

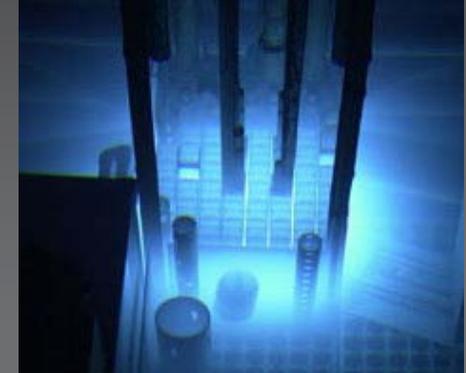
# NUCLEAR ENERGY & THE SUCCESSFUL STUDENT

*"What every high school student should know"*

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Director of Nuclear Engineering**

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**INL  
National Physics Teacher Workshop  
Idaho Falls, ID  
17 July 2009**



# ENERGY *"It comes in many forms"*

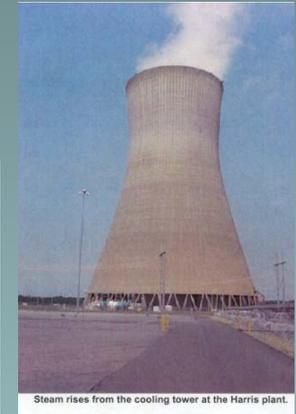
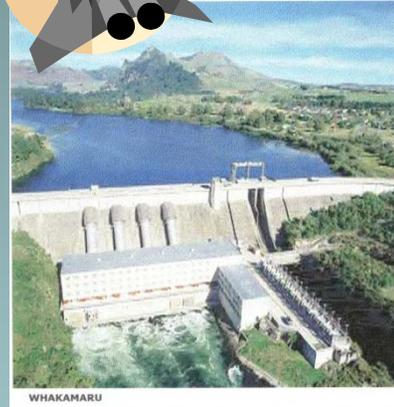
- **WORK:**  $W = F \times d$
- **KINETIC ENERGY** =  $\frac{1}{2} mv^2$
- **POTENTIAL ENERGY** =  $mgh$
- **NUCLEAR**  $E = mc^2$
- **HEAT** "the graveyard of all energy"

Coal – Oil – NG

- **CHEMICAL** 'battery'
- **Others...**

## ENERGY 'CARRIERS'

- **FUELS** (gas, oil, H<sub>2</sub>, ...)
- **ELECTRICITY**



Energy is Important in many occupations...

Chemistry / Physics / Engineering / Others

**TRADITIONAL  
ENGINEERING**

(undergraduate)

Mechanical

Civil

Electrical

Chemical

Mining

Others

**SPECIALIZED  
ENGINEERING**

(graduate)

Computer

Petroleum

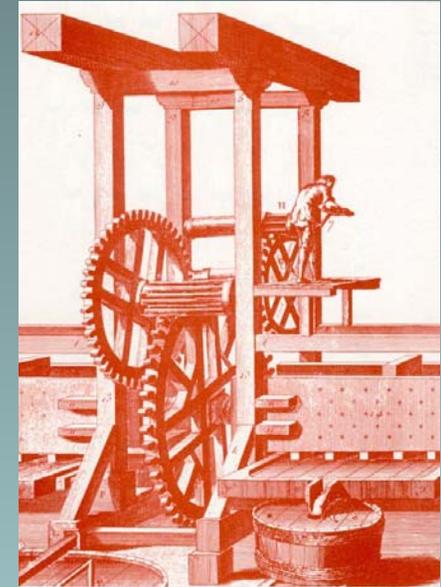
Aerospace

Nuclear

Agricultural

Biomedical

Others



## MECHANICAL ENGINEERING

"Anything that moves,  
gets hot or cold"



## NUCLEAR ENGINEERING

"Anything radioactive"



### Common Elements

**Physics** (Energy, Fluid Mechanics, Thermodynamics  
Materials Science, EM radiations, Mechanics,...)

**Chemistry** (periodic table, isotopes, ...)

**Mathematics** (and statistics)

**Computer Science**

**Others**

# Mechanical Engineering

*"Anything that moves, gets hot or cold"*

## Transportation

(cars, trains, planes, spacecraft, ...)

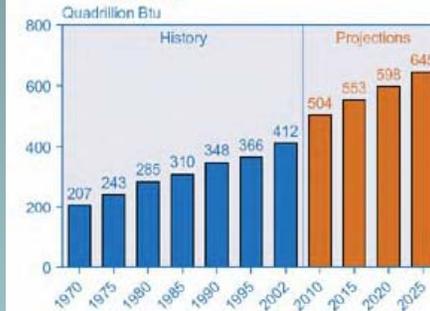
## Energy

(oil, gas, coal, nuclear, wind, solar, hydro, biofuels, materials, ...)

## Creature Comforts

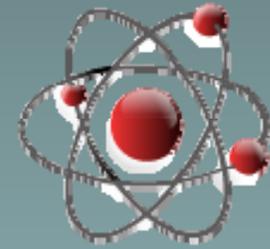
(refrigeration, air-conditioning, electricity, safety, biomedical, ...)

Figure 7. World Marketed Energy Consumption, 1970-2025



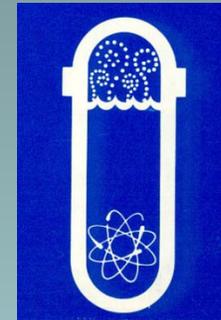
# Nuclear Engineering

"Anything radioactive"



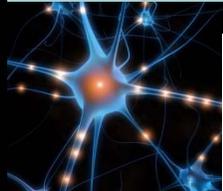
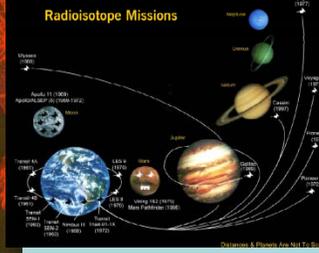
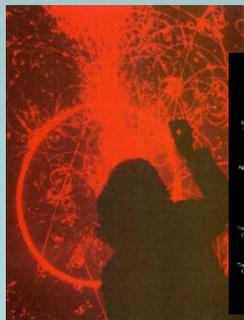
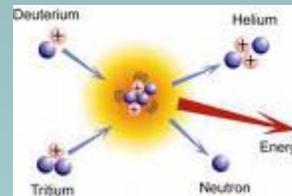
## ENERGY

- Production of electricity & heat
- Fission & Fusion
- Space
- Others



## NUCLEAR & ATOMIC RADIATIONS

- Alpha Beta Gamma X-rays n's
- Medical & Industrial
- National Security
- Others



# ENERGY

## 1<sup>st</sup> Law of Thermodynamics

### CONSERVATION OF ENERGY

*"energy is neither created nor destroyed, it just changes form"*

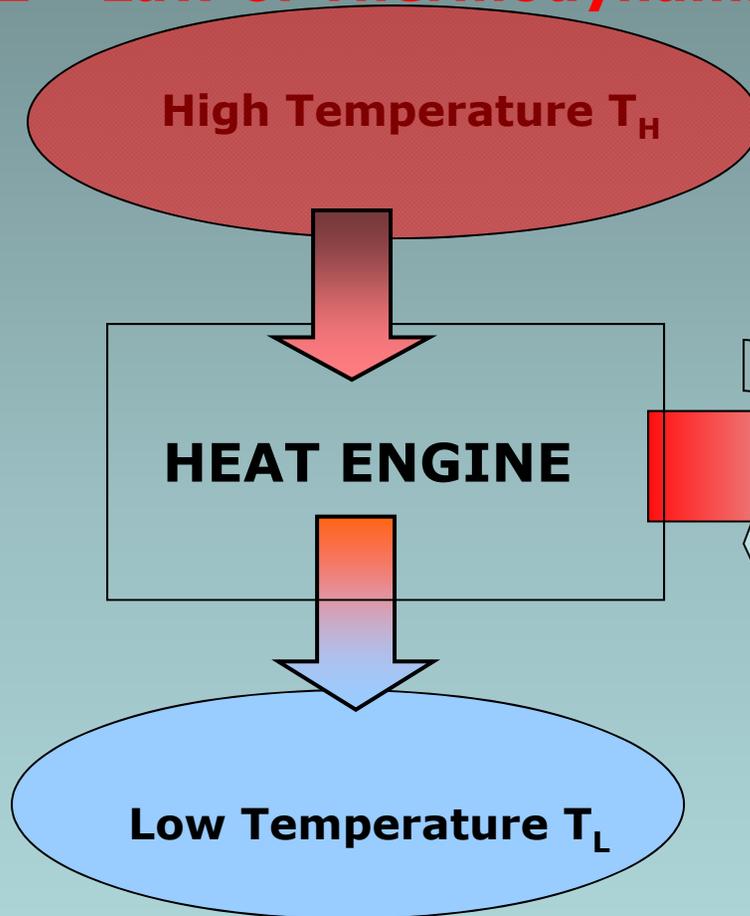
*"heat is the ultimate fate of all energy"*

$$dE = \delta q - \delta w$$

$$dE = d(\text{PE, KE, U, Pv, ChE, } \Delta mc^2 \text{ ..})$$

# ENERGY

## 2<sup>nd</sup> Law of Thermodynamics



## HEAT ENGINE

Autos / Jets / Power Plants /..

*All heat cannot be converted into work, some heat is wasted as thermal pollution*

**WORK**

$$\eta_{\max} = 1 - T_L / T_H$$

# Nuclear Science & Engineering

## Renewed Interest in Nuclear S&E – Why?

Climate change

Greenhouse gases

World-wide energy demand

Public acceptance of nuclear

Proven technology

Economics

INL designated US Lead

Nuclear Lab / BEA 10-y

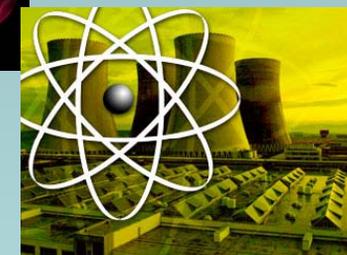
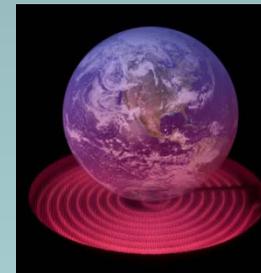
Research funding opportunities

Who's building nuclear power plants?

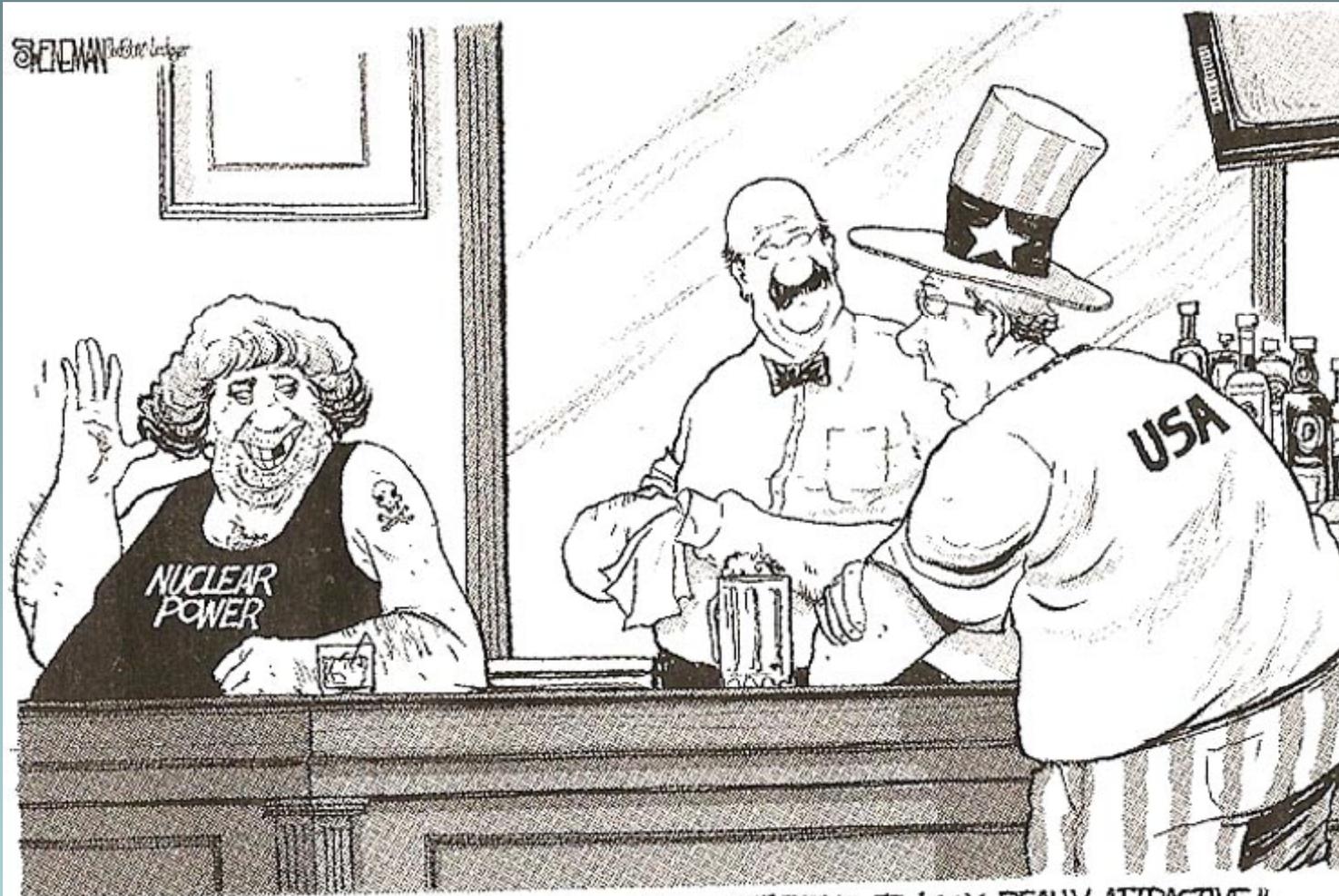
India, China, and Russia are the global leaders in constructing nuclear power plants to meet their growing electricity needs. Most of the new units are being built in developing nations.

India	7
China	5
Russia	5
Bulgaria	2
China, Taiwan	2
Ukraine	2
Argentina	1
Finland	1
France*	1
Iran	1
Japan	1
Pakistan	1
Romania	1
South Korea	1
TOTAL	30

\*Construction to begin later this year



University of Idaho  
Open Space. Open Minds.



"I MUST BE GETTING DESPERATE. SHE'S STARTING TO LOOK REALLY ATTRACTIVE."

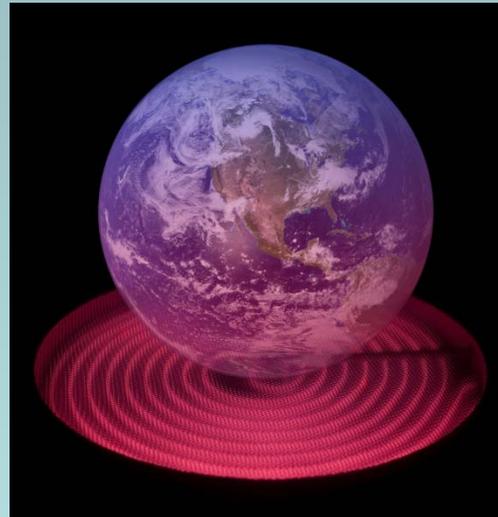
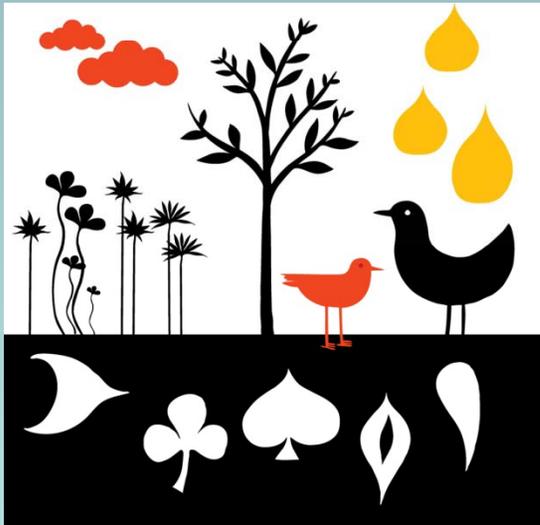
THE WEEK July 4-11, 2008

# Nuclear Energy: Did you know?

I'm naturally radioactive,  
you are too!

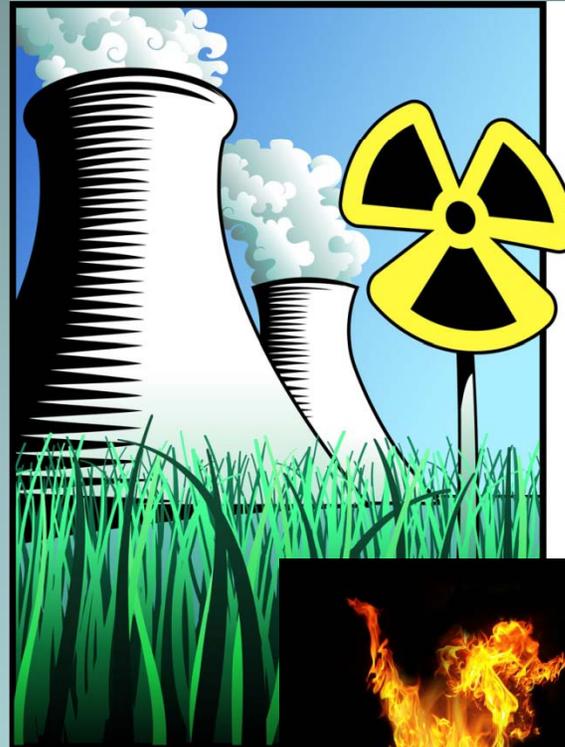


Radiation is natural



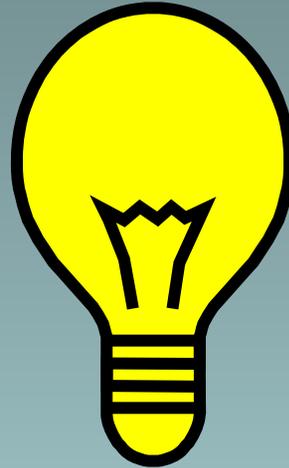
# Nuclear Energy: Did you know?

*Nuclear power is the only proven technology to safely and reliably produce large quantities of electricity without greenhouse gas emissions*



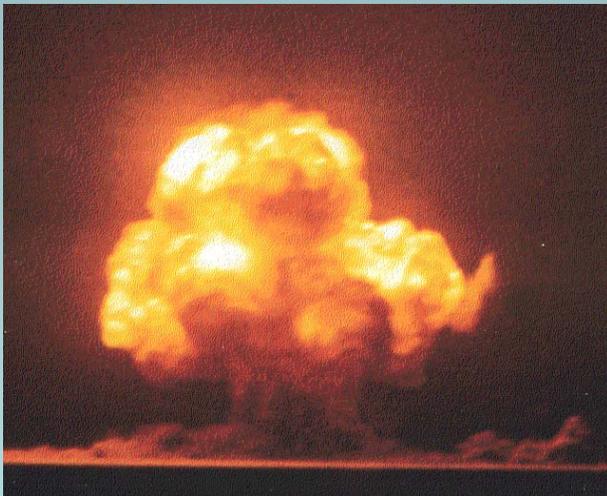
# Nuclear Energy: Did you know?

*One in every ten light bulbs  
in the U.S.A....*



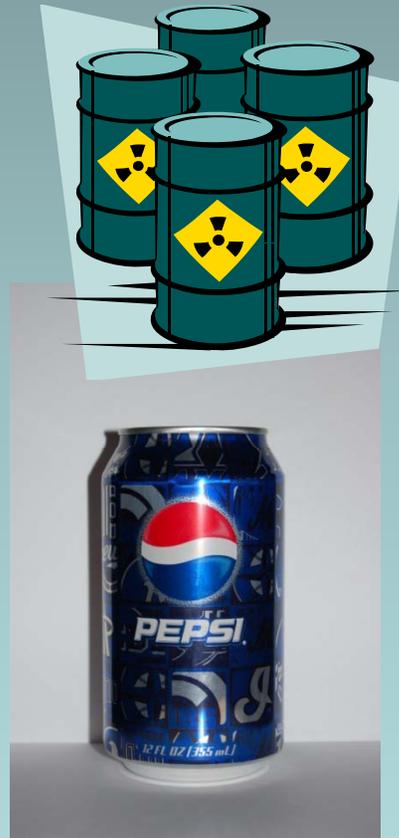
*..is powered by uranium from  
a former Soviet warhead*

ANS-2006



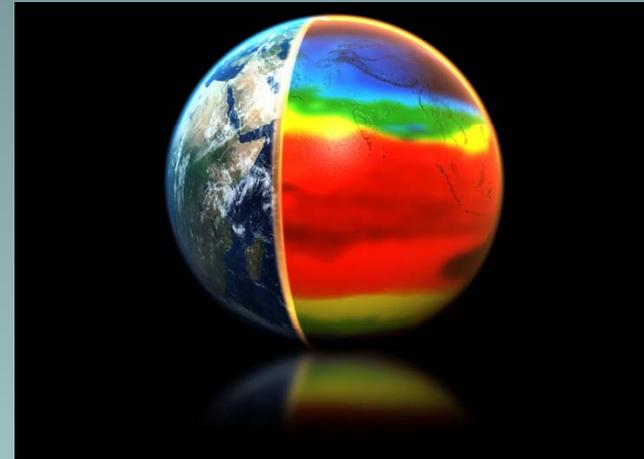
# Nuclear Energy: Did you know?

*If all the electricity used by you during your lifetime were generated by nuclear power, the total nuclear waste generated .. would fit into a single soda-pop can*

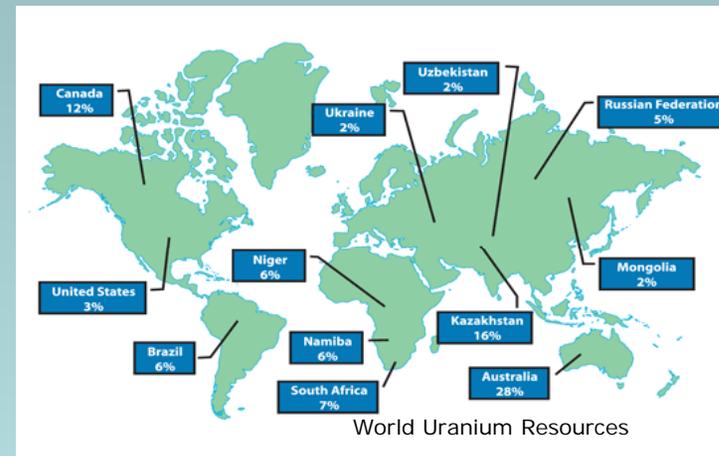


# Nuclear Energy: Did you know?

*A world-wide nuclear renaissance is underway.*



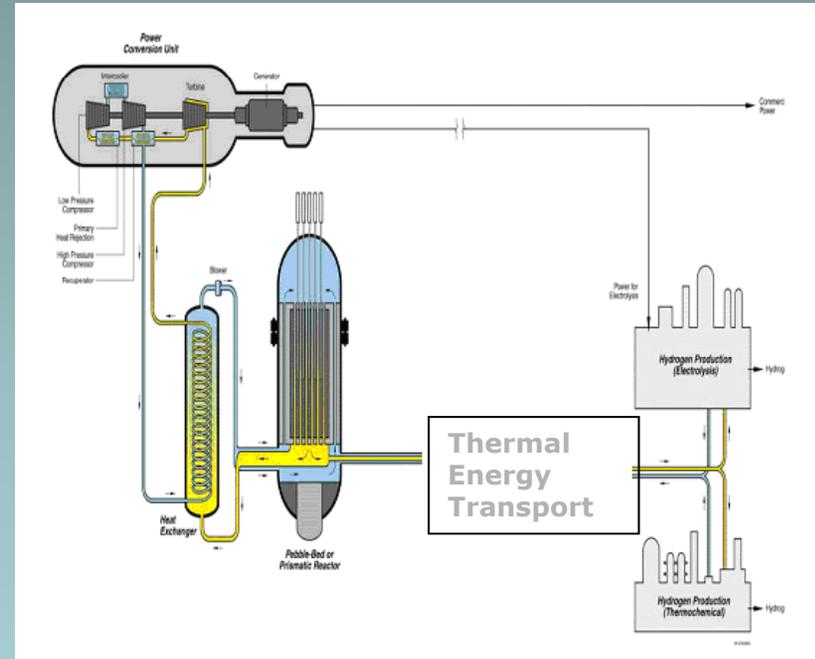
*New nuclear power plants are under construction around the world and planned for the USA.*



# Nuclear Energy: Did you know?

**I**daho is home to the nation's lead nuclear R&D laboratory that employs hundreds of scientists and engineers

And provides summer opportunities for students and teachers



# Energy: Did you know?

*The energy industry  
(including R&D) needs  
mechanical, chemical  
and electrical  
engineers....*

*..now and all 21<sup>st</sup> c*

*And physicists, chemists,  
mathematicians,  
others..*



## ~ **STARTING SALARY 2007**

U.S. Bureau of Labor Statistics

**BS....\$56k**

**MS....\$60k**

**PhD...\$70k (est)**

# True or False?

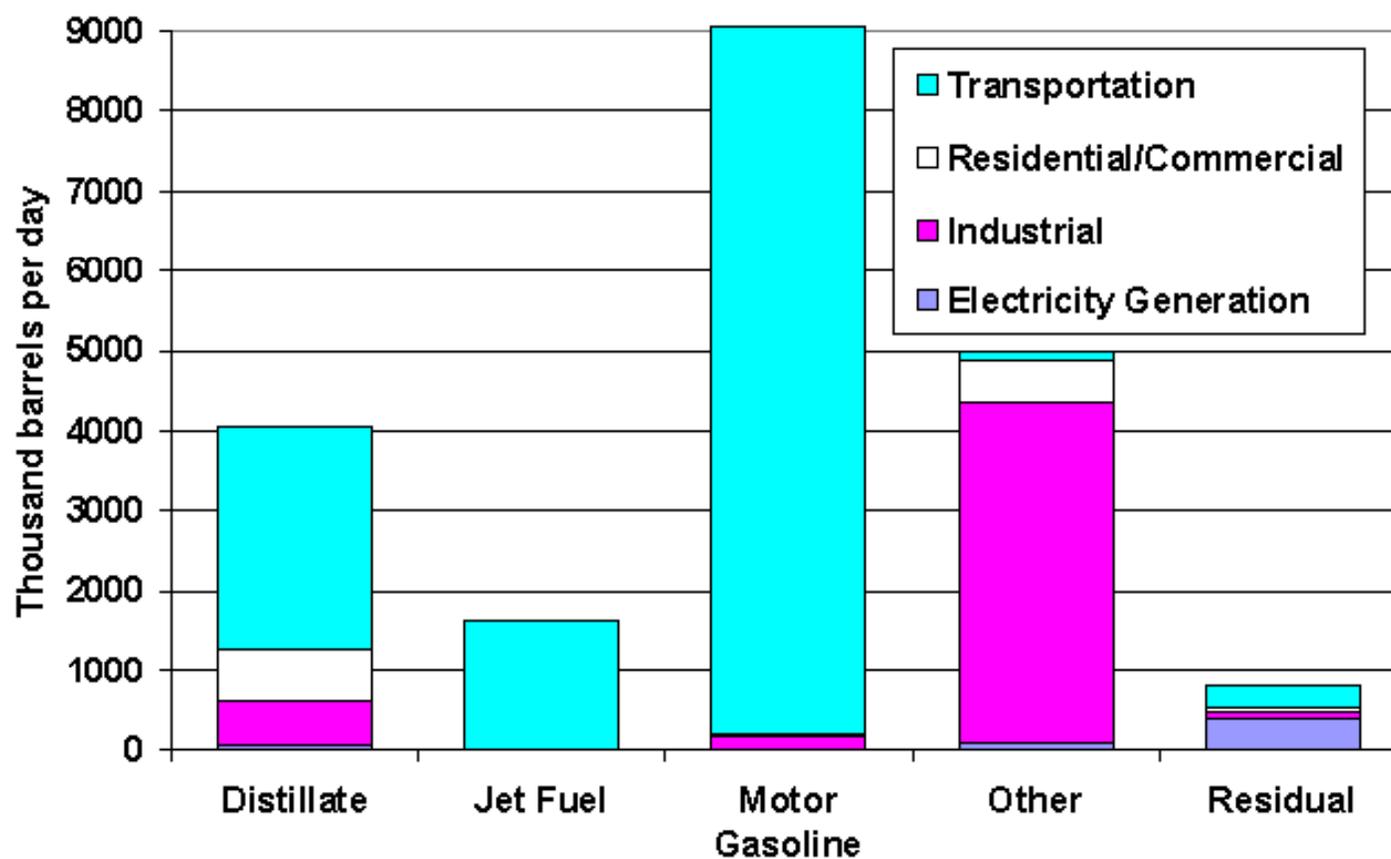
**W**e can reduce our dependence on foreign oil by building more nuclear power plants and wind turbines.



**FALSE ?**

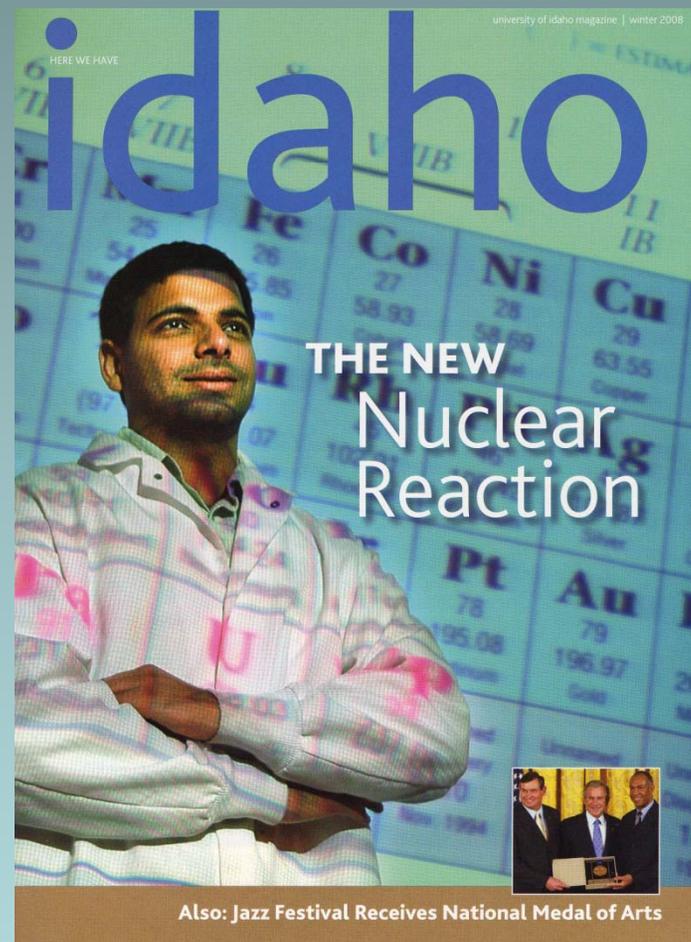


## U.S. Oil Demand by Product, by Sector, 2004



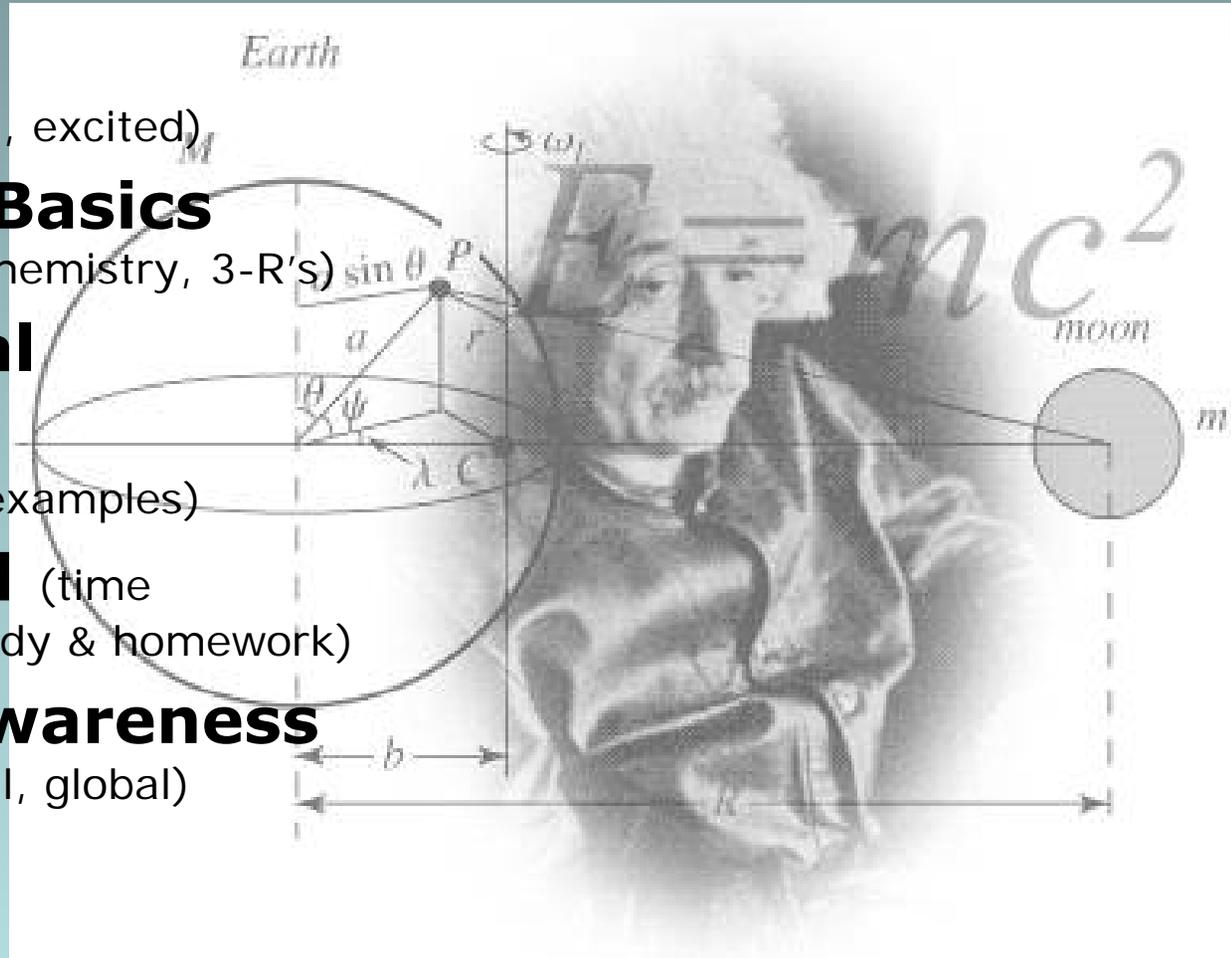
# The 'successful' student

- **How does one define the 'successful' student?**
- **Academic success?**  
*GPA / Degrees / Leadership / Clubs / Scholarships / ...*
- **Professional success (after graduation)?**  
*Doctor / Lawyer / Chemist / Physicist / Engineer Technician / Teacher / ...*
- **Others ....**



# ATTRIBUTES OF THE 'SUCCESSFUL' STUDENT

- **Motivated**  
(keen on learning, excited)
- **Academic Basics**  
(math, physics, chemistry, 3-R's)
- **Intellectual Curiosity**  
(Disney & NASA examples)
- **Disciplined** (time management, study & homework)
- **Societal Awareness**  
(regional, national, global)
- **Others?**



What I tell my students

# THE SECRETS OF SUCCESS

- Be there
- Pay attention
- Ask question(s)
- Don't give up
- Be nice



# SUMMARY

All high school students should be introduced to the concepts of ....

- Energy (including nuclear)
- Different forms of energy  
1<sup>st</sup> Law and 2<sup>nd</sup> Law
- World-wide energy perspective
- Careers in science and engineering
- Success



**QUESTIONS?**

