Quarterly

Newsletter

(Oct-Dec 2016)

COMSATS ENERGY RESEARCH CENTER

COMSATS Institute of Information Technology, Lahore

Contents

Co-Editor: Kanwal Bilal Editor: Engr. Fawad Azeem

International Conference on Energy for Environmental and Economic Sustainability (ICEEES) 2016

COMSATS Energy Research Center, in collaboration with the Texas University, USA and UMT, Lahore organized an International Conference on Energy for Environmental and Economic Sustainability (ICEEES) 2016 held on 21-23 October, 2016 at Pearl Continental Hotel, Lahore. Dr. Qaisar Abbas Director CIIT, Lahore co-chaired the inaugural session. In his speech Dr. Qaisar introduced CIIT and Energy Research Center. He stated that state of the art energy technology, especially renewable energy is the need of the hour while energy efficiency and conservation are equally important for energy security and sustainability.

Dr. Qaisar appreciated the efforts of the conference organizers and assured of COMSAT's continued support for such activities in future as well.

A special session on Energy for Environmental and Economical Sustainability (ICEEES) 2016 on "**Least Cost Energy Mix Options for Pakistan"** was hosted by COMSATS ERC as part of the conference. Various international and national speakers presented their papers in the event. Speakers from Finland, China Turkey, ERC and the Chemical Engineering Department, CIIT, Quaid-e-Azam Solar Park, Punjab Energy Efficiency and Conservation Agency (PEECA), Pakistan Council of Renewable Energy Technologies (PCRET), Pakistan Agriculture Research Council (PARC), COMSATS Sahiwal Campus and UET Lahore presented their research articles.

Lecture on Need of New and Renewable Energy Approach: Cascading and Integrating

by

Dr. Arfeen Khan Lodhi

The COMSATS Energy Research Center, as part of its lecture series, arranged a lecture by Prof. Dr. M. Arfeen Khan Lodhi, on the "**Need of New and Renewable Energy Approach: Cascading and Integrating".** Dr. Lodhi is a Research Professor in Physics at Texas Technology University, USA.

In his lecture Dr. Lodhi presented the significance of renewable energy resources in terms of climatic changes in the world. Advanced solar energy technologies, especially the concentrating parabolic and dish type technology(s) / solar tower, their technical merits and status at global level were discussed in detail. He also highlighted the advanced fuel cells research and explained his research initiatives and projects implemented at the Texas Tech University USA. The faculty members of Chemical Engineering, Electrical Engineering and Physics Departments, along with their students attended the lecture. The lecture was followed by a lively question and answer session. The prospects for collaboration between COMSATS and Texas Tech University in undertaking joint research projects in Renewable Energies were also discussed.

Consultative Seminar on Sustainable Energy for All

A seminar on **"Sustainable Energy for All"** was arranged by Planning Commission of Pakistan in collaboration with Punjab Energy Department on, 21st November, 2016 at PC hotel Lahore. The seminar was attended by experts, engineers and managers from public sector organizations including Planning Commission, WAPDA, NTDC, Punjab Energy Department, P & D Punjab, COMSATS, UET and other universities, private sector / industry, consultants etc. The main objective of seminar was to deliberate on current energy situation and develop a viable plan for achieving energy security in Pakistan on asustainable basis. Key targets of expanding grid electricity access to the far flung areas population, promoting energy efficiency and conservation measures for all industrial machinery and electronic appliances used in Pakistan, increased power generation form renewables and enhanced share of cheap hydel power generation etc. were discussed in depth and recommendations were made by the participants. It was agreed that the action plan finalized after the seminar shall be circulated to all participants for comments before its finalization so that a consensus document is prepared. Head, ERC, along with the Principal Scientific Officer, ERC actively participated in the seminar where Mr. Khalid Saeed Head Energy Research Center chaired the Technical Session of the seminar.

Seminar on Net Metering

A seminar on net metering and its implementation in Pakistan was arranged by the Punjab Energy Efficiency and Conservation Agency (PEECA), Government of the Punjab on 25th November, 2016 at the PC Hotel Lahore. Main objective of the seminar was to create awareness regarding use of Net Metering System and discuss the relevant procedures and regulations. The seminar was attended by a large number of energy experts, Government officials including Punjab Power Development Board (PPDB), Alternative Energy Development Board (AEDB), Pakistan Council of Renewable energy Technologies (PCRET), Energy Department Punjab, LESCO, MEPCO, IESCO, UET Lahore, Pakistan Engineering Council, private entrepreneurs, COMSATS Energy Research Center and UET Lahore.

Mr. Khalid Saeed, Head ERC delivered the key note speech on **Road to Energy Conservation and Efficiency.** He highlighted the current profile of the power sector of Pakistan and the issues faced by it. He emphasized on the promotion of Renewable Energy sources for power generation along with the need for seriously implementing Energy Efficiency and Conservation in the country. He shared the valuable achievements made by European countries while practicing energy conservation and efficiency. Challenges of Pakistan power sector and available solutions for the sustainable development were also discussed.

DICE Water and Energy Exhibition

ERC and the Electrical Engineering Department, CIIT Lahore participated in the All Pakistan DICE Water and Energy Exhibition at UET Lahore. A project on Microgrid Control Algorithm supervised by Dr. Mujtaba Jaffery, Assistant Professor, EE Department and Engr. Fawad Azeem, Lecturer ERC was exhibited and presented to faculty members and students of various universities and industrial representatives at the event.

Road to Energy Conservation and Efficiency

by

Khalid Saeed
Head Energy Research Center

Pakistan's power sector has been facing a serious crisis over last 8-9 years. According to various studies, the inefficiency of the power sector has caused a loss of between 5 to 7% to Pakistan's GDP over the last few years as it has long been riddled with issues such as poor governance and corruption, an overburdened transmission network, circular debt, an expensive fuel mix, below cost consumer tariffs, power shortages, transmission and distribution losses and theft. The government has had to pay billions of rupees as subsidies while the problems of circular debt and long hours of load shedding, ranging from 10-16 hours in urban and rural areas, has caused severe loss to the economic activity resulting in closure of industries, unemployment and loss of global market share. In a recent IFC study also it was pointed out that the power shortage was the main factor deterring foreign investment in Pakistan.

The power distribution losses alone result in a loss of around 20% electricity being generated in the country. The Punjab based Distribution Companies (DISCOs) are, comparatively, in a much better position and Islamabad's IESCO is rated amongst the best along with Gujranwala (10-12%). Even the performance of Lahore, Faisalabad and Multan DISCOs, in terms of distribution losses, is much better (14-16%) than the other DISCOS. In Peshawar, Sukkur, Hyderabad, Karachi and Quetta, the losses range between 25-34%. It's not just the losses, the recoveries of dues are also much lower in these DISCOs compared to the Punjab based DISCOs and since we follow a system of uniform tariffs throughout the country, the losses and poor recoveries of the inefficient DISCOs affect everyone.

The transmission system, with its inadequate and poor infrastructure, is overburdened. Due to the below cost consumer tariff, the government has been heavily subsidizing tariffs. Only in the recent past, due to the fall in oil prices, the burden on the government exchequer has been somewhat reduced. Earlier, it was a major drain on government resources to pay the difference between the NEPRA determined tariffs and the actual tariffs. The delays in payment of the government subsidies to the DISCOs, and their inability to pay to the CPPA and, in turn, fuel suppliers resulted in the nagging circular debt. The high cost of power generation was also inherently due to the expensive fuel mix. We relied heavily on imported furnace oil in the absence of sufficient domestic gas supplies, while the cheaper hydel power's contribution to the total supply has been on a decline for last many years.

The power supply in the country is mainly controlled by the government owned GENCOS in the public sector and the IPPs in the private sector. The Energy Policy 2013, like its predecessors, has aimed at eliminating the power supply deficit by augmenting the country's generation capacity.

It has been projected that in the next four to five years, the generation capacity will be doubled from the current 23000 MW and that by 2018, as promised by the government, we will probably be free from load shedding with the addition of around 10000MWs, which will be sufficient to meet the peak demand.

What has been grossly ignored from the equation though, has been the demand side management.

The institution of ENERCON has been there for the last many years but we hardly found much impact. It is for the first time that demands side management has been given adequate importance and with the recent enactment of the Energy Conservation Act, now even the provincial governments are empowered to enforce the practical measures for labeling and standardization of electrical machinery and appliances, conduct energy audit and implement energy efficiency promoting policies.

The Punjab Energy Department's commitment for handling demand side management is evident through the establishment of the Punjab Energy Efficiency and Conservation Agency (PEECA).

We basically need to understand that every MW saved is much cheaper than every MW produced.This is the philosophy that needs to be popularized to resolve our energy crisis. When and how did we reach this low point in electricity generation, how important is the issue of Energy Efficiency and Conservation and what kinds of challenges lie ahead of us? Answering these questions will orient us in the right direction for solving this issue more effectively.

We can see that the current demand for electricity in the domestic sector, namely, households, is where the recently introduced concept of net metering will play a very important role. Households account for nearly 48% of the total electricity consumption in Pakistan followed by the Industry and agricultural sectors.

NEPRA, the electricity Regulator, too has an integral role to play in demand side management. Way back in 2009, NEPRA had recommended two important steps in this direction. One was the abolishment of slab benefits for high end consumers as even those who were using thousands of units were availing it and so, in a way, they were benefitting from a much higher percentage of the subsidy that was to be given to the people who really deserved it. Secondly, introduction of the time of use differentiated tariffs for peak and off peak hours. The objective was that people must be made aware that the electricity generated during peak hours was costing the government very dearly as the most expensive plants had to be run to meet the peak demand requirement. Those recommendations have finally been implemented after many years now and will help in improving the power sector economics and rationalizing our tariff structure.

We have started enforcing peak and off peak hours and the slab benefit has now also been greatly curtailed. These are two important regulatory steps which will help in managing the demand side.

Another important development which needs to be highlighted is the changing profile of Pakistan's power generation. In the thermal power generation, we have been depending for one third of our generation on gas and another one third on oil. Coal was almost completely missing from our fuel mix .However, as we move forward, by 2021 we are expecting that coal will be contributing around 18%, nuclear 9%, gas now supplemented with the LNG 18%, solar and wind will each be contributing 3%, while oil's share will be reduced to less than half of its present contribution i.e 14% and hydelwill remain around the present level of 29%.

These welcome changes will be saving us from the vicissitudes of the international oil prices. According to the estimates of the International Energy Agency, in the next 15 to 20 years, only 2% of electricity will be generated from oil globally. There is really no reason for us to continue relying on imported furnace oil. The induction of indigenous and imported coal is a welcome step. The renewable energy is trending all over the world for its various advantages and the induction of solar and wind power in our fuel mix is also in line with these global trends.

Though the increase in the supply capacity and the fuel generation mix are positive changes, we cannot remain complacent as these benefits can be nullified very easily unless we take care of some other important and equally pressing issues such as transmission and distribution losses in the power supply chain alongwith the corruption and poor recovery by the DISCOs. A DISCO which pays to the CPPA for let's say 100 units, then bills for only 70 units and makes just 65-70% recovery can never remain sustainable and will always remain dependent on the Government subsidies.

The corrective strategy is to bring down the losses and improve recoveries. Some DISCOs like IESCO, GEPCO etc. have been performing very well. There is need for other DISCOs, too, to come up to the benchmarks already achieved by most of the Punjab based DISCOs. DISCOs really have to take effective measures to take care of these issues. The true benefits of the augmentation of the power generation capacity and rationalization of fuel mix for power generation can remain sustainable only with an upgraded transmission network and an efficiently run distribution network.

As a part of the power sector's structural reforms of 1992, the erstwhile WAPDA was unbundled into many entities and the idea was to corporatize the sector, which is how DISCOS and generating companies

(GENCOs) were established in the late nineties.

Unfortunately, however, these reforms have remained only half-baked reforms. Though all the public sector GENCOs and DISCOs have their Board of Directors, but on every step of the way, since the principal or the only shareholder is the Government of Pakistan, the Boards and the CEOs are dependent on the Ministry of Water and Power even for the routine repair, replacement and maintenance works. The corporatization reforms have to be taken to their logical end if we want them to achieve success.

Energy Efficiency and Conservation is the hallmark for the production of sustainable and environment friendly energy the world over. Conservation simply means saving energy, efficiency comes in where this energy is used efficaciously.

The International Energy Agency has reported that 870 million oil wells, 205 million tons of coal and 224 billion cubic meters of natural gas have been saved because of energy efficiency and conservation measures taken globally.

There are many challenges in taking the cause of energy efficiency and conservation forward. There is clearly an awareness deficit in the nation, coupled with behavior and attitude constraints. Starting right from our school going children to everyone, a lot has to be done to build and promote a culture of conserving and using energy efficiently. We have to be sensitized towards the realization that small things like switching off fans, air-conditioners and lights on leaving a room, all matter. These positive habits have to be inculcated and re-enforced. The culture of energy conservation needs sustained awareness campaigns for cultivating energy saving habits and attitudinal changes in society. Both the government and corporate sectors can play a leading role in this regard. The measures should be introduced, enforced and widely publicized.

The financing of energy efficiency measures including replacement of energy inefficient technologies and infrastructure has also been an issue. It is difficult to predict the outcome of various initiatives and monitoring and enforcement are also major and expensive challenges.

To bring about energy efficiency and conservation we need to fully engage with the industry in prescribing and enforcing minimum energy efficiency standards in various household appliances and industrial machinery. The provisions of the recently enacted Energy Efficiency Conservation Act for appliances like standards and labeling and energy usage reporting requirements must be implemented effectively. Energy conserving building codes for new commercial and public buildings must be among priority projects and the industrial and commercial sectors should be incentivized through fiscal and other incentives to implement energy conservation and efficiency schemes.

We will have to focus industry by industry. We'll have to sit with their associations and leading manufacturers to understand the reasons for their reluctance to the idea. They could be facing a wide range of issues including financial, physical, and technical and manpower constraints. We must convince them that their interests converge with ours. It would be ideal if a consensus could be developed, however, hopefully, the negotiations will be more successful this time because legal power now available with the provincial governments and the federal government will aid the enforcement of rules.

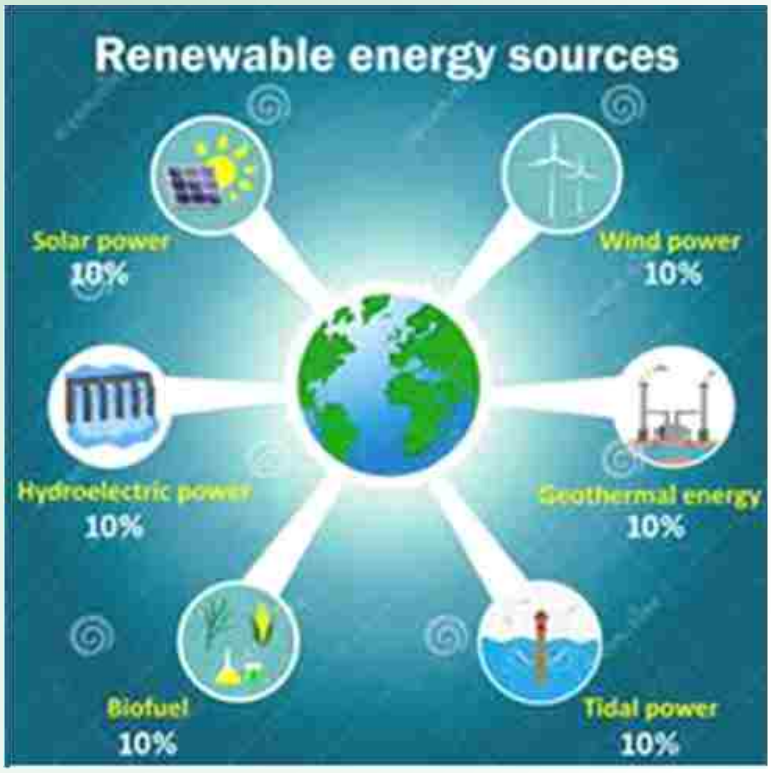
Renewable Energy Resources

by

Dr. Muhammad Saleem
Assistant Professor, Physics Department, CIIT Lahore

Abstract:

"Energy provides services to meet many basic human needs, particularly heat, motive power (e.g. water pumps and transport) and light. Business, industry, commerce and public services such as modern healthcare, education and communication are highly dependent on access to energy services. Indeed, there is a direct relationship between the absence of adequate energy services and many poverty indicators such as infant mortality, illiteracy, life expectancy and total fertility rate. Inadequate access to energy also exacerbates rapid urbanization in developing countries, by driving people to seek better living conditions. Increasing energy consumption has long been tied directly to economic growth and improvement in human welfare. However it is unclear whether increasing energy consumption is a necessary precondition for economic growth, or vice versa. Although developed countries are now beginning to decouple their energy consumption from economic growth (through structural changes and increases in energy efficiency), there remains a strong direct relationship between energy consumption and economic development in developing countries.



Introduction:

Energy is the lifeblood of civilization. Access to relatively inexpensive and plentiful energy has been and will continue to be its deriving force. But in the past few years, increasing concern about the global warming have fuelled the intensive search for sustainable (green) energy harvesting technologies. Moreover, the reality of the fragile nature of oil and its skyrocketing prices dominated energy infrastructure has become apparent. To meet these requirements of the civilization, which is engaged in a life and death struggle to redefine its primary energy resources and to find transitional solutions without invoking chaos. Significant progress has been made in the development of renewable-energy technologies such as wind, solar, hydropower, geothermal, ocean, bioenergy,

Wind Energy

The kinetic energy of wind is harvested using wind turbines to generate electricity. Among various renewable energy sources, wind energy is the second most technologically advanced renewable energy source; hydropower is the first. Although there is a significant potential for converting wind energy to electricity, a number of issues must be addressed before it can be used to its full potential. Wind blows in every corner of the earth; however, it does not blow constantly. In addition, it must maintain a certain speed to be effective for running a wind turbine and generating electricity.

The utilization of wind energy can be dated back to as early as 5000 B.C., when wind energy propelled boats were sailing along the Nile River. By 200 B.C., the use of windmills in China for pumping water was documented. Vertical-axis windmills with woven reed sails were used for grinding grain in Persia and the Middle East. During that time period, the primary applications were for grain grinding and water pumping. Between 1850 and 1970, over six million, mostly small (one horsepower or less) wind mills were installed in the U.S. alone for conversion of the wind energy to the mechanical energy. The primary use was water-pumping for stock watering and meeting the water needs of farms and homes. Very large windmills, with rotors up to 18 m in diameter, were used to pump water for the steam railroad trains that provided the primary source of commercial transportation in areas where there were no navigable rivers. The historical perspective of wind energy development has been discussed by a number of researchers.

Wind energy got a big boost following the OPEC (Organization of Petroleum Exporting Countries) Oil Embargo of 1973, when several countries started investing in wind power related technologies.

The current wind-powered electricity generation capacity of various countries is shown in Table1.1.

GLOBAL INSTALLED WIND POWER CAPACITY (MW) – REGIONAL DISTRIBUTION

		End 2014	New 2015	Total End 2015
AFRICA & MIDDLE EAST	South Africa	570	483	1,053
	Morocco	787	-	787
	Egypt	610	200	810
	Tunisia	245	-	245
	Ethiopia	171	153	324
	Jordan	2	117	119
	Other[1]	151	-	151
	Total	**2,536**	**953**	**3,489**
ASIA	PR China	114,609	30,753	145,362
	India	22,465	2,623	25,088
	Japan	2,794	245	3,038
	South Korea	610	225	835
	Taiwan	633	14	647
	Pakistan	256	-	256
	Thailand	223	-	223
	Philippines	216	-	216
	Other[2]	167	-	167
	Total	**141,973**	**33,859**	**175,831**
EUROPE	Germany	39,128	6,013	44,947
	Spain	23,025	-	23,025
	UK	12,633	975	13,603
	France	9,285	1,073	10,358
	Italy	8,663	295	8,958
	Sweden	5,425	615	6,025
	Poland	3,834	1,266	5,100
	Portugal	4,947	132	5,079
	Denmark	4,881	217	5,063
	Turkey	3,738	956	4,694
	Netherlands	2,865	586	3,431
	Romania	2,953	23	2,976
	Ireland	2,262	224	2,486
	Austria	2,089	323	2,411
	Belgium	1,959	274	2,229
	Rest of Europe[3]	6,564	833	7,387
	Total Europe	**134,251**	**13,805**	**147,771**
	of which EU-28[4]	129,060	12,800	141,578
LATIN AMERICA & CARIBBEAN	Brazil*	5,962	2,754	8,715
	Chile	764	169	933
	Uruguay	529	316	845
	Argentina	271	8	279
	Panama	35	235	270
	Costa Rica	198	70	268
	Honduras	126	50	176
	Peru	148	-	148
	Guatemala	-	50	50
	Caribbean[5]	250	-	250
	Others[6]	285	-	285
	Total	**8,568**	**3,652**	**12,220**
NORTH AMERICA	USA	65,877	8,598	74,471
	Canada	9,699	1,506	11,205
	Mexico	2,359	714	3,073
	Total	**77,935**	**10,817**	**88,749**
PACIFIC REGION	Australia	3,807	380	4,187
	New Zealand	623	-	623
	Pacific Islands	12	0,6	13
	Total	**4,442**	**380,6**	**4,823**
	World total	**369,705**	**63,467**	**432,883**

Source: Global Wind Energy Council

Solar Energy

The sun is the main source of all alternative energies on the earth's surface. Wind energy, bioenergy, ocean energy, and hydro energy are derived from the sun. However, the term solar energy refers to the energy that is harvested directly from the sun using solar cells, solar concentrators, etc. Although solar energy is abundant on the earth's surface, about 89 x 10^{15} watt (W) of solar energy is absorbed annually by the earth's land mass and oceans. However, this only translates to around 1,000 W m^{-2} spread over the earth's surface area. The diffuse nature of solar energy has limited its growth because it is difficult to base systems on resources with a low energy density. Solar energy can be used either as a source of thermal energy when using solar concentrators, or for direct electricity generation when using photovoltaic.

Throughout the history, humans have used the heat from sunlight to dry grains, cook food, and heat water and homes. The concept and the use of solar thermal energy started in 1767 when the Swiss scientist, Horace de Saussure, invented the world's first solar collector, or “hot box”. Renowned astronomer, Sir John Herschel, used solar hot boxes to cook food during his expedition to Southern Africa in the 1830s. Today, solar collectors can gather solar thermal energy in almost any climate to provide reliable, low-cost source of energy for many applications including heating water for homes and residential heating systems. Various other industries, such as laundries and food processing companies, also utilize solar energy. In recent years, utilities have begun to use solar thermal energy to generate electricity by using steam turbines. The steam is produced by concentrating the solar energy into a water boiler.

	ANNUAL INSTALLED CAPACITY	CUMULATIVE INSTALLED CAPACITY
China	**15,15 GW**	**43,53 GW**
Japan	**11 GW**	**34,41 GW**
USA	**7,3 GW**	**25,62 GW**
UK	**3,51 GW**	**8,78 GW**
India	**2 GW**	**5,05 GW**
Germany	**1,45 GW**	**39,7 GW**
Korea	**1,01 GW**	**3,43 GW**
Australia	935 MW	**5,07 GW**
France	879 MW	**6,58 GW**
Canada	600 MW	**2,5 GW**
Pakistan	600 MW	**1 GW**
Netherlands	450 MW	**1,57 GW**
Chile	446 MW	848 MW
Taiwan	400 MW	**1,01 GW**
Honduras	389 MW	389 MW
Switzerland	300 MW	**1,36 GW**
Italy	300 MW	**18,92 GW**
Algeria	270 MW	300 MW
Turkey	208 MW	266 MW
South Africa	200 MW	**1,12 GW**
Israel	200 MW	881 MW
Denmark	183 MW	789 MW
Austria	150 MW	937 MW
Philippines	122 MW	155 MW
Thailand	121 MW	**1,42 GW**
Mexico	103 MW	282 MW
Romania	102 MW	**1,33 GW**
Belgium	95 MW	**3,25 GW**
Portugal	63 MW	454 MW
Malaysia	63 MW	231 MW
Spain	56 MW	**5,44 GW**
Sweden	51 MW	130 MW
Greece	10 MW	**2,61 GW**
Czech republic	16 MW	**2,08 GW**
Finland	5 MW	20 MW
Norway	2 MW	15 MW

Hydropower

Among all the renewable energy sources, the contribution of hydropower to the worldwide electricity generation is the highest. A hydropower system can be used to generate a few kilowatt of electricity to about 18,000 MW. Hydropower generating plants capture the kinetic energy of falling water, such as from a river and waterfalls, to generate electricity. A turbine and a generator convert the kinetic energy from water, first to mechanical energy and then to electrical energy using a generator. Hydropower is considered a renewable energy source since the water cycle, shown in Fig. is a continuous cycle.

The Greeks are believed to be the first to use hydropower in about 100 B. C. for grinding wheat into flour. Around 4 A.D., Asia and Europe started utilizing hydropower for milling. Modern hydropower turbines were designed in the mid-1700s by a French hydraulic and military engineer, Bernard Forest de B´elidor, who wrote Architecture Hydraulique, in which he described the use of a vertical-axis versus a horizontal-axis turbine. Around 1880, hydropower was used to generate direct-current.

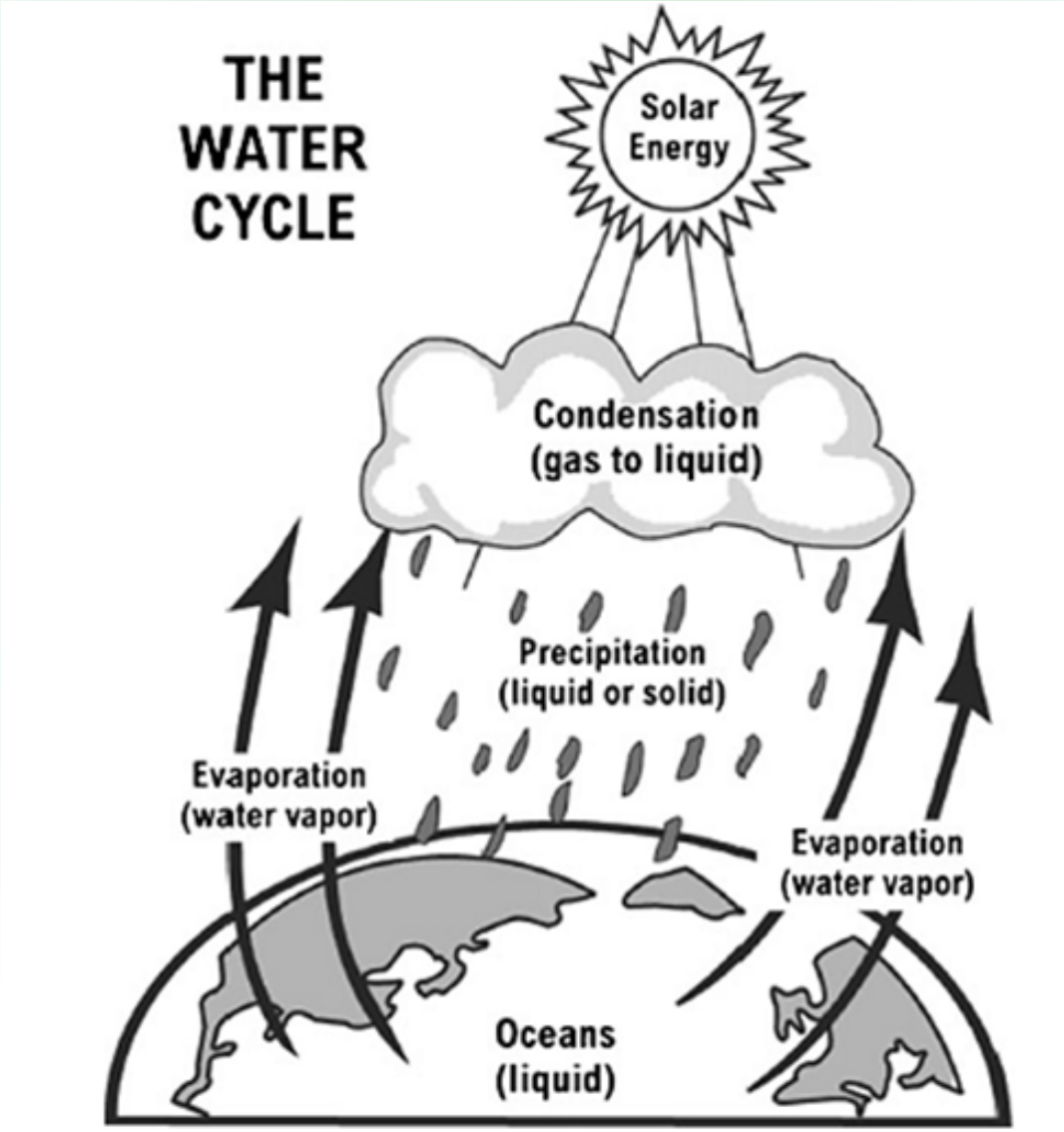
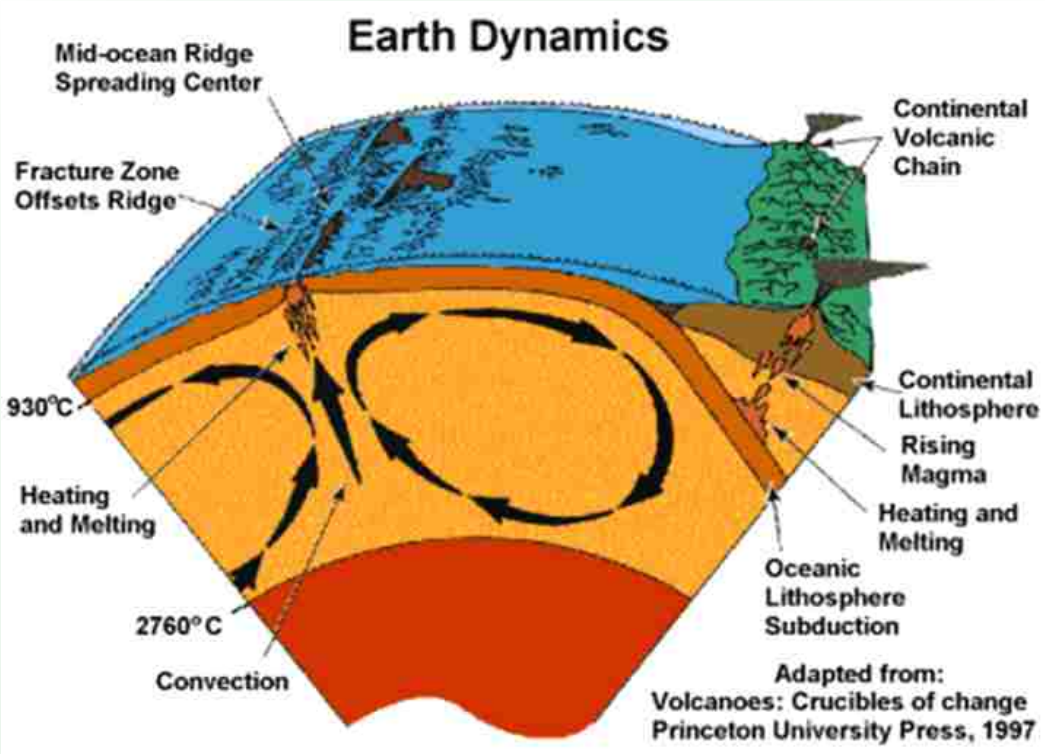


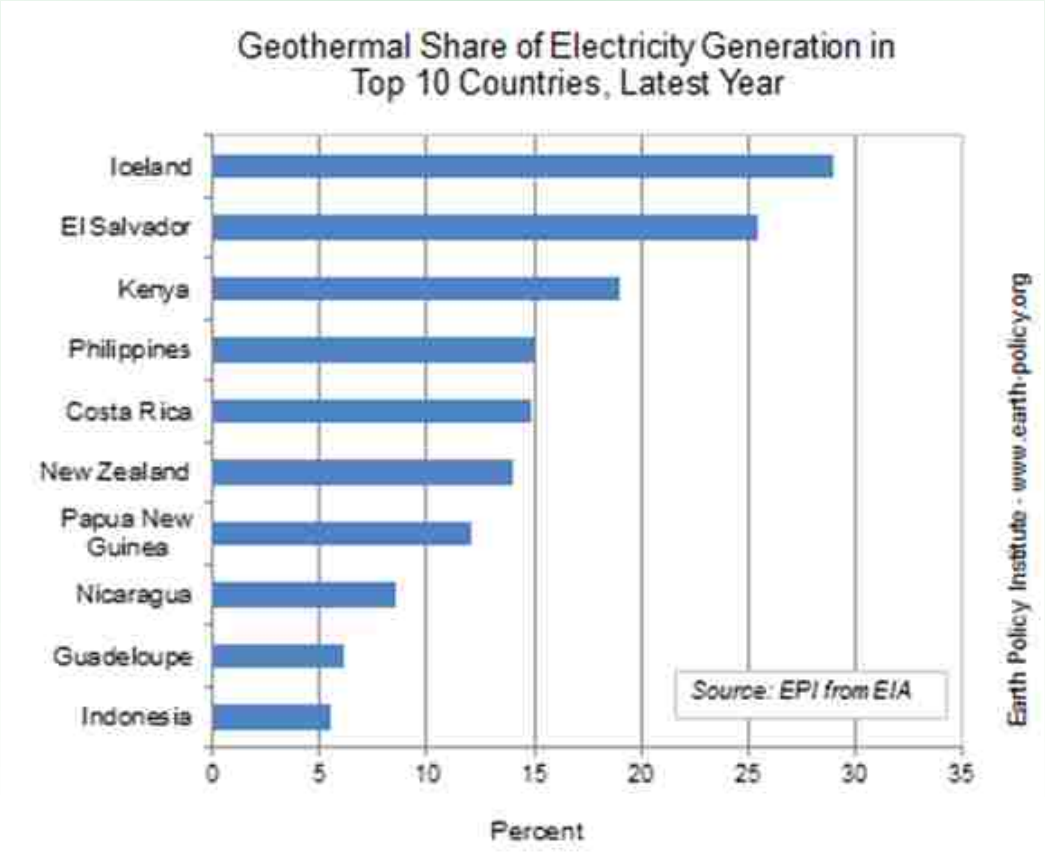
Table 3.1 Contribution of hydroelectricity to the total electricity generation of selected countries

Country	Total electricity generation (billion kilowatt hour)	Total hydro electricity generation (billion kilowatt hour)	% of the total generated electricity
Australia	244.22	16.68	7
Austria	59.31	33.59	57
Belgium	82.94	0.37	0
Brazil	437.26	370.63	85
Canada	612.60	365.30	60
China	3,042.31	429.98	14
France	537.91	57.61	11
Germany	594.66	20.09	3
India	665.30	121.18	18
Italy	292.11	33.13	11
Japan	1,082.24	74.61	7
Mexico	243.29	26.86	11
Nepal	2.70	2.69	100
New Zealand	42.41	23.28	55
Norway	135.02	132.82	98
Pakistan	93.26	32.79	35
Romania	58.25	15.74	27
Russia	964.21	177.01	18
Spain	287.39	27.15	9
Sweden	143.82	65.38	45
Switzerland	64.56	34.85	54
Turkey	181.56	35.44	20
United Kingdom	371.01	5.05	1
United States	4,166.51	248.31	6
Venezuela	110.73	83.03	75
Vietnam	61.02	27.12	44

Geothermal Energy

Geothermal energy is the heat from the Earth. It's clean and sustainable. Below the earth's surface, at its center, there is a body of hot molten rock called Magma. Heat is continually produced at the center from the decay of radioactive materials trapped in Magma during formation of the earth. It is believed that this heat source is going to last for billions of years and the thermal energy can be harvested from this source on a regular basis. As a result, geothermal energy is considered a renewable energy source. The term geothermal comes from the Greek Word geo, meaning earth, and thermal, meaning heat. Geothermal energy can be used for a variety of applications including electricity generation, heating buildings, and in heat pumps. Many technologies have been developed to take advantage of geothermal energy.


Earth Dynamics
Mid-ocean Ridge
Spreading Center
Fracture Zone
Offsets Ridge
Continental
Volcanic
Chain
930°C
Heating
and Melting
Continental
Lithosphere
Rising
Magma
Heating and
Melting
Oceanic
Lithosphere
Subduction
2760° C
Convection
Adapted from:
Volcanoes: Crucibles of change
Princeton University Press, 1997


Geothermal Share of Electricity Generation in
Top 10 Countries, Latest Year
Iceland
El Salvador
Kenya
Philippines
Costa Rica
New Zealand
Papua New
Guinea
Nicaragua
Guadeloupe
Indonesia
Source: EPI from EIA
0
5
10
15
20
25
30
35
Percent
Earth Policy Institute - www.earth-policy.org

Bioenergy

Energy derived from the biomass is called bioenergy. Biomass can be vegetation-trees, grasses, plants parts such as leaves, stems and twigs, sea weeds, and waste products from various industries—including agriculture, forest products, transportation, and construction—that dispose of large quantities of wood and plant products. All of these materials can be used for generation of energy. Since some biomass, such as trees and plants, can be cultivated on a regular basis and replenished, bioenergy is considered a renewable energy source. Biomass can be also used to produce biofuels, which is short for biomass fuel. It can be in the form of both liquid and gas. Another term, "biopower" refers to biomass power systems that produce electricity. The major use of "biofuels" is in the transportation sector. Bioenergy may be considered as a carbon neutral system. Carbon dioxide is released back into the atmosphere when burning biomass as shown in Fig.

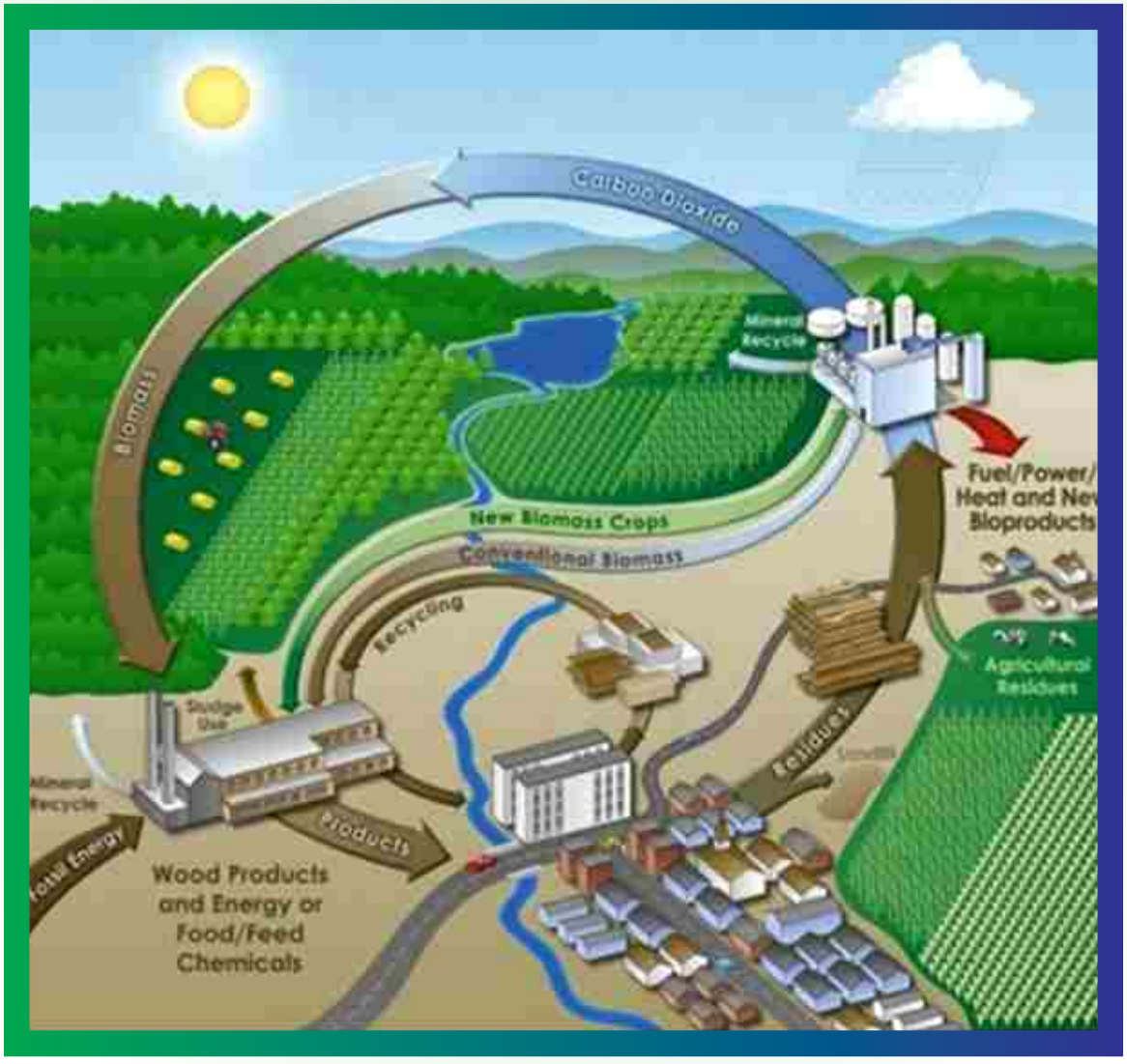


Fig. 6.1 The bioenergy Cycle (Courtest of Oakridge National Laboratory)

Transmission line approved for Karachi Nuclear power plants

The Central Development Working Party (CDWP) cleared 18 projects worth Rs.154 billion, including a key transmission line to distribute 2,200MW electricity from Karachi's two upcoming nuclear power stations. Provincial governments and the federal ministries concerned, cleared technical and financial parameters of the transmission line for evacuation of electricity from the two nuclear coastal power plants (K-2 and K-3) of 1,100MW each being set up at Paradise Point, about 11 kilometers from the city (Karachi) center. It requested the Executive Committee of the National Economic Council (ECNEC) to approve the transmission line with an estimated cost of Rs.5.6bn, including a foreign exchange component (FEC) of Rs.2.6bn. The two nuclear plants are planned to be completed by 2022-23 under a government-to-government deal with China. Overall, the 11 projects of Rs.20 billionhas been approved. Besides the transmission line for the two nuclear plants, the CDWP also cleared a project for evacuation of electricity from 1,320MW (2x660MW) coal-based power projects of Sino-Sindh Resources and Sindh Engro Coal Limited (SSRL/SECL) in Thar at a cost of Rs.23bn, including FEC of Rs.12bn. The cost will be approved by ECNEC. The meeting also approved evacuation of 350MW electricity from Siddiqsons coal-fired energy power plant near Port Qasim at a cost of Rs.2.9bn, with FEC of Rs1.4bn. The three transmission line projects aimed at transmitting electricity to the national grid from the power plants are currently at different stages of implementation. The CDWP approved Rs.145 million for rehabilitation of the damaged 66kV grid station at Ghiljo, Orakzai Agency, and construction of a 132kV SDT transmission line for making interconnecting arrangement between 132kV Kharan grid station and Mall station grid (82km) at a cost of Rs.650 million.

Renewable energy: Work on wind power projects underway in Sindh

The work on 22 wind power projects is underway at Gharo-Keti Bandar and Hyderabad in Sindh. The place where the projects are being carried out is a wind corridor having a production capacity of 1,530 megawatts of electricity. According to media reports, official sources said that nine wind turbine generator projects are in the final stages of development while the other nine are still under-construction. Presently, five wind turbine generator projects, each with 50 MW production capacities are currently operating in the Gharo-Jhampir wind corridor.

Pakistan's Second LNG FSRU Achieves Completion

The second LNG floating storage and regasification unit (FSRU) to be deployed in Pakistan has achieved completion and will sail to Karachi on schedule. Constructed by Samsung Heavy Industries, this brand new FSRU is part of the fast-track LNG terminal being established by Pakistan Gas Port Consortium Limited (PGPC) at Mazhar Point, Port Qasim. It will provide 600mmcfd of regasification capacity to state-owned Pakistan LNG Terminals Limited (PLTL) under a 15-year contract at a tariff of $0.4177 per mmbtu. The FSRU, owned by the BW Group, is scheduled to reach Karachi in June. The ceremony for the vessel took place at the Samsung shipyard in Geoje, South Korea, on January 12, 2017. The FSRU has been named the BW Integrity. This FSRU will more than double Pakistan's LNG regasification capacity, to over 1,200mmcfd.

Russia to Build 60 LPG Air Mix Plants in Pakistan

In a new development Russia will install 60 LPG AirMix plants in Pakistan out of which 24 will be set up in Balochistan. The remaining will be set up at Muree, in Gilgit-Baltistan and AJK.

This will be the second deal on natural gas with Moscow being finalised as Russia will construct 1,100 kilometer LNG pipeline from North to South too. The Economic Coordination Committee (ECC) has accorded approval to the plan for setting up of the LPG Air Mix Plants at Muree (Kurbagla, Dewal, Company Bagh and Tret), Awaran and Bella at an estimated cost of Rs1.353 billion.

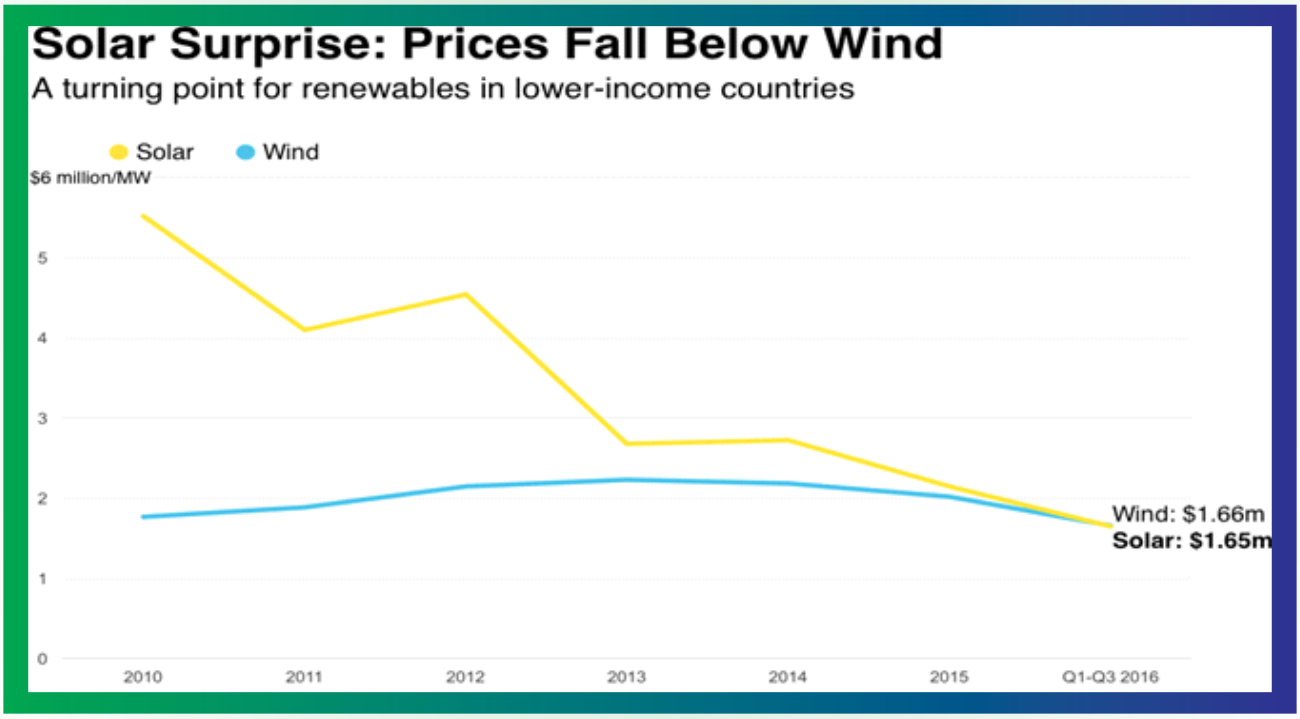
The price of gas for the dwellers of the said areas will be equal to the price of highest domestic slab consumers. However, it's cost will be about one third of LPG cylinder of 11.8 kg.

The above projects would cost Rs.600 per MMBTU which is equal to the highest slab for supply of natural gas to domestic consumers. However, the impact on weighted average cost of gas has been calculated in terms of five projects at Rs.0.60 per MMBTU as worked out by SNGPL and SSGC. The UFG (unaccounted for gas),if any, in case of LPG AirMiX supplies would be ring fenced ad will be borne by consumers of the LPG AirMix Plants.

Solar power is becoming the world's cheapest energy source

Solar power is becoming the world's cheapest energy source. The cost of solar power has declined drastically over the past six years, to the point where it is cheaper than wind power in certain countries. This is particularly true in the developing countries which don't have the necessary infrastructure in place for fossil fuels. These countries are assembling their infrastructure. However, they've seen what coal and gas can do in other industrialized nations. Thus, they're looking to invest in energy-saving and renewable infrastructure.

A Bloomberg New Energy Finance report said the average price of solar energy in nearly 60 countries fell to $1.65 million USD per megawatt during 2016. This is just below wind energy which is at $1.66 million USD per megawatt.



China scraps 85 coal plants in pivot to green energy

The world's largest producer of emissions China has canceled several dozen planned and under construction coal power projects with a total capacity of over 100GW according to Greenpeace reports.

Instead, Beijing will invest 2.5 trillion Yuan (about $365 billion) in renewable energy. However, the curb on coal power plants has only been implemented in 13 regions of the country, and Greenpeace expects more action from the Chinese authorities. The decision will reportedly create over 13 million jobs in the sector, and renewable power capacity will include wind, hydro, solar and nuclear power, contributing to about 50 percent of new electricity generation by 2020. At present, China's coal plants have a capacity of 920GW. In the electricity chapter of the 13th Five-Year Plan, the country committed to a coal capacity cap of 1,100GW, still a great increase from the current numbers. Without scrapping the plants, Beijing would have exceeded the self-imposed cap by 150 GW.

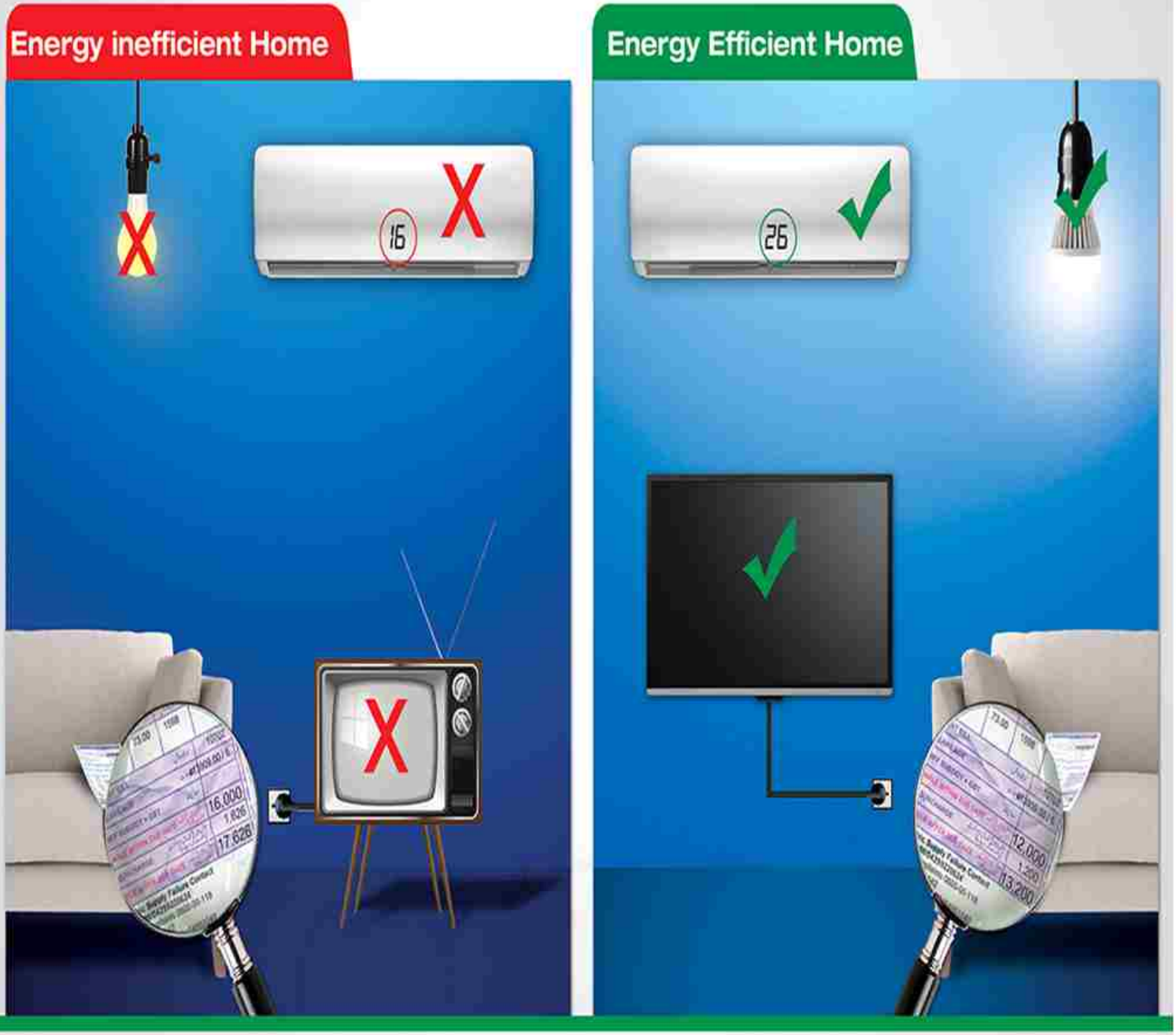
Last year, Beijing introduced several measures against coal overcapacity by announcing a 'traffic light' system for coal power station approvals. In October the government began canceling projects under construction.

Saudi Arabia seeking up to $50bn of investment in solar and wind energy

Saudi Arabia, one of the world's biggest oil producers, is seeking up to $50bn of investment in solar and wind energy, while also drawing up plans for the country's first nuclear power stations. The Saudi Oil Minister Khalid al-Falih, who has spoken of his ambition to turn the petrochemical state into a “solar powerhouse”, said they would start issuing tenders for major renewable projects “within weeks”. The decision comes amid a slump in oil revenues that has forced the Government to draw on more than $100bn of its reserves and increasing concern that climate change is becoming a more pressing problem. Mr Falih said the tenders would be worth between $30bn and $50bn by 2030. He said: “We are committed to expanding renewables; we are committed to turning Saudi Arabia into a solar powerhouse.” Saudi Arabia was currently using a lot of fossil fuels but could make a lot of energy from its abundant sunshine. Saudi Arabia wants to balance economic needs against environmental goals as it has considerable solar power potential and is eager to reduce its use of fossil fuels.

کیا آپ کا گھر انرجی ایفیشینٹ ہے؟

ماہانہ 4000 روپے کی بچت



پنجاب انرجی ایفیشینسی اینڈ کنزرویشن ایجنسی (PEECA)، محکمہ توانائی حکومتِ پنجاب