary

And, our body knows how to handle it!

It has been handling radiation and keeping us safe for all this time

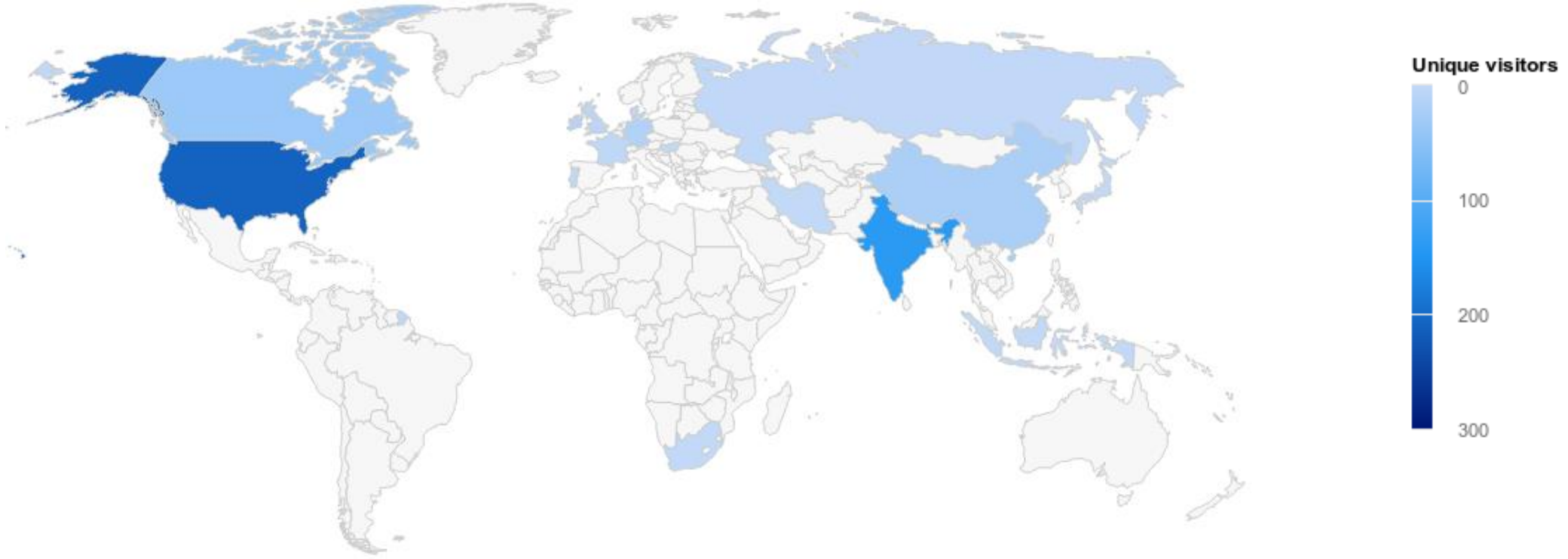
To receive a fatal or a potentially dangerous dose (>1000 rem), you need to receive a lot of it

Fear is a by-product of ignorance. Now is the time to shed ignorance about radiation and its ill-effects and accept Nuclear power for all the benefits it can offer.

And hence this initiative – *Nuclear Energy – The Better Energy*

Nuclear Energy – The Better Energy

Progress Report



Up to 176 followers worldwide and 300 unique visitors per month!

85 years of scientific experience and the nucleus has still managed to keep the entire mankind baffled. Such is the enigma of Nuclear Power. The immense energy that it releases can not only light your bulbs but can also provide you medical assistance. It is something that stays inside your body, gets replenished every time you eat and breathe. You cannot escape it. You need it. Coal, Petroleum and Natural Gas won't last for your great grandchildren, but Nuclear Power will. Not necessarily the last resort but, a greener, safer and a better one.

Thank You!

[Image adapted from businesstech.co.za]