

INDIA'S SOLAR POWER SCENARIO IN GLOBAL CONTEXT



SATISH KUMAR JAIN

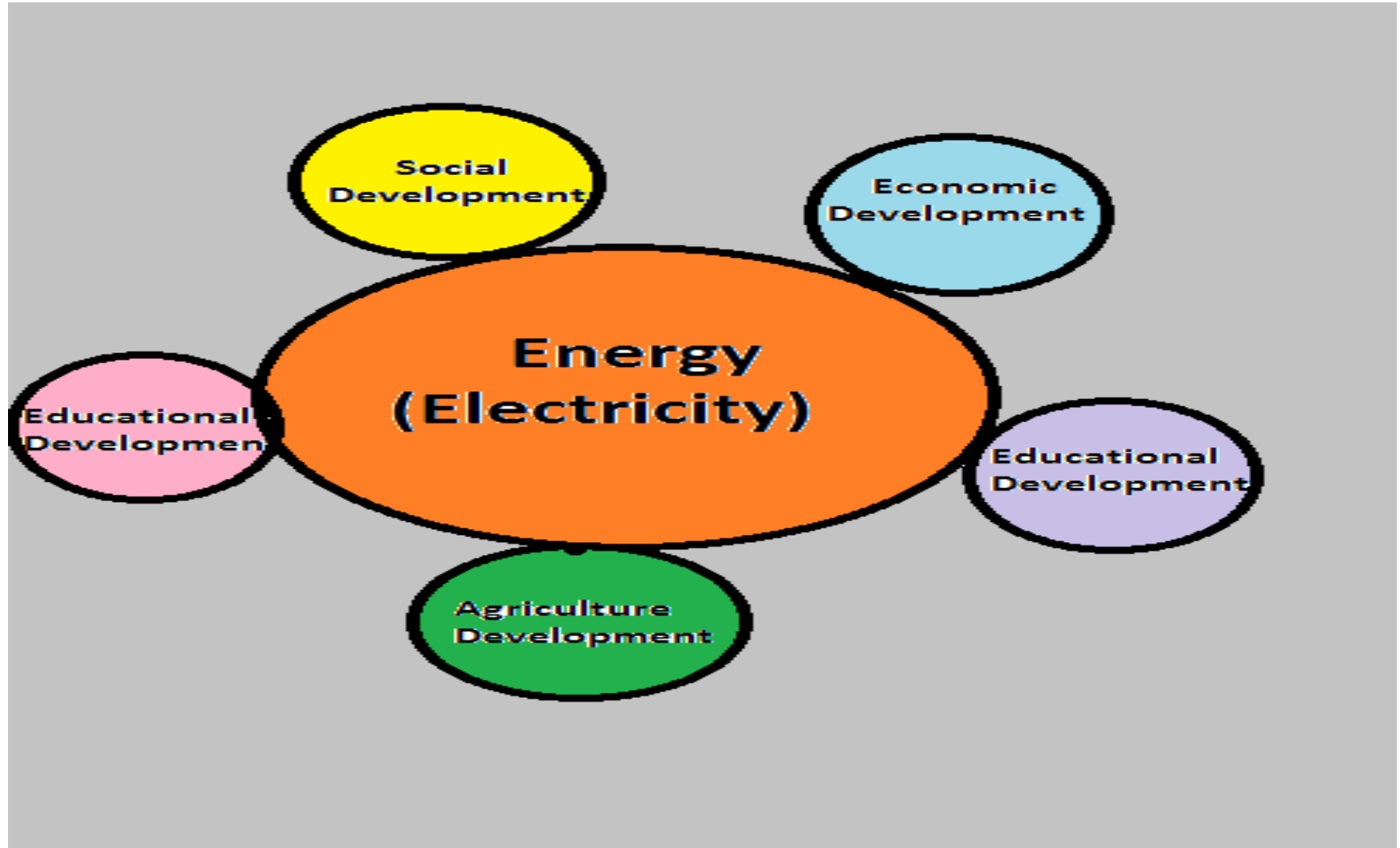
Dept. of Civil Engg.

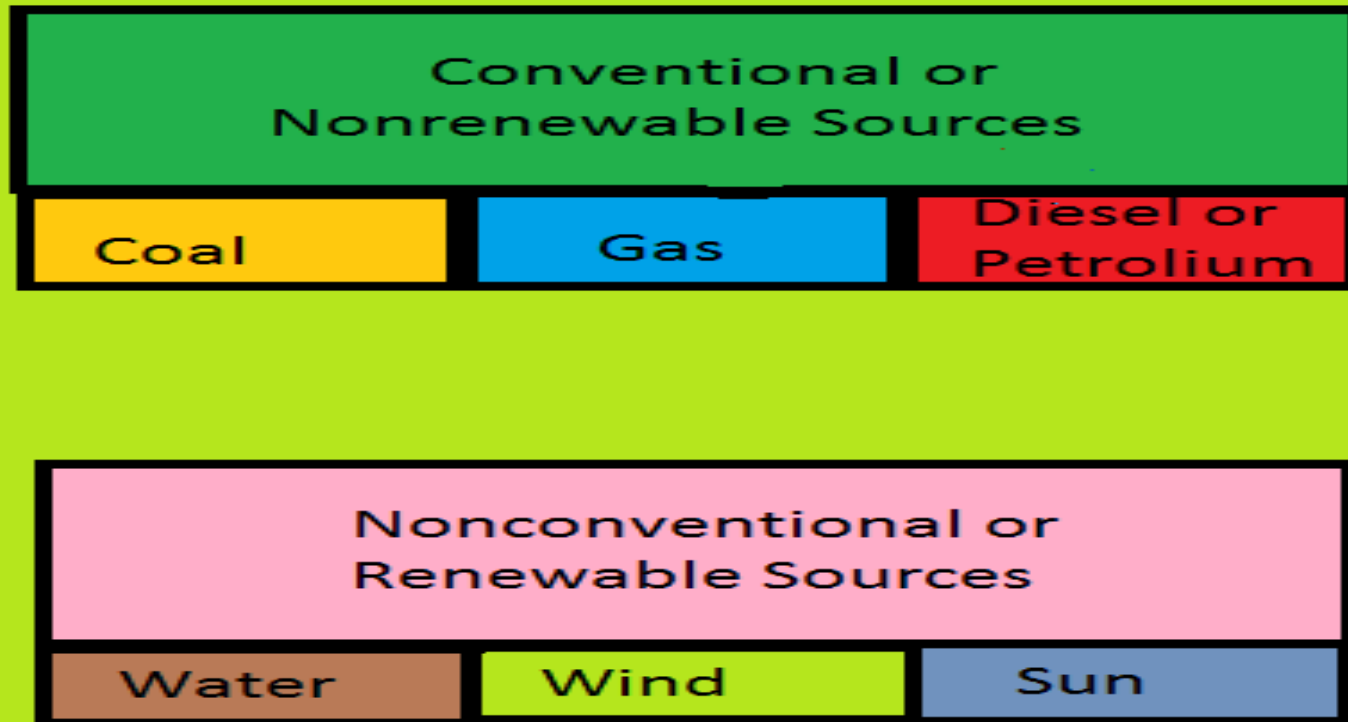
University Institute of Technology

Rajiv Gandhi Proudyogiki Vishwavidyalaya,

Bhopal (M.P.), India

Satish Kumar Jain/UIT,RGPV, Bhopal(M.P.), India

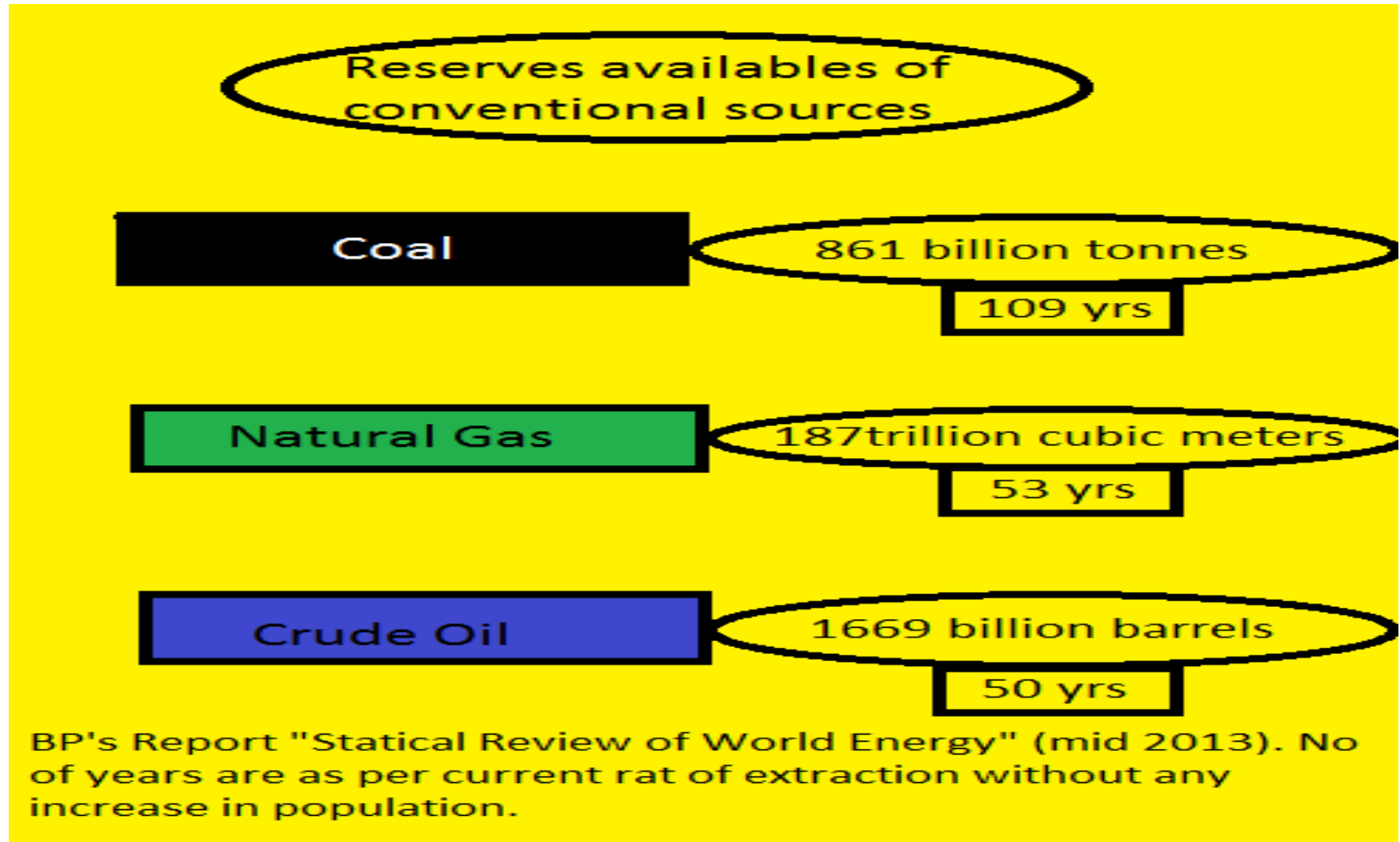


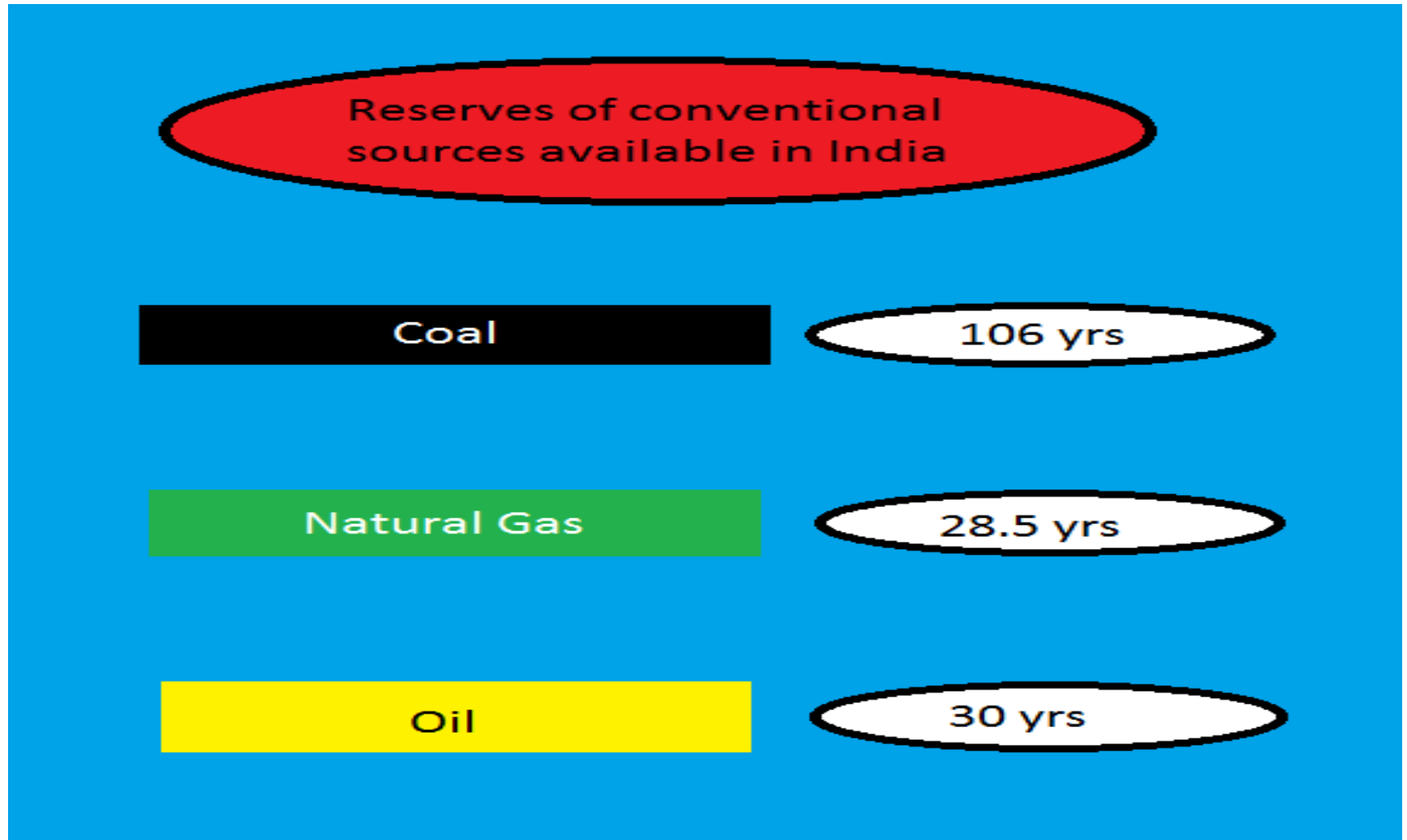


- **Reason for electricity Crisis**

1. Growth of world's population (In 2012- 7 billion- every year increase of 75 million i.e. 1.1%- India is second largest populated nation in the world with 1.27 billion-17.31% of world's population and growth rate is 1.58% per year)
2. Overexploitation of conventional source
3. Technological innovation
4. Urbanization
5. Industrialization

6. As per 2010-per capita consumption of electricity in America was 13246 KWh while in India it was 684 KWh.
7. Present per capita consumption in India is 917.18KWh.
8. Current rate of GDP of India is more than 5.6% which is projected to be 6.4% in 2014-15. While China's projected GDP for 2014-15 is 7.5%.
9. All sectors require increased demand of energy in the form of electricity for sustainable development.
10. By 2012 , net shortage of electricity was 20 GW in India.





- **Percentage deficit between demand of electricity in India**

June 2013--- 4.1%

June 2014--- 3.7%

At 11th five year plan when total installed capacity– 150323MW

As on 2010, India was third largest in coal production with 0.6 billion tonne while China was the largest with 3.25 billion tonnes

2004-2013 –Coal consumption increased –75.50%

2005-2013—percapita power consumption increased—45.26%

2004-2011 –average cost of power supply increased –52.11%

Need Of Sola Energy

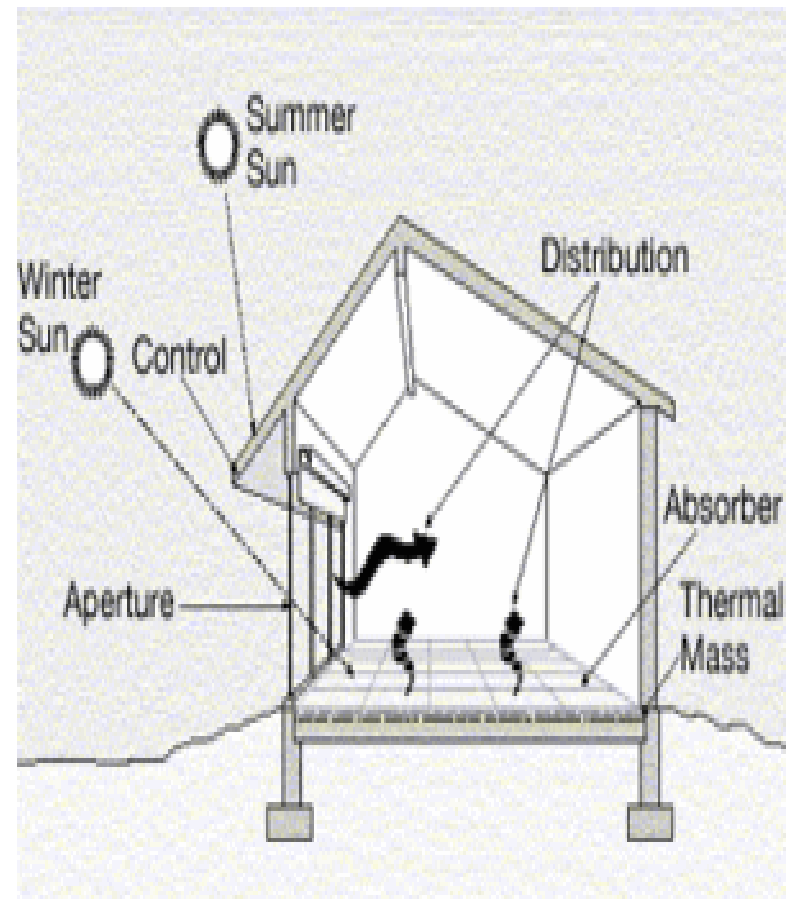
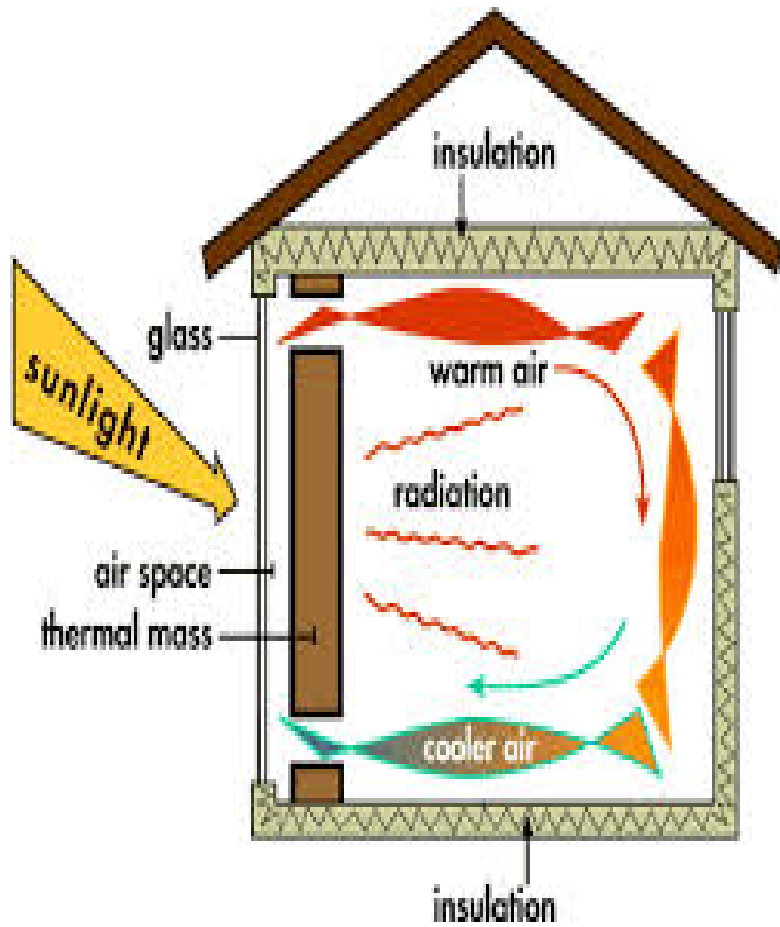
- Till today 65-70 % of energy is derived from firing fossil fuels on the cost of great damage to environment
- International Finance Corporation has reported that \$37 billion is spent every year on fossil fuels to power the developing world. Despite of huge electricity generation globally, more than 2 billion people in the world are still beyond the reach of electricity and most of the industries perform less than their capacity due to that they do not get sufficient quantity of coal.
- In India 300 million people have no access to electricity and many more suffer from frequent power cut due to shortage of generated electricity.
- CO₂ and other green house gases (GHG) emissions from fossil fuels have created many serious problems such as global warming, big hole in ozone layer and millions of early deaths due to atmospheric pollution.
- A world Health Organization report of 2008 says that more than 1000000 deaths including 24000 deaths in U.S. per year are caused due to pollution by coal industries worldwide.

- According to a study by Friedman and Wire (2013), up to 115000 people die each year in India due to pollution caused by coal-fired plants and it costs \$4.6 billion to the country. Now damage to environment is at alarming stage. If energy generation from fossil fuels is continued without caring environment then very soon people will not be able to breathe fresh air. Also ground water is contaminated, landscape is altered and natural environment value is reduced in areas of coal mines. River water is polluted by fly ash produced by coal fired boilers.
- Uranium, Thorium and other radioactive isotopes are found in small quantity with coal which causes radioactive contamination in environment. A study known as Externalities of Energy, conducted between 1995-2005 found that the cost of electricity production by coal will be double in terms of damage to environment and human health due to various harmful gases and toxic matters produced. Coal fired power plants produces double the green house gases per kilowatt compared to the generation of GHG by natural gas.

- Thus rapid deterioration of environment, fast diminishing of conventional resources of energy and regular increasing costs of energy production through conventional resources are those issues which compel to search and adopt alternate resources of energy.
- In search of new resources of energy, some renewable energy sources have been found satisfactory. These are wind energy, hydro energy, solar energy, geothermal energy etc. which do not harm to environment to any degree hence also known as clean energy resources. These resources replenishes themselves hence can be harnessed unlimited.
- Sun is the only provider of abundant energy directly in the form of solar radiation and indirectly as wind, hydro and geothermal energy. Only 60 % of total energy emitted by sun reaches on the earth. If 0.1 % of this energy is captured and converted to electricity with an efficiency of 10 % then the produced electricity will be four times the global energy installed capacity of 5000 GW .
- Solar energy in the form of sun heat is captured on earth through various means and is used for different applications such as electricity generation, home and street lighting, water heating, cooking food and passive building heating and cooling. Due to easy capturing of solar energy, global demand has increased 30% per annum in the last 15 years. Increasing cost of petroleum products, decreasing cost of solar power products and awareness about environment are some of the reasons for this high growth rate of solar energy demand.

ENERGY SAVING THROUGH SOLAR ENERGY

- Today's saving of energy is tomorrow's production. According to World Business Council for Sustainable Development (WBCSD), 40% of world's energy is consumed by buildings and if construction is included then consumption rises to 50% . Germany is at top in energy efficiency while US with world's largest economy is least energy efficient. India and China are more energy efficient from US.
- Residential buildings in China consume less energy per square foot than any other country. Indian households consume 21.79 % of total power generated as at end of first year of 12th five year plan. This consumption includes air conditioning, water heating, lighting and various other small consumptions such as kitchen appliances and water pumping etc.
- Consumption of air conditioning and lighting are major part of household power consumption and may be greatly reduced by passive solar design of buildings.



GLOBAL INITIATIVES

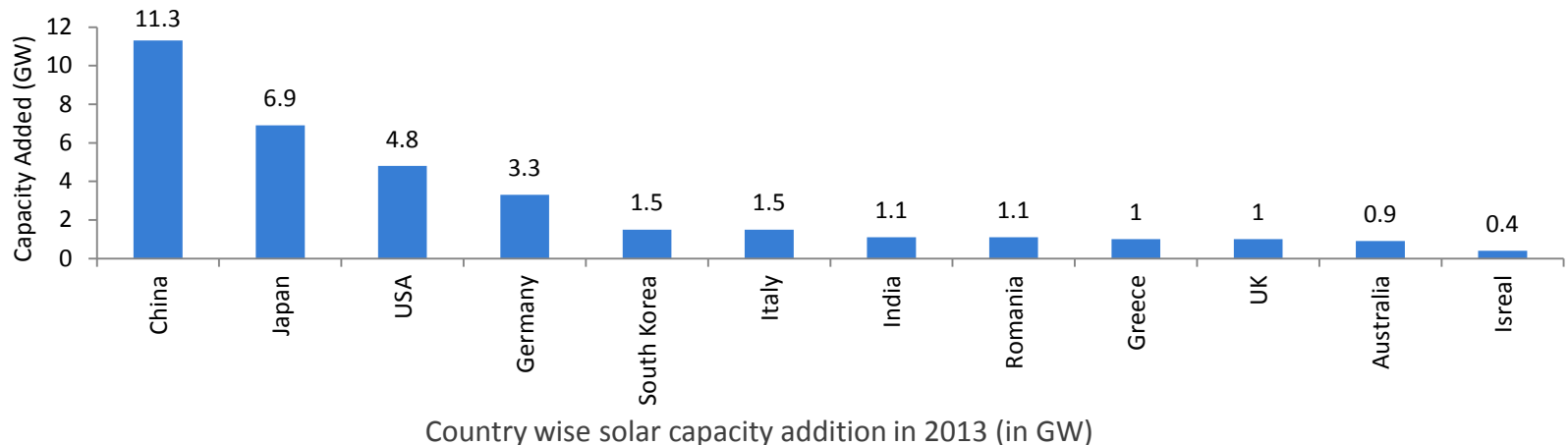
- United States pioneered in research and installations of solar PV and concentrated solar power (CSP).
- The very first solar power plant of world with 354 MW capacity was installed in California. Another Ivanpah Solar Electric Generating System solar thermal power plant with gross capacity 377 MW was also installed in California. 'Ivanpah'. **The world's largest 280 MW Salona Generating Station solar power plant near Gila Bend, Arizona with molten salt thermal energy storage was completed in 2013.** In 2002-2007, the growth accelerated to average 20 % each year in PV production and after 2007 it raised to 63.6% which is almost double to the growth of wind power. In 2013 a new annual record was setup with 38000 MW capacity installation of PV. Presently the total PV generating capacity is 140000 MW. In 2012-13 China has emerged world's leader in installation of PV. In between 2010-12, china's PV installed capacity grew to nine times to 7000 MW and in alone 2013, 11300 MW new PV capacity was added which is largest addition in world by any country in one year. **Now China is second in the world with 18300 MW installed solar capacity after Germany with 36000 MW.**

- In May 2014, China announced a PV target of 70000 MW by . 2017. China also aimed for 8000 MW rooftop installations in 2014. China is stepping fast in PV solar power to lead the world as it is leading in wind energy. Japan was the second to install PV in 2013 with addition of 6900 MW with total in the country to 1360 MW in operation.
- In beginning of 2014, Japan's largest 82 MW park was opened in Oita Prefecture. Japan has set a target of 28000 MW solar power installed capacity by 2020.
- In Asia, South Korea added nearly 1500 MW PV capacity in 2013 and Thailand expanded his Lopbury Solar Farm to 84 MW. In 2013, Asia left behind Europe in one year PV installations.
- Europe installation rate reduces to one third while Germany reduces to half in 2013. With 17600 MW installed capacity, Italy the third largest in the world has also reduces the PV installation in last year while PV rates fallen to 56-70 % in last five years in the country.

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- United States, increased 65% solar power in 2013 and added 4800 MW to make total of 12000 MW PV installed capacity. Out of this 4800 MW, 50% was installed in California. Two big solar projects in California of total 580 MW capacity are to be completed in 2015 which will supply enough electricity to 25000 houses.
- Canada added 440 MW in 2013 to total of 1200 MW. Mexico almost doubled its PV capacity to 100 MW. Brazil is also doubling its PV capacity to 70 MW by end of 2014. In Australia, with 3300 MW capacity, every seventh home generates electricity from rooftop solar system and in south Australia every fourth home is lightened from rooftop solar system. Israel grew with 75% to install 420 MW solar power capacity in 2013 and is largest to install maximum number of PV solar system in Middle East of world. Saudi Arabia has set a target to install 10000MW capacity PV by 2032.

- Clean solar energy demand has risen extremely in USA as solar market grew with 76 % in 2012 and 16 million solar panels were installed across the country. In last decade, Europe was leading the solar market but at present Asia has taken baton from Europe, particularly China and Japan installed PV capacity over 56% of globally installed PV capacity to 36.9 GW in 2013. This boom in solar PV is due to increased concern about climate change, advancement in technologies, falling prices of solar products and commitment of nations and it seems that in near future, solar energy alone will take place of fossil fuel energy.



Over view of global solar Power

Country	Average solar irradiation	Solar target	Capacity installed in 2013	Installed capacity as on December 2013
India	5.1	20 GW on grid and 2 GW off grid by 2022	1.1 GW	2.3 GW
China	3.61	50 GW by 2020	11.3 GW	18.3 GW
Japan	3.63	33 GW by 2020	6.9 GW	13.6 GW
USA	4.68	Different RPS for states	4.8 GW	12 GW
Germany	2.9	52 GW by 2020	3.3 GW	35.5 GW
Italy	3.81	23 GW by 2020	1.5 GW	17.6 GW
Australia	4.16	20% by 2020	0.9 GW	33 GW

WORLD'S LARGE EXISTING SOLAR PROJECTS

- Some of the existing world's large solar power plants are Charanka Solar Park (India, 590 MWp), Topaz Solar Farm (USA, 500 MWp), Desert Sunlight Solar Farm (USA, 500 MWp), LongyangxiaDam Solar Park (China, 320 MWp), Agua Caliente Solar Project (USA, 290 MWp), California Valley Solar Ranch (USA, 250 MWp), Huanghe Hydropower Golmud Solar Park (China, 200 MWp), Mount Single Solar (USA, 206 MWp), Solarpark Meuro (Germany, 166 MWp), Welspun Energy (India, 130 MWp) etc.

WORLD'S LARGE SOLAR PROJECTS UNDER PLANNING OR CONSTRUCTION

- Some of the world's large solar power projects under planning and construction are Project Helios (Greece, 10000 MWp, by 2020), West Lands Solar Park (USA, 2700 MWp, by 2015), Mohammed Bin Rashid Al Maktoum Solar Park (UAE, 1000 MWp, by 2030), Quaid E Azam Solar Park (Pakistan, 1000 MWp, by 2016), McCoy Solar Energy Project (USA, 750 MWp, by 2016), Ultra Mega Solar Park (India, 700 MWp, by 2018), Calzadilla de los Barros (Spain, 400 MWp, by 2016), Ukujima Mega Solar (Japan, 400 MWp, by 2015), Kathu Solar Park (South Africa, 100 MWp, by 2014) etc

SCOPE OF SOLAR ENERGY IN INDIA

- Because of India's location between Tropic of Cancer and the Equator, mean annual temperature prevails with range from 25°C -27.5°C and high solar irradiation of 5.1, which means that huge solar potential, may be harnessed in the country.
- **India comes in the sunny region of the world where solar radiations are received 4-7 KWh per m² per day with 260-300 clear sunny days in year. Hence solar thermal as well as solar PV technologies can be used for power generation.**
- Remote villages which are not connected to grid power can be electrified and other demands for power and heating or cooling in both rural and urban areas can be meet by low temperature applications such as solar water heater, solar cooker and solar lighting system etc. It is expected that solar energy with solar PV will contribute a major part of countries' energy.
- It has been estimated that on 1% land of India i.e. 32000 km², 1.33 million MW capacity plants can be installed while more than 8% of total area of earth is unproductive barren. There are large areas which are useless from agriculture or any other point of view can be used suitably for solar power generation.

- Solar power generation has unlimited opportunities that with best use of land, whole demand of country may be fulfilled through solar power generation without use of any fossil fuels. Solar power projects face the problem of land acquisition in India. This problem has been taken seriously by some states and resolving it by some alternative through innovations such as irrigation canal top may be used for installation of solar panels. This will reduce water evaporation and no separate land will be required. Such first experiment has been started in Gujarat State on 19000 km long net-work of Narmada Canal.
- Canal Solar Power Project in Kadi, Gujarat



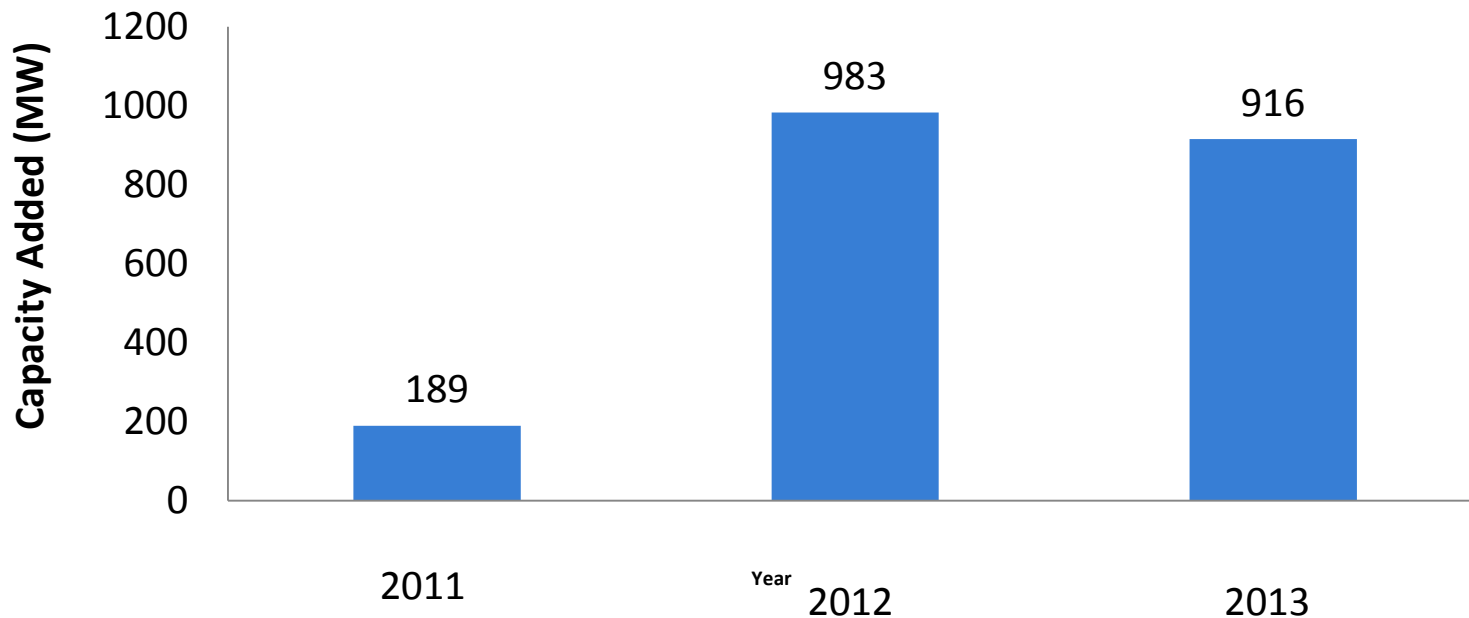
Canal Solar Power Project in Kadi, Gujarat

- New researches and healthy competition in solar field brought down the rates close to half in last two years. The price of silicon PV cells dropped \$76.67 in 1977 to \$0.36 in 2014. This rapid reduction in price may lead to enormous development in future.

INDIA'S INITIATIVES

- Jawaharlal Nehru National Solar Mission (JNNSM) of Government of India is one great step in journey of solar energy with target of 20 GW of solar by 2022. India was very first country to set up a separate and independent department as Ministry of Non-conventional Energy Resources in the world in early 1980s. Presently this department is known as Ministry of New and Renewable Energy (MNRE).
- Total energy installed capacity of India at the end of 6th five year plan (1987) was 42584.72 MW, out of which installed capacity through Renewable Energy Resources (RES) was 0.00 MW. At the end June 2014 of 12th five year plan the total energy installed reached to 249488.32MW out of which installed capacity through RES is 31692.14 MW. In 2007 the contribution of solar energy was less than 1% of total energy demand in the country.

- In December 2010, the grid connected solar power was very less to 10 MW, which rose to remarkable high 2208.36MW as on January 2014. Further additional 10000 MW installation is expected in 2017 and a total of 20000 MW by 2022. In 2013, the total PV solar capacity was nearly doubled but in single year 2013, it was 6.8% less than in 2012.
- More than half of the country's 2300 MW has been installed in western deserts Gujarat and Rajasthan. As on 31 May 2014, the contribution of all solar energy was 1.13% of total energy installed capacity of country while it is 8% of total renewable energy installed capacity.
- In June 2014, Prime Minister, Narendra Modi emphasized on solar energy and his administration announced a target of 34000 MW PV installations from at present 2300 MW by 2022 through expansion of National Solar Mission in order to generate 3% of total electricity.



Solar capacity addition in India from 2011 to 2013

Installation of solar energy in last one year

	As on 31.05.2013 MW	As on 31.05.2014 MW	% Growth
Grid interactive power capacity	1759.44	2647.00	50.44
Off-power capacity	124.67	174.35	39.84
Total	1884.11	2821.35	49.74
Solar water heater collector areas (million Sqm)	6.98	8.15	16.76

- The Jawaharlal Nehru National Solar Mission is ambitious major initiative of Indian and state governments for promoting solar energy.
- This mission is not only promoting solar energy but also contributing in war against challenges of climate change.
- Under this mission; bank loan is financed at subsidized rate of not exceeding 5% and exemption of excise duty is given on transmission equipments for installation of solar power plant.
- MNRE offers 70% subsidy on cost of installation of solar PV solar power plant in North-East region and 30% in other regions of the country.
- As the incentives under this mission, government made many provision in budget such as allocated a fund of US \$ 220 million in 2010-11, reduction in custom duty by 5% and exemption in excise duty on solar PV panels for private companies and coal tax of US\$ 1 per metric tonne was imposed on domestic and imported coal used for power generation. **One incentive is offered from Gujarat State Government that state government purchase power at Rs. 12.00 per KWh and Rs. 9.00 per KWh from solar PV and solar thermal plants for first 12 years and then rates will be Rs. 3.00 per KWh for both Solar PV and solar thermal plants for next 12 years.**

- Solar parks are being developed for utility scale solar power generation plants in which infrastructures will be provided by state government. First such solar park is being developed as Charanka Solar Park in Patan district of Gujrat State. These solar parks will be great motivation for private investors.
- Energy Globe World Award given for sustainability of financial help through loan for solar home systems was won by Indian Solar Loan Programme. In last three years, 16000 solar home systems were financed mostly in rural areas of south India through 2000 bank branches.
- The installation of world's largest ultra mega solar power plant of 700 MW capacity on 1300 hectares will soon start at Gudh Thasil of Rewa district in Madhya Pradesh, India. The cost of this plant is estimated as Rs. 4000 crores. The cost of generated electricity will be Rs. 5.40 per unit. This projected will be completed in 4 years.

PROVISIONS FOR SOLAR ENERGY IN ANNUAL BUDGET 2014-15 OF INDIA

- Narendra Modi, Prime Minister of India has vibrated the solar sector in the country just after resuming the office in May 2014. After successful experiments in Gujrat State, he wants to extend the field of solar energy all over the country. In annual budget of Indian Government, following provisions have been made for spread of solar energy in the country.
- Rs. 500 Crore allocated for Ultra Mega solar power projects in Rajsthan, Gujrat, Tamil Nadu and Ladakh in Jammu & Kashmir.
- Rs. 400 Crore for one lack solar power driven agricultural pump sets and water pumping stations.
- Rs. 100 Crore for development of 1 MW solar parks on the banks of canals.
- Clean energy cess increased from Rs. 50pe tone of coal to Rs. 100 per tonne.
- Excise duty exempted for EVA and back sheets, tempered glass and copper wires used in PV modules.
- Ten year income tax holiday (section 80 IA) has been extended till March 2017on solar projects.

CONCLUSIONS

- Future growth of solar energy in world and particular in India is as bright as Sun. For attaining the object of providing light to all households in future and at the same time conservation of environment, development of solar energy must be kept at top priority in budget planning of nation.
- It is good initiative that Asian countries have taken large initiatives for competition with Europe in installation of solar PV in last two years.
- Narendra Modi, the Prime Minister of newly formed government in India is committed to harness full potential of solar energy in the country. However, India has remarkably progressed in generation, transmission and distribution of electricity in last five years, but demand of electricity has always been ahead to the supply hence the present growth rate of installation is not sufficient to meet the required electricity and also this is very less if compared with China and other developed countries.
- Declination of global investment in solar energy in last two years is a matter of concern, but it is hoped that soon solar markets will be geared up due to keen interest of Asia and other small countries. Subsidy has been motivation in investment and installations hence it must be continued till solar sector get full-fledged.
- There is enough scope in field of passive solar building construction. Architects and engineers may play a major role in this direction to avail potential of solar power through passive solar designing of buildings. This will help in reduction of transmission and distribution losses, theft and investments on grid network installation. Shortage problem of power supply will be greatly solved due to construction of solar homes.