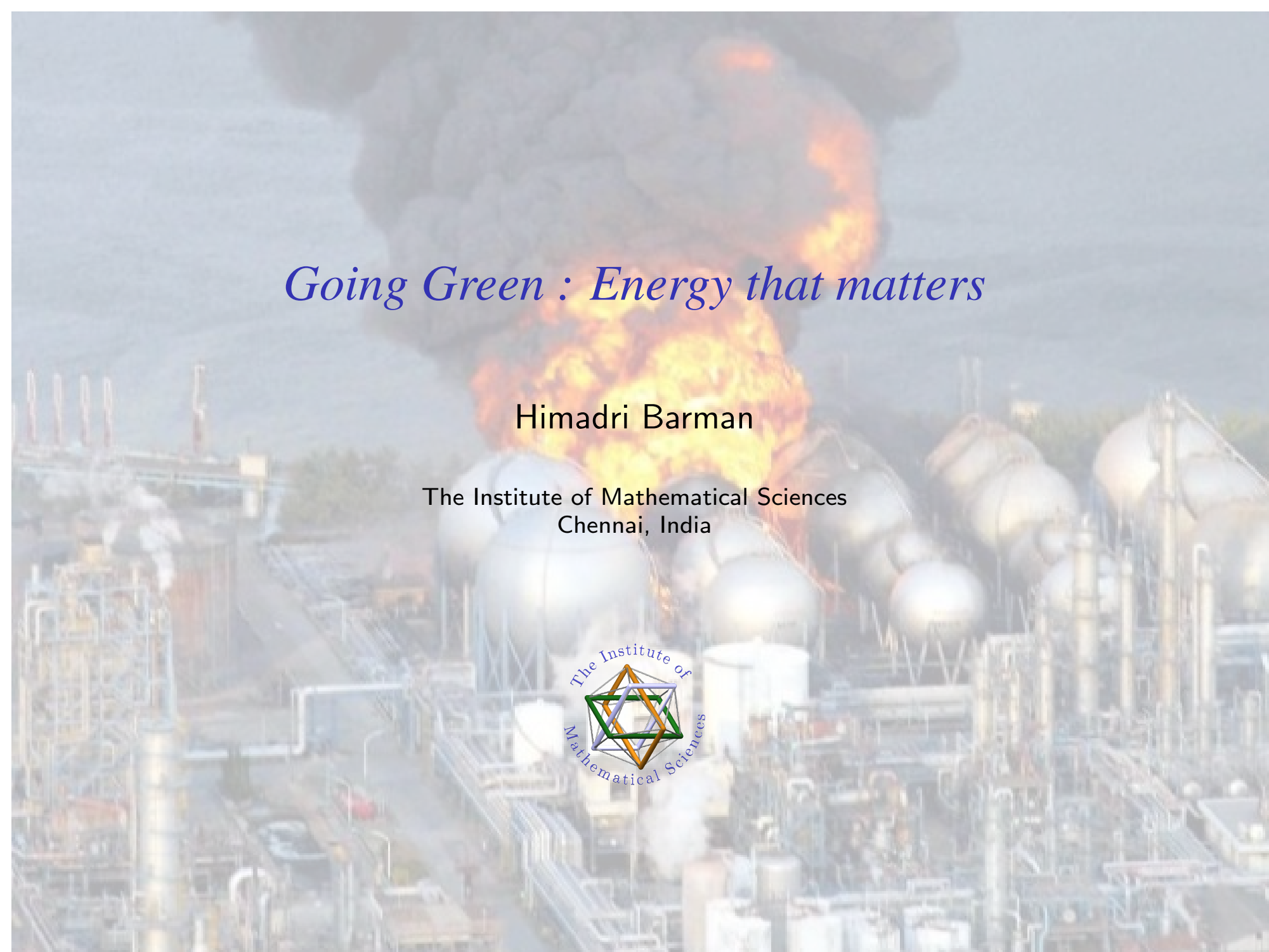

Going Green : Energy that matters

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Plan

E for Energy, E for Electricity.

- Introduction : Need for green E equations.
- The nuclear (or unclear ?) story.
- The renewable story.
- Energy storage (battery).

Introduction : Need for green E equations.

Fossil fuels : conventional energy equations

- Coal
- Oil
- Gas

What's bad about them ?

- Natural resources are going to end.
- Huge carbon emission hence accelerating global warming !
- Hazards related to mining/extracting.

Image: nationalgeographic.com

Why global warming a serious concern?

Death Toll in India's Intense Heat Wave Soars to Over 1,100

Rohit Inani / New Delhi @josefkisdrunk | May 27, 2015

Temperatures in parts of the country have neared 122°F (50°C)

India's heat wave has now claimed over 1,100 lives, with spiking temperatures melting roads in the capital, New Delhi, as the country awaits the arrival of the annual monsoon rains.

More than 850 people have succumbed in the southeastern Indian state of Andhra Pradesh, where extreme temperatures claimed more than 200 lives in one district alone. In neighboring

Jagadeesh NV—EPA

An Indian farmer sits in his dried-up land in Gauribidanur village, near Bangalore, India, on May 26, 2015

- Heatwave kills people, animals, and vegetations.

Image: hindustantimes.com, time.com

The nuclear (or unclear ?) story

Nuclear craze

Fuel comparison

- 1 kg coal gives $\simeq$ 8 kWh; 1 kg crude oil 12 kWh 1 kg U-235 gives 24 $\times 10^6$ kWh.

- 1 kg of U-235 =: 3 $\times 10^6$ kg coal =: 3 coal cars (each carrying 100 tons).

Source : www.euronuclear.org, 1 W h = 3600 joules

How to get nuclear energy?

The nuclear energy equation : $E = mc^2$.

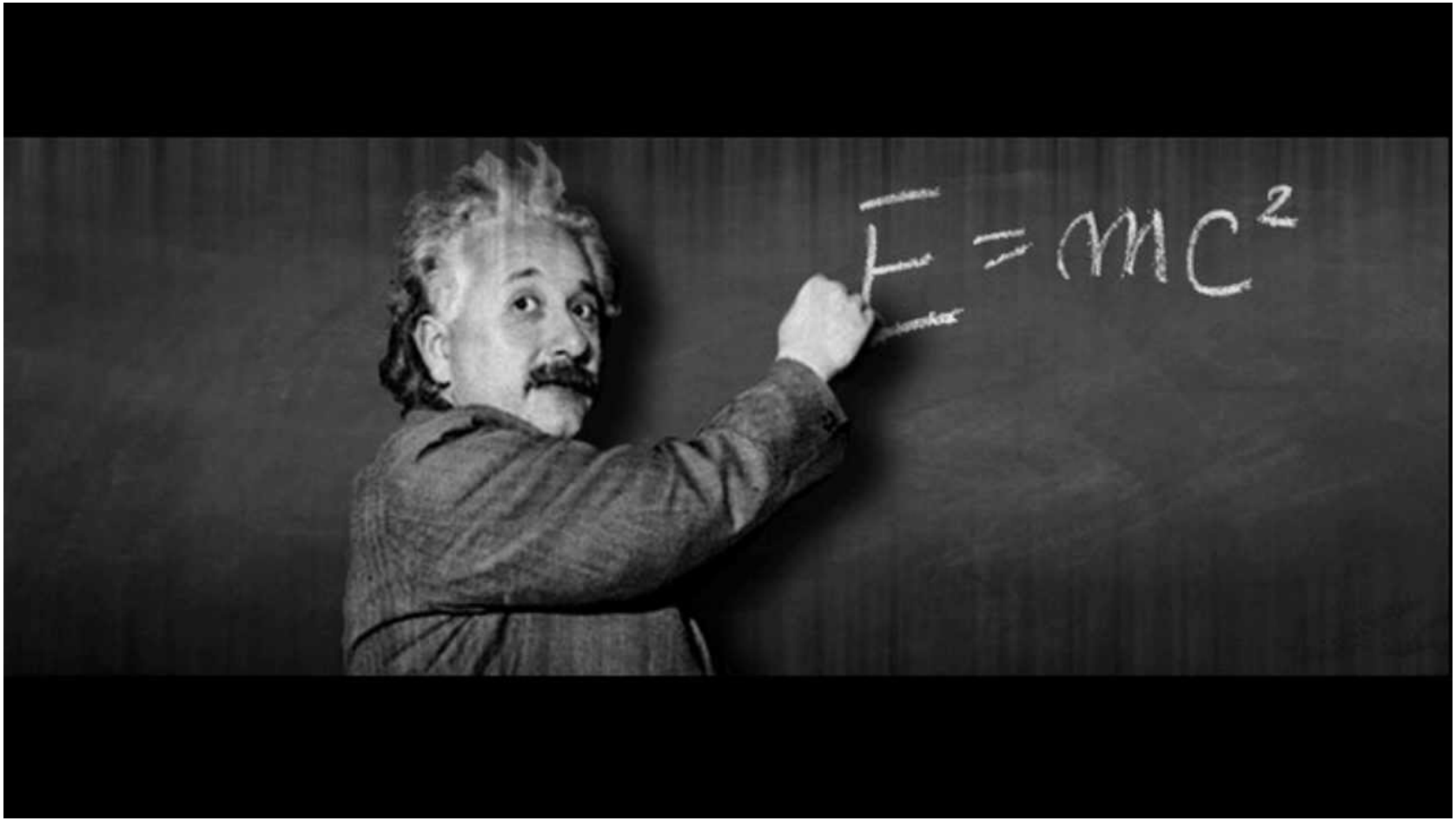


Image : wallpaper24x7.com

How to get nuclear energy?

The nuclear chain reaction (fission) :

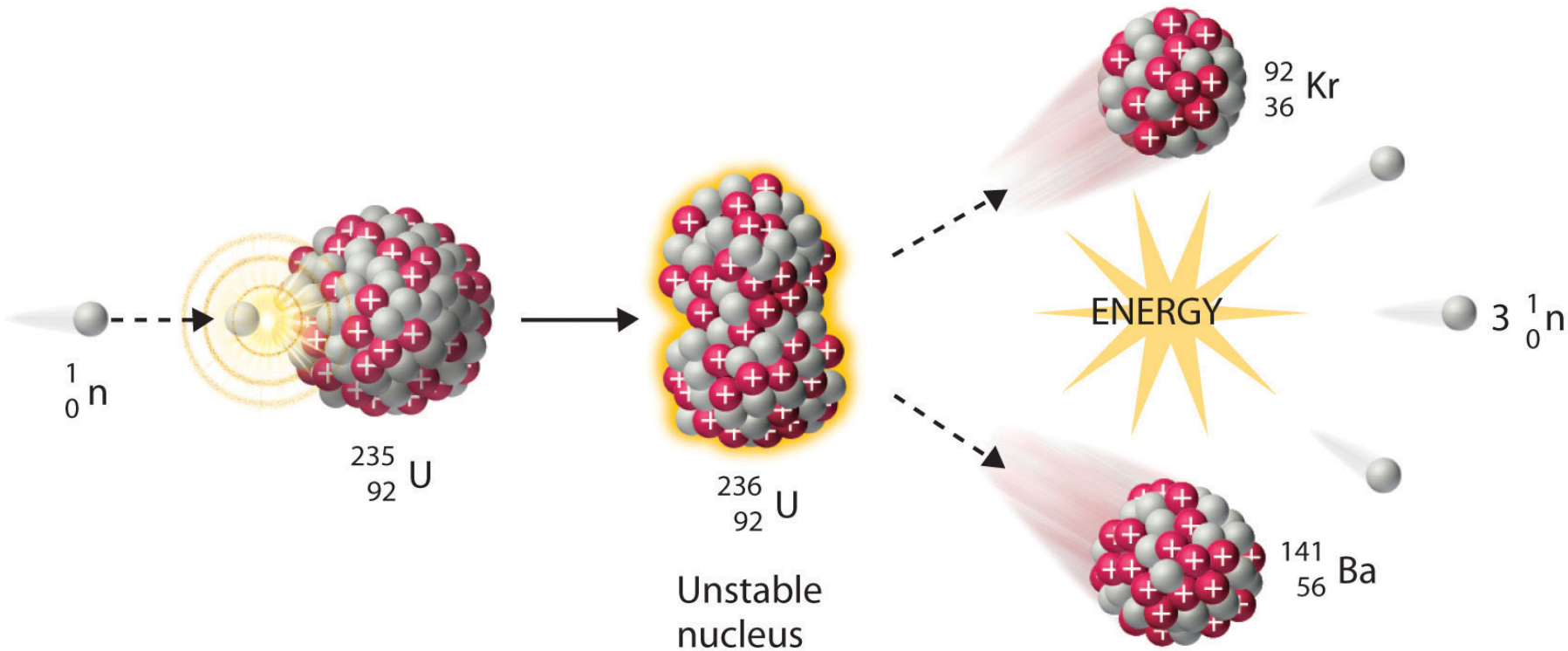


Image : nuclear-power.net

Nuclear disasters

Three Mile Island (USA, 1979)

Nuclear disasters

Chernobyl (Russia, 1986)

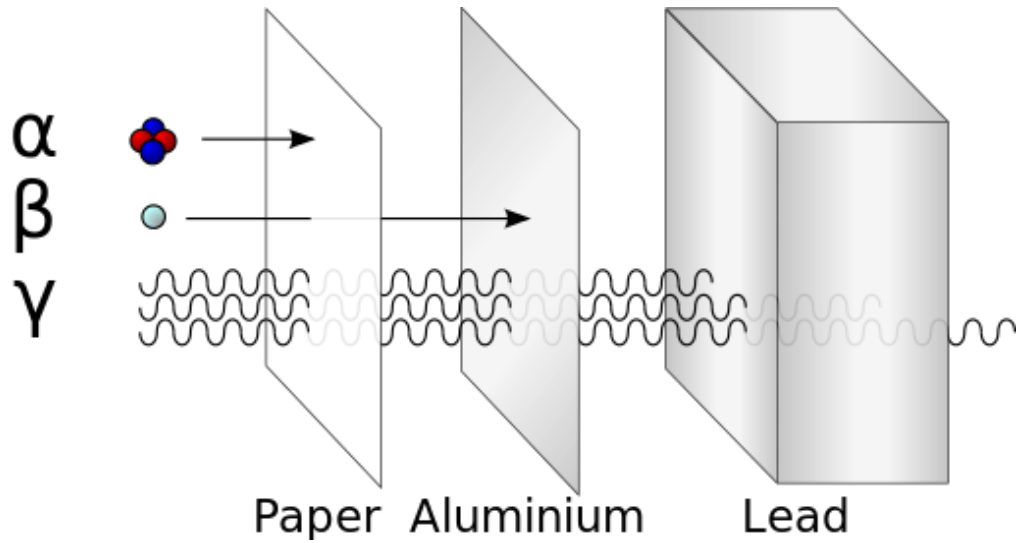
Nuclear disasters

Fuskushima (Japan, 2011) Video : Fukushima disaster footage.

Radioactivity 101

Radioactivity : Process of unstable to stable nuclei

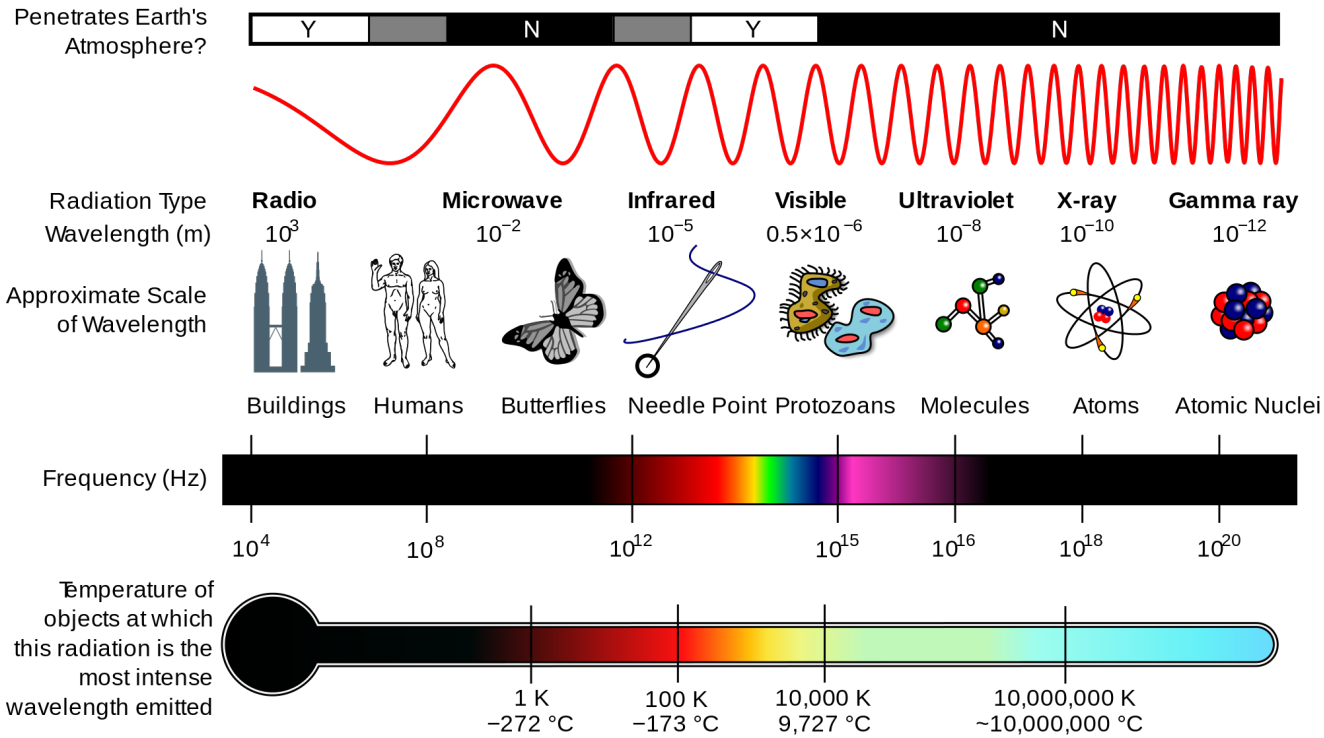
- Emits particles: α (helium), β (electron/positron), γ (high energy light).



- Decay law : $N = N_0 e^{-\lambda t}$. λ : Decay constant, N_0, N : initial and final number of particles after time t.
- Half life : The time when $N = N_0/2$. More half-life $\Rightarrow$ longer duration of radioactivity !

Radioactivity 101

So gamma ray is the most dangerous one !



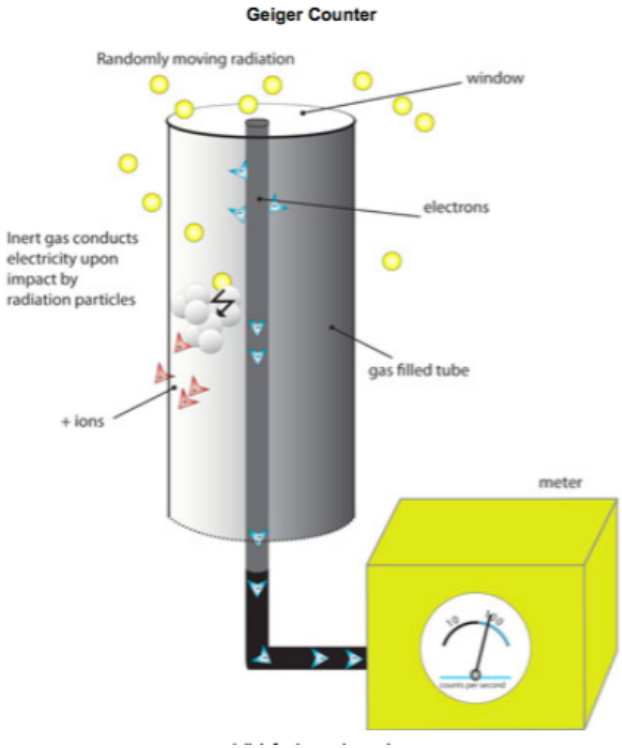
Danger of nuclear radiation

Madam Curie died due to radioactivity!

Detecting radiation

Radioactive sources are pretty around us, say banana!

A banana contains naturally occurring radioactive material in the form of potassium-40.

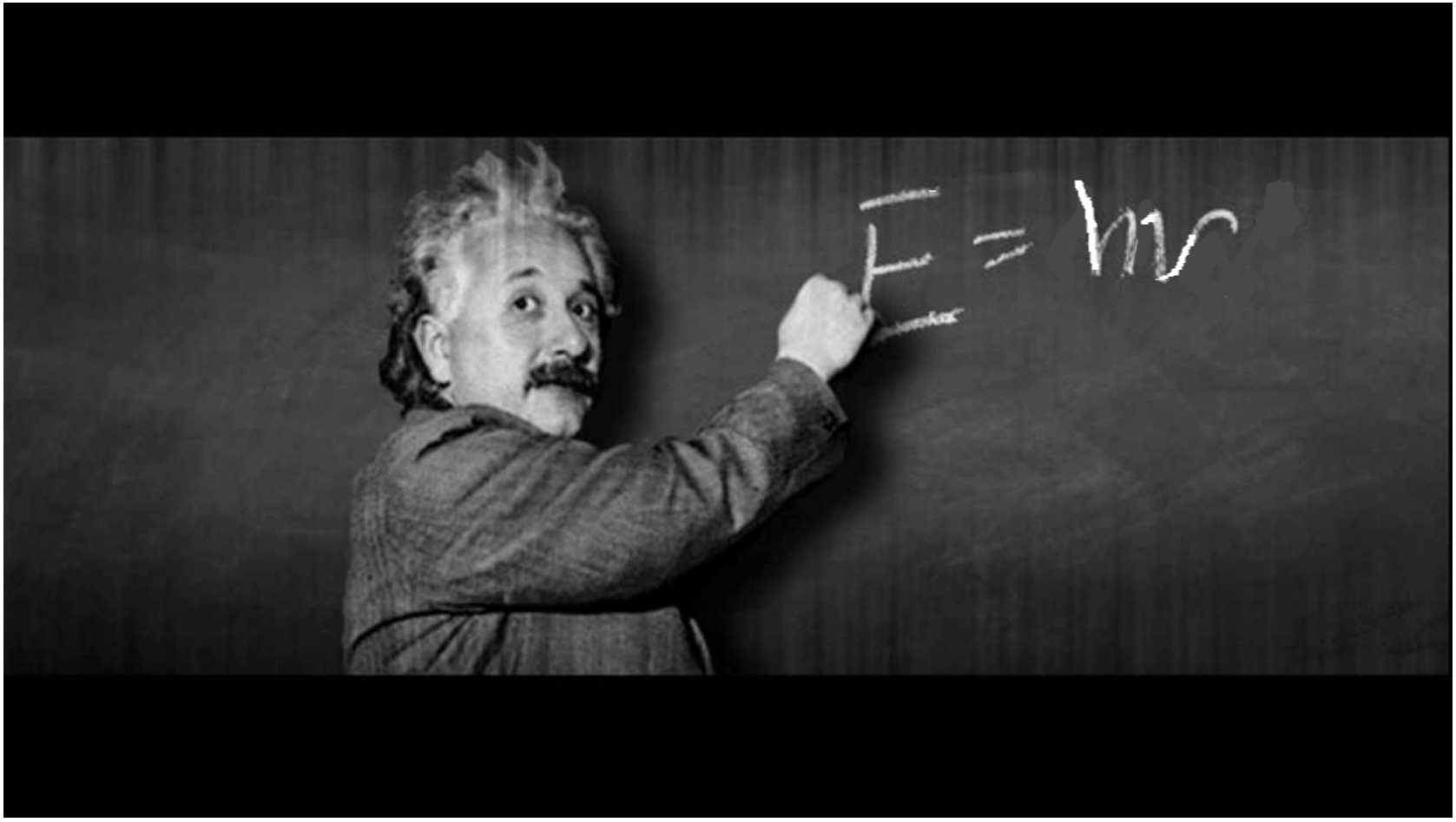


Geiger-Müler counter reading !

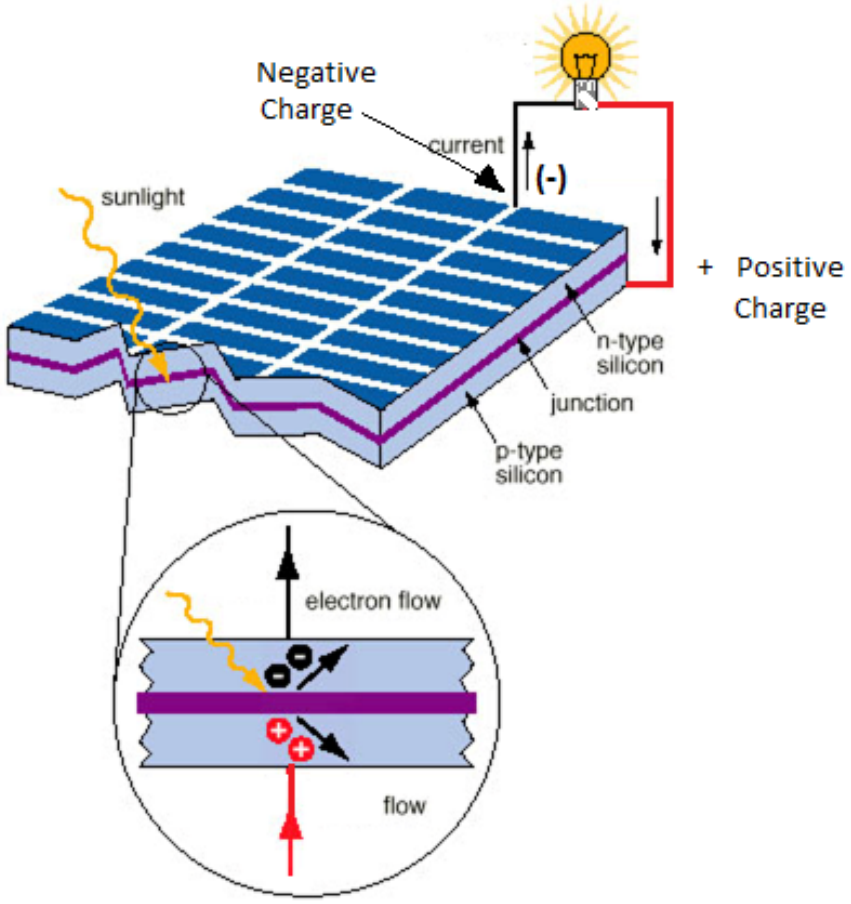
The renewable story

Solar energy

Equation : $E = h\nu$.



Solar panel : photovoltaic effect



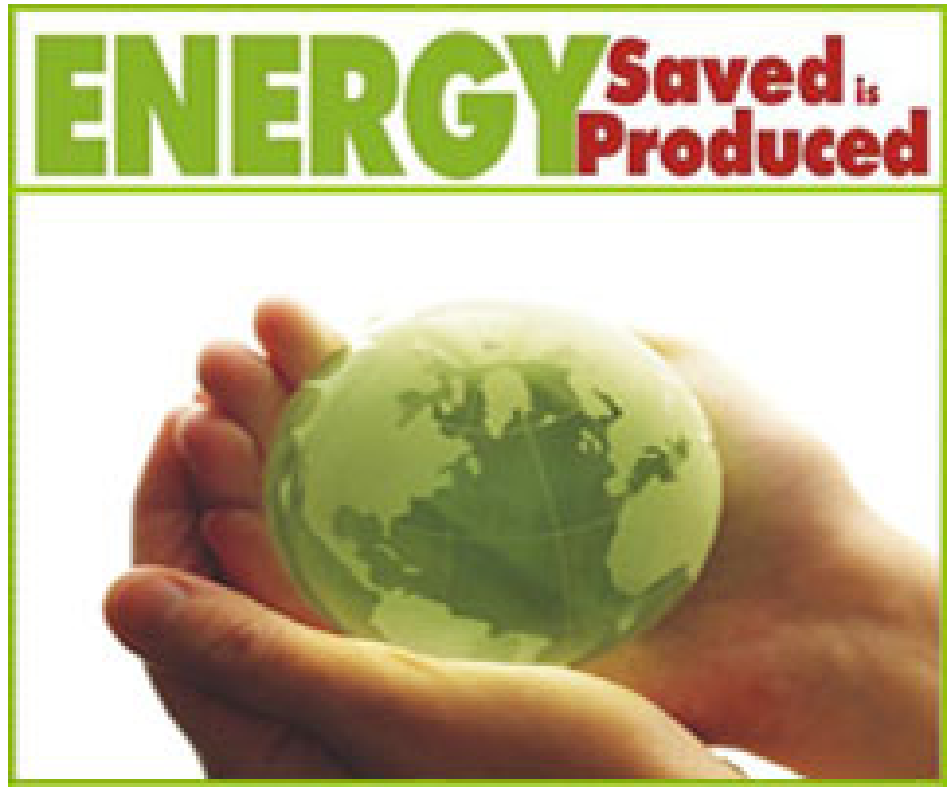
Wind energy

- Aralvaimozhi station, Tamilnadu.

Energy storage

Energy storage

A penny saved is a penny earned - Benjamin Franklin



Energy equation :

- Save (reduce wastage) and harness.
- More energy-efficient utilities (eg. CFL, LED).
- Efficient batteries, power-grid.

Energy storage

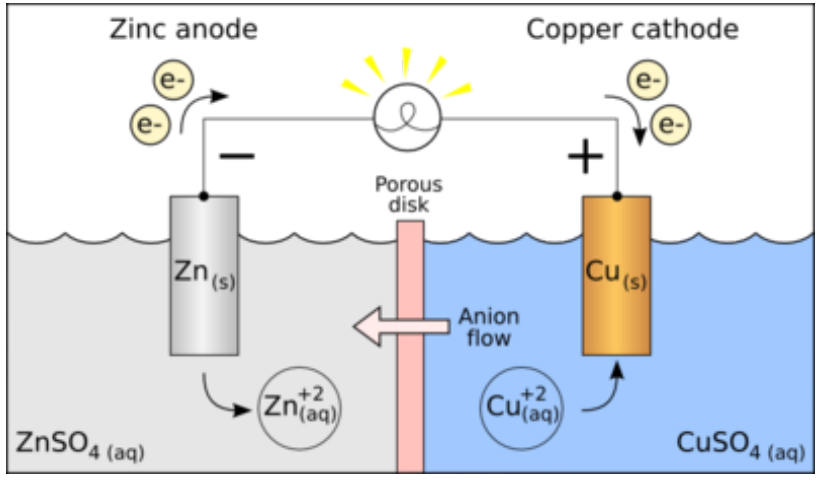
- Pumped hydro storage.
- Lithium ion.
- Tesla battery.
- Compressed air energy storage (CAES).
- Molten salt storage.
- Smart grid (smart distribution network, sensors, meters).

Battery 101

Battery mainly consists of

- **cathode** : Positive electrode that collect electrons (reduction).
- **anode** : Negative electrode that loses electron (oxidation).
- **electrolyte** : Material that reacts with electrons conducts elctric current when elecrodes are wired.
- **Separator (Spacer)** : Separates cathodes and anodes from direct contact but allows charge carriers to pass through.

Galvanic cell

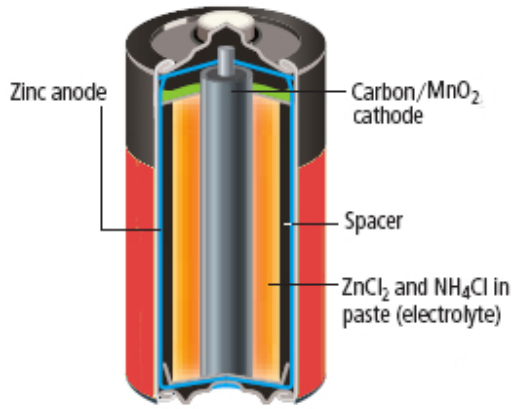


Chemical reactions:

- Anode : $Zn(s) \rightarrow Z^{2+}(aq) + 2e^{-}$.
- Cathode : $Cu\ (aq) + 2e^{-} \rightarrow Cu\ (s)$.

Demo : Potato battery experiment !

Dry cell



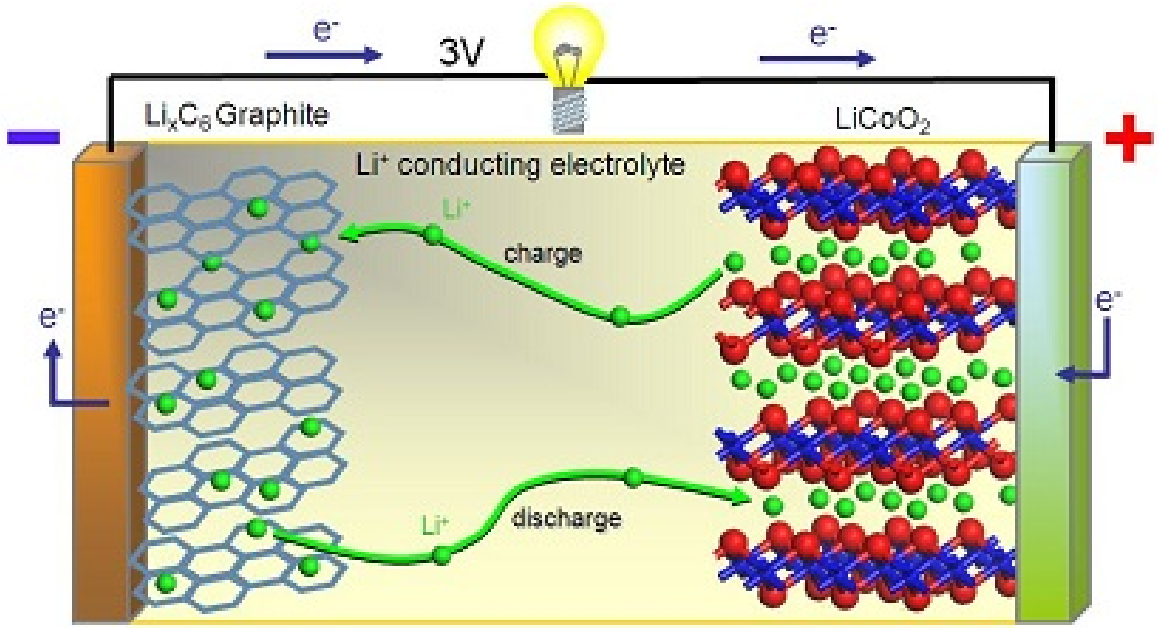
Zinc-carbon dry cell

Chemical reactions:

- Anode : $Zn(s) \rightarrow Z^{2+}(aq) + 2e^{-}$.
- Cathode : $2\ MnO_2 + 2e^{-} + 2NH_4Cl(aq) \rightarrow Mn_2O_3(s) + 2\ NH_3(aq) + H_2O(l) + 2\ Cl$.

Battery 101

Rechargable battery : Lithium ion



- **Charging:** $\mathrm{Li}_{1-x}\mathrm{CoO}_2 + x\mathrm{Li} + x\mathrm{e}^- \rightarrow \mathrm{LiCoO}_2$.
- **Discharging :** $\mathrm{LiC}_6 \rightarrow x\mathrm{Li}^+ + x\mathrm{C}_6 + \mathrm{e}^-$.

Fuel cell

- A device that converts energy of a fuel into electrical energy with no heat engine (combustion chamber).

Additional informations

Glossary

- **Breeder reactor :** A nuclear reactor that generates more fissile material than it consumes.
- **Capacity factor :** The ratio of a power plant's actual output over a period of time, to its potential output if it were possible for it to operate at full nameplate capacity continuously over the same period of time.
- Critical mass : The smallest amount of fissile material needed for a sustained nuclear chain reaction.
- **Enriched uranium :** A type of uranium in which the percent composition of uranium-235 has been increased through the process of isotope separation.
- **Half-life :**
- **MeV to kWh (electrical unit) :** 1 MeV $= 4.45 \times 10^{-20}$ kWh.
- **Nuclear transmutation :** The conversion of one chemical element or an isotope into another.
- **Tamper :** A nuclear moderator to slow down the speed of fast neutrons.

Glossary

- **Fissionable materials :** Isotopes that can go for fission after capturing either fast or thermal neutrons.
- **Fissile materials :** Isotopes that can go for fission after capturing thermal neutrons.
- **Fertile materials :** Isotopes that are not fissionable by thermal neutrons, but can be converted into fissile isotopes (after neutron absorption and subsequent nuclear decay).

A few myths

1. Radioactive radiation is not the threatening one, it's the radioactive particles in the environment are dangerous. The radiation becomes pretty strong inside our body.