Current energy situation and future energy

- Prof. Dr Thet Naing
- PHYSICS DEPARTMENT
- SAGIANG UNIVERSITY
- MYANMAR

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Energy

- energy is the ability to do work,
- work is the application of a force through a distance
- force is that which can put matter into motion or stop it if it is already moving and motion is a change in distance or direction with time

- 1 *Renewable energy*.
- ‘Energy obtained from natural and persistent flows of energy occurring in the immediate environment’. An obvious example is solar (sunshine) energy, where ‘repetitive’ refers to the 24-hour major period. Such energy may also be called *Green Energy* or *Sustainable Energy*.

- 2 *Non-renewable energy*
- . ‘Energy obtained from static stores of energy that remain underground unless released by human interaction’. Examples are nuclear fuels and fossil fuels of coal, oil and natural gas.
- To avoid using the ungainly word ‘non-renewable’, such energy supplies are called *finite supplies* or *Brown Energy*.

- The practical sources of energy include the fossil fuels, natural gas, petroleum (or oil), and coal.
- Fossil fuels are referred to as nonrenewable energy sources because, once used, they are gone.
- .

ENERGY

Renewable

- . sun
- . Water
- wood
- . Wind
- . biomass
- . Geothermal
- . ocean tides

Nonrenewable

- coal
- natural gas
- . petroleum
- nuclear fission

Types of energy:-conventional and non-conventional.

- **Energy Conversion**
- **Oil burns to make heat -->Heat boils water -->Water turns to steam -->Steam pressure turns a turbine -->Turbine turns an electric generator -->Generator produces electricity -->Electricity powers light bulbs -->Light bulbs give off light and heat**

The Formation of Fuels

- **Solar energy is converted to chemical energy through photo-synthesis in plants**
- **Energy produced by burning wood or fossil fuels**
- **Fossil fuels: coal, oil and natural gas**

Type of Fuels

- **Liquid Fuels**
- **Solid Fuels**
- **Gaseous Fuels**

- **Liquid Fuels**
- **Usage • Used extensively in industrial applications**
  Examples
- **•Furnace oil**
- **•Light diesel oil**
- **•Petrol**
- **•Kerosine**
- **Ethanol**
- **•LSHS (low sulphur heavy stock)**

Petroleum or Oil

- This is the black, thick liquid pumped from below the earth's surface wherever you see an oil rig. To make it useful, it is refined. Refining separates the gasoline portion which is used in transportation. Products from the remaining portions include synthetic rubber, detergents, fertilizers, textiles,paints, and pharmaceuticals.

Solid Fuels

- **Coal classification**
- **Anthracite: hard and geologically the oldest**
- **Bituminous**
- **Lignite: soft coal and the youngest**
- **Further classification: semi-anthracite, semi-bituminous, and sub-bituminous**

Coal

- Coal is the most abundant fossil fuel. It is not a widely used energy source due to the cost of mining and its impurities, which cause pollution (acid rain). There are two ways to mine coal; underground mining and strip mining. Disadvantage to these methods is the environmental change caused in the process. New ways of using coal are being explored, such as liquefication, in which a product similar to oil is produced.

Wood

- Wood provides homes and industries as much power as nuclear plants. Burning is the major global source of carbon dioxide in the atmosphere. Worldwide, wood is poor man's oil, providing 50-60% of the people with the barest energy necessities. Roughly half of the earth's forests have disappeared since 1950. Wood is considered a renewable energy source.

Gender

- In Myanmar, 60% of the people are female and the remainder are male and children.
- Female use energy in cooking ,house keeping and entertainment.
- In Rural area, the female used wood and coal for cooking.
- In urban area,the femal use electricity for cooking and house keeping.
- So, wood and coal are major fuel in myanmar.

Gaseous Fuels

- **Classification of gaseous fuels**
- ***(A) Fuels naturally found in nature***
- ***-Natural gas***
- ***-Methane from coal mines***
- ***(B) Fuel gases made from solid fuel***
- ***-Gases derived from coal***
- ***-Gases derived from waste and biomass***
- ***-From other industrial processes***

- *(C) Gases made from petroleum*
- *-Liquefied Petroleum gas (LPG)*
- *-Refinery gases*
- *-Gases from oil gasification*
- *(D) Gases from some fermentation*

Non Conventional Energy Resources

- Solar Energy
- Wind Energy
- Tidal & Wave Energy
- Biogas Energy

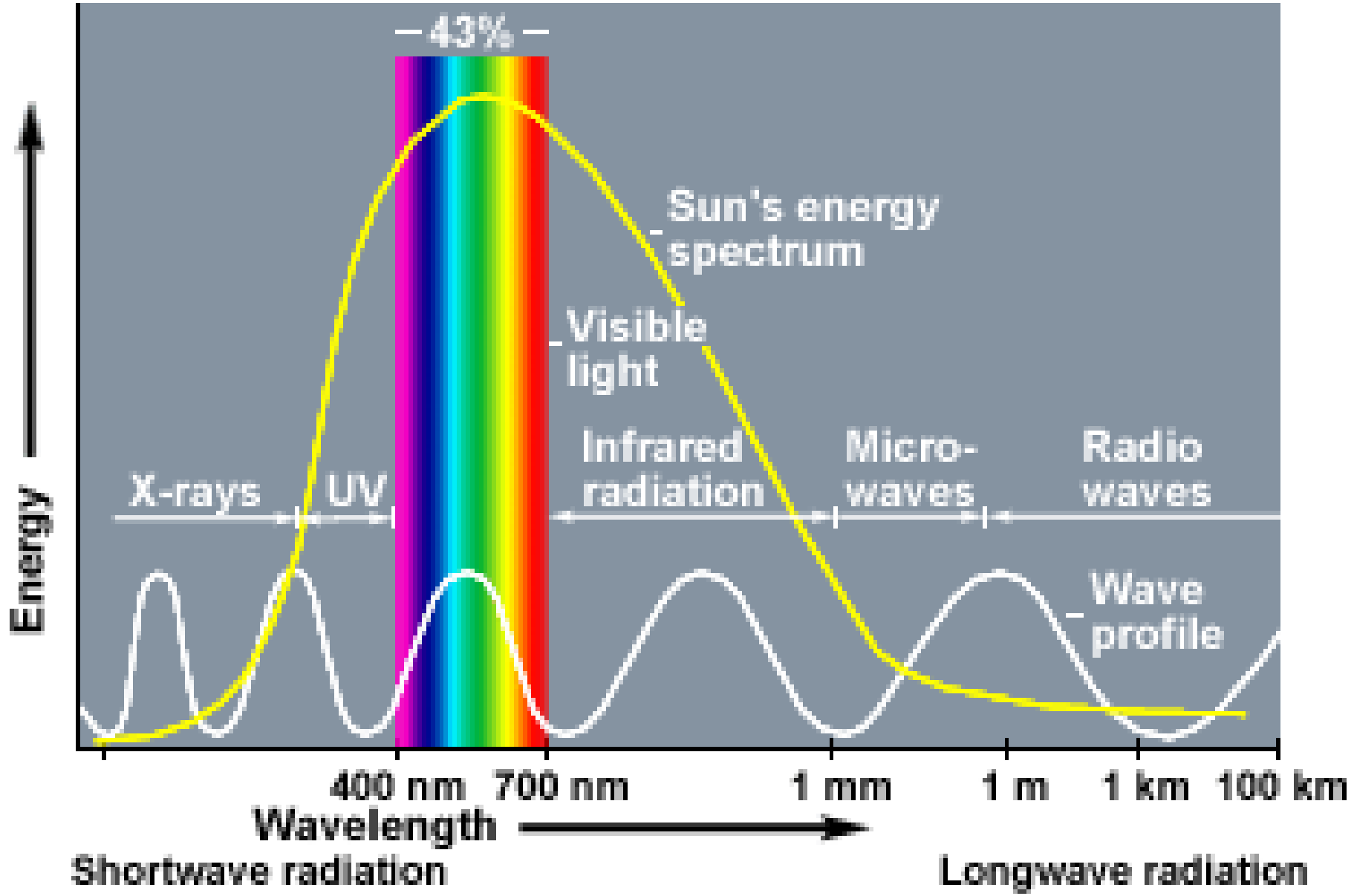
Solar Energy

- With the exception of nuclear power, all of the energy we use is "solar" in origin-
  - wind and hydro are driven by solar heating.
  - wood and other bio-fuels are solar energy converted and stored by plants
  - coal, oil, natural gas are fossilized bio-fuels.
- Solar energy refers to the *direct* use of the energy contained in sunlight.
- The power flux of direct, normally incident sunlight averages about 1 kW/m^2 ($\cong$ 100 W/ft^2).

V. Solar

What is Solar Energy?

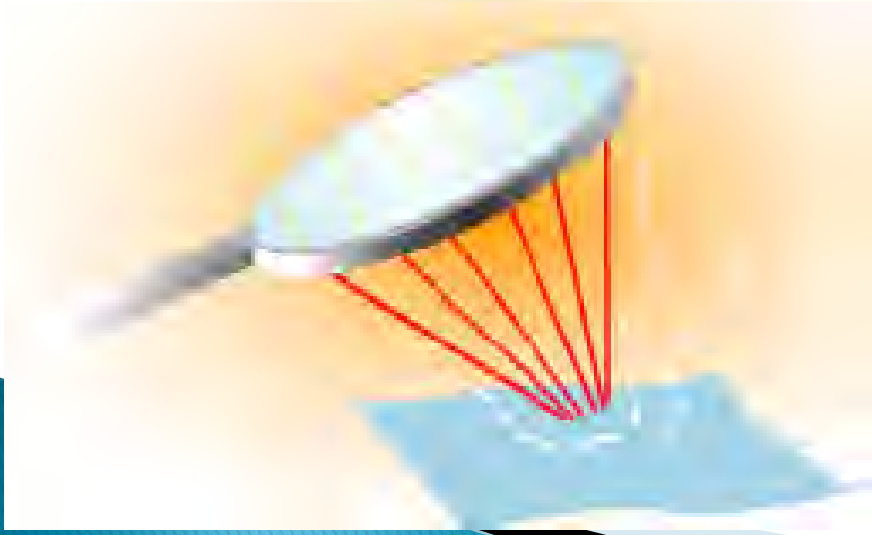
- **Originates with the thermo-nuclear fusion reactions occurring in the sun.**
- **Represents the entire electromagnetic radiation (visible light, infrared, ultraviolet, x-rays, and radio waves).**



The COMET Program

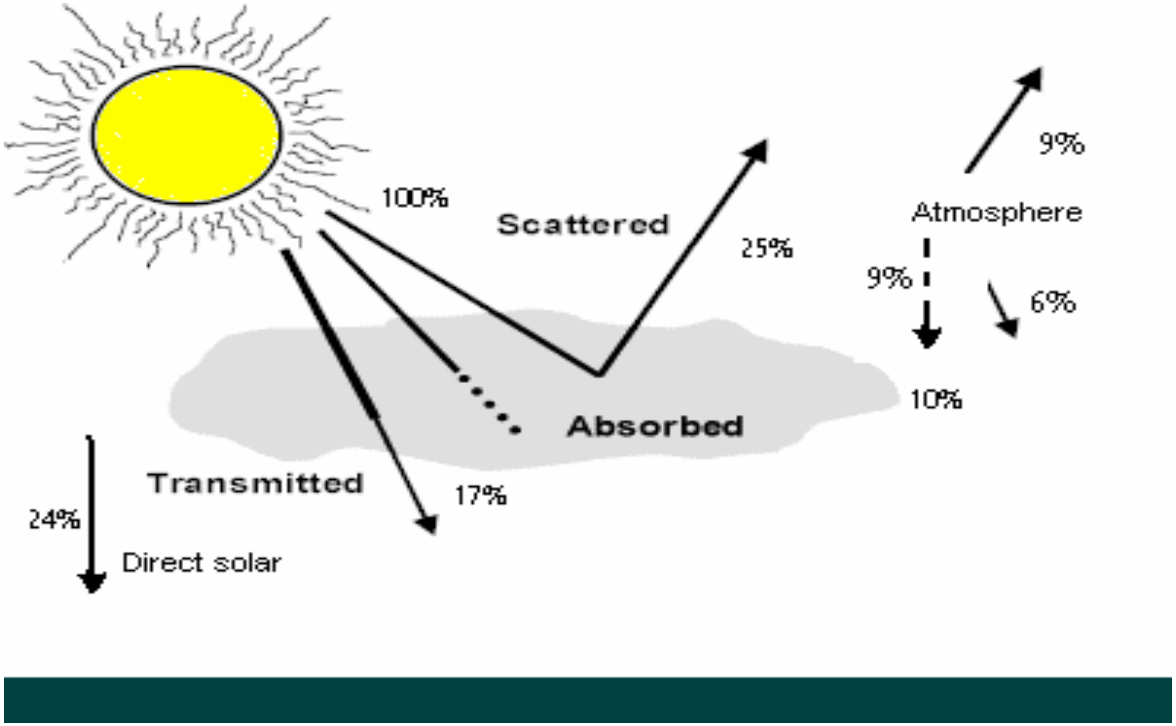
Nature of Solar Energy

- Solar energy is available as long as the sun shines, but its intensity depends on weather conditions and geographic location.
- Solar energy travels in straight lines and can be blocked by objects such as clouds.



Solar energy can be reflected or concentrated by diffraction. For example, we can focus light rays from the sun using a magnifying glass to generate heat and raise the temperature of an object.

How much solar energy?



The surface receives about 47% of the total solar energy that reaches the Earth. Only this amount is usable.

Advantages of Solar Energy

- **All chemical and radioactive polluting byproducts of the thermonuclear reactions remain behind on the sun, while only pure radiant energy reaches the Earth.**
- **•Energy reaching the earth is incredible. By one calculation, 30 days of sunshine striking the Earth have the energy equivalent of the total of all the planet's fossil fuels, both used and unused!**

Disadvantages of Solar Energy

- **Sun does not shine consistently.**
- **Solar energy is a diffuse source. To harness it, we must concentrate it into an amount and form that we can use, such as heat and electricity.**
- **Addressed by approaching the problem through: 1) collection, 2) conversion, 3) storage.**

Power tower in Barstow, California.

Applications of Solar Energy

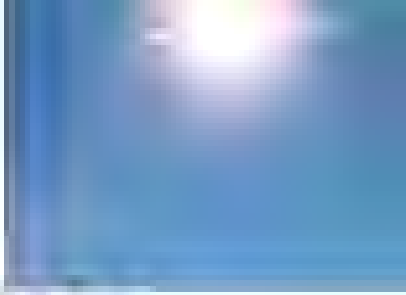
Japan
Small-scale rooftop PV systems are commonly used for domestic purposes.

Germany
This picture shows one of the world's largest grid-connected PV systems (10 MW), Bavaria Solarpark.

USA
BIPV system at Moscone Convention Centre, 675 kW, San Francisco.

Rank	Country	Installed Capacity
1	Japan	1,132 MW
2	Germany	794 MW
3	USA	365 MW

Benefits of Solar Energy



- **It is abundant**

  Solar energy is generally available everywhere, every day, though the intensity varies with weather conditions and geographical locations.

- **It is environmentally friendly**

  No noise, heat or greenhouse gases. It will not deplete natural resources. Every 1,200 units of solar electricity generated reduces around 1 tonne of carbon dioxide (CO_2).

- **It is convenient to install**

  Solar panels can be retrofitted into exist building structures and fixtures.

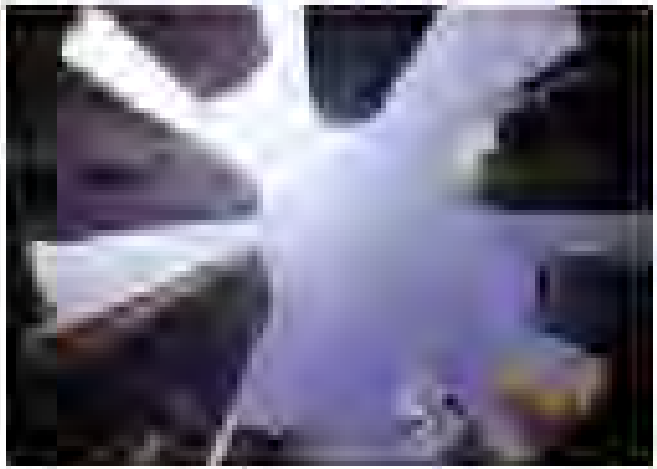
Challenges of Solar Energy

- **It is unpredictable.**

  Controlled by nature. It is only available during daylight hours and with clear skies.

- **It usually works better in rural areas than urban areas.**

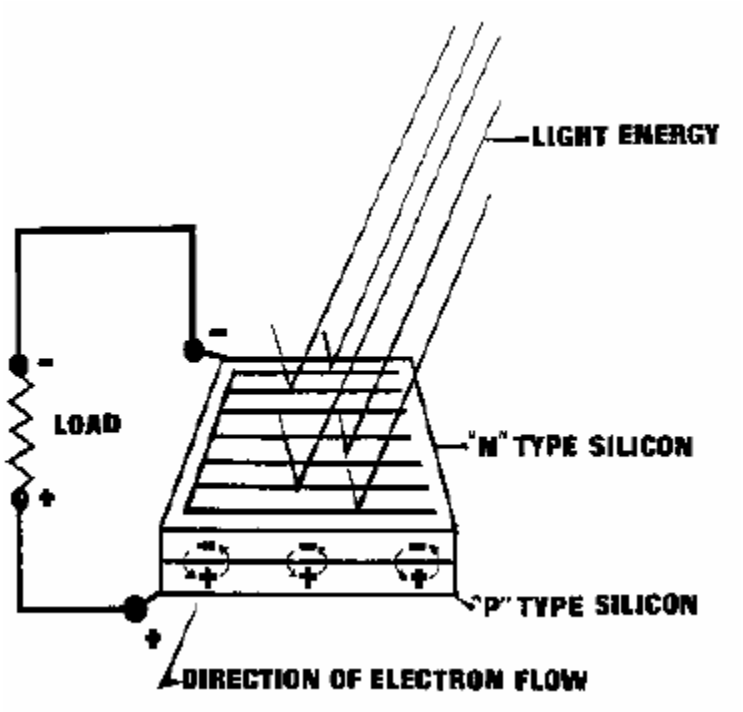
  The close proximity of buildings in urban areas and the resulting shadows sometimes pose limitations on the absorption of solar energy.



- **It can be costly** to build solar energy facilities …high start-up costs

Direct Conversion into Electricity

- •Photovoltaic cells are capable of directly converting sunlight into electricity.
- •A simple wafer of silicon with wires attached to the layers. Current is produced based on types of silicon (n-and p-types) used for the layers. Each cell=0.5 volts.
- •Battery needed as storage
- •No moving parts do no wear out, but because they are exposed to the weather, their lifespan is about 20 years.


LIGHT ENERGY
LOAD
"N" TYPE SILICON
"P" TYPE SILICON
DIRECTION OF ELECTRON FLOW

Wind Energy

- **What is Wind ?What is wind energy?**

- **The kinetic energy of the wind can be changed into other forms of energy, either mechanical energy or electrical energy.**
- **When the wind fills a boat sail, the boat is using wind energy to push it through the water.**

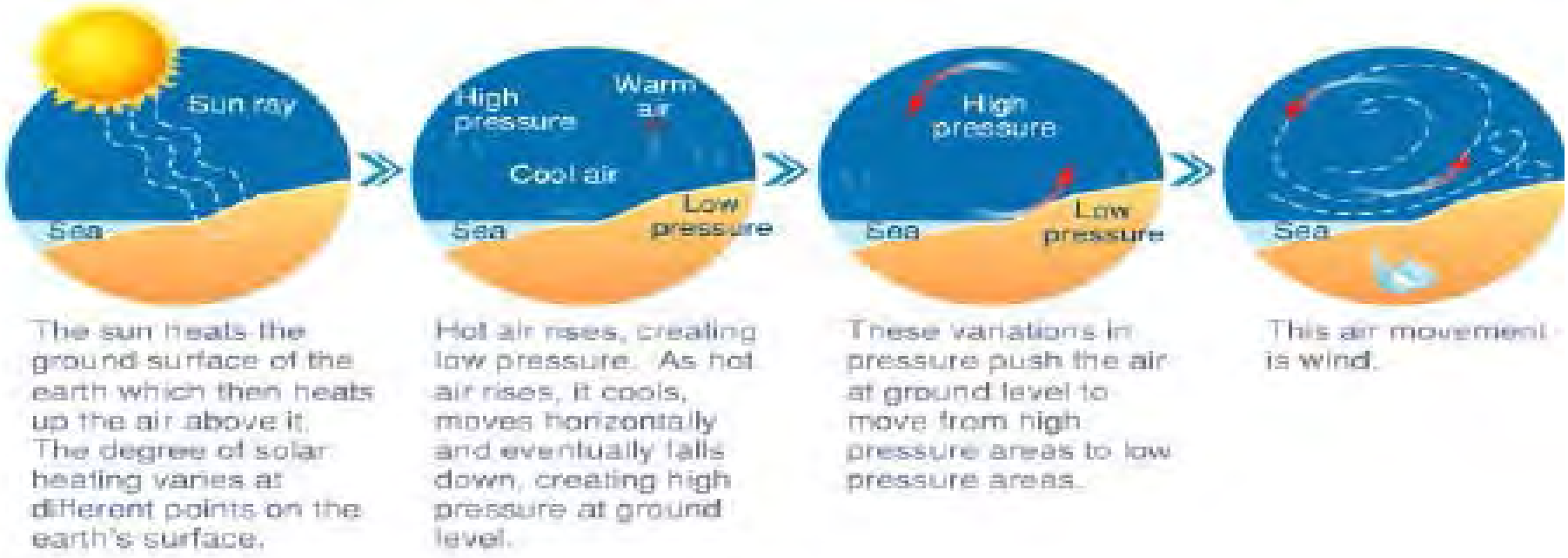
IV. Wind

People have been raising sails to capture wind energy and push their boats through the water.

Wind has been used to produce electricity since the 19th century. One of the earliest wind turbines was built in Cleveland, Ohio, in 1888 by Charles F. Brush. It featured 144 rotor blades made of cedar, and had a 12 kW capacity.

As at 2005, the largest wind turbine is a pilot installation in Hamburg, Germany, with a capacity of 5 MW.
Photo Courtesy of REpower Systems AG

How is Wind Formed?



Theoretically, about 1 to 2% of the sun's radiation turns into wind energy when it arrives at the earth, which is about a hundred times of all the energy consumed on the planet.

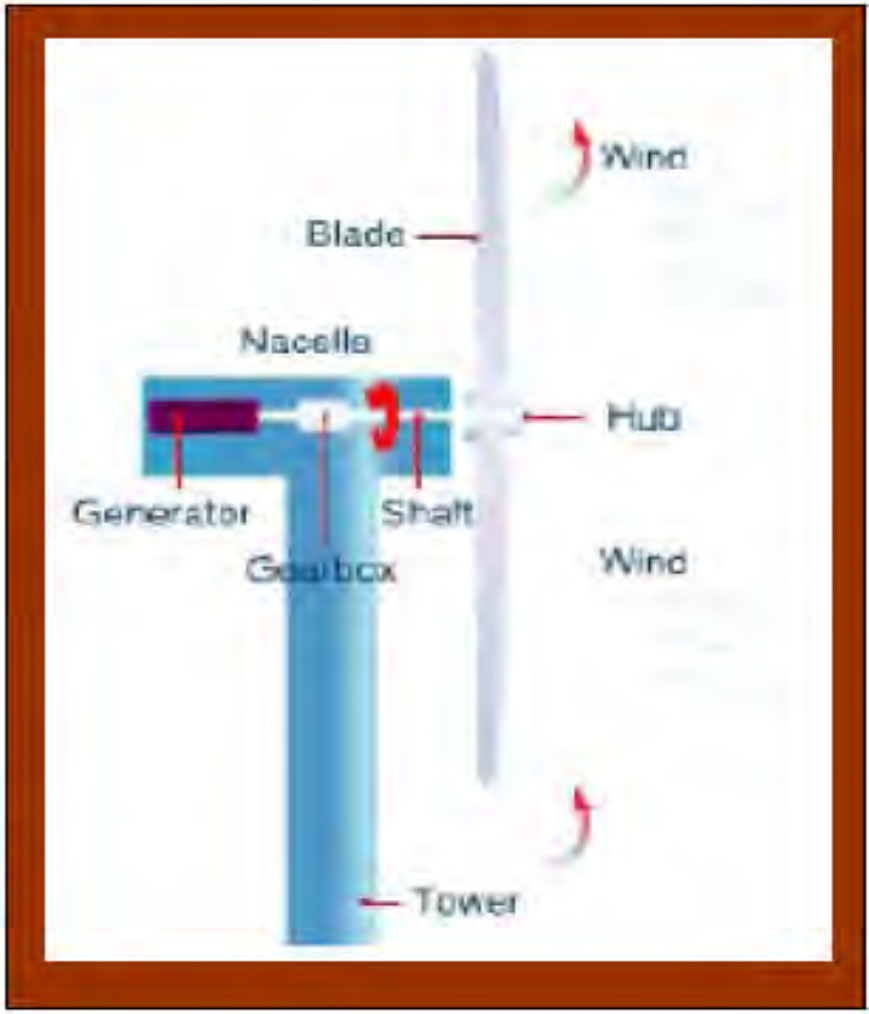
How to Extract Wind Energy?

- All moving objects contain kinetic energy.
- The kinetic energy contained in wind can be transferred to other objects, such as boat sails, or transformed into electrical energy through wind turbine generators.


II. Renewable Electricity in the U.S.

How is electricity generated by wind turbine?

- Wind blows over the angled blades and results in a turning force.
- The force will turn the shaft, gearbox and generator, which are all connected.
- The gearbox increases the rotational speed, enabling the generator to produce electricity.
- The yaw control would turn the rotor and nacelle to face the wind.



Onshore Wind Farms

Onshore wind farms continue to make up the majority of wind farms around the world.

Advantages

- **Lower construction costs compared with offshore wind farms, easy access for maintenance, relatively convenient to connect to power grids.**

Constraints

- **Height restrictions for hilltop wind turbines, unsteady wind conditions, concerns over noise and visual impact on the environment.**

Offshore Wind Farms

• They are typically constructed in regions with high population densities with few suitable sites.

Advantages

• Steady and stronger supply of wind than onshore wind farms, less visual impact, less likely to be affected by height restrictions than hilltop wind turbines.

Constraints

• Higher construction costs, subject to water depth restrictions (most existing off-shore installations are in waters shallower than 20 m.

An offshore wind farm located at Rodsand of Denmark, with 72 wind turbines, total installed capacity of 165.6 MW.

Installed Wind Power Capacity Worldwide

Rank	Country	Installed Capacity
1	Germany	16,629 MW
2	Spain	8,236 MW
3	USA	6,740 MW

Germany
Schuby Wind Farm, near Schleswig, with installed capacity of 18 MW.

Spain
Leitza-Beruete Wind Farm, Navarre, Spain, with installed capacity of 19.2 MW

USA
White Deer Wind Farm, Texas, with installed capacity of 80 MW.

Benefits of Wind Energy

- It is clean and does not pollute the air

Wind turbines do not emit greenhouse gases or
contribute to global warming.

- It does not deplete resources

Every 1 million units of electricity generated by a wind turbine can offset approximately 350 tonnes of coal.

- It is more cost-effective than other forms of renewable energy

As wind energy technology matures, construction and operating costs continue to drop, providing greater cost effectiveness

Challenges of Wind Energy

• It is intermittent and unpredictable

Wind turbine generator outputs are not controllable or predictable. Wind energy alone cannot be relied upon as the sole source of electricity.

• Wind farms occupy large areas

Places with high population densities and land limitation often have difficulty finding the necessary space for wind farms

* Wind turbines can impose adverse impact on the environment

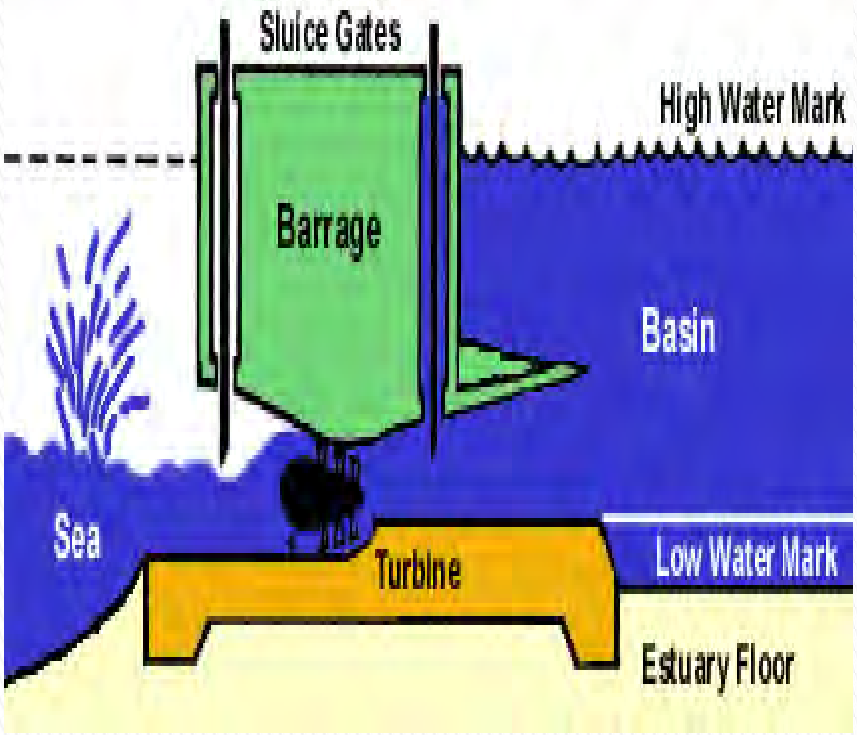
Impact on migrating birds. Create noise, visual blight.

Wave and Tidal Energy

- The most practical use for tidal energy is for conversion to electricity (similar to hydroelectric dams)
- **-this is done by creating a dam or barrage, containing several gates and turbines, across an estuary. When there is a difference in water level across the dam, the gates are opened, water flows through the turbines (creating a hydrostatic head), and an electric generator is activated.-generation of electricity peaks and ebbs with the tides each day, so that there is a peak of maximum generation every twelve hours, with no generation at the converse twelve hour mark.**
- **Gilbrat Ratio-ratio of annual energy production in kilowatt hours to length of barrage in meters. -used to determine cost effectiveness and efficiency of tidal power site**

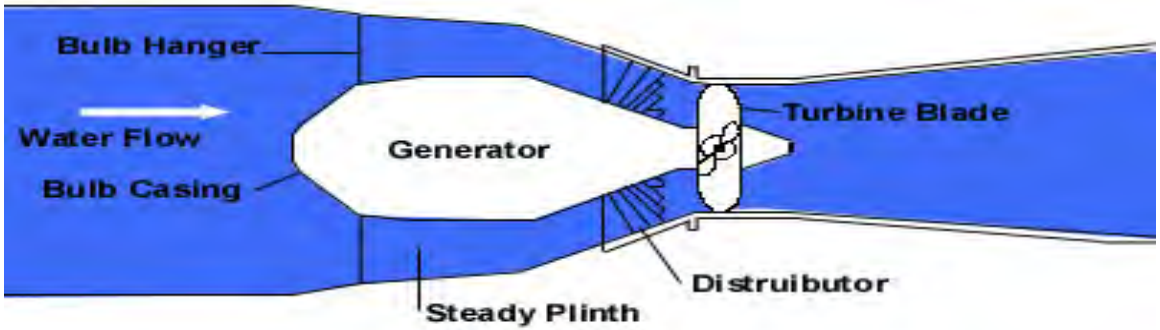
Turning Tides into Usable Energy

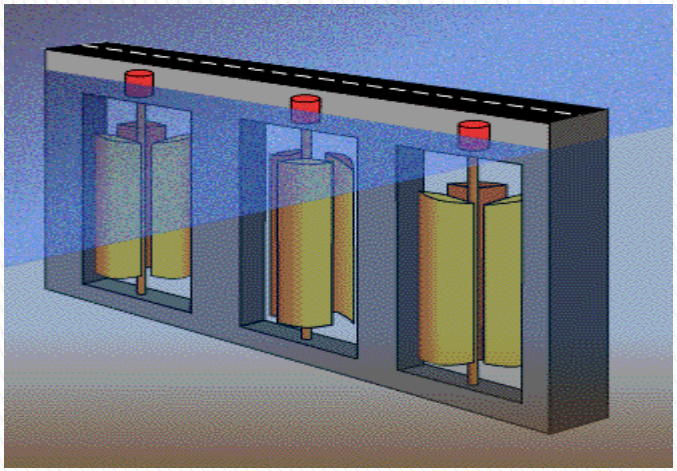
- •Ebb generating system
- •A dam (barrage) is built across the mouth of an estuary.
- •Sluice gates allow incoming tides to fill the basin.
- •As the tide ebbs, the water is forced through a turbine system to generate electricity.



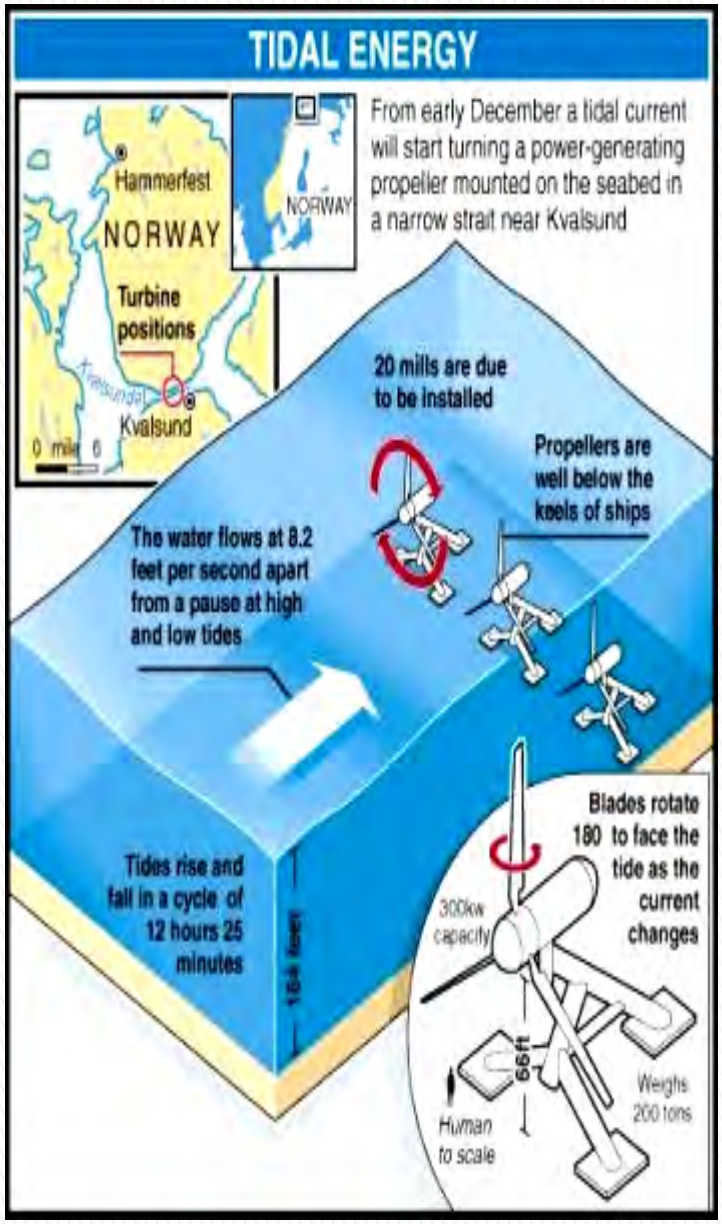
Types of Turbines

Bulb turbine used at La Rance tidal plant on the Brittany coast in France





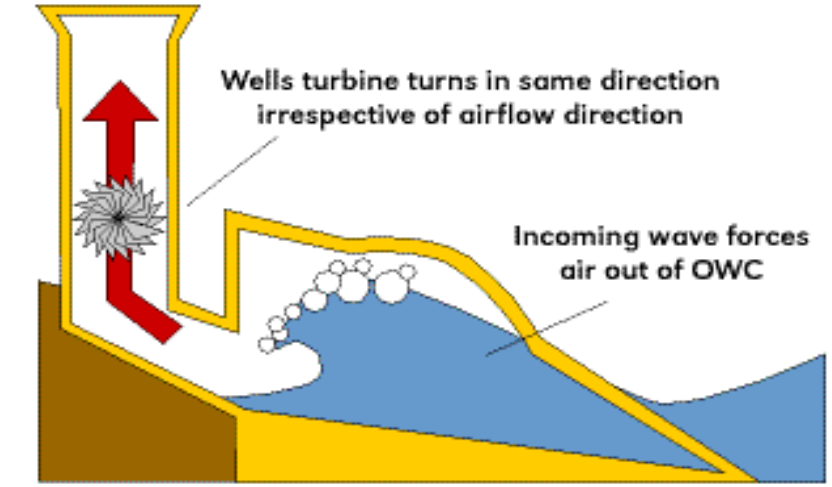
- •Tidal Fences
- Completely blocks a channel so as the tide rises, water is forced through the styles to turn them.
- •Can be used between islands or between a mainland and an island as opposed to only across the mouth of a confined bay.

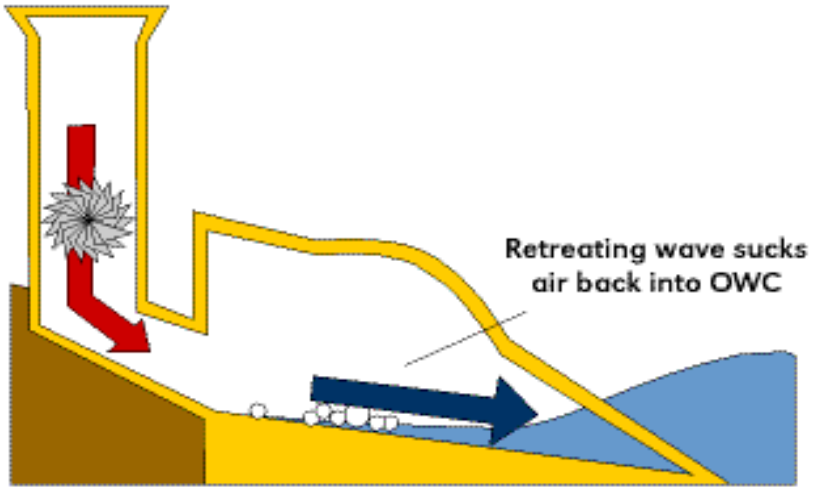


- Tidal Turbines
- Only been feasible for about 5 years
- Similar to wind turbines, they use tidal currents to turn propellers mounted on the seabed to generate power.

Turning Waves into Usable Energy

- Oscillating water column
- Incoming waves force air up column to turn the turbine
- Outgoing waves suck air down column to turn the turbine





Advantages

- •Renewable
- •Abundant (estimated that it could produce 16% of worlds energy.)
- •Pollution free (except during construction)
- •Relatively consistent (unlike wind that is inconsistent and is highly concentrated in certain areas depending on the topography.)
- •Water is a free resource
- •Presents no difficulty to migrating aquatic animals (avoidable)

Disadvantages

- •Disturbance/Destruction to marine life (effect wave climate that effects shallow/shore plant life)
- •Expensive to construct (estimated 1.2 billion dollars.)
- •Reliability (have not been around long so we do not know long-term reliability is.)
- •Recreational costs (visual impact, sport fishing, swimming, etc.)
- •Cost of Maintenance Higher
- •Power transmission from offshore facilities harder
- •Power quality (waves fluctuation)

Present use of Tidal Energy

- **Tidal power has on a small scale been used through out the history of mankind. It was not until the twentieth century that large scale tidal projects were considered. Today, sites suitable for the utilization of tidal power exist in many places around the world.**
- **France**
- **United Kingdom**
- **Former Soviet Union**
- **Canada**
- **United States**

IX. Advanced Water Power

Biogas Energy

- ·Biogas is the name applied to a gaseous product released from anaerobic decomposition of different bio-wastes.
- ·In this process, organic wastes are an aerobically fermented by microorganisms.

- **The gas thus produced contains about 60% methane and 40% CO_2. Biogas can be produced from cow dung, leaf litter mixtures, animal excreta particularly dairy cattle, pig and sheep etc.**

Biomass

- This is garbage! As bacteria decomposes organic waste such as manure, septic tank sludge, food scraps, pond- bottom muck, etc., methane is produced. This methane is the same as natural gas from the ground. There are power plants in the United States, which use methane derived from these organic wastes (mainly manure). Some cities produce electricity by burning garbage in especially designed power plants.

VII. Biopower

XI. Renewable Fuels

- **This is one of the popular treatment methods even for municipal waste, various industrial wastes such as dairy, tannery, fruit processing, pharmaceutical etc.**

Hydroelectric (Falling Water)

- When water is collected behind dams on large rivers, it provides a source of energy for the production of electricity. The enormous power of falling water is capable of turning giant turbines. These turbines drive the generators, which produce electricity. The degree of power is determined by the amount of water and the distance it falls. Hydroelectric power plants do not cause pollution, but there are fewer and fewer places to build dams. The environmental problem arises because a dam is typically built on a river creating a lake where land once stood. Water is a renewable energy source.

VIII. Hydropower

Geothermal

- Geothermal energy refers to the energy deep within the earth. It shows itself in the fountains of b oiling water and steam known as geysers. Geothermal energy was generated by the decay of natural radioactive materials within the earth. In addition it is the heat energy remaining within the earth from gravitational formation of the earth. Geothermal energy is used to heat some homes, greenhouses, and factories. The actual usable geothermal sites are few, but is considered a renewable energy source.

VI. Geothermal

Geothermal resources are available throughout the entire U.S.

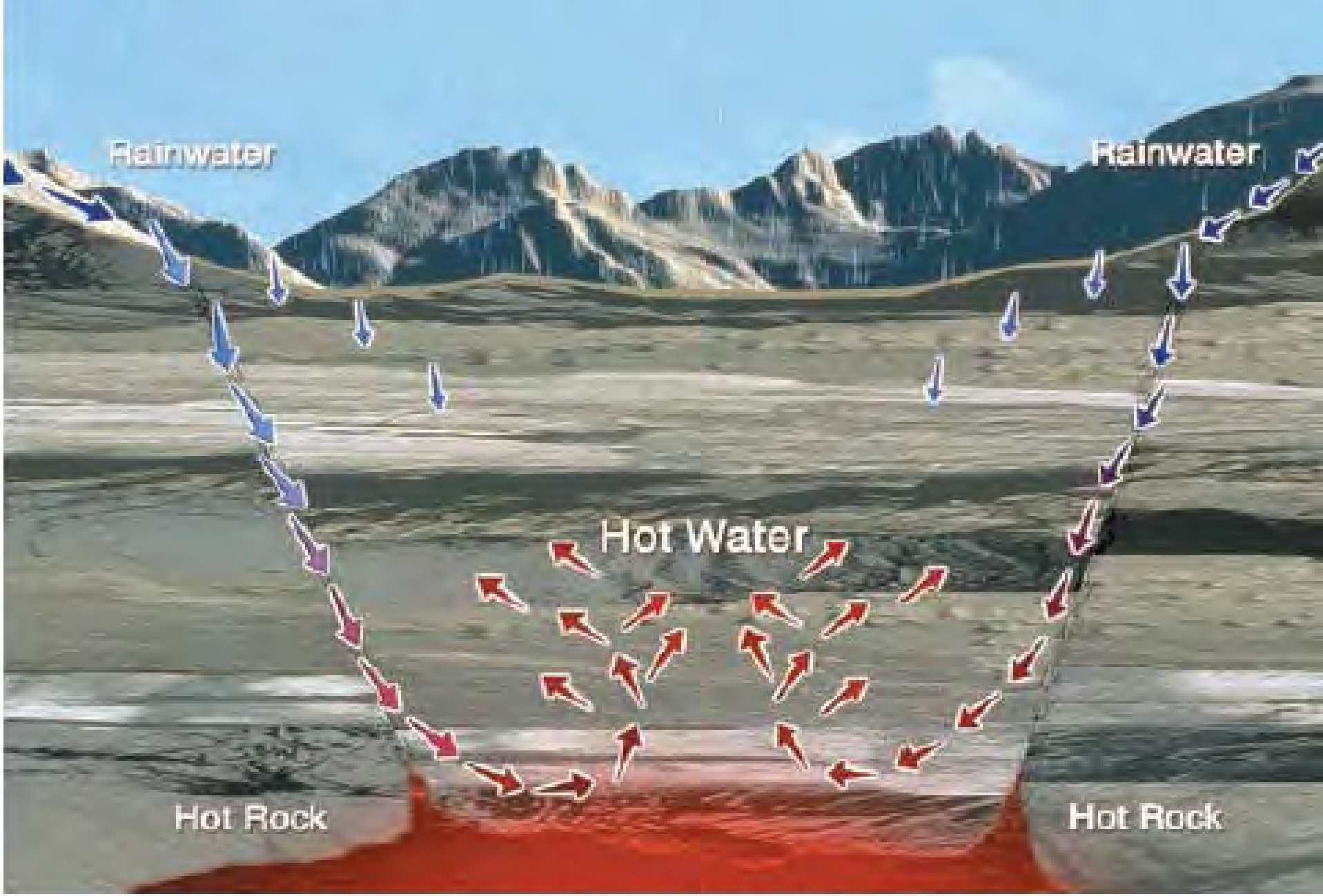


Figure 2. Ilustration of a hydrothermal reservoir, showing the natural recharge, fractures, and heat source.
Courtesy: Geothermal Education Office

Advantages of Non Conventional Energy

- Available in unlimited extent.
- Very low operation cost.
- Very Low maintenance Cost
- Totally pollution free.

Disadvantages of Non Conventional Energy

- High capital cost
- Low output in terms of power and efficiency as compared to conventional sources of energy.
- Conveyance from one place to other is difficult
- Conversion from one form to other is difficult
- Storage is difficult.
- These energy sources cannot be explored under unfavourable atmospheric conditions such as cloudy environment for producing solar energy or very calm days for producing wind energy etc.

Nuclear

- With oil prices relatively high and concern about the potential impact of fossil fuels on the environment, talk of a nuclear energy solution is enjoying a revival. This talk comes at a time when new technologies are available to make nuclear power safer and help deal with the issue of disposal of radioactive waste.

The Nucleus

- Made up of protons and neutrons

- Almost all of the mass of the atom is concentrated in the nucleus.

- >99.9% of the known mass in the universe.

- Occupies almost none of the volume of the atom.
  - Radius < 1/10,000
  - Volume < 1/1,000,000,000,000

Protons

- **Positively charged**
  (+1 elementary charge)
- **Size ~ 1 fm (10^{-15} m)**
- **Mass 938 MeV/c^2 = 1**

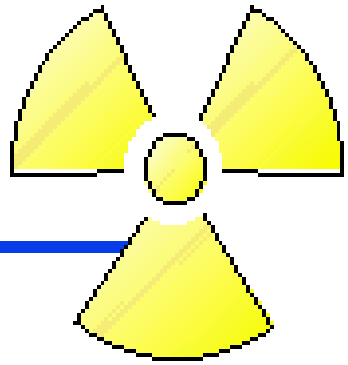
Neutrons

- **Neutral**
  (0 charge)
- **Size ~ 1 fm (10^{-15} m)**
- **Mass 939 MeV/c^2 ~ 1**

Half Life

- **Time taken for half of the substance to decay away**
- **Example:**
- **If you have 1000 radioactive nuclei**
- **And If their half life is 30 minutes**
- **After 30 minutes 500 nuclei remain**
- **After 60 minutes 250 remain**
- **After 90 minutes 125 remain**
- **After 120 minutes 62 remain**

Radiation and Radioactivity



- Radiation: Energy in transit, either as particles or electromagnetic waves
- Radioactivity: The characteristic of various materials to emit ionizing radiation
- Ionization: The removal of electrons from an atom. The essential characteristic of high energy radiations when interacting with matter.

Radioactivity

is the **spontaneous transformation** of an **unstable** atom and often results in the **emission of radiation**. This process is referred to as a transformation, a decay or a disintegrations of an atom. These emissions are collectively **called ionizing radiations**. Depending on how the nucleus loses this excess energy either a lower energy atom of the same form will result, or a completely different nucleus and atom can be formed.

Ionization

is a particular characteristic of the radiation produced **when radioactive elements decay**. These radiations are of such high energy that when they interact with materials, they can **remove electrons from the atoms in the material.** This effect is the reason why ionizing radiation is **hazardous to health**.

Radioactive Material

is any material that contains radioactive atoms.

Radioactive Contamination

is radioactive material distributed over some area, equipment or person.

- **Energy Scale**

- The energy scale used by most nuclear scientists is electron volts (eV), thousands of electron volts (keV), and millions of electron volts (MeV). An electron volt is the energy acquired when an electron falls through a potential difference of 1 volt. 1 eV=1.602*10^{12}ergs. Masses are also given by their "mass-equivalent" energy ($E=mc^2$). The mass of the proton is 938.27231 MeV.

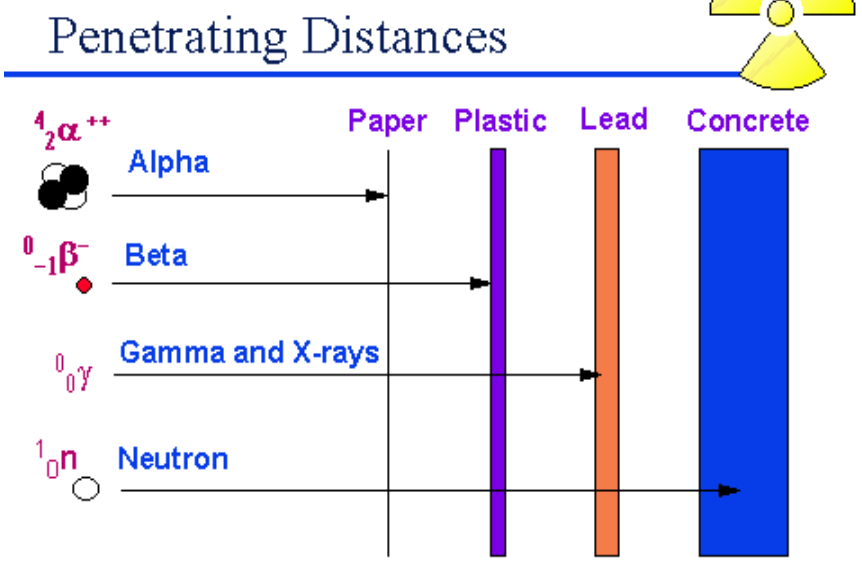
- **$E=mc^2$**

- Where: e is energy, m is mass, and c is the speed of light. Einstein's famous equation describes how energy and mass are related. In our animated decays, mass is lost. That mass is converted into energy in the form of electromagnetic waves. Because the speed of light is so great, a little matter can transform into large amount of energy.

Common Types of Radiation

- **Alphas**
- An alpha is a particle emitted from the nucleus of an atom, that contains **2 protons and 2 neutrons**. It is identical to the nucleus of a Helium atom, without the electrons.
- **Betas**
- A beta is a high speed particle, identical to an electron, that is emitted **from the nucleus** of an atom
- **Gamma Rays**
- Gamma rays are **electromagnetic waves / photons** emitted **from the nucleus** (center) of an atom.
- **X rays**
- X Rays are **electromagnetic waves / photons** emitted **not from the nucleus**, but normally emitted **by energy changes in electrons**. These energy changes are either in electron orbital shells that surround an atom or in the process of slowing down such as in an X-ray machine.
- **Neutrons**
- Neutrons are **neutral particles** that are normally contained in the nucleus of all atoms and may be removed **by various interactions or processes like collision and fission**

Properties of Radiation



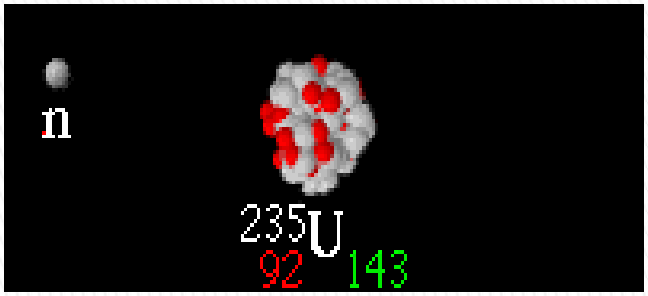
Alpha particles are heavy and doubly charged which cause them to lose their energy very quickly in matter. They can be **shielded by** a sheet of paper or the **surface layer of our skin**. Alpha particles are considered **hazardous only to a persons health if an alpha emitting material is ingested or inhaled**.

Beta and positron particles are much smaller and only have one charge, which cause them to interact more slowly with material. They are effectively shielded by thin layers of metal or plastic and are again considered **hazardous only if a beta emitter is ingested or inhaled.**

Gamma emitters are associated with alpha, beta, and positron decay. X-Rays are produced either when electrons change orbits within an atom, or electrons from an external source are deflected around the nucleus of an atom. Both are forms of high energy electromagnetic radiation which **interact lightly with matter**. X-rays and gamma rays are best **shielded by** thick layers of lead or other **dense material** and are **hazardous to people when they are external to the body.**

Neutrons are neutral particles with approximately the same mass as a proton. Because they are neutral they **react only weakly with material**. They are an external hazard best **shielded by** thick layers of **concrete**.

- **Neutron-Induced Fission**
- Bombardment with a **neutron** resulting in **splitting** the nucleus **into** two parts (fission fragments), **neutrons, and gamma rays**.



- **Fusion**
- Cold Fusion
- Neutron Capture
  Coulomb Excitation
- Particle Transfer

The Detector

- The function of the detector is to produce a signal for every particle entering
- into it. Every detector works by using some interaction of particles with matter.
- Following is a list of the most common detector types.
- 1. Gas-filled counters (ionization, proportional, Geiger-Muller counters)
- 2. Scintillation detectors
- 3. Semiconductor detectors
- 4. Spark chambers
- 5. Bubble chambers
- (used with high energy particles)
- 6. Photographic emulsions
- 7. Thermoluminescent dosimeters (TLDs)
- 8. Cerenkov counters
- 9. Self-powered neutron detectors

Nuclear Fuel Cycle

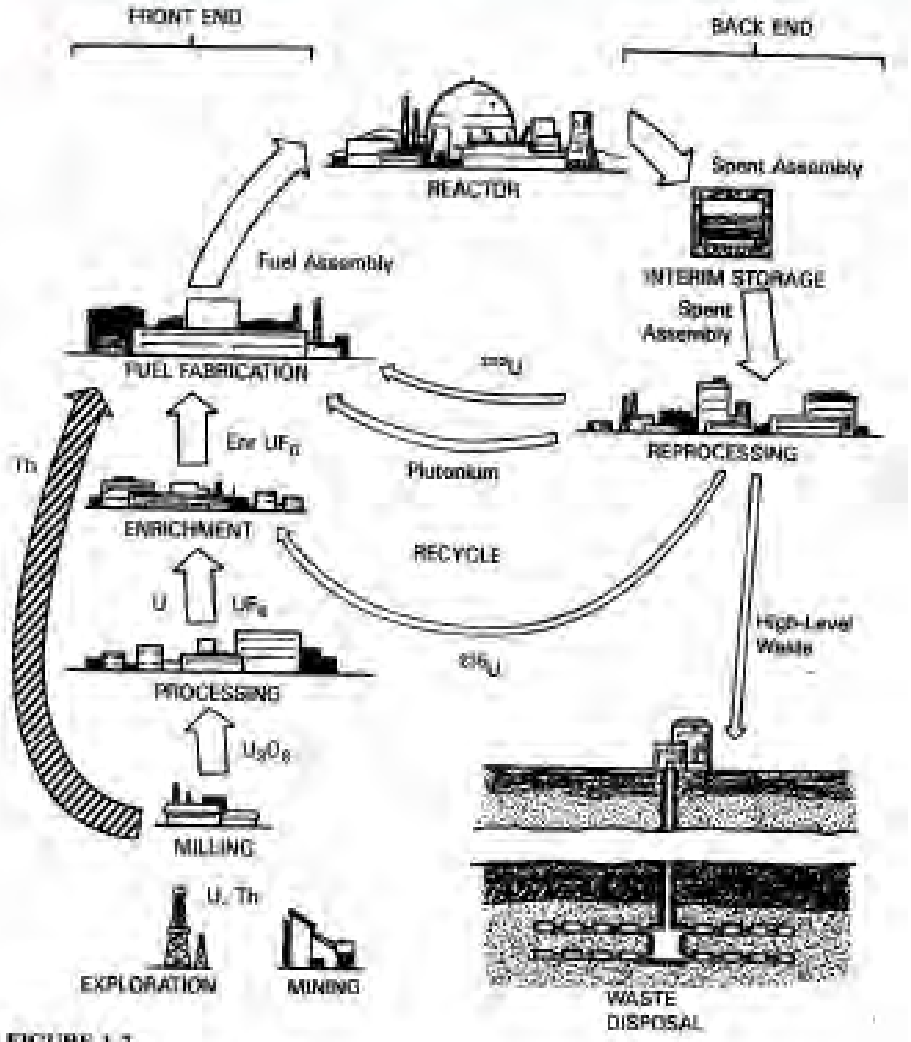


FIGURE 1-2
Nuclear fuel-cycle material flow paths

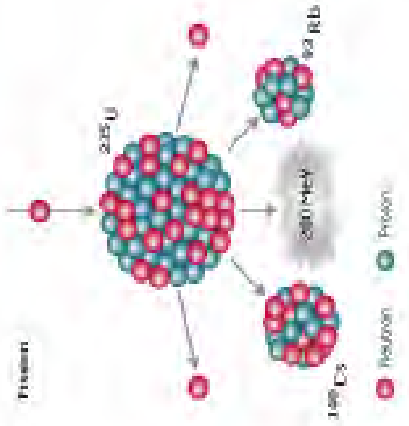
Power Reactor Types

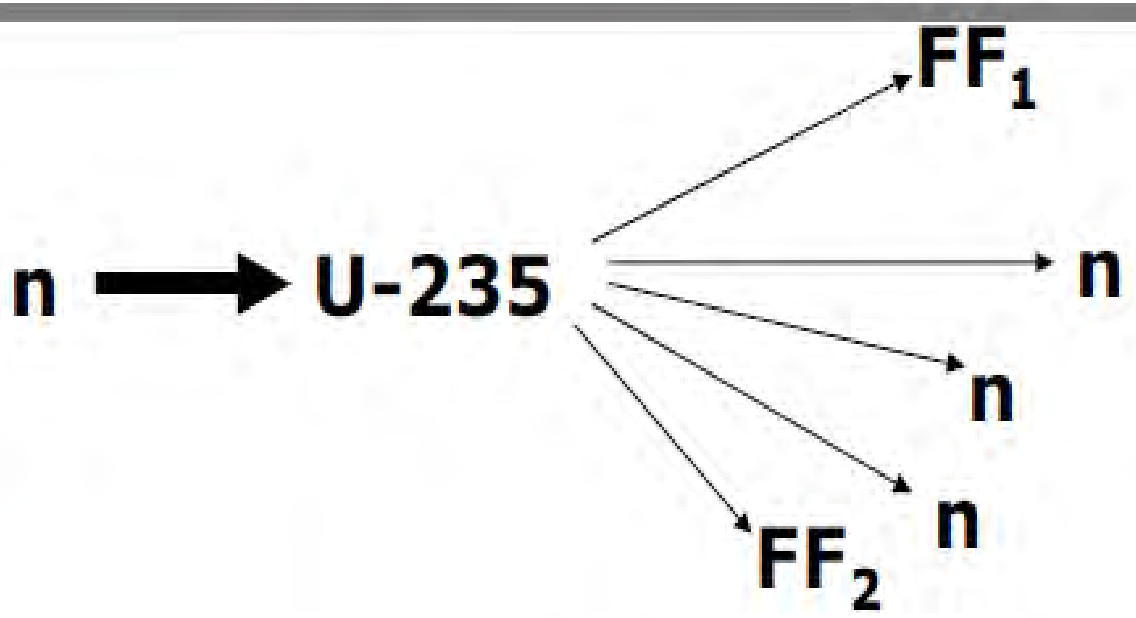
- Pressurized Water Reactor
- Boiling Water Reactor
- Natural Uranium Heavy Water Cooled Reactor (CANDU)
- RBMK - Russian Chernobyl Like - Water Cooled
- Fast Reactors - Liquid Metal (Sodium)
- Gas Reactors (CO_2 or Helium Cooled)
- Molten Salt Cooled Reactors (Organic Coolants)

Making Heat

- Use the fissioning of uranium atoms (or plutonium) to release 200 Million electron volts per fission.
- Need to enrich natural uranium to 3 to 4 weight percent U-235 (from 0.7% found in nature.
- Need to fabricate uranium into pellets clad in zironium fuel assemblies which are placed into the reactor core.

Fission Event





Release of excess neutrons creates the potential for chain reaction.

The energy (mostly as kinetic energy of the fission fragments) is substantial.

Energy Release

1 fission = 200 Mev

1 gram U-235 fissioned = 8.6×10^{10} joules = 24,000 kwh

(Equivalent to lighting a small city for overnight)

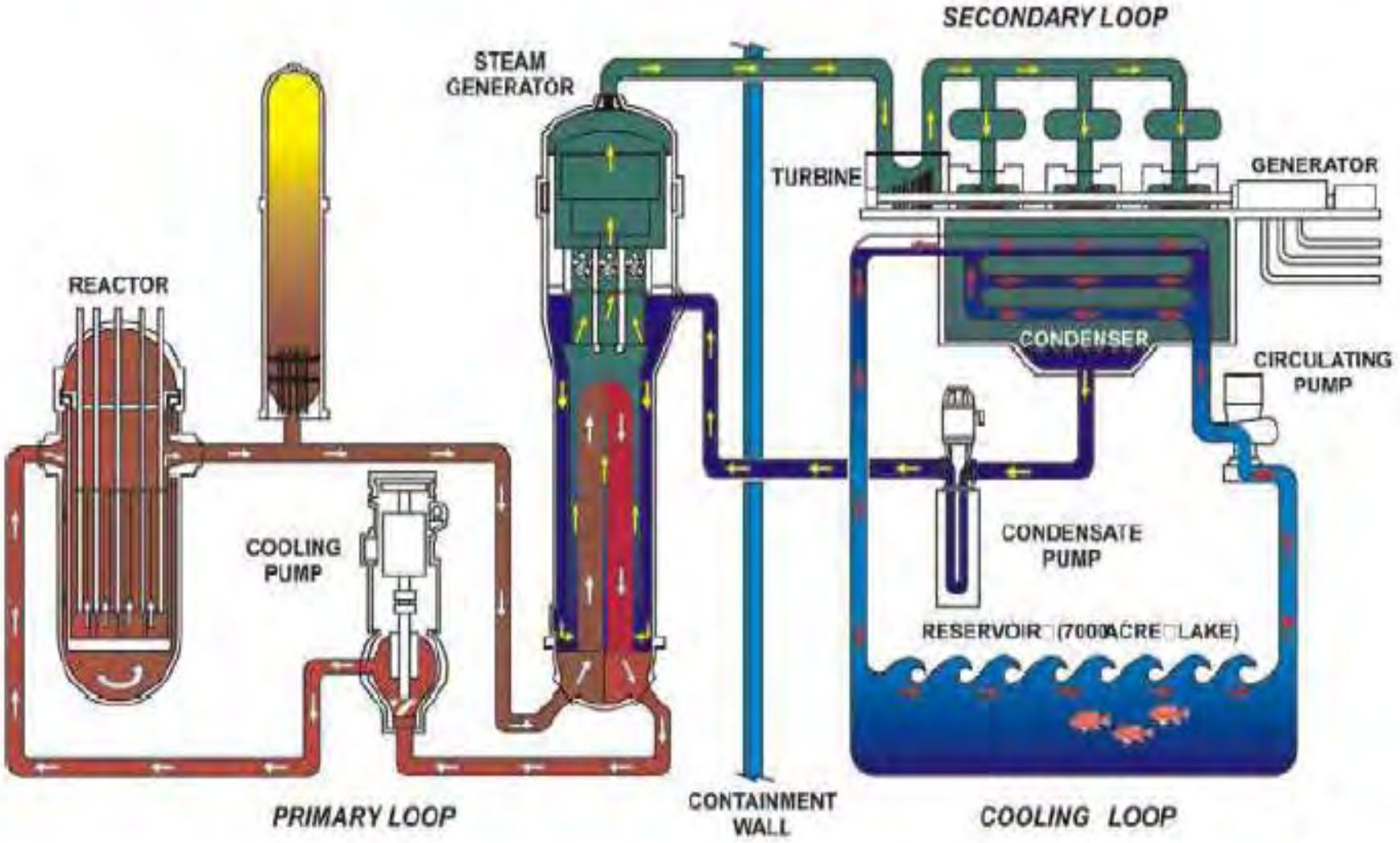
24,000 kwh requires 3.2 tons of coal

12.6 bbls oil

Energy Density (energy / mass)

Energy Density of U-235 = 28,000 times energy density of coal

Schematic of Pressurized Water Reactor



Advantages

- Nuclear energy has a number of positives going for it.
- First, it does not give off carbon emissions, earning it supporters in the environmental community among those concerned about global warming.
- Second, unlike oil, two of the three largest producers are Australia and Canada, both of which have stable governments and represent reliable sources of supply.
- Third, once reactors are built, it is very cost effective to keep them running at high capacity and for utilities to address demand fluctuations by cutting back on usage of fossil fuels.
- Fourth, nuclear plants tend to last a long time and many existing plants have become more efficient over time, reducing their demand for uranium.

Disadvantages

- There are a number of disadvantages to the nuclear-power
- option. These include not only the obvious safety questions but also some economic and supply-related questions that are currently being debated by those for and opposed to renewal of outdated power plants or an expansion of the sector. In terms of safety, two issues are regularly debated. First, the issue of nuclear waste and, second, concerns over potential terrorist attacks on nuclear power plants. The first objection may be overcome through the introduction of new types of power plants, such as the pebble-bed modular reactor.

- This type of reactor uses graphite balls flecked with tiny amounts of uranium, rather than conventional fuel rods. With the fuel encased in graphite and impermeable silicon carbide, the theory is that the waste should be relatively easy to dispose of. The terrorism fears are less easily addressed and may ultimately stall the construction of new plants in countries such as the U.S., where these worries are greatest.
- Among economic concerns is the question of construction costs. Although the cost of energy produced by existing nuclear plants is competitive, the upfront capital costs of constructing new plants are extremely high, calculated at $1,300-$1,500 per kilowatt- hour, or twice the amount it costs to construct a gas-fired power station.10 In addition, nuclear plant operators are subject to a government tax to help pay for the disposal of nuclear waste, pushing potential costs even higher. Given the long life of nuclear power stations, however, supporters argue that the upfront costs, at least, are justified.

Country Information

Location

- Southeast Asia
- Latitudes = 9° 58′ to 28° 29′ N
- Longitudes = 92° 10′ to 101° 10′ E

Area

- Total land area = 676,577 km² (67.7 mil ha)
- Length (north to south) = 2,090 km
- Maximum width(west to east) = 805 km

Mean Temperature range

- 25° C to 33° C (Rainy Season)
- 10° C to 25° C (Cold Season)
- 32° C to 38° C (Hot Season)
- 43° C (Maximum Temperature)

Mean Rainfall

- Minimum rainfall <800 mm
- Maximum rainfall = 5,000 mm

Demography

Population = 58 million

Pop: density = 87 per km²

Energy Resources

1	Crude Oil (Offshore & Onshore)	2100 Million Stock Tank Bbl (Proved as at 1-4-2012)
2	Natural Gas (Offshore & Onshore)	25 TCF (Proved as at 1-4-2012)
3	Oil Shale (65 Sq. Miles)	720 to 3300 Million Barrel (Gross Estimated)
4	Coal (Sub-Bituminous and Lignite)	711 Million Metric Tons (Gross Estimated)
5	Hydro	34,765 of 108,000 MW in 209 locations (Gross Estimated)
6	Biomass, Biogas and Bio-fuel	About 52.5% of total land area covered with forest, Manufactured Digesters in rural area.
7	Wind	365.1 TWH per year New Energy and Industrial Development Organization (**NEDO**)
8	Solar Power	51973.8 TWH per year by (**NEDO**)
9	Geothermal	93 Locations, (26.7°C to 65°C) in 43 locations, Estimated max. 200°C in underground.
10	Others	Tide, Wave etc.

Today: Production, Supply and Consumption of Crude Oil and Natural Gas(Onshore and Offshore)

Daily Average Oil & Gas Production, Gas Export and Gas Domestic Use (June, 2012)

Daily Produciton	Oil (bopd)	Gas (mmcfd)	Export Gas (mmcfd)	Domestic Gas (mmcfd)
Offshore (Yatana)		885	684	187
Offshore (Yetagun)	10600	465	465	
Onshore	7500	70		70
Total	**18100**	**1420**	**1149**	**257**

Domestic Demand & Supply in Year 2011

CRUDE OIL (BBL/D)

DEMAND	SUPPLY	RATIO
60,000	20,000	33%

GAS (MMCFD)

DEMAND	SUPPLY	RATIO
590	240	41%

Domestic Gas Supply Projects on 2013 *(unit in mmcfd)*

Project	Demand	Supply	Supply Ratio (%)	Remark
Onshore+Offshore	590	240	41	Present
Zawtika Project	73	60		2013
Shwe Project	130	100		2013
Total	**793**	**400**	**51**	2013

Proved Reserve, Recoverable Volume
Produced Volume and Future Recoverable Volume

(As at April 2012)

Onshore	Proved Reserve	Recoverable Volume	Cumulative Production	Future Recoverable Volume
Crude Oil (MMBL)	2100	735	603	132.241
Natural Gas (TCF)	2.5	2.0	1.52	0.5

Offshore				
Crude (MMBL)	100	40	3.91	36.09
Natural Gas (TCF)	20	16	4.23	11.77

Greenhouse Gas Emission Control

Increasing Natural Gas Utilization

To reduce the CO_2 emission by increasing natural gas utilization in industrial sector, transportation and power generation. Gasoline to CNG Conversion was started in 1986. In year 2011, country wise NGV vehicles amount is reached up to 27,472 Nos along with 46 filling stations.

Increasing PAS

To protect the permanent forest area by reducing deforestation rate and increasing protected area system(PAS).(PAS area was 10275.52 sq mile in 2008.

Enhancement of carbon stock (Re- afforestation)

Area of forestation (1981 – 2010)

Plantation type	Area (ha)	% of total area
Commercial	1,113,120	53.7
Village supply	444,621	21.5
Watershed	334,584	16.2
Industrial	179,121	8.7
Total	2,071,446	100

Source: Forest Department, 2010

Biomass Gasification (50 m^3 fixed dome type biogas plant)

State/Division	No. of biogas plant
Mandalay	98
Magwe	8
Sagaing	20
Shan (N)	1
Total	127

Rice Husk Gasifier Used for Water Pumping & Electrification

Sawdust

+

Rice Husk
high calorific value (3410 kcal/kg)

=

Estimated paddy production ('000 ton/year)	Estimated Husk volume ('000 ton/year)	Rice husk for power plant ('000 ton/year)
1,637	307	32
8,002	1,600	320
9,539	**1,907**	**352**
12,424	2,485	-
21,963	**4,392**	**352**

Small scale applications between 10~200 KW usually use a rice husk gasifier coupled with modified internal combustion engine that drives a generator.

Today - Bio-ethanol Production

Name of plant	Gallon/day	Status
Ethanol Distillery No.2 Sugar mill (MSE)	**500**	**Operating**
Kantbalu Distillery (MEC)	**3000**	**Operating**
Taungsinaye Distillery (MEC)	**3000**	**Operating**
Mattaya Distillary	**15,000**	**Operating**
MaungKone	**37,500**	**Operating**
Pyinhtaunglay	**45,000**	**Operating**

Generating Units of Hydropower Generation Enterprise

Dapein (1)
240
2011

Thapanzeik
30 MW
2002

Sedawgyi
25 MW
1989

Kinda
56 MW
1985

MoneChaung
75 MW
2004

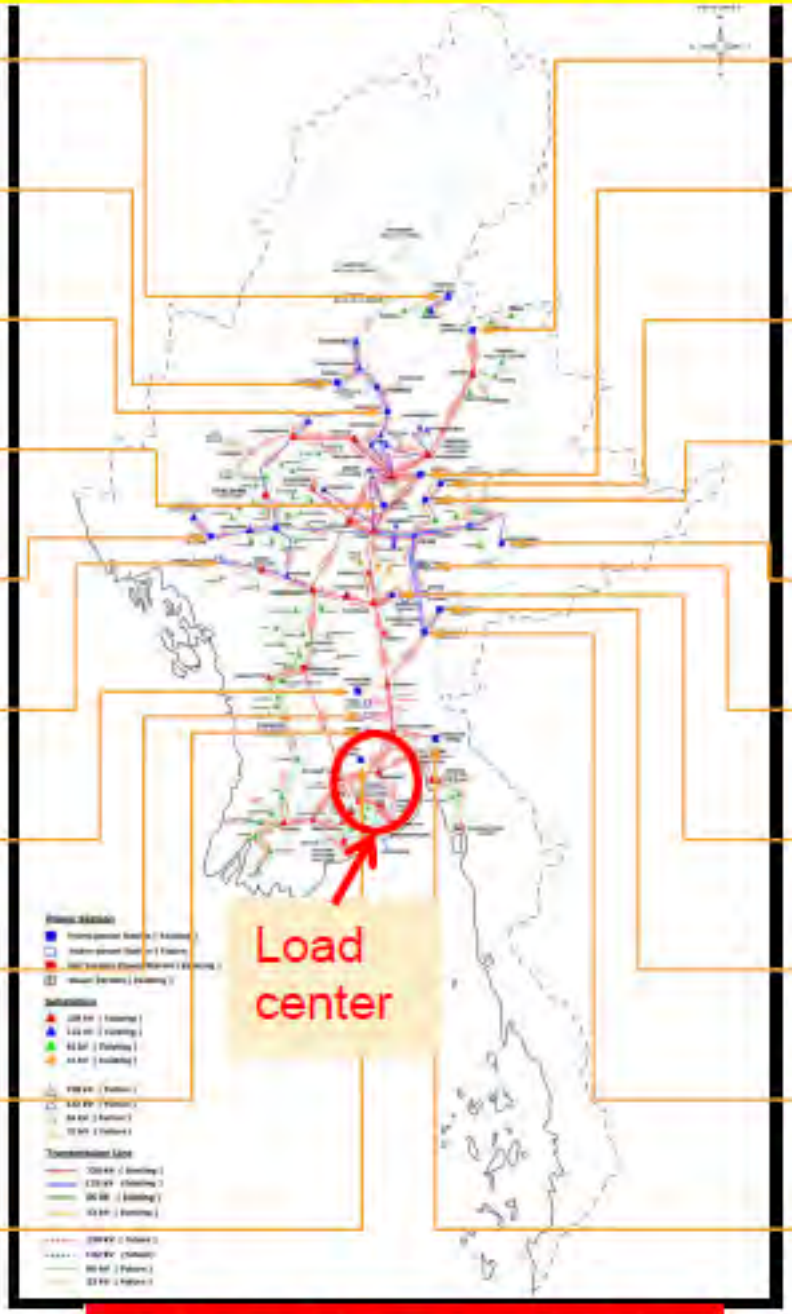
Kyeeon Kyeewa
74 MW
2012

Kabaung
30 MW
2008

Kun Chaung
60 MW
2012

Yenwe
25 MW
2007

Zaungtu
20 MW
2000

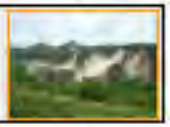


Shweli (1)
600 MW
2009

Yeywa
790 MW
2010

Zawgyi (2)
12 MW
1998

Zawgyi (1)
18 MW
1995



Kengtawng
54 MW
2009

Tigyit
120 MW
2005

Paunglaung
280 MW
2004

Baluchaung (1)
28 MW
1992

Baluchaung (2)
168 MW
1960/1974

Shwegyin
75 MW
2011

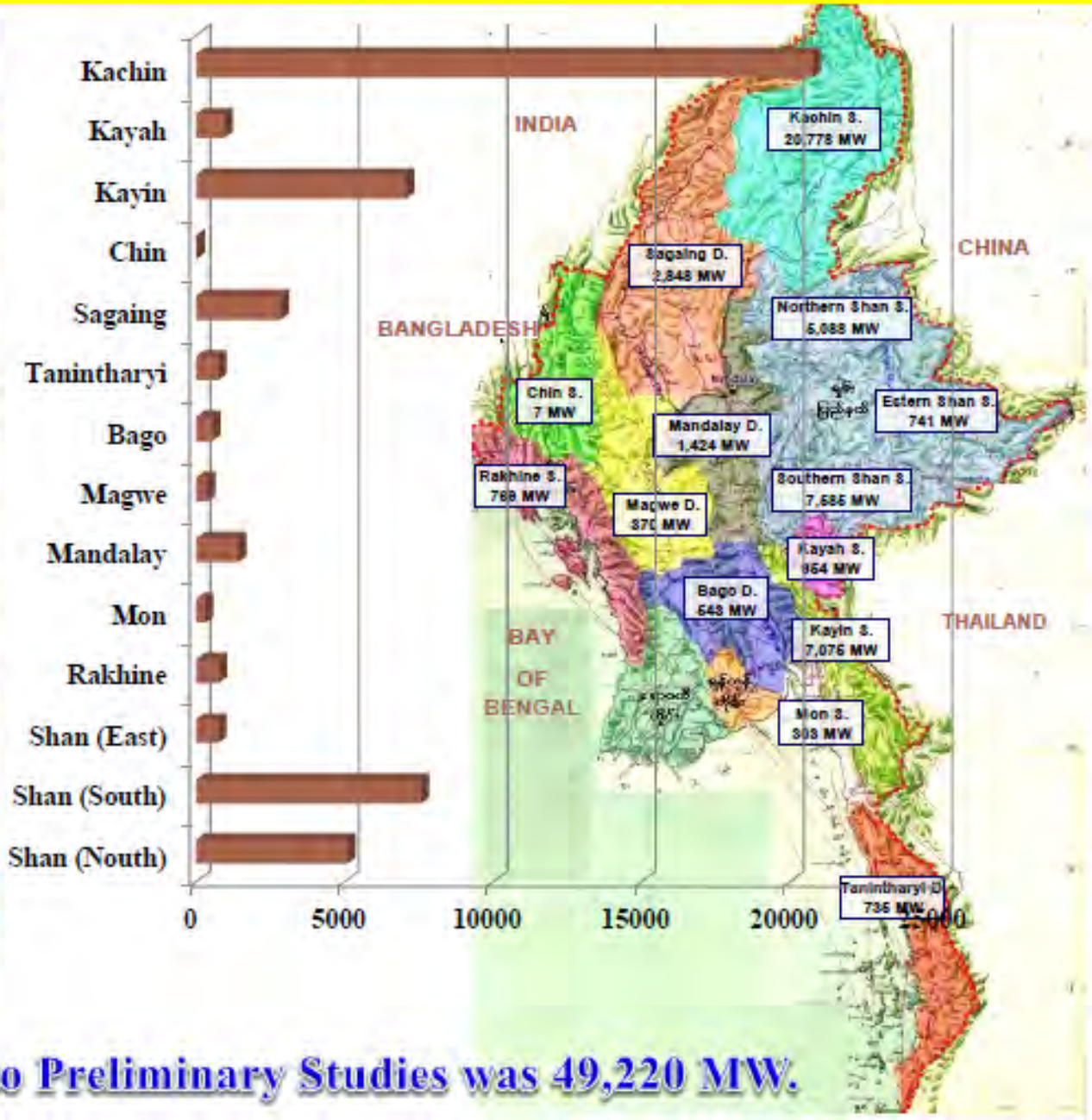
Total Installed Capacity = 2780 MW

Hydropower Stations and a Coal-fired Thermal Station

Sr. No	Stations	Installed Capacity (MW)	Annual Energy Generation (GWh)	Remarks
1	Baluchaung-2	168	1190	1960/1974
2	Kinda	56	165	1985
3	Sedawgyi	25	134	1989
4	Baluchaung - 1	28	200	1992
5	Zawgyi -1	18	35	1995
6	Zawgyi -2	12	30	1998
7	Zaungtu	20	76	2000
8	Thapanseik	30	117.2	2002
9	Mone	75	330	2004
10	Paunglaung	280	911	2005
11	Tigyit (Coal-fired Thermal)	120	600	2005
12	Yenwe	25	123	2007
13	Kabaung	30	120	2008
14	Keng Tawng	54	377.6	2008
15	Shweli -1	600	4,022	2008
16	Yeywa	790	3,550	2010
17	Dapein - 1	240	1065	2011
18	Shwegyin	75	262	2011
19	Kyee On Kyee Wa	74	370	2012
20	Kun	60	190	2012
	Total	2,780	13,867.8	

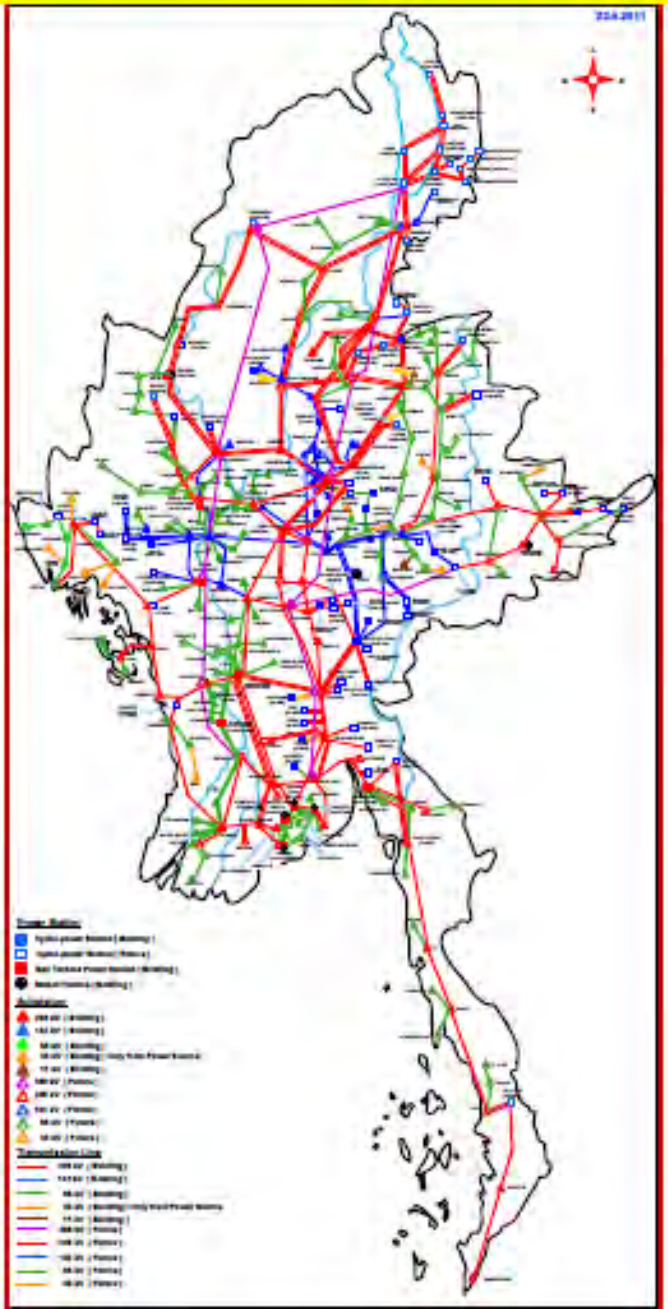
REGIONAL HYDROPOWER POTENTIALS OF MYANMAR

State / Division	Number of Sites	Potential (MW)
Kachin	51	20,778
Kayah	8	954
Kayin	22	7,075
Chin	12	7
Sagaing	30	2,848
Tanintharyi	23	735
Bago	15	543
Magwe	13	370
Mandalay	14	1,424
Mon	10	303
Rakhine	14	769
Shan (East)	24	741
Shan (South)	27	7,585
Shan (North)	40	5,088
Total	**303**	**49,220**



•According to Preliminary Studies was 49,220 MW.

NATIONAL GRID SYSTEM FOR FUTURE PLAN IN MYANMAR



Power Station

- Hydro-power Station (Existing)
- Hydro-power Station (Future)
- Gas Turbine Power Station (Existing)
- Steam Turbine (Existing)

Substation

- 230 kV (Existing)
- 132 kV (Existing)
- 66 kV (Existing)
- 33 kV (Existing)
- 500 kV (Future)
- 230 kV (Future)
- 132 kV (Future)
- 66 kV (Future)
- 33 kV (Future)

Transmission Line

- 500 kV (Future)
- 230 kV (Existing)
- 230 kV (Future)
- 132 kV (Existing)
- 132 kV (Future)
- 66 kV (Existing)
- 66 kV (Future)
- 33 kV (Existing)
- 33 kV (Future)

The Electric Power Projects to be Completed in Third Five Years Short Term Plan (from 2011-2012 to 2015-2016)

1.	Phyu Chaung	40	MW	Bago Region
2.	Baluchaung (3)	52	MW	Kayah State
3.	Upper Paunglaung	140	MW	Mandalay Region
4.	Upper Baluchaung	30.4	MW	Southern Shan State
5.	Thaukyegat(2)	120	MW	Bago Region
6.	Chipwinge	99	MW	Kachin State
7.	Nancho	40	MW	Mandalay Region
	Total	**521.4**	**MW**	

Yearly Growth Installed Capacity of Electricity

Sr.No	Year	Total Number Of Plants	Installed Capacity (MW)	Annual Growth(MW)	Remark
1	2009	29	2255.90		
2	2010	32	3304.65	1048.75	
3	2011	33	3380.90	76.25	
4	2012	34	3494.90	114	
5	2013	39	3945.90	451	
6	2014	42	4004.90	59	
7	2015	49	5327.30	1322.4	
8	2016	52	7267.30	1940	
9	2017	59	15692.30	8425	
10	2018	60	21692.30	6000	
11	2025	64	29392.30	7700	
12	2026	74	34923.80	5531.5	

Small Hydropower Station

Sr.No	State / Division	Number of Plant	Number of Machine	Kilowatt (kW)
1	Kachin	3	8	6420
2	Kayah	1	2	118
3	Kayin	1	2	62
4	Chin	8	16	2953
5	Sagaing	2	3	1310
6	Tanintharyi	2	6	342
7	Bago (East)	1	2	2000
8	Mandalay	2	4	4450
9	Mon	1	3	192
10	Shan (South)	2	4	1425
11	Shan (North)	6	12	9150
12	Shan (East)	3	8	4680
	Total	**32**	**70**	**33102**

Rural Electrification (Villages)

Sr.No	State / Division	Total Villages	2012	2013	2014	2015	2016
1	Kachin	2579	1	5	10	17	25
2	Kayah	511	50	58	66	76	87
3	Kayin	2063	38	44	50	58	66
4	Chin	1352	-	-	-	-	-
5	Mon	1200	123	141	163	187	215
6	Rakhaing	3860	-	-	-	-	-
7	Shan (North)	5893	49	56	65	75	86
8	Shan (South)	5190	85	98	112	129	149
9	Shan ((East)	3501	-	-	-	-	-
10	Mandalay	4772	480	552	635	730	840
11	Nay Pyi Taw	808	107	123	142	163	187
12	Bago (East)	2907	250	288	331	380	437
13	Bago (West)	3623	276	317	365	420	483
14	Magwe	4795	300	345	397	456	525
15	Sagaing	5997	578	665	764	879	1011
16	Tanintharyi	1230	-	-	-	-	-
17	Ayeyawaddy	11937	359	413	475	546	628
18	Yangon	2128	456	512	568	624	680
	Total	**64346**	**3152**	**3617**	**4143**	**4740**	**5419**

Rural Electrification by Ministry of Industry

- **Solar Power Home System** **86,480 Watts** **- 149 Villages**
- **By Using Generating Sets with Diesel Engines (31) Nos** **- 37 Villages**

  10KVA (2) Nos, 20KVA (5) Nos,30KVA (15) Nos

  50KVA (5) Nos, 100KVA (3) Nos,300KVA (1) Nos
- **Hydro Turbine Power System** **(38)Sets** **- 43 villages**

  75 kW (3) Sets,30kW (3) Sets,5kW(32) Sets
- **LED Lamp Factory** **- Annual production rate is 10 millions**

Renewable Energy Target in Year 2020 -2025

- To enhance Fuel substitution with Biofuel at least 8% by 2020 based on 2005 level in Transport sector.
- To achieve a collective target of 15~18% of Renewable Energy in the total power installed by 2020

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THANK YOU VERY MUCH