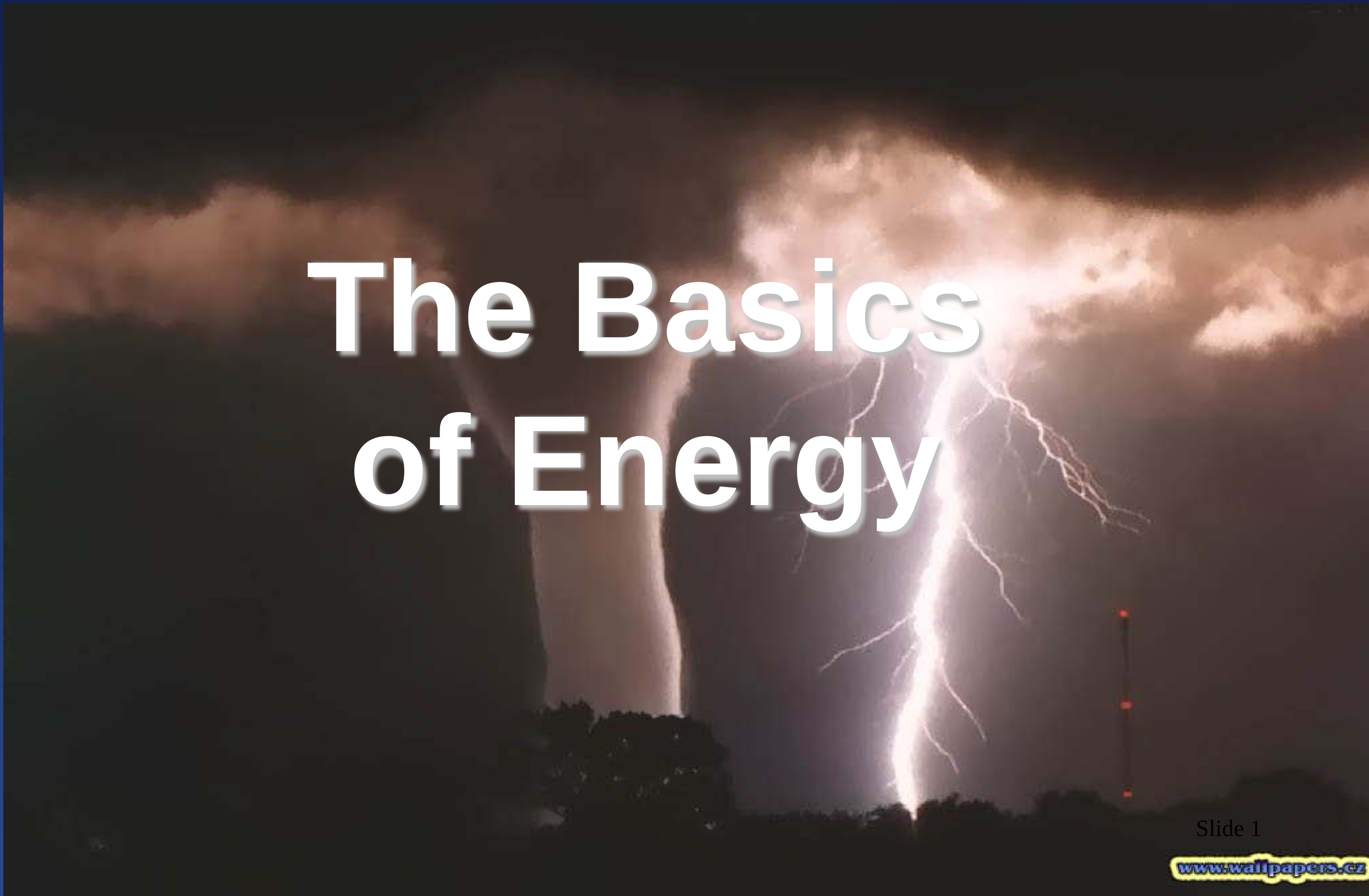
The Basics of Energy



Outline:

- Definitions
- Types of energy
- Laws of thermodynamics
- Energy efficiency
- Direct vs. Indirect Energy
- Energy “quality”

DEFINITIONS

1. Energy

2. Work

3. Power

Energy

"The ability to do work"

- What does that mean?

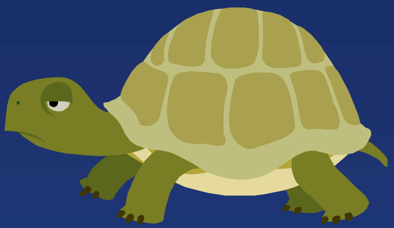
Work

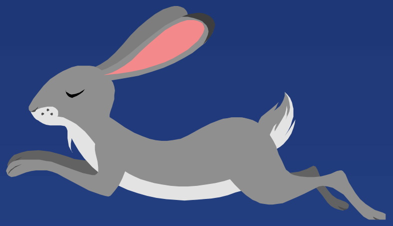
"The act of moving things. The transfer of energy."

- Work occurs when a force is applied over some distance

Power

- ***"The rate at which work is done***





Power (P) =

Work (W) / time (t)

Power

KWH / H = KW

1 HP =

0.746 Kilowatts

How do we measure energy?

- **Kilocalorie**: Heat required to raise the temperature of 1 Liter of water 1^{o}C.
- **British Thermal Unit**: The heat required to raise the temperature of 1 pound of water 1^{o}F.
- **Joule**: The force required to move a mass of 1 kg 1 meter.
- **Watt (power)**: One joule per second.

Energy Conversions to BTU's [1/]			
Code	Energy Source	Unit	Conversion factor
1	# 2 Fuel Oil[2/]	Gallon	139,000
2	Coal	Pound	10,550
3	Diesel	Gallon	138,694
4	Electricity	Kilowatt hour	3,413
5	Ethanol	Gallon	84,400
6	Gasohol. (10% ethanol)	Gallon	120,900
7	Gasoline	Gallon	125,000
8	Kerosene	Gallon	135,000
9	Methanol	Gallon	62,800
10	Natural Gas	Therm	100,000
11	Propane/LPG	Gallon	95,475
12	Residual Fuel Oil	Gallon	149,690
13	Wood	Standard Cord	21,000,000

Two Broad Types of Energy

Working Energy(Kinetic Energy)

The energy of motion.

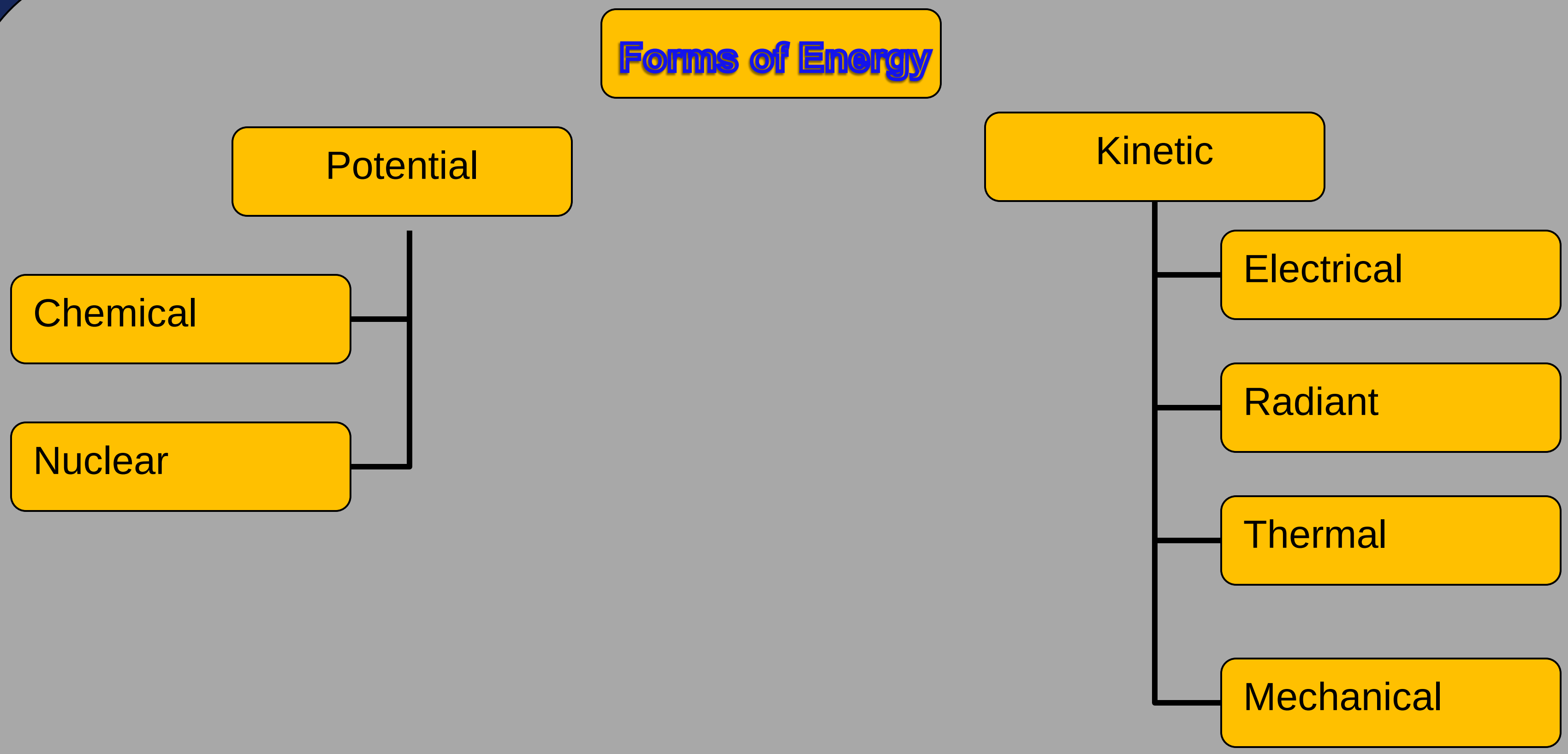
Two Broad Types of Energy

Stored Energy (Potential Energy)

Any energy source that is available or on stand by.

Potential or Kinetic?

- Tillage
- NH_3 fertilizer
- Diesel fuel
- Electricity
- Irrigation
- Ethanol
- Corn crop


Forms of Energy
Potential
Chemical
Nuclear
Kinetic
Electrical
Radiant
Thermal
Mechanical

Laws of Thermodynamics

Law #1 ***Energy cannot be created or destroyed.***

Law #2 **Energy spontaneously tends to disburse. Every time energy is transferred or transformed, some useable energy is lost as heat.**

The British scientist, C.P. Snow, had an easy way of remembering the laws:

- ***You cannot win*** (that is, you cannot get something for nothing, because matter and energy are conserved).

- ***You cannot break even*** (you cannot return to the same energy state, because there is always an increase in disorder; entropy always increases).

Energy Efficiency

The ratio of energy output to energy input

$$\text{Efficiency } (\eta) = \frac{\text{power output}}{\text{power input}}$$

Can output divided by input = 100%?

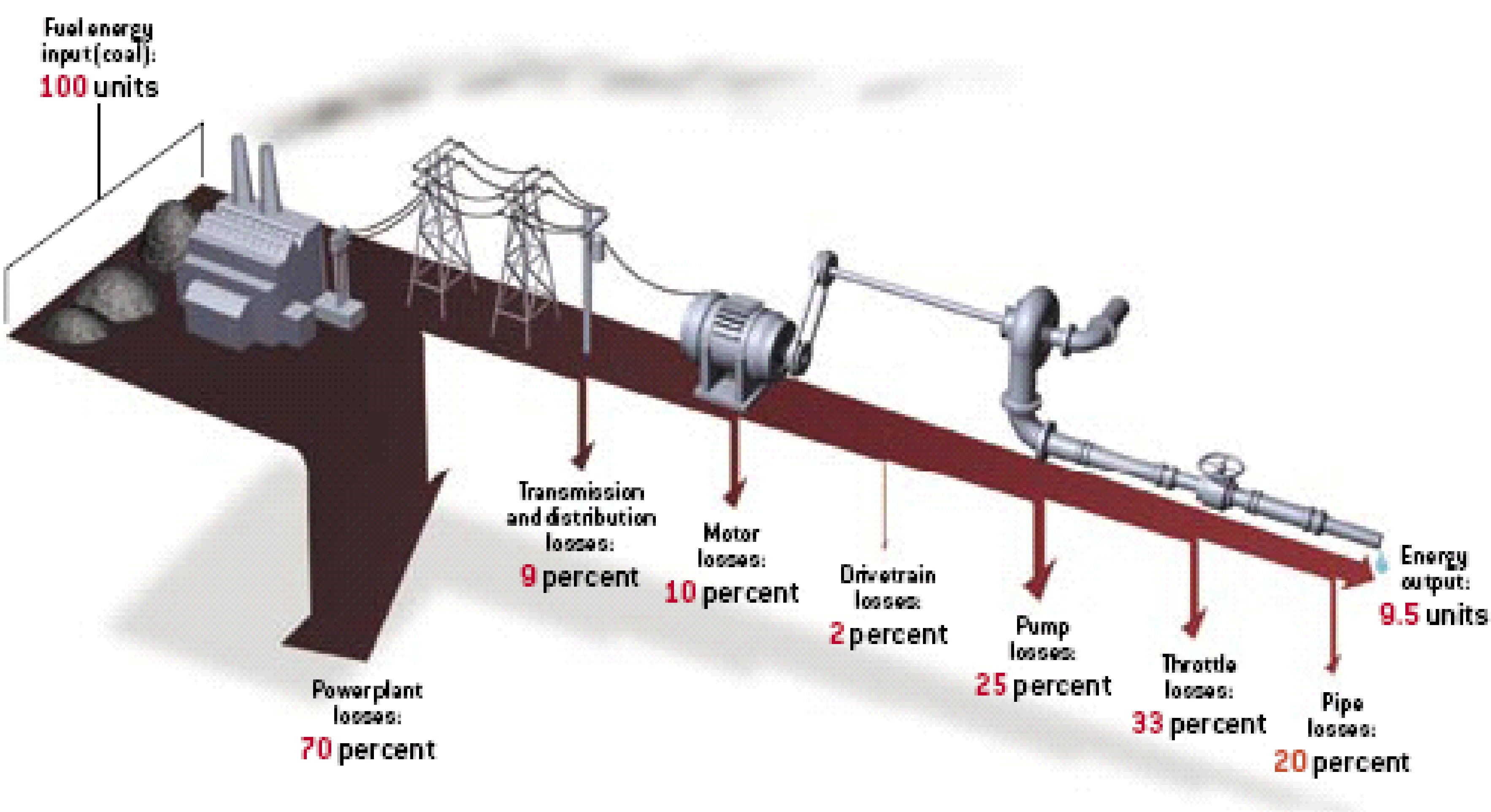
Energy Efficiency

Not according to 2nd Law of thermodynamics.

It says, there can never be a perpetual motion machine, there is no such thing as 100% efficiency.

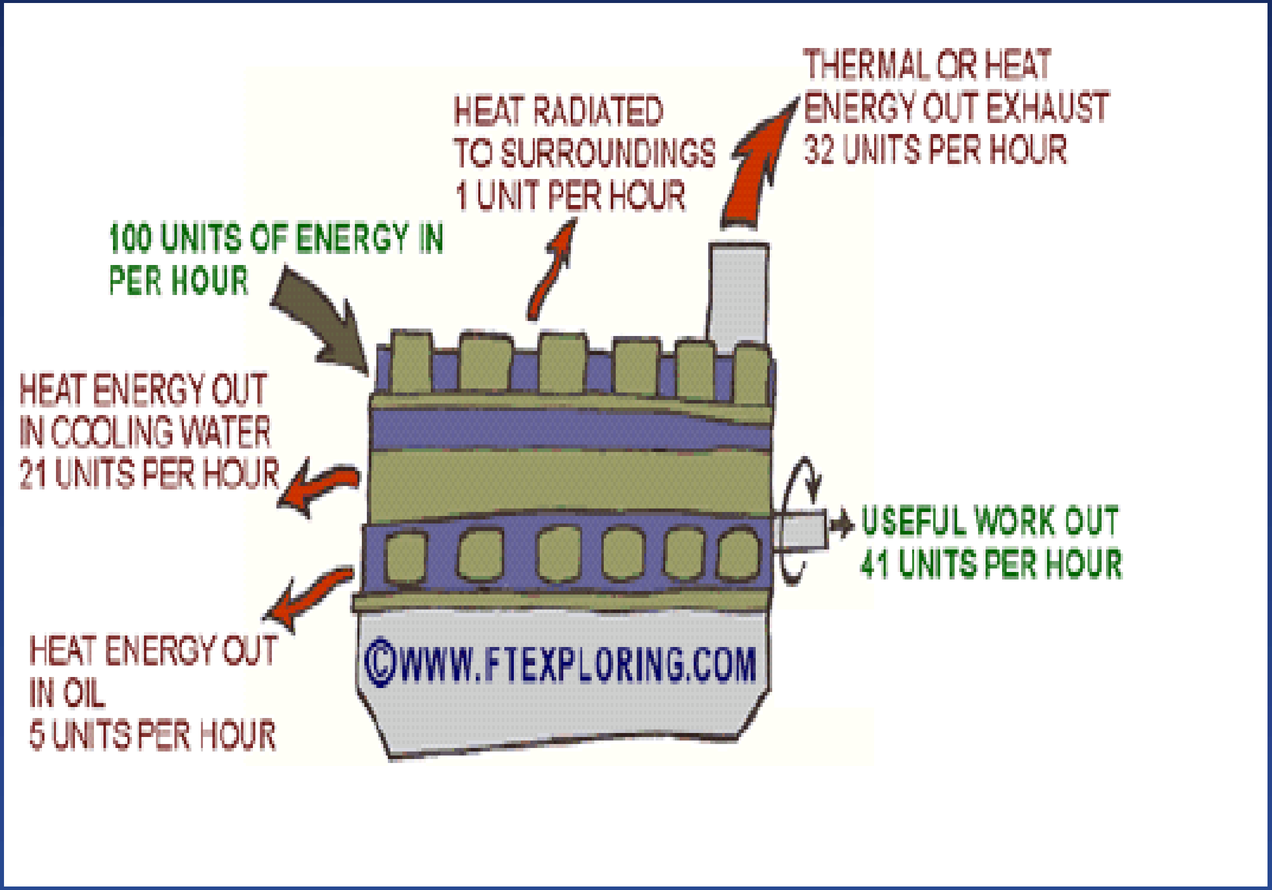
COMPOUNDING LOSSES

From the power plant to an industrial pipe, inefficiencies along the way whittle the energy input of the fuel—set at 100 arbitrary units in this example—by more than 90 percent, leaving only 9.5 units of energy delivered as fluid flow through the pipe. But small increases in end-use efficiency can reverse these compounding losses. For instance, saving one unit of output energy by reducing friction inside the pipe will cut the needed fuel input by 10 units, slashing cost and pollution at the power plant while allowing the use of smaller, cheaper pumps and motors.

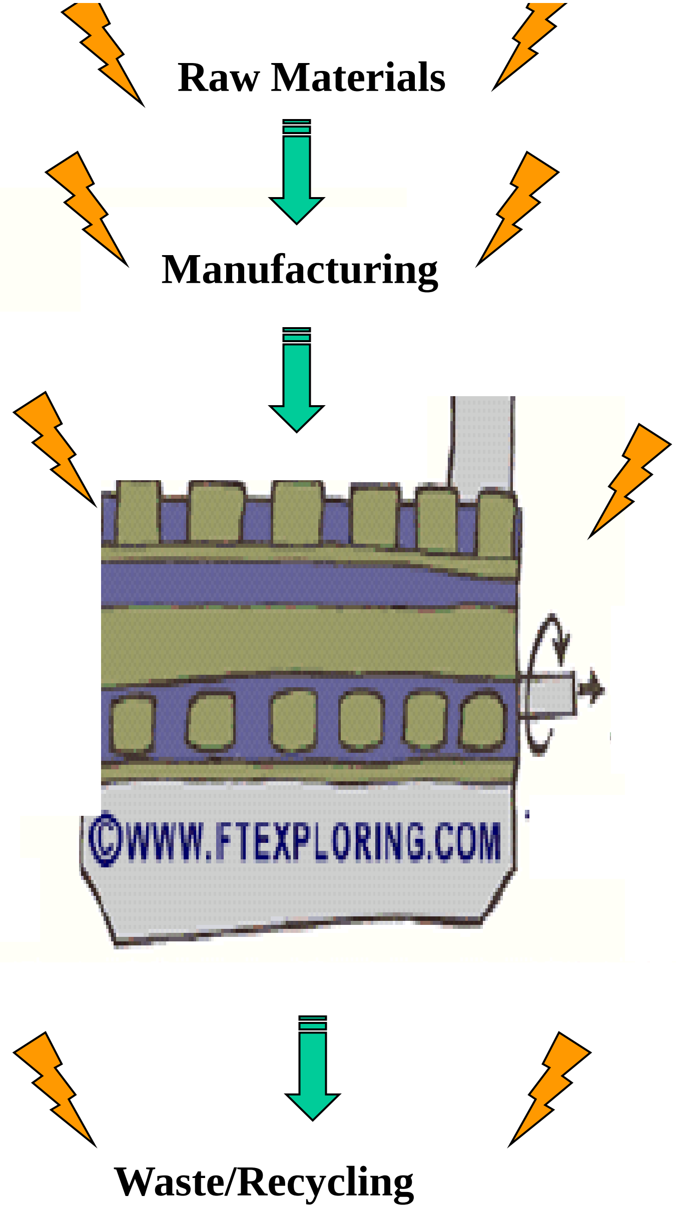


DON FOLEY

Energy Conversion in an Efficient Diesel Engine



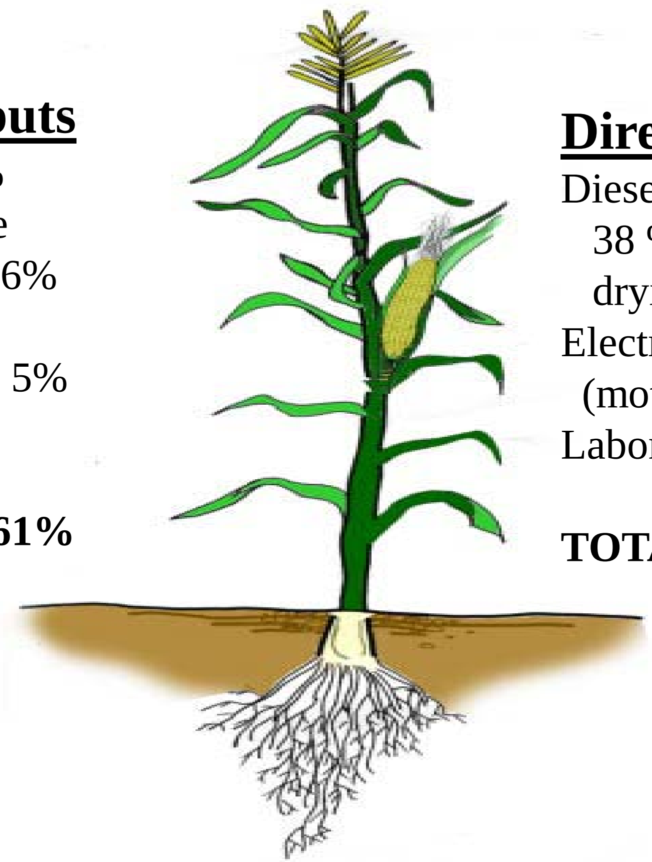
Indirect Energy and Lifecycle Analysis



Indirect Energy Inputs

Nitrogen Fertilizer 27%
Phosphorus, Potash, Lime 6%
Pesticides 11%
Seeds 5%
Machinery 12%

TOTAL 61%



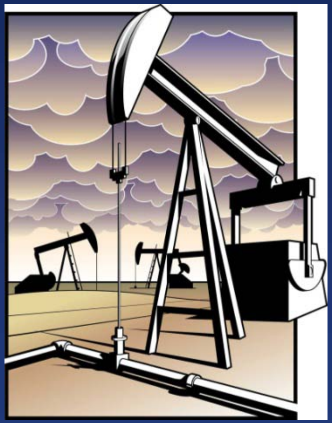
Direct Energy Inputs

Diesel, LP gas, gasoline 38 % (field ops, grain drying, irrig.)
Electricity (motors) 1.%
Labor 0.1%

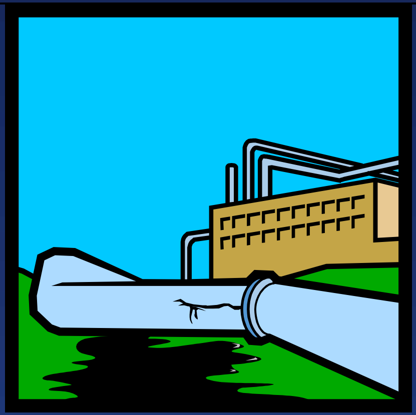
TOTAL 39%

Pimentel, 1984

Not all Energy is the Same



Drilling



Transport

Refining

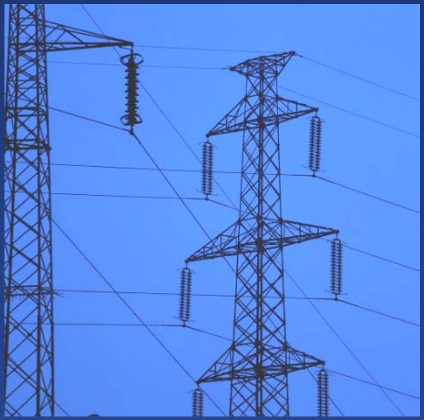
Gasoline from Oil

Not all Energy is the Same

Mining

Transportation

Burning

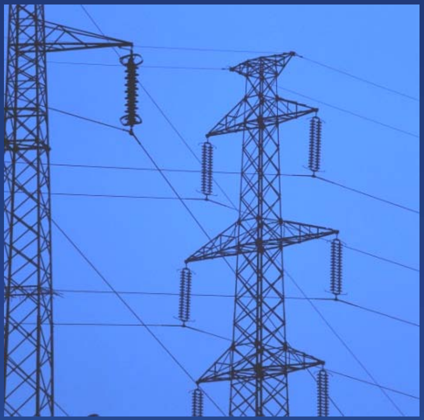


Electricity from Coal

Not all Energy is the Same


Indirect Energy


Wind harvesting


Electricity from Wind

Summary: Energy Concepts

1. Energy efficiency can be improved by:
    - Reducing the number of transformations necessary
    - Reusing the heat released during transformations
    - Sizing equipment to the task at hand
    - Smart building design
2. Saving energy is good, but not all energy is the same. Where the energy comes from is also important.
3. Lifecycle analysis can help us make smart energy decisions.

Photo Courtesy of
Government of Kerala, India