ALMUSTAQBAL UNIVERSITY COLLEGE
Iraq – Babylon

RENEWABLE ENERGY TECHNOLOGY

Sustainable Path For a Carbon Free Future

Refrigeration and Air conditioning Techniques Engineering Department

Subject : Renewable Energy

Grade: 4th Class

Lecture :1 – Renewable Energy Resources and its Applications

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Lecture Objective

Behavioral Objective

After this lecture , the students should be able to :

- Understand the concept and the benefit of renewable energy .
- Know the types of the renewable energy resources and its applications.
- Explain the types of the solar energy systems and its applications.
- Know the solar cell types
- Know the types of the solar thermal systems and its applications.

Contents

- INTRODUCTION
- ENERGY CATEGORIES
- RENEWABLE ENERGY RESOURCES
- ENVIRONMENTAL DAMAGE Due To FOSSIL FUELS
- APPLICATIONS AND POTENTIAL OF SOLAR ENERGY
- SOLAR CELL TYPES
- SOLAR THERMAL SYSTEM

Cont.

Introduction

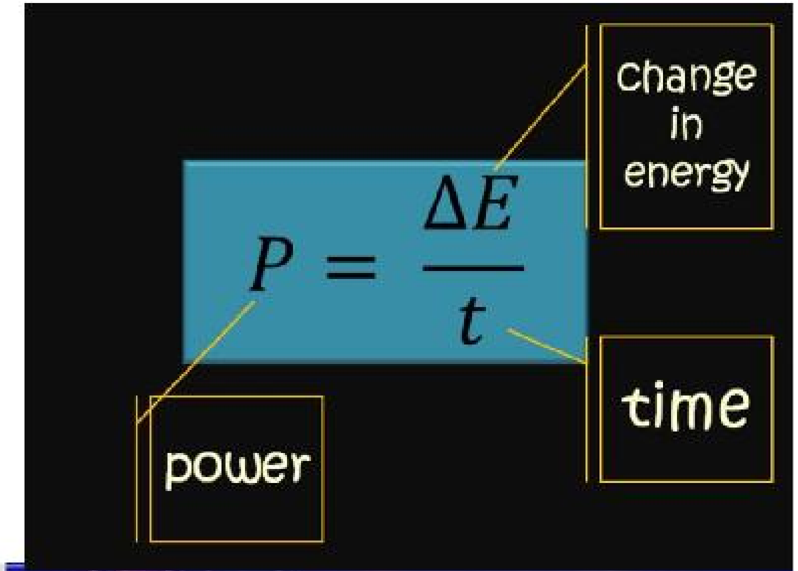
Energy : Measure of the ability of a body or system to do work or produce a change, expressed usually in joules or kilowatt hours (kWh). No activity is possible without energy and its total amount in the universe is fixed. In other words, it cannot be created or destroyed but can only be changed from one type to another. The two basic types of energy are (1) Potential: energy associated with the nature, position, or state (such as chemical energy, electrical energy, nuclear energy). (2) Kinetic: energy associated with motion (such as a moving car or a spinning wheel).

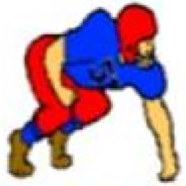
Power is defined as ability to do work.

$$\text{Power} = \frac{work}{time}$$

$$\text{Power} = \frac{force * displacement}{time}$$

$$Power = Force \times velocity$$





The Power of body.....
Strong and Fast...... (Big Force and small times..)

Cont.

Introduction

Power Delivery

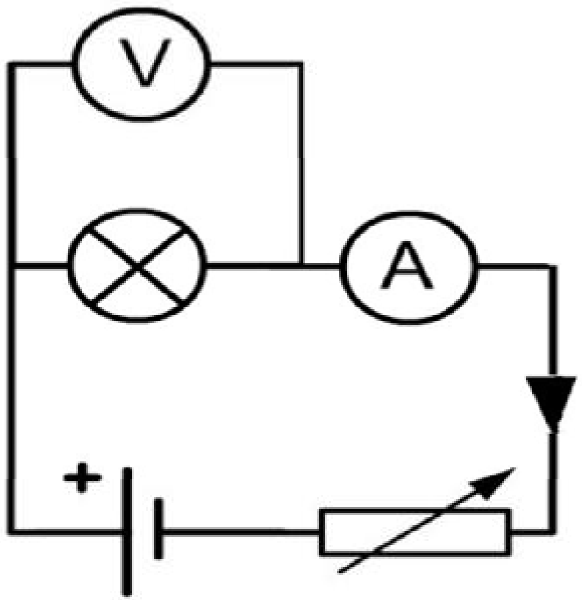
When we talk about Power what we mean is “the amount of energy delivered per second”

1 Joule / 1 Second = 1 Watt

It then makes sense that the Power used by a component can be found from the product of current through and voltage across the component;

Power = Voltage x Current

P = V x I



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Introduction

Physical measurement and express of energy

Heat:

British Thermal Unit (Btu): the amount of energy to raise 1 pound of water 1 degree Fahrenheit

1-The joule : 1 J = 1 W.s
1 W= 1J/s
1 wh= 3600 J
1 kWh = 3,600,00 J

2- The calorie :
1cal = 4.184 J , and 1 kcal = 4184 J

3- The British thermal unit (Btu):
1 Btu = 1055 J.
1 Btu/h=0.294 w
1000 Btu/h= 293 W

Power Units Conversion Table

Btu/hour	Watt	HP	kW
1	0.293	0.00039	0.00029
3.413	1	0.00134	0.001
2546.10	746	1	0.746
3413	1000	1.341	1

Quantity	Unit	Symbol	Name
Energy	Kg m^2/s^2 (N.m)	J	Joule
power	Kg m^2/s^3 (j/s)	w	watt

Cont.

Introduction

TEMPERATURE

Scale

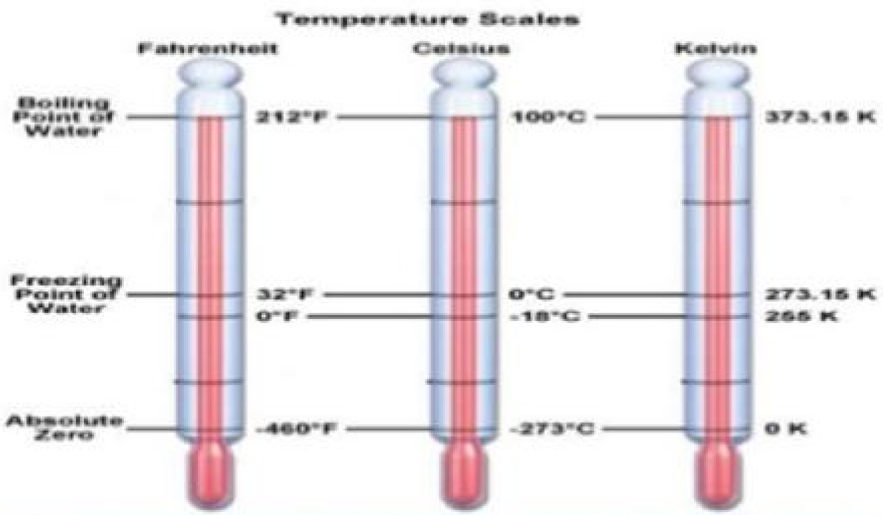
1- The Celsius (centigrade) scale :
2- The Kelvin scale

$0\ ^{o}C = 273.15\ K$
$+100\ ^{o}C = 373.15\ K$

3- The Fahrenheit scale :
$^{o}C = (5/9)(^{o}F - 32)$
$^{o}F = 1.8\ C + 32\ ^{o}$

4- The Rankine scale :
$(T)\ R = 1.8\ (T)\ K$

- Temperature - measure of the thermal energy.
- Measured in degrees [°]using scales.
  1. Fahrenheit.[°F]
  2. Celsius or centigrade. [°C]
  3. Kelvin .[°K]



$$T(\mathrm{K}) = T(^\circ\mathrm{C}) + 273.15$$

$$T(\mathrm{R}) = T(^\circ\mathrm{F}) + 459.67$$

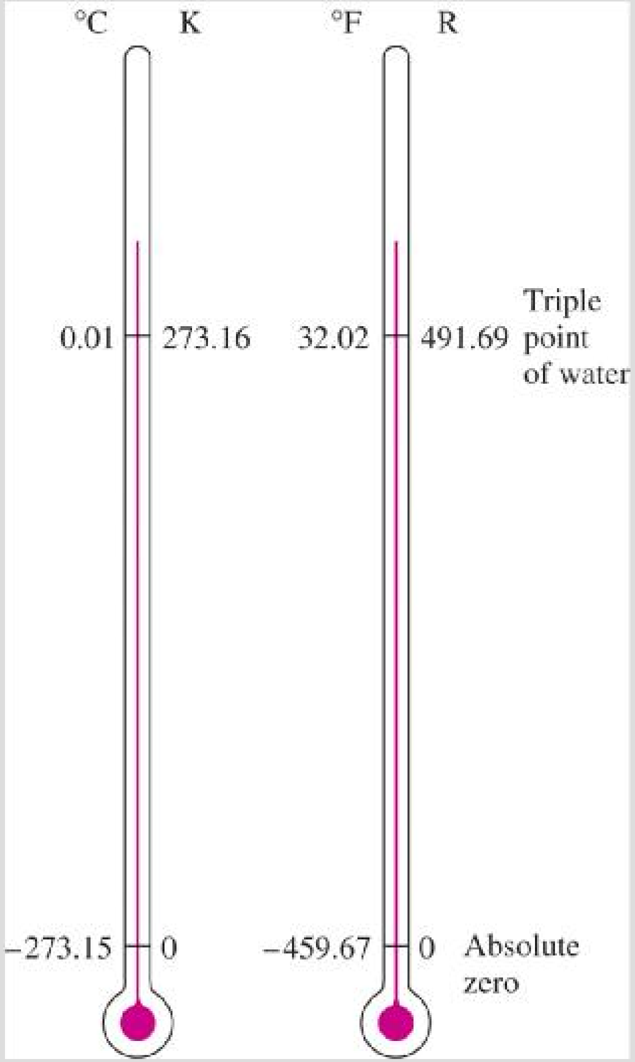
$$T(\mathrm{R}) = 1.8T(\mathrm{K})$$

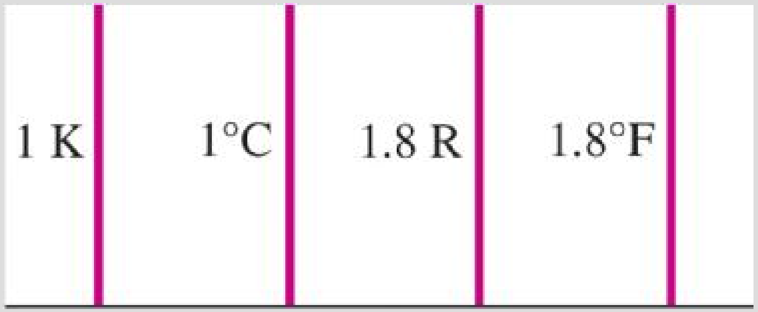
$$T(^\circ\mathrm{F}) = 1.8T(^\circ\mathrm{C}) + 32$$

$$\Delta T(\mathrm{K}) = \Delta T(^\circ\mathrm{C})$$

$$\Delta T(\mathrm{R}) = \Delta T(^\circ\mathrm{F})$$

Comparison of temperature scales.





Comparison of magnitudes of various temperature units.

- The reference temperature in the original Kelvin scale was the ***ice point*****,** 273.15 K, which is the temperature at which water freezes (or ice melts).
- The reference point was changed to a much more precisely reproducible point, the ***triple point*** of water (the state at which all three phases of water coexist in equilibrium), which is assigned the value 273.16 K.

Cont.

Introduction

International System of Units (SI)

SI Base Units

Base Quantity	Name	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

SI Derived Units

Derived Quantity	Name	Symbol	Equivalent SI units
Frequency	hertz	Hz	s^{-1}
Force	newton	N	$m \cdot kg \cdot s^{-2}$
Pressure	pascal	Pa	N/m^2
Energy	joule	J	N·m
Power	watt	W	J/s
Electric charge	coulomb	C	s·A
Electric potential	volt	V	W/A
Electric resistance	ohm	Ω	V/A
Celsius temperature	degree Celsius	°C	K*

*Unit degree Celcius is equal in magnitude to unit kelvin.

SI Prefixes

Factor	Name	Symbol	Numerical Value
10^{12}	tera	T	1 000 000 000 000
10^{9}	giga	G	1 000 000 000
10^{6}	mega	M	1 000 000
10^{3}	kilo	k	1 000
10^{2}	hecto	h	100
10^{1}	deka	da	10
10^{-1}	deci	d	0.1
10^{-2}	centi	c	0.01
10^{-3}	milli	m	0.001
10^{-6}	micro	µ	0.000 001
10^{-9}	nano	n	0.000 000 001
10^{-12}	pico	p	0.000 000 000 001

- Adapted from NIST Special Publication 811
- SI rules and style conventions recommend using spaces rather than commas to separate groups of three digits.

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Cont.

Introduction

The Conversion Factors of Joule to Other Units

	Joule	Calorie	BTU	Foot-pound	Kilowatt-hour	Megawatt-day	Electronvolt
Joule	XX	0.2390	0.000948	0.7375	2.77778E-07	1.15741E-11	6.2383E+18
Calorie	4.184	XX	0.00397	0.3238	1.16279E-06	4.85437E-11	2.61097E+19
BTU	1055	252	XX	778.2	0.000293	1.221E-08	6.57895E+21
Foot-pound	1.356	0.3238	0.001285	XX	3.84615E-07	1.60256E-11	8.47458E+18
Kilowatt-hour	3.6E6	8.6E5	3412	2.6E6	XX	4.16667E-05	2.24719E+25
Megawatt-day	8.64E10	2.06E10	8.19E7	6.24E10	24000	XX	5.40541E+29
Electronvolt	1.603E-19	3.83E-20	1.52E-22	1.18E-19	4.45E-26	1.85E-30	XX

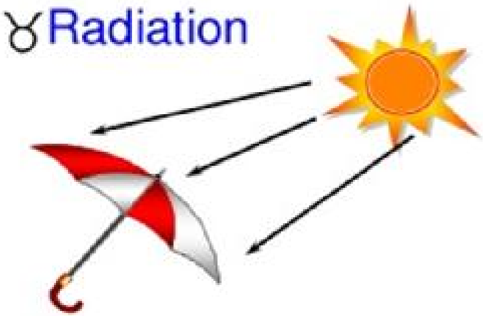
Cont.

Introduction

How is heat transferred?

- Conduction
  - Metal coffee cup

- Radiation

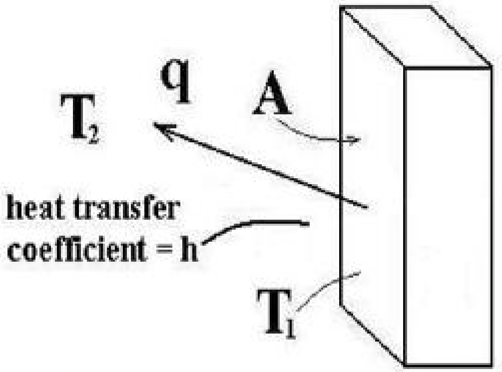


- Convection

Forms of Heat Transfer

Convection

Transfer of energy involving fluid motion

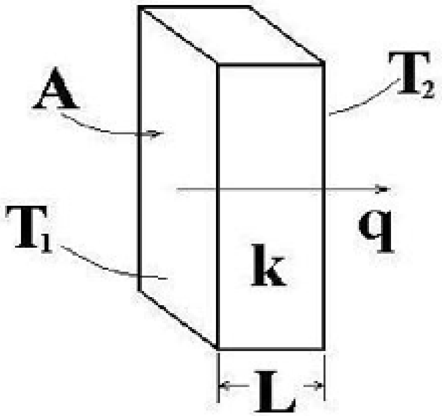


Newton's Law

$$Q = hA\,\Delta T$$

Conduction

Transfer of energy by molecular interactions

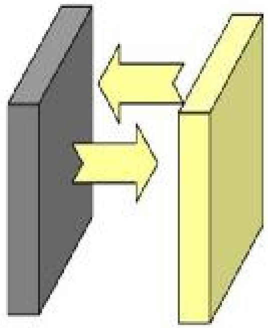


$$q = k\,A\,\frac{T_1 - T_2}{L}$$

Fourier's Law

Radiation

- Heat transfer between two surfaces by emission and later absorption of electromagnetic radiation



requires no physical medium .

■ Stefen-Boltzmann Equation:

$$q = A\,\sigma\,\varepsilon\,(T_2^4 - T_1^4)$$

where σ = Stefen-Boltzmann's constant, 5.669×10^{-8} W/m^2K^4

ε = emissivity, (varies from 0 to 1) dimensionless

A = area, m^2

T_1 = temperature of surface 1, Absolute

T_2 = temperature of surface 2, Absolute

ENERGY TRANSFER BY HEAT

Heat: The form of energy that is transferred between two systems (or a system and its surroundings) by virtue of a temperature difference.

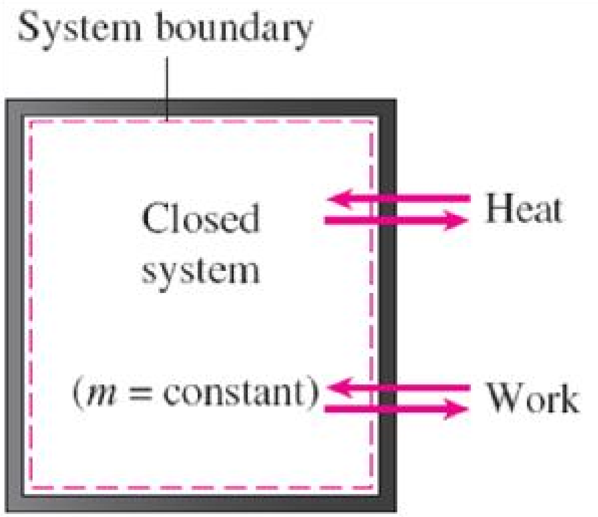


FIGURE 2–13
Energy can cross the boundaries of a closed system in the form of heat and work.

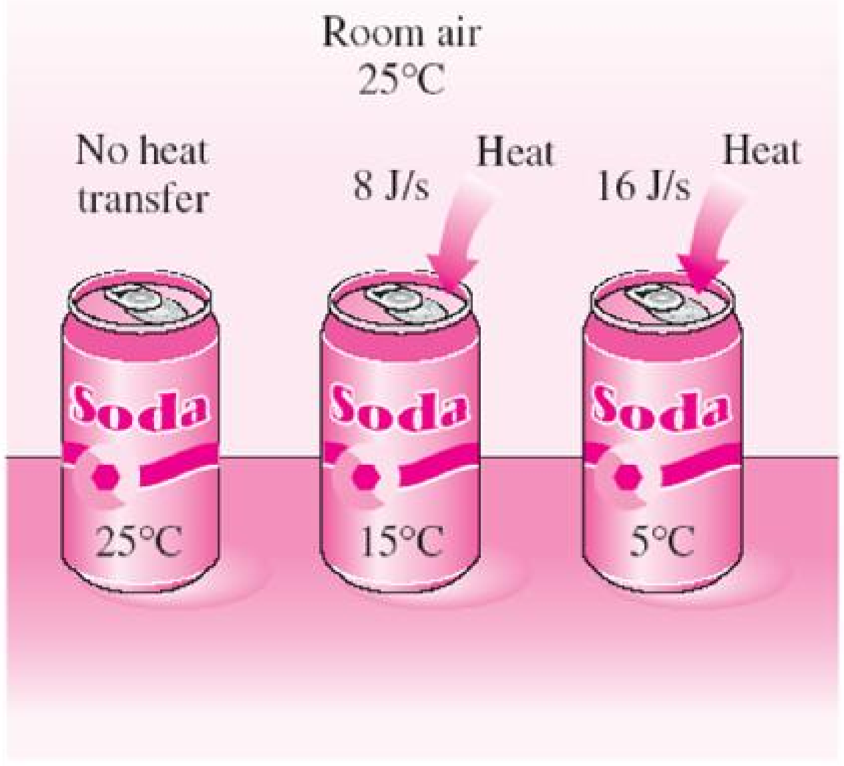


FIGURE 2–14
Temperature difference is the driving force for heat transfer. The larger the temperature difference, the higher is the rate of heat transfer.

$$q = \frac{Q}{m} \qquad (\text{kJ/kg})$$

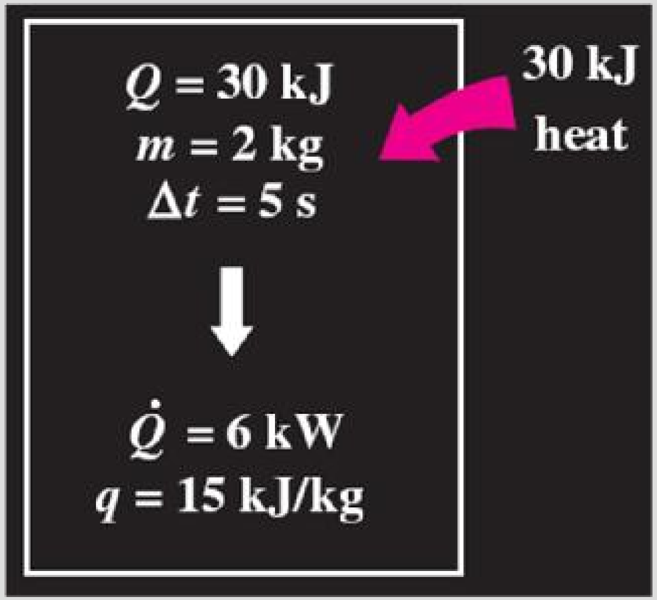
Heat transfer per unit mass

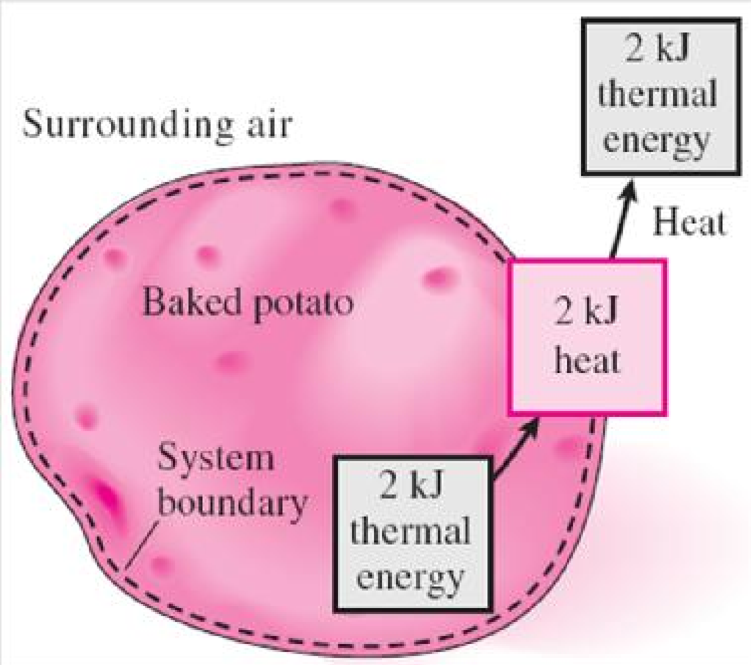
$$Q = \dot{Q}\,\Delta t \qquad (\text{kJ})$$

Amount of heat transfer when heat transfer rate is constant

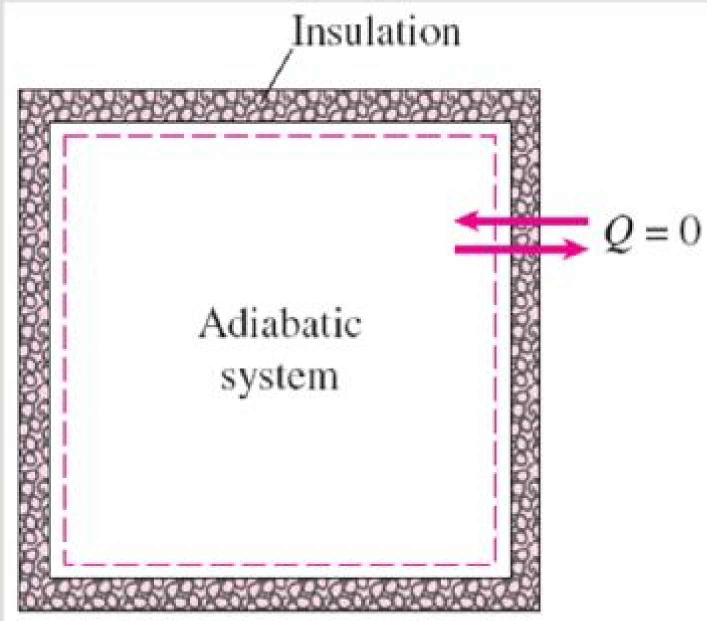
$$Q = \int_{t_1}^{t_2} \dot{Q}\,dt \qquad (\text{kJ})$$

Amount of heat transfer when heat transfer rate changes with time





Energy is recognized as heat transfer only as it crosses the system boundary.



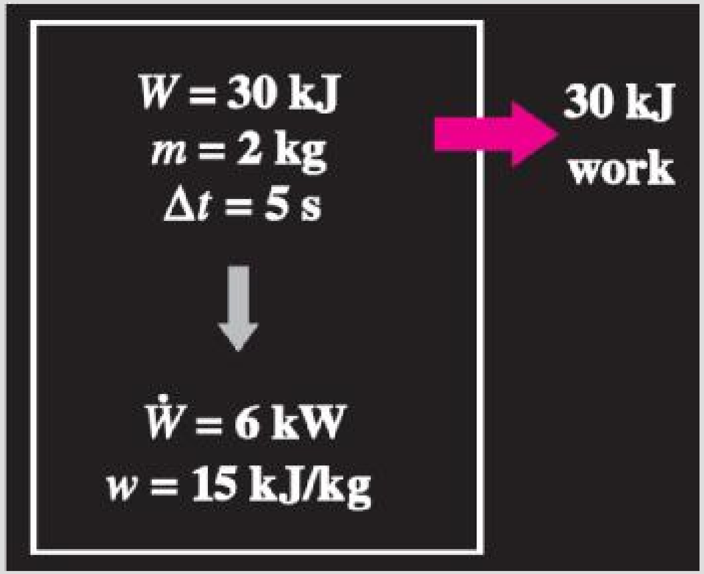
During an adiabatic process, a system exchanges no heat with its surroundings.

ENERGY TRANSFER BY WORK

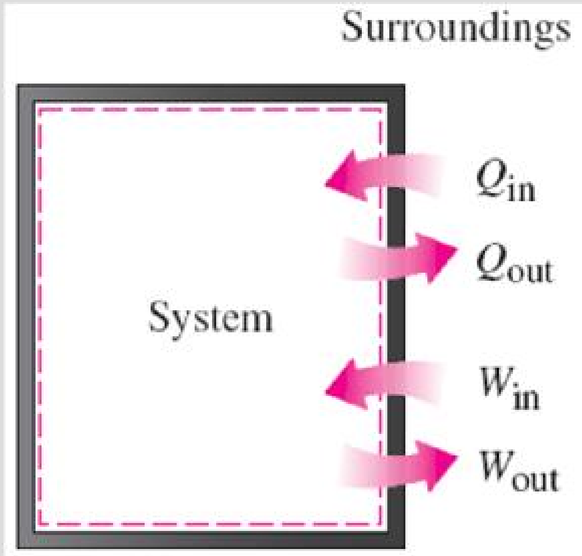
- **Work**: The energy transfer associated with a force acting through a distance.
  - ü **A rising piston, a rotating shaft**, and **an electric wire crossing the system boundaries** are all associated with work interactions
- **Formal sign convention**: *Heat transfer to a system and work done by a system are positive; heat transfer from a system and work done on a system are negative*.
- Alternative to sign convention is to use the subscripts ***in*** and ***out*** to indicate direction. This is the primary approach in this text.

$$w = \frac{W}{m} \qquad (\text{kJ/kg})$$

Work done per unit mass



Power is the work done per unit time (kW)

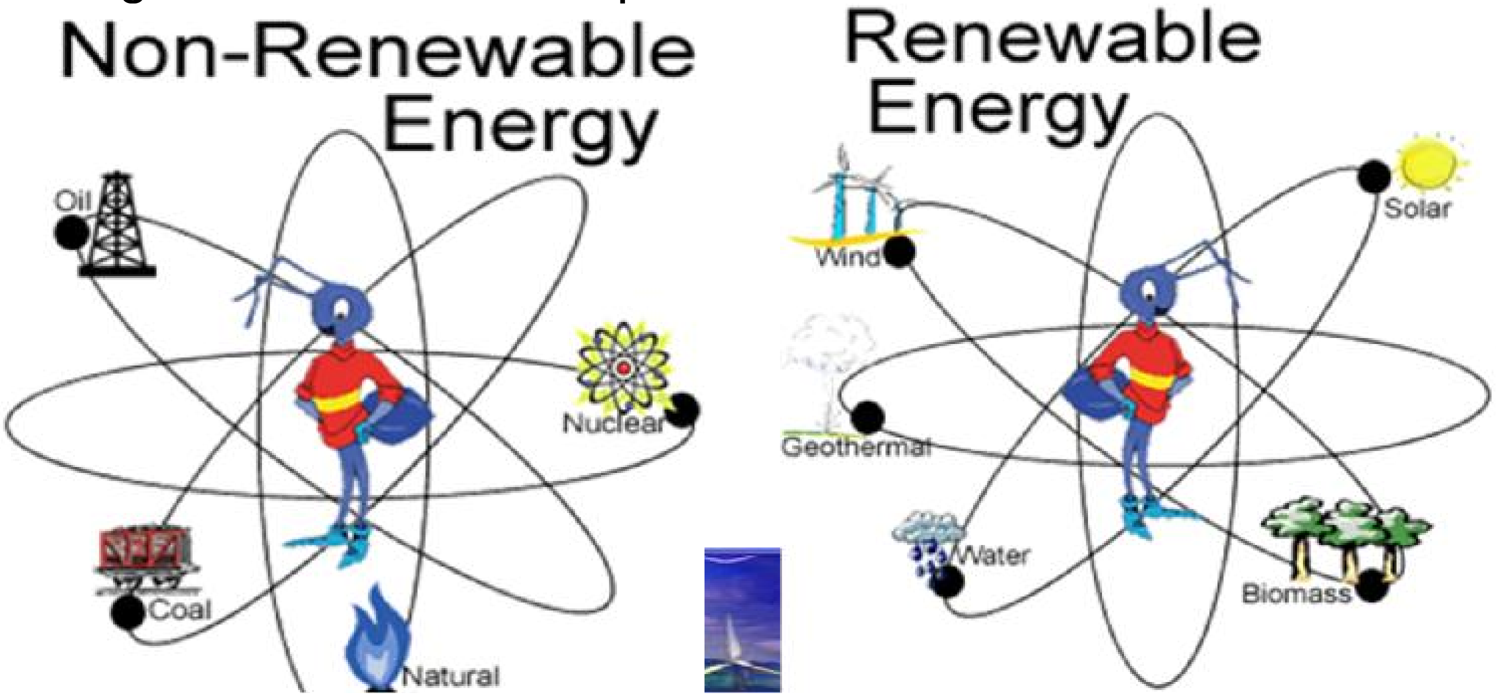


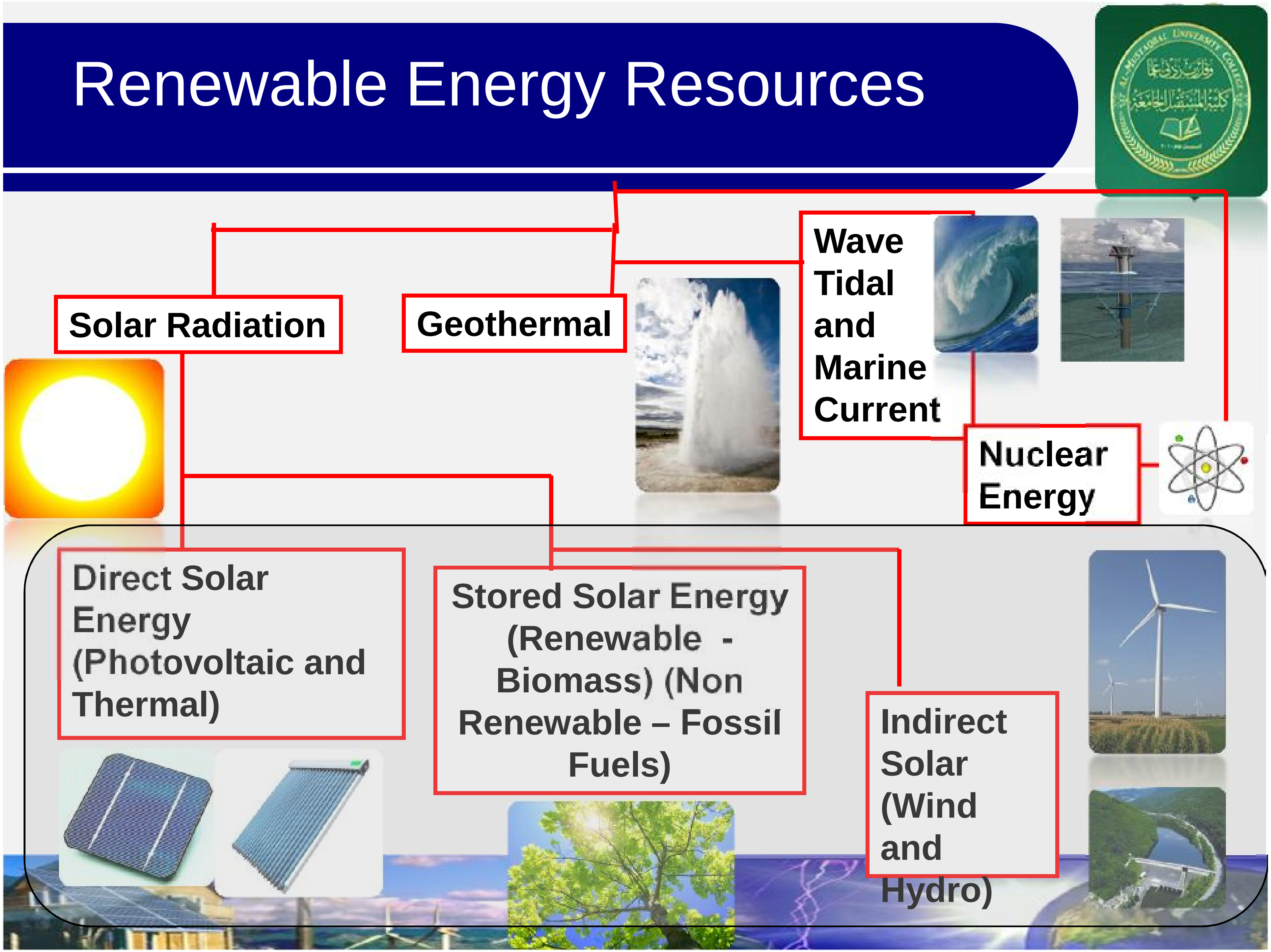
Specifying the directions of heat and work.

Energy Categories

Energy can be broken down into two distinct categories

- Non-renewable :- comes from fossil fuels (coal, oil, natural gas) and uranium.
- Renewable –Renewable energy is the energy which is generated from natural sources i.e. sun, wind, rain, tides and can be generated again and again as and when required.




Renewable Energy Resources
Solar Radiation
Geothermal
Wave
Tidal
and
Marine
Current
Nuclear
Energy
Direct Solar
Energy
(Photovoltaic and
Thermal)
Stored Solar Energy
(Renewable -
Biomass) (Non
Renewable – Fossil
Fuels)
Indirect
Solar
(Wind
and
Hydro)

R.E. Energy Resources

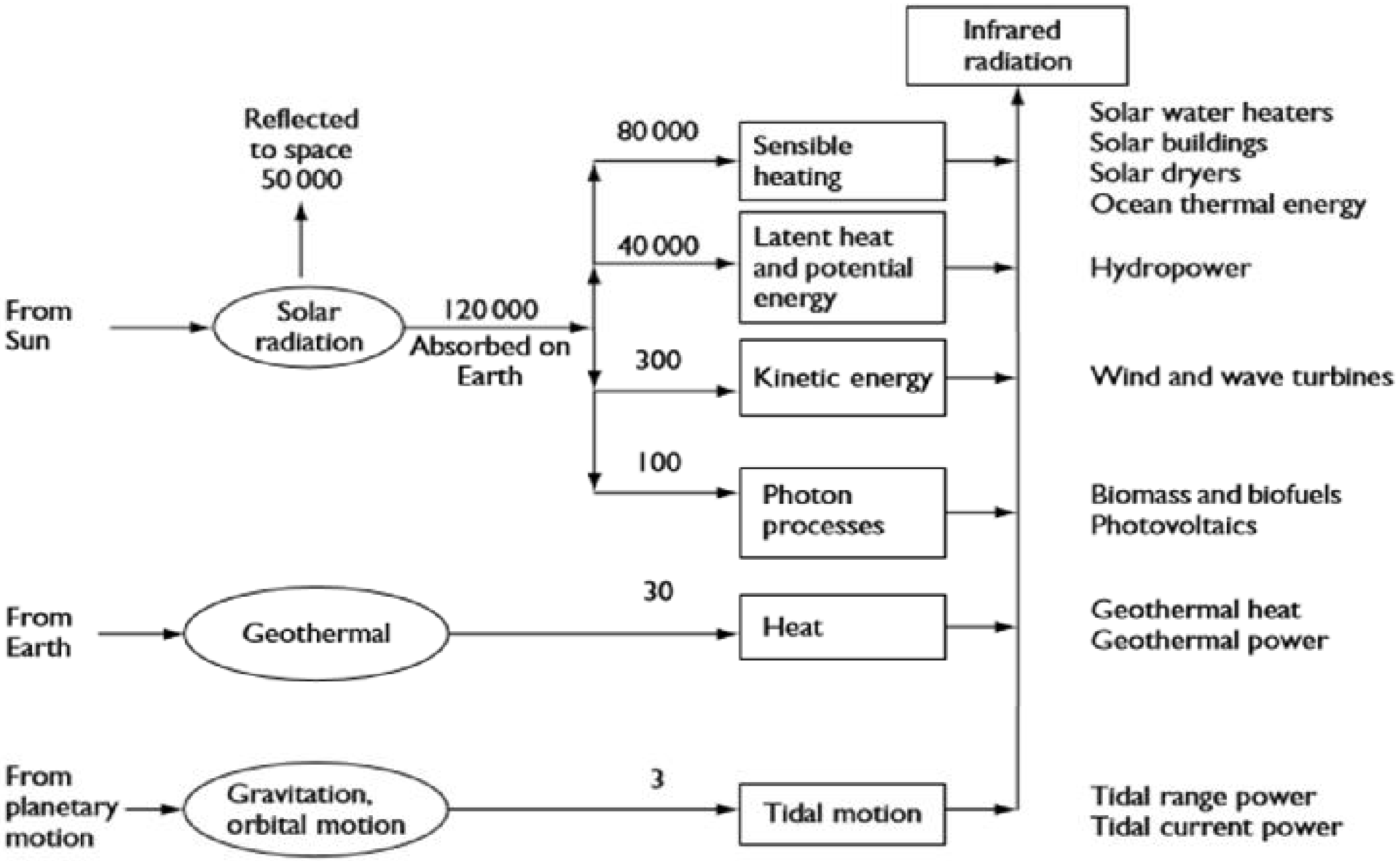


Figure 1.2 Natural energy currents on earth, showing renewable energy system. Note the great range of energy flux ($1:10^5$) and the dominance of solar radiation and heat. Units terawatts (10^{12} W).

Global Drivers

من اهم الاسباب التي تدفع نحو استخدام الطاقة المتجددة او الطاقة البديلة هو مشكلة تلوث البيئة نتيجة استخدام الوقود بالاضافة الى التغير او التذبذب في اسعار الوقود وغيرها من الاسباب التي جعلة من التفكير في استخدام الطاقة المتجددة كحل امثل

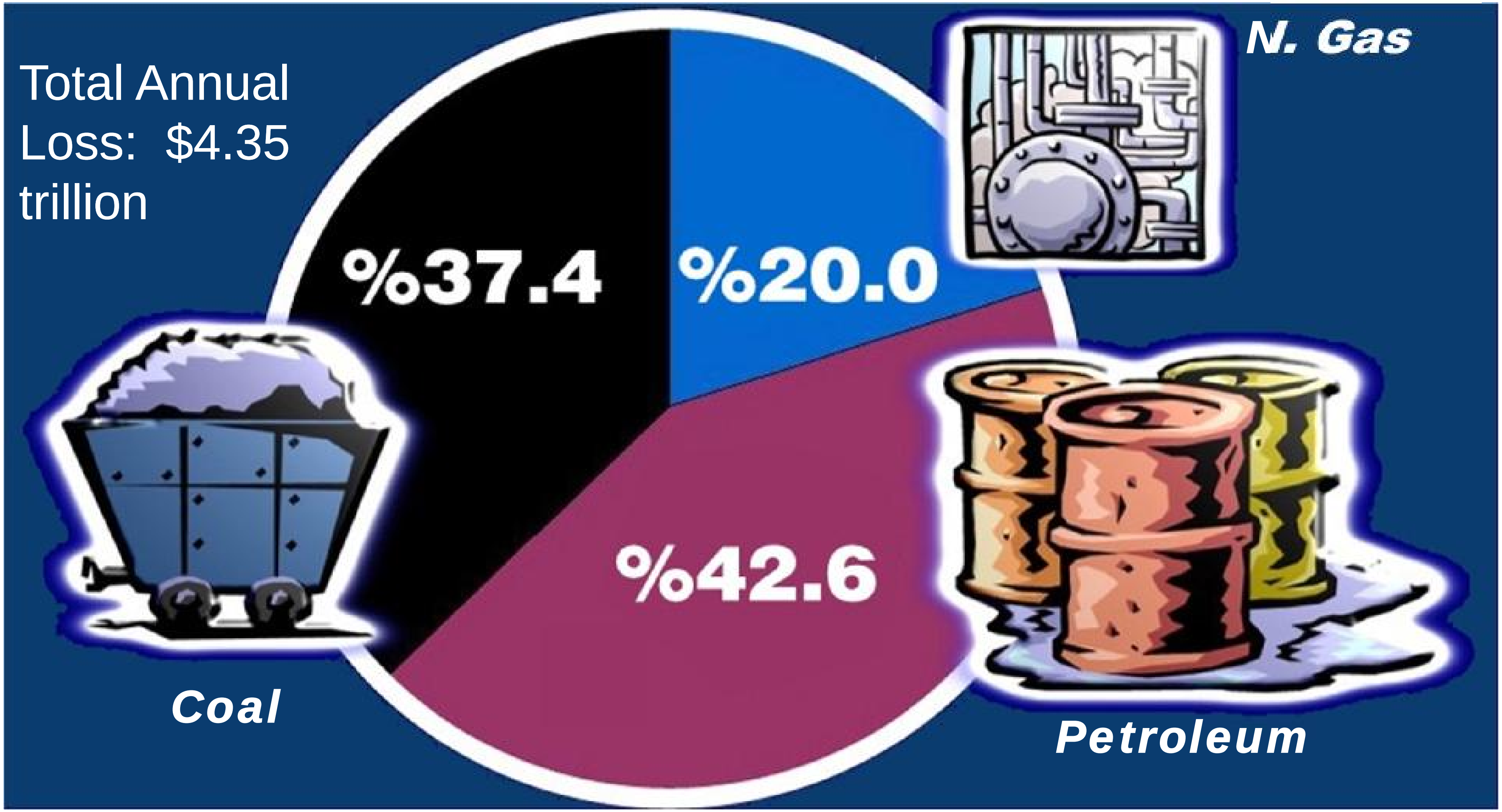
ENERGY SECURITY

FOSSIL FUEL PRICE INCREASE

ENVIRONMENTAL PROBLEMS

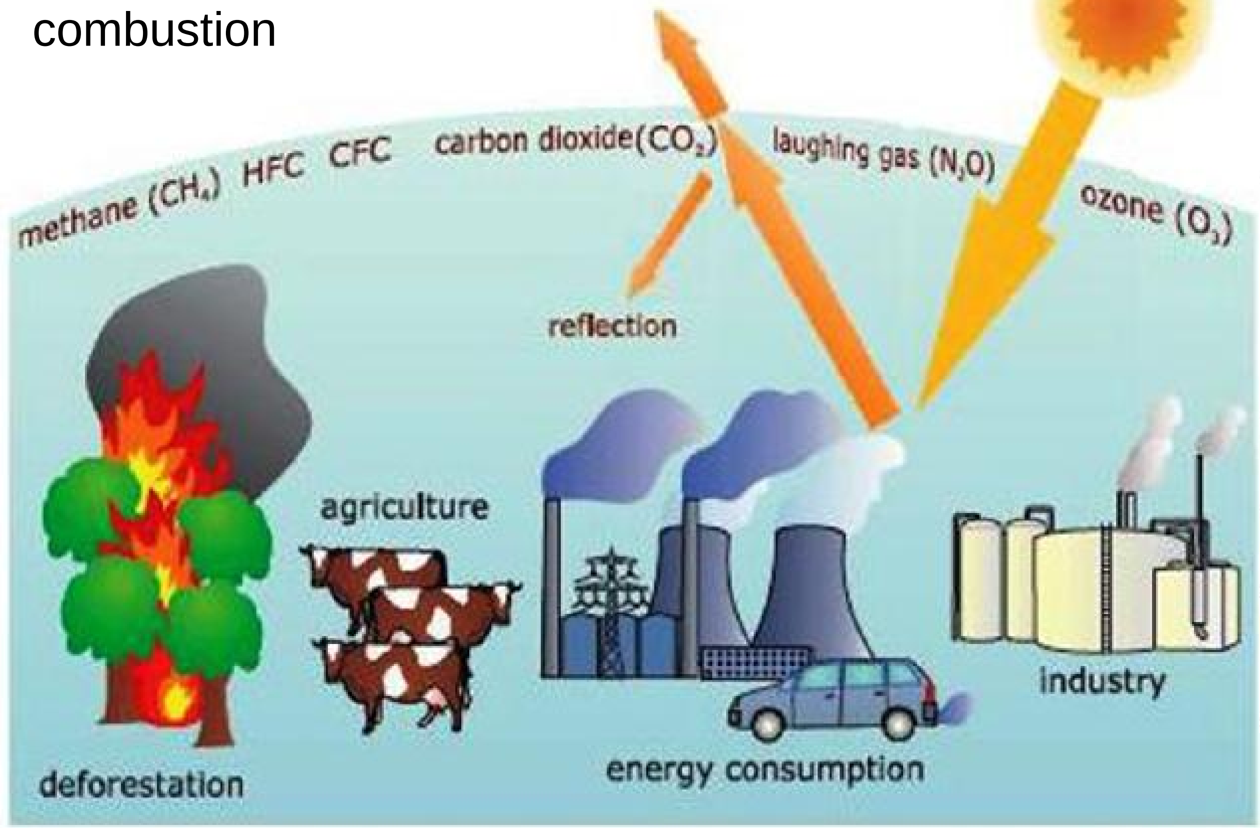
Environmental damage due to fossil fuels

Fossil fuels are hydrocarbons containing traces of nitrogen, sulfur and other elements.



Effects of Human Activities

significant contribution to the CO2 emitted to the atmosphere is attributed to fossil fuel combustion



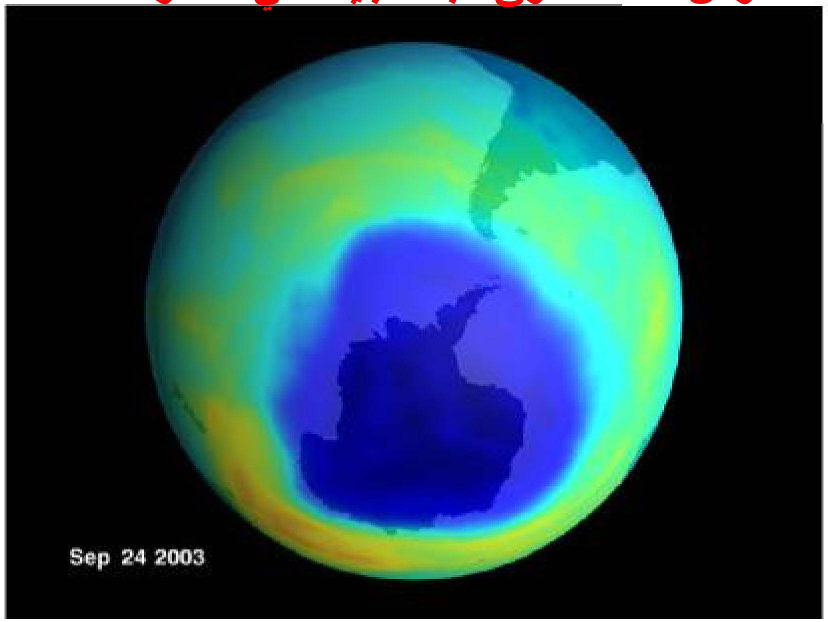
Causes of anthropogenic greenhouse effects due to human activities

Pollutant	A Major Impact of This Pollutant	Marginal Emissions Rate (kg/MWh)
SO_2	Acid rain	1.48
NO_X	Smog, asthma	0.5
CO_2	Global climate change	606.8

Ozone Layer Depletion

- Ozone is a good absorber of solar ultraviolet radiation, and depletion of upper atmosphere ozone results in increased surface levels of UV radiation.
- Increased levels of UV at the surface enhance global warming, but more importantly, can result to increased human skin cancer and plant damage.

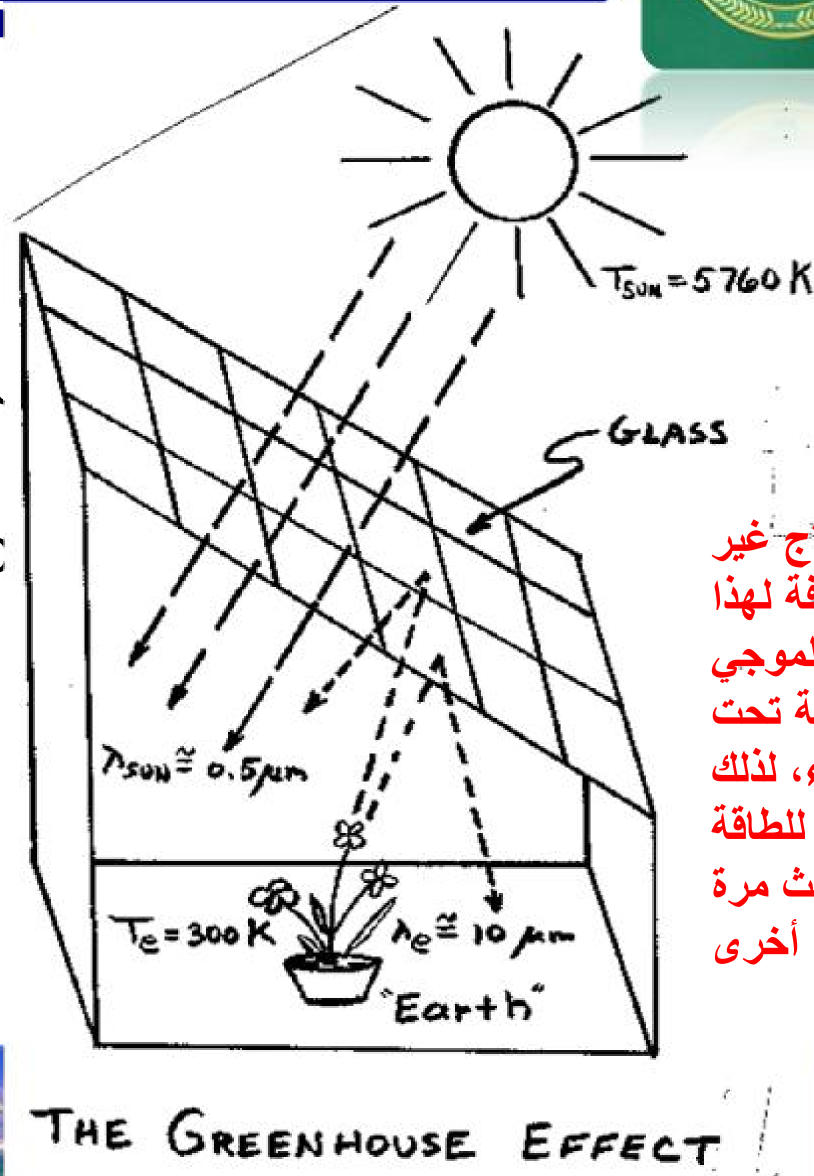
طبقة الأوزون، هي طبقة من الغلاف الجوي، تشكل درع
الأرض الواقي من حرارة الشمس القاتلة للحياة،
ومن الأشعة فوق البنفسجية التي تصدرها



The ozone hole at its peak in 2003 over Antarctica

A Greenhouse...

- Sunlight at λ = 0.5 μm mostly passes through the glass
- Re-emitted radiant energy from the ~300 K interior is at λ ≅ 0.5 μm
- The glass is nontransparent to this infrared wavelength, so re-emitted energy cannot radiate away
- The greenhouse warms up

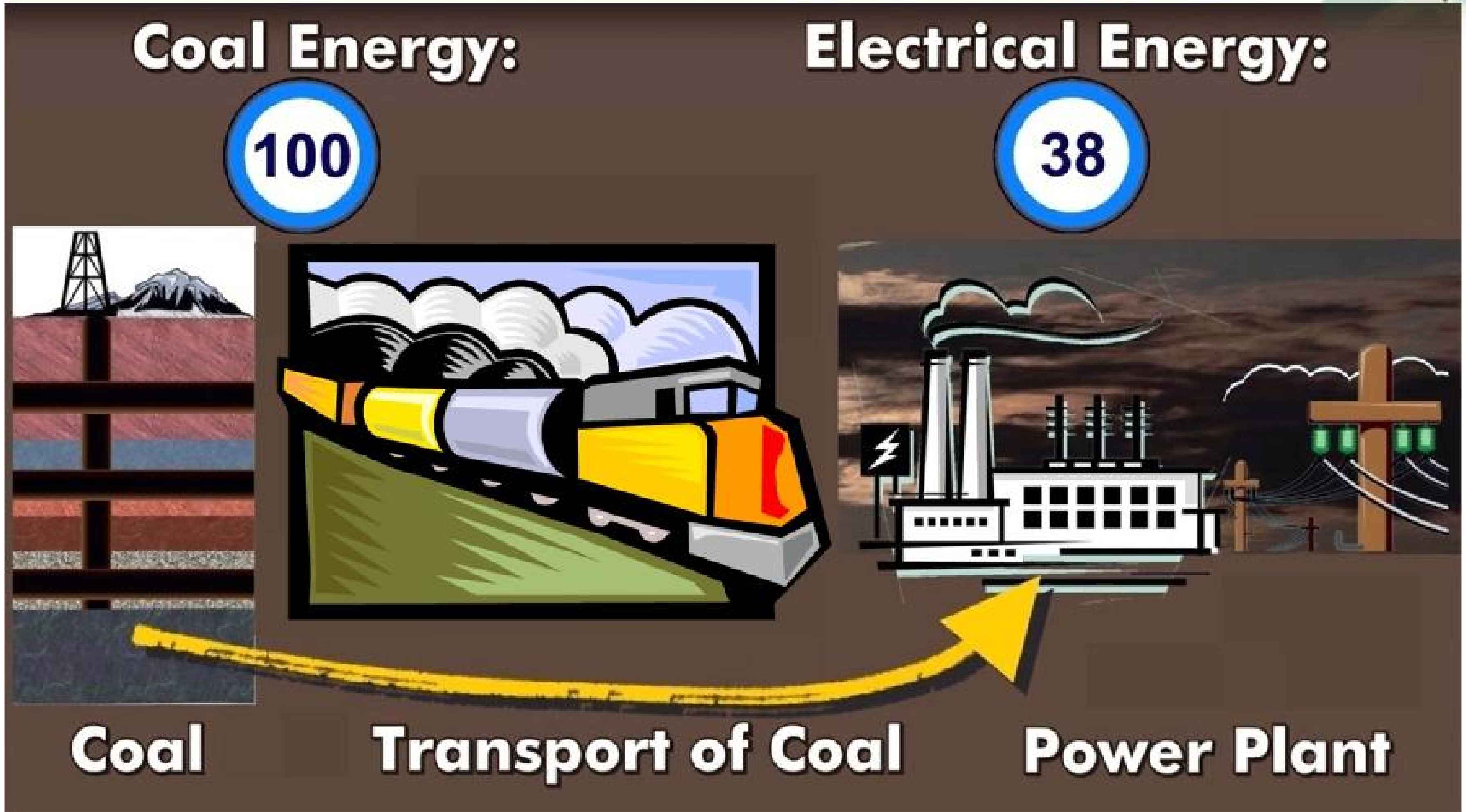


الزجاج غير شفافة لهذا الطول الموجي بالأشعة تحت الحمراء، لذلك لا يمكن للطاقة أن تنبعث مرة أخرى

How Can Global Warming Be Reduced?

- Increased energy efficiency. This is simplest and most cost-effective.
- Substitution of natural gas for coal and oil (short term, limited supplies)..
- Safe nuclear power (fission).
- Alternative renewable energy: OTEC, wind, solar thermal, solar photovoltaic, biofuels.
- Hydrogen transportation fuel (needs research).
- Other alternatives???

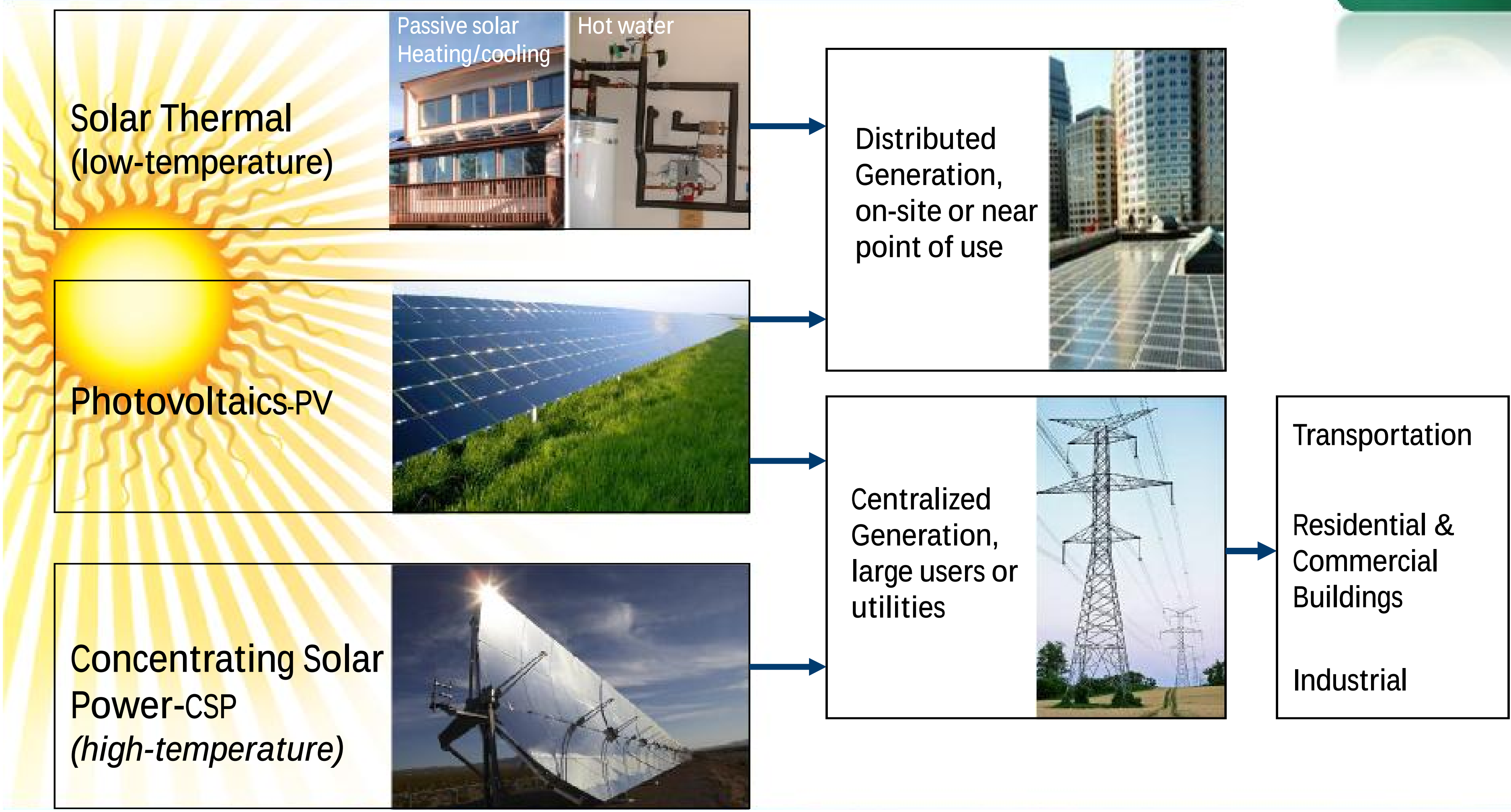
COAL UTILISATION TODAY



Benefits of Renewable Energy Use

Renewable energy provides substantial benefits for our climate, our health, and our economy. Each source of renewable energy has unique benefits and cost.

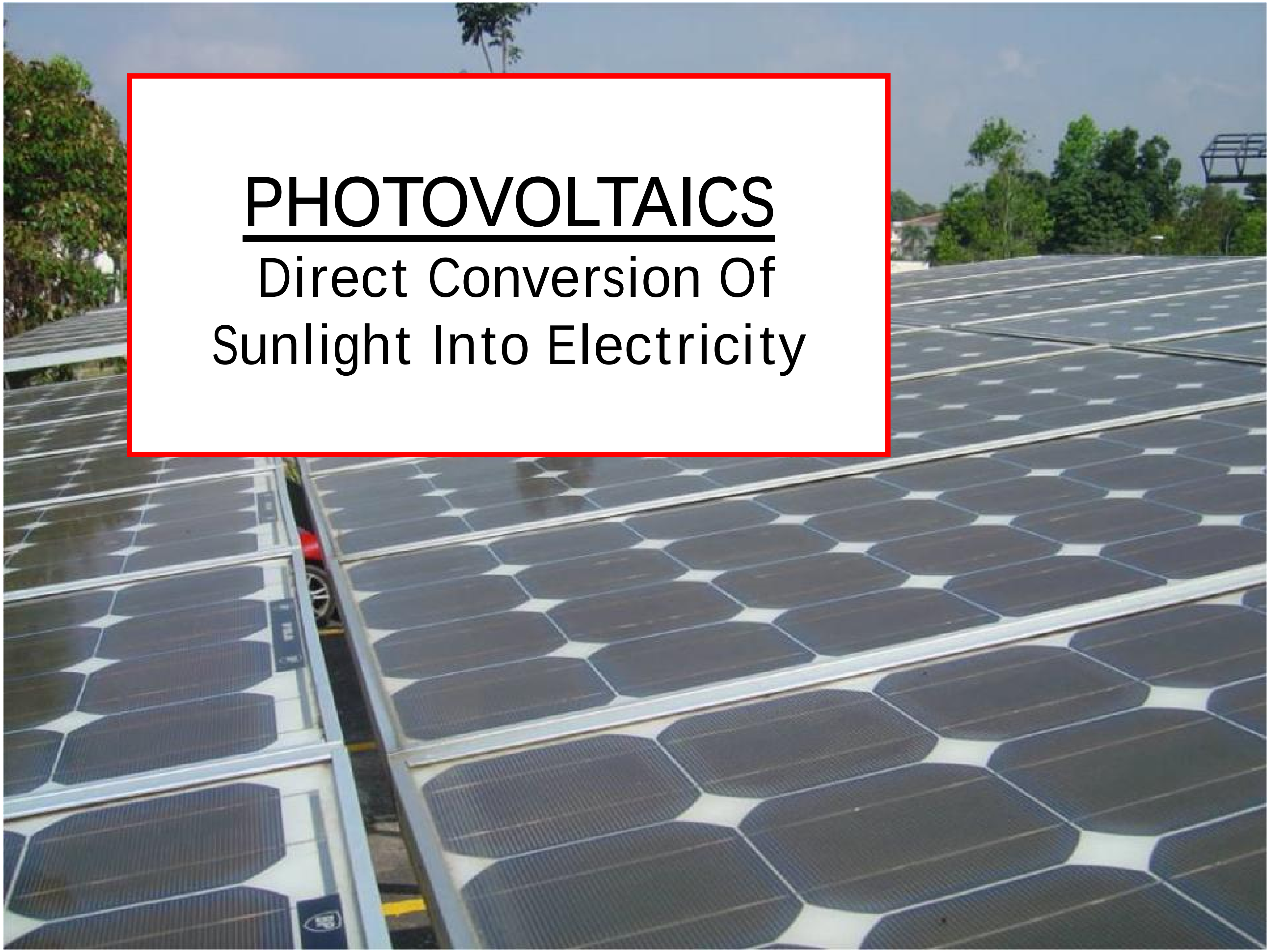
Applications and Potential of Solar Energy



Solar Thermal and Solar Electricity

PHOTOVOLTAICS

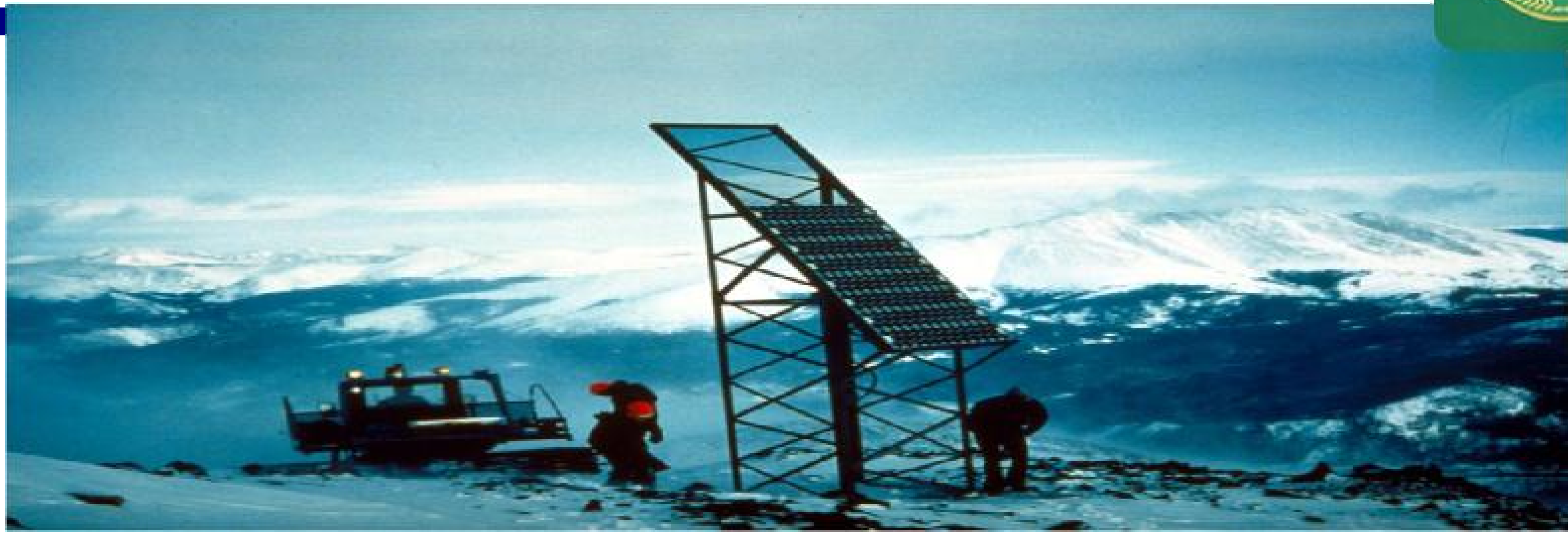
Direct Conversion Of Sunlight Into Electricity



PV Applications

- PV can be applied in any environment
  - Snow
  - Sea
  - Desert
  - Space
- Some of the most typical are shown in the next slides

PV in snow



Portable unit

PV in Alaska

PV transmission station

PV in sea

Solar car

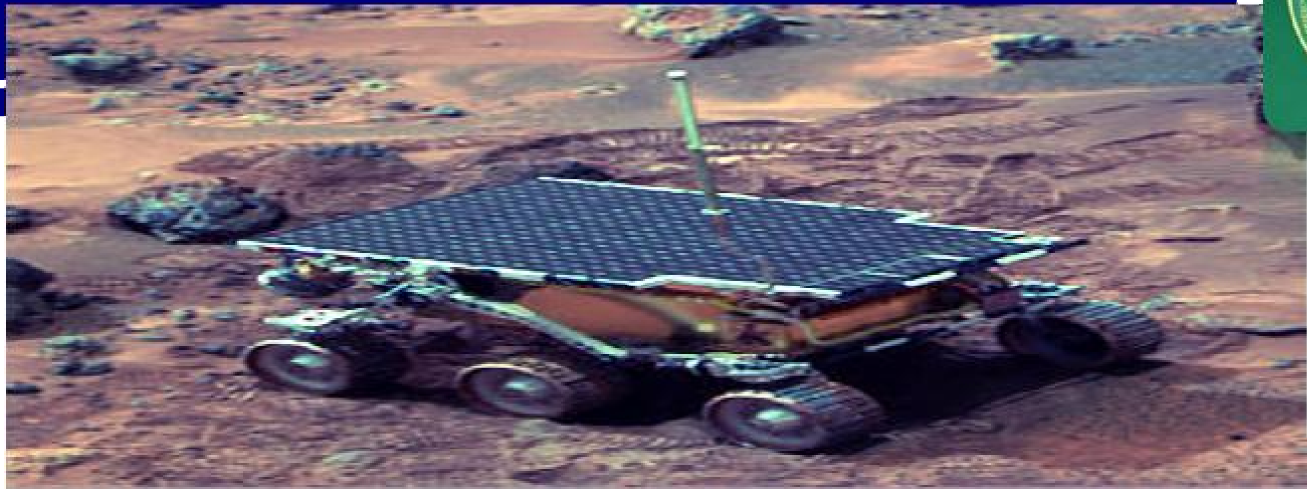
PV in desert

Concentrating PV

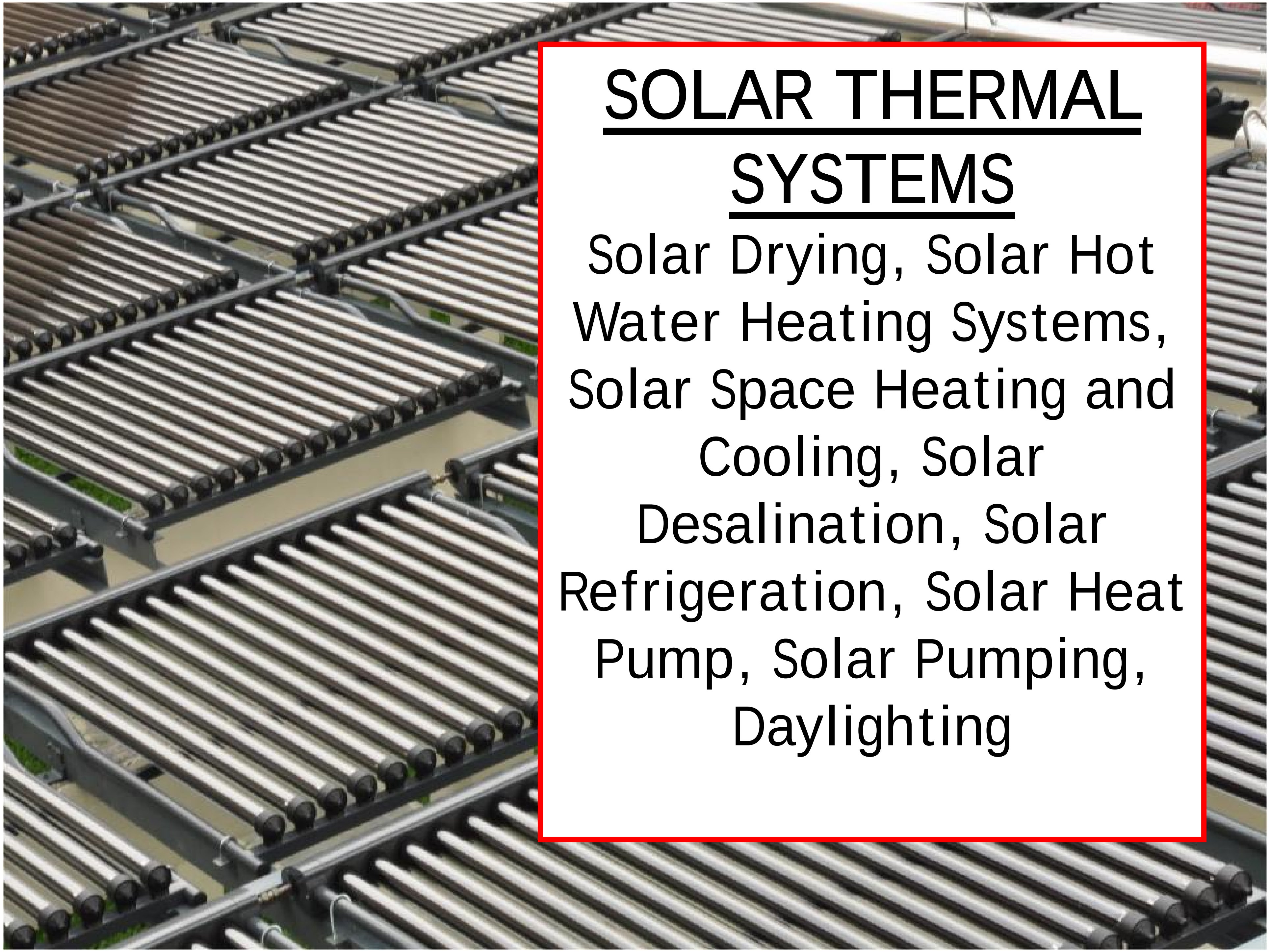
PV in space

Roof system-daylight

PV on Mars



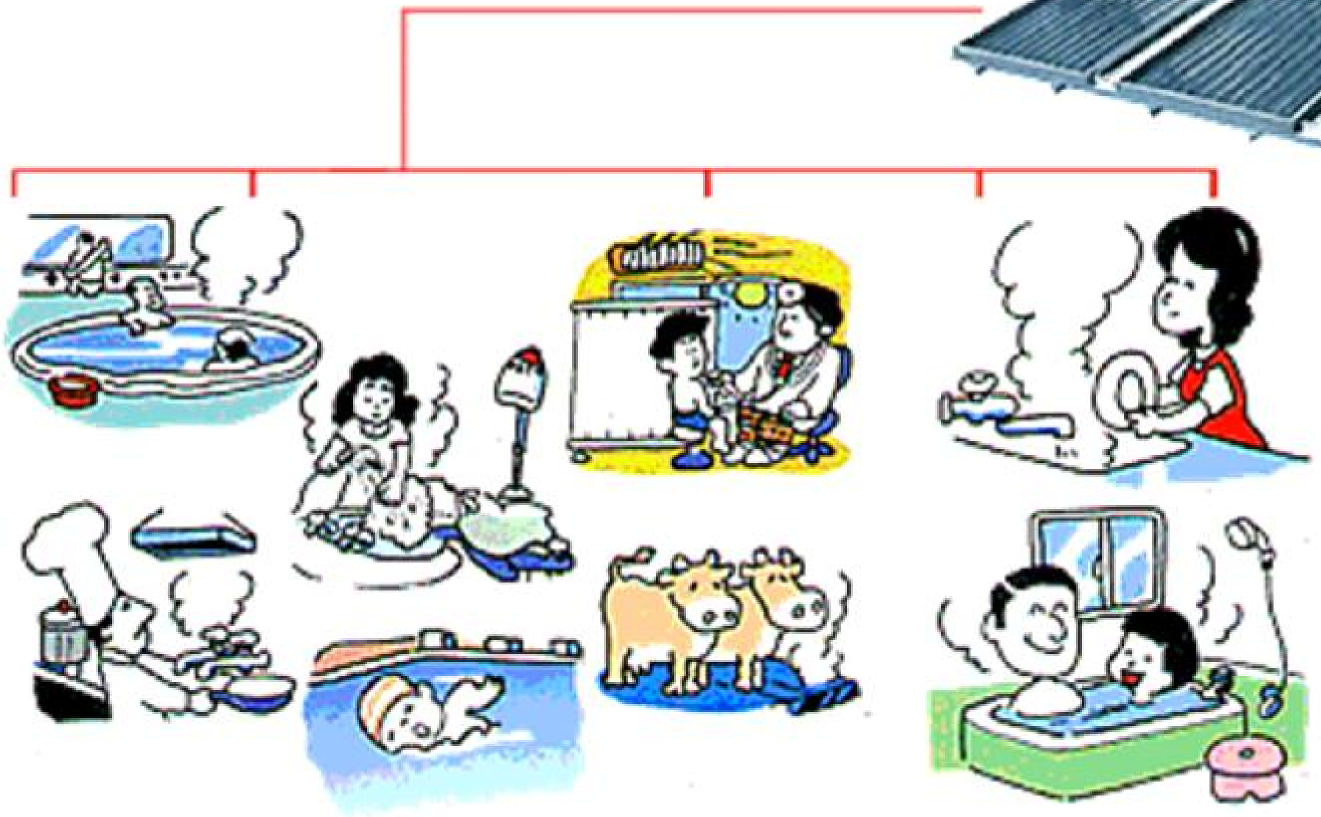
PV tracking



SOLAR THERMAL SYSTEMS

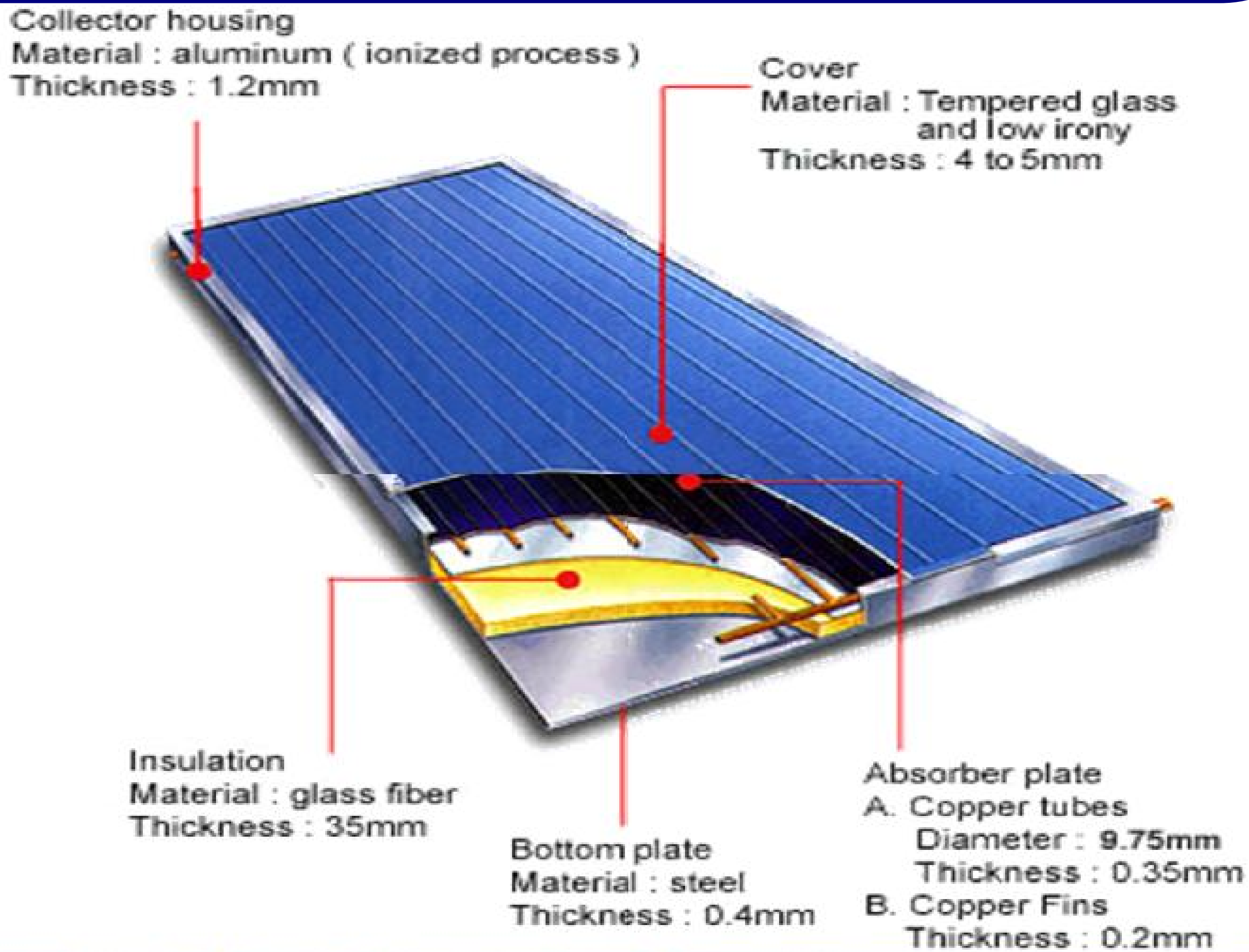
Solar Drying, Solar Hot Water Heating Systems, Solar Space Heating and Cooling, Solar Desalination, Solar Refrigeration, Solar Heat Pump, Solar Pumping, Daylighting

Applications of Solar Thermal system



- Domestic Water Heating
- Pool and Spa Heating
- Process Water Heating
- Air Conditioning "Reheat"

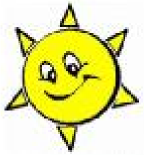
Solar Thermal Collector Details



Solar Cooling Technologies

DRIVEN SYSTEM

HEAT



ELECTRICITY

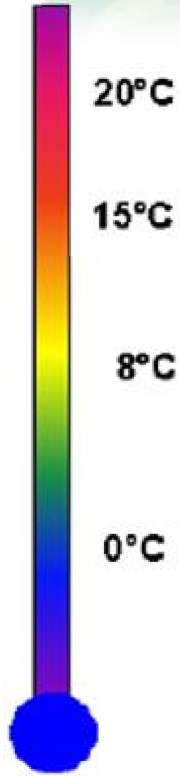
REFRIGERATION CYCLE

Heat-driven cycles:
- Dessicant cycle
- Ejector cycle
- Rankine cycle
- Absorbtion
- Absorption
- Adsorption
- Chemical reaction

Electricity-driven cycles:
- Thermo-electric cycle
- Vapour compression
- Stirling cycle

APPLICATION

- AIR CONDITIONING
- FOOD, VACCINE STORAGE
- Freezing



HOMEWORK ASSIGNMENT

1- What is renewable Energy and its types ?

2- Why is renewable energy important?

3- What is solar electricity?

4- What Technologies Generate Solar Electricity?

5- Draw diagram for house connected with PV system .

6- How a PV system works

8- What is the Solar Cooling System?

References

1- J. Twidell. and T. Weir “ Renewable Energy Resources “ Taylor and Francis Group, 2006.

2- J. A. Duffie and W. A. Beckman” Solar Engineering of Thermal Processes” John Wiley & Sons, Inc., Hoboken, New Jersey , 2013.

Do You Have Any Questions?