COMSATS ENERGY RESEARCH CENTER

Newsletter

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Contents

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

Picture Gallery

Mr. Parvez Butt (Ex- Chairman Atomic Energy Commission, Ex-Federal Secretary MoST), had a meeting with Director CIIT, Lahore along with the Head Energy Research Center

Mr. Qasim Khokhar, M.D Punjab Energy Efficiency and Conservation Agency (PEECA) visited ERC for promotion of Energy Research and Development in Punjab.

Head ERC, Mr. Khalid Saeed and PSO, Dr. Ghaffar Doggar attended Pak-German Renewable Energy Forum (PGREF)

Energy Research Center leads the Workshop on "Renewable Energy Technologies" at the Pak China Business Forum

The Pak China Business Forum was held on 19-22 March, 2016 at the Expo Centre, Lahore. The forum was inaugurated by Chief Minister Punjab, Mian Muhammad Shahbaz Sharif. Among many other themes, one of the very important section was based on current global energy crises and solutions based on the renewable energy technologies. A thematic workshop "Renewable Energy Technologies: Prospects and Challenges" was also arranged by CIIT on 20th March 2016. More than seventy (70) professionals from academia /industry of both countries (Pakistan and China) participated at the event. The panel discussion was chaired by Mr. Khalid Saeed (Head, ERC, CIIT).

He highlighted the significance of the energy issues for the economic development of Pakistan. He stated that to attain energy security, provision of indigenous, reliable, sustainable and affordable energy is only possible by adopting state of the art renewable energy technologies for Pakistan. He emphasized the need to balance the current power generation mix and induct more hydel, solar and wind based electricity.

Mr. Khalid Saeed requested the forum participants to focus on the areas where Pakistan could collaborate with China in reducing the cost and increasing efficiency in various renewable energy technologies. He appreciated the efforts of Pak-China business forum organizers to provide such platform, where professionals from both countries could discuss and collaborate the needs of the nation and society. He also highlighted the significance of carrying out research on energy which is a multi disciplinary subject and people from all disciplines should undertake joint projects to alleviate energy crisis prevailing in the country.

Dr. Muhammad Ghaffar Doggar, Principal Scientific Officer, Energy Research Center, highlighted the potential of biomass in Pakistan. Dr. Doggar highlighted that the available biomass potential in Pakistan, especially the Punjab with versatility in its use is highly favorable for energy production as a clean and cost-effective fuel option.

Discussing the biomass project economics, Dr. Doggar highlighted that Biomass power plants are an economical option for the energy demands of Pakistan. Because of the fact that more than 60% of the population live in rural areas of Pakistan and they are mostly related to agriculture and livestock. Pakistan, being rich in biomass resources, must generate some percentage of its total energy demand, create job opportunities by building biogas plants and to cope with environmental issues and decrease the burden on its economy by the reduction of oil imports. Dr. Doggar further highlighted the opportunities for China to invest in the areas of biogas and biomass power projects. Speakers from UET, CERAD, PCRET and China also participated in a workshop. The forum was a wonderful opportunity to hold business meetings.

The Punjab Energy Efficiency and Conservation Agency (PEECA) to collaborate with the ERC, CIIT Lahore

Mr. Qasim Khokhar, Managing Director Punjab Energy Efficiency and Conservation Agency (PEECA), visited CIIT Lahore on 21-April-2016. During an introductory session Head Energy Research Center, Mr. Khalid Saeed introduced ERC and ongoing activities. HoD Electrical engineering introduced EE department and discussed energy related R & D activities.

Mr. Qasim Khokhar was briefed on the Projects Proposal submitted to Punjab Energy Department to establish Cable and LED Testing Labs and Energy Auditing of Public Sector Buildings. He was also briefed on the power improvement factor and proof of concept demonstrated at CIIT Lahore. Head EE briefed MD PEECA about the available research facilities in the department followed by a short visit to EE Labs. Mr. Qasim lauded strength of COMSATS Institute of Information Technology in energy auditing and expressed his views to develop collaboration with CIIT and the projects by PEECA.

Follow up meetings were also held with the MD PEECA during June and-July 2016 and it was agreed that CIIT and PEECA shall hold joint training workshops on Energy Efficiency and Conservation Measures in Punjab. Further, in response to an advertisement issued by PEECA for short listing of service providers for energy auditing of buildings the CIIT in collaboration with NSR Pvt Limited, submitted an application and it is likely that CIIT shall be shortlisted for this purpose. This will help enable CIIT to provide commercial services for energy auditing in the Punjab province of Pakistan.

COMSATS ERC to Establish Comprehensive Data Base of Research, Academia and Public Sector Organizations Working on Renewable Energy Technologies

Energy sector in Pakistan has grown rapidly over the last couple of years. Not only in academia but public and private sector organizations are actively participating in it. Main objective is to resolve the energy crisis in the country through research, development and practical implementation. Energy shortfall is a national issue and cannot be solved without coordination between research and development, policy making and projects implementation.

Coordination between ongoing research, policy making and practical implementations must be synchronized to address energy issues of the country. For this purpose a platform is needed where organizations, Universities, power entities, policy makers and researchers share their activities. Due to lack of coordination, the concerned offices, authorities do not share their experiences, projects concept and lessons learned. Further, there is no database for facilities like labs, researchers of different energy fields, ongoing research, and project activities available on single platform.

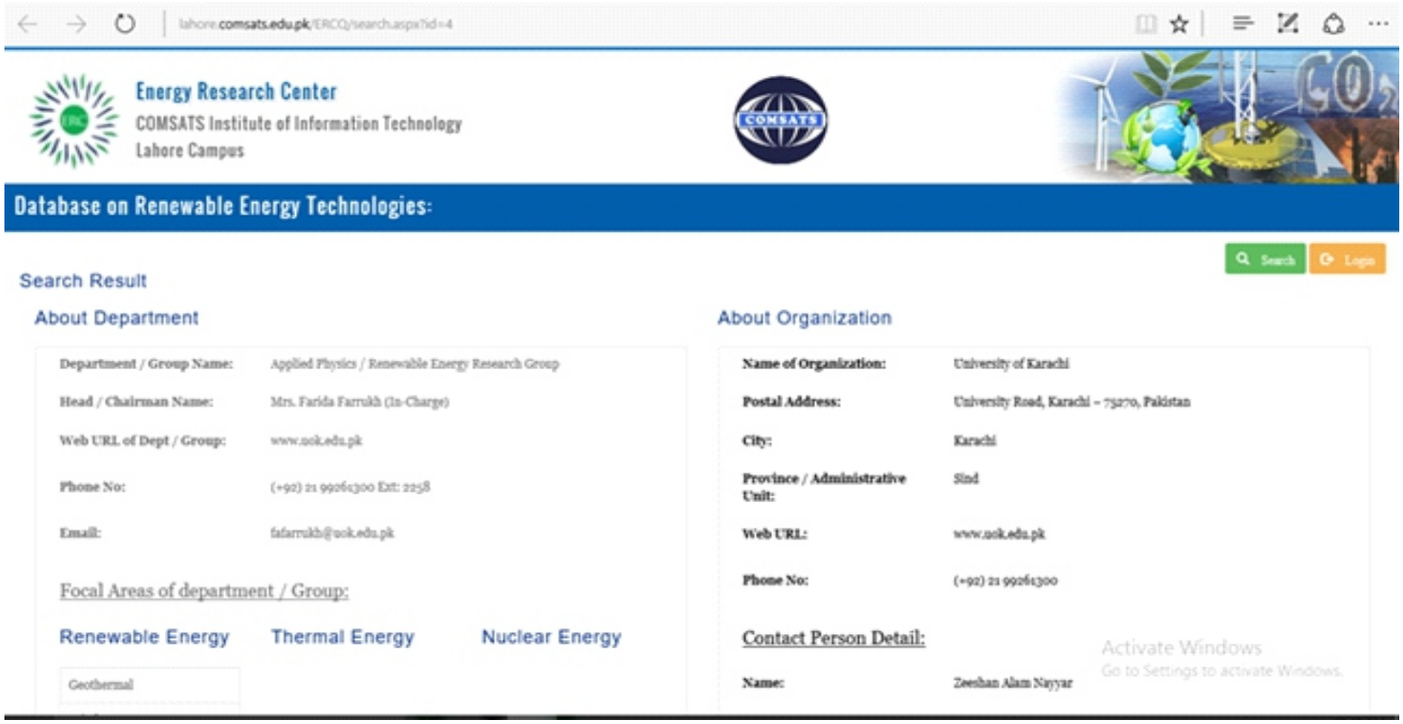
Therefore, establishing a comprehensive data base of organizations working on RE technologies and sharing the information with stake holders (researchers, engineers, end users and policy makers) is necessary. Efficient coordination between these organizations will help to work together where necessary.

The data base shall provide the following information:

1. Type of Organization (research, academia, public sector service providers etc.)
2. Areas of expertise, staff and labs facilities in RETs
3. Nature of activities, projects completed and lessons learned
4. Ongoing activities / projects
5. RE systems and products developed and commercialized
6. Testing and certification facilities for quality assurance of RE systems and equipment in the country
7. Facilitation of researchers, students for R&D studies and projects.
8. Publications - RE reports, papers published and patents etc.

Feeling the importance of efficient and seamless coordination and sharing of valuable knowledge, COMSATS Energy Research Center has taken an initiative to develop a comprehensive database of research, academia and public/private sector organizations working on renewable energy.

In order to collect the information, a questionnaire has been designed and developed. Further a list of organizations working on RE technologies has been identified using website. The questionnaire has been circulated to these organizations by emails. The first phase of data base development is under process where website has been developed and data entering is in process. This database will also help researchers to find out the energy related programme and availability of labs and researchers/experts of their interest in Pakistan. Industries and professionals related to energy/renewable energy profession will get a chance to explore more energy related firms and organizations.



Energy Research Center Signs MOU with the Shandong Normal University-Lishan College

A delegation led by Prof. Delu Jin, Chairman Shandong Normal University –Lishan College (SNU-LC) visited Energy Research Center (ERC), COMSATS Institute of Information Technology (CIIT) Lahore on 28-March-2016.

Mr. Khalid Saeed, Head (ERC), introduced COMSATS Institute of Information Technology and ongoing activities of ERC. Prof. Delu Jin introduced Shandong Normal University-Lishan College and Lucy New Energy Technology Co., Ltd., a private company under the management of SNU-LC. Later on Prof. Hong Bin Wang, Associate Dean SNU-LC briefed ongoing renewable energy and energy efficiency based projects at SNU-LC.

A MOU was signed at the event where both parties agreed to collaborate and support Joint Research projects for development and promotion of technologies in the field of Biomass, biogas, biodiesel, solar thermal, solar PV, solar air-conditioning, air source heat pump and energy efficiency measures. SNU-LC will also offer its services related to establishment of Energy Research Laboratories including biomass, biofuels, solar air conditioning, energy efficiency. SNU-LC will also share research experience and products with ERC for its further development and commercialization in Pakistan.

Guangzhou Institute of Energy Conversion (GIEC) China signs MoU with COMSATS Energy Research Center

The COMSATS Energy Research Center is interacting with renowned international energy institutes including Guangzhou Institute of Energy Conversion (GIEC) China. Purpose is to collaborate on research and development on energy technologies and capacity building of manpower. The GIEC is renowned research institute working on biomass, biofuels, energy efficiency and other renewable energy technologies. Recently ERC signed an MoU with GIEC envisaging joint research projects for promotion of various energy technologies and energy efficiency measures.

Both parties agreed to collaborate and support each other in preparing joint research projects for development and promotion of technologies in the field of biomass, establishing energy research laboratories, collaborating on research in energy including biomass, biofuels, solar, geothermal, energy efficiency. The MoU also propose the capacity building of technical manpower of CIIT Energy Research groups, facilitating Ph.D research students to undertake their research at GIEC Labs and providing technical assistance for successful completion of research work.

ERC will share research output, products and visits of faculty and researchers, development of joint research proposals, funding of joint projects from donors, arrangement of joint seminars, workshops and conferences. Both parties shall take prompt actions so as to realize the cooperation and translate it into product development and utilization so as to mitigate the energy crisis in the country.

Seminar on Energy Labeling Scheme

A seminar on Energy Labeling Scheme was arranged by National Energy Conservation Center (ENERCON) in collaboration with Pakistan Council of Scientific and Industrial Research (PCSIR) Labs, on 24-6-2016.

Dr. Muhammad Ghaffar Doggar, Principal Scientific Officer, COMSATS Energy Research Center, Director Pakistan Standard and Quality Control Authority (PSQCA), M.D. Punjab Energy Efficiency and Conservation Agency (PEECA), Director UET CERAD, manufacturers of electrical appliances and fans, private consultants etc attended the seminar.

Presentation were given on available lab facilities in PCSIR Labs, potential market for manufacturing of quality fans/lighting systems/motors in Pakistan and plan for energy labeling. PCSIR Lab has been designated as focal laboratory for testing and certification of fans and other appliances in Pakistan. An MoU was also signed by M.D. ENERCON and DG PCSIR Labs for this purpose.

Punjab Agriculture Department to Work on Renewable Energy Projects with COMSATS ERC

Officials from Punjab Agriculture Department visited COMSATS Energy Research Center on 26-May-2016. Projects related to renewable energy and their prospects and outcomes were discussed in the meeting. Agriculture Department Punjab and COMSATS will jointly explore the opportunities to work together to address energy related issues in agricultural sector. Mr. Abdul Malik highlighted the areas where joint projects can be initiated to address real life issues in the sector. The meeting was also attended by private entrepreneurs, Alternative Energy Solutions Private Limited and Dynamic Green Private Limited to share their experiences.

Dr. Ghaffar Doggar, PSO, ERC assured active participation of COMSATS Energy Research Center in developing PC1s, Proposal and R & D activities during joint projects. Dr. Doggar further intensifies the need of educating people related to energy and renewable energy, through arranging workshops, seminars and training for Students, Researchers, Farmers and Industrial personnel.

Visit of COMSATS Faculty to University of Agriculture Faisalabad to Attend Inauguration Ceremony of 100 KW Biomass Power Plant

The CIIT faculty comprising of (5) energy experts from ERC, EE and CE Departments visited University of Agriculture Faisalabad (UAF) on 25th July, 2016 to attend the inaugural ceremony of Biomass Gasification Power Plant (100 KW).

The visit was arranged by Dr. Muhammad Ghaffar Doggar, PSO, ERC on the invitation of Prof. Dr. Ehsan Ali, Director (Bio Energy) UAF and Prof. Dr. Haibin Li, Guangzhou Institute of Energy conversion (GIEC) China. The 100 kW power equipment has been donated by the Chinese Academy of Sciences, GIEC to UAF through Punjab Government.

During the visit, introduction to equipment and technology was explained by the Chinese experts and its operation was demonstrated at UAF agriculture research farm. The equipment generates 100 kW power using crops residue of all types.

Supervision of Final Year Projects (FYP) Research of Undergraduate Students of EE Department

In order to develop energy systems through research and development, the ERC faculty encourage students to undertake their research in the field of energy. The ERC faculty has co supervised the research projects undertaken by BE and MS students. Dr. M.G.Doggar acted as co-supervisor on the research thesis "Performance Evaluation of 332.5 kW Solar PV plant" which was undertaken by two BE students (Syed Shozab Husaain Ziaid and Muhammad Usman Arshad) from EE Department: Dr. Naeem Shahzad Assistant Professor EE was the supervisor.

The PV Plant of 332.5 kW capacity is installed at Aitchison College Lahore. It's performance was evaluated and technical parameters of output voltage, current and net savings in electrical consumption was measured by the students. Dr. Doggar is also co-supervising another research project entitled Solar Water Pumping for Irrigation Purposes of M.Sc. student in AIOU Islamabad.
Engr. Fawad Azeem, Lecturer Energy Research Center, along with Dr. Mujtaba Jaffery Assistant professor EE department is co-supervising Final Year Project of EE department. This project is related to development of efficient algorithms for load management in microgrids.

Pak-German Renewable Energy Forum (PGREF)

An inauguration Ceremony of Pakistan German Renewable Energy Forum (PGREF) was held on 26th May, 2016 at Energy Department, Punjab Government, Lahore. The event was chaired by Mr.Asad Rehman Gilani, Secretary Energy Department and attended by officials of GIZ and German Embassy, Alternate Energy Development Board, Chairman Pakistan Solar Energy Association, Chairman QA Solar Park Private Limited.

Mr. Khalid Saeed, Head Energy Research Center along with Dr. Muhammad Ghaffar Dogar PSO, ERC also attended the meeting on behalf of CIIT. The PGREF is a cooperative initiative between the two countries and has been created to develop network between respective industries, researchers and public sectors in renewable energy and energy efficiency. The PGREF will help promote the knowledge transfer and development of renewable energy (RE) and Energy Efficiency (EE) projects under PPP mode, between the partner organizations and also establish permanent links between business community and Governments of both countries. It will also help build the capacity of manpower and service providers through training programs in Germany and also establish training institutions of international standards in Pakistan. Important members of the PGREF include Alternate Energy Development Board, Energy Department Punjab, Pakistan and German Solar Associations, and German Pakistan Trade Investment organization.

Mr.Asad Rehman Gilani, Secretary Energy Department welcomed the representatives of GIZ / German Embassy and briefed the participants about potential, initiatives taken by Punjab Government on promotion of renewable energy and energy efficiency measures in the Punjab province. He also explained the objectives of PGREF and expected role of PGREF in future.

Potential of Biomass Power Generation in Pakistan

Dr. Muhammad Ghaffar Doggar

Summary

Majority of the people in Pakistan do not have reliable access to the grid electricity, either because they are not connected with grid, or because they experience daily black-outs which last for 12 hours per day. The power shortfall (5000 MW) has severely hampered the economic development and job creation across the country. The economic cost to economy due to power interruptions is estimated around 7% of the GDP.

The problem of electricity shortage is more severe in the rural areas and 30% people do not have access to electricity. At farm level the electricity supply is more worse. In past decade the cost of electricity and diesel oil has increased manifolds as such the profitability of farms has been reduced. Farmers therefore, look for alternate energy sources. One option is to use crops residue for electricity generation through combustion power plants. Pakistan being agriculture country produces all types of crops and the crops biomass is available in all areas of the country. It has been estimated that 12,000 GWh of electricity can be produced through power plants using 25% of the available crops residue of major crops every year. This paper describes the potential of crops biomass in Pakistan and discusses its role in mitigating the energy crisis. It also explains the installed power plants based on bagasse and crops residue and their capacity.

Introduction

Agriculture is the most important sector of Pakistan. It contributes 21% to national GDP, employs 43% of the labor force and have major share in exports[1]. Agriculture sector consumes 1.5% of the commercial energy [2]. Major crops produced are wheat, sugarcane, cotton, maize and paddy. The minor crops like mustard, millet, barley, sunflower, groundnut, gram etc. are also a source of food and income to farmers. The crops residue left over after harvesting is collected by traditional methods and used as animal feed, for domestic cooking etc. and also burnt in field.

The burning of crops residues is very common in Pakistan; it destroys the soil fertility by removing nitrogen and sulfur depriving the soil from nutrients and increased greenhouse gas emissions thus polluting the environment. Further, it kills favorable bacteria in soil. As the smoke travels surprisingly long distances so caused large number of people to suffer from respiratory diseases.

Major reasons for burning of crops residue are the short time between rice harvesting and sowing of wheat crop. The left over straw in field poses a great problem to timely sowing of next crop in case of combine harvested fields and also require huge amount of energy in field preparation.

The farmers need alternative equipment to manage crop residues e.g. baling, briquetting, pelletizing etc., and used these as fuel later on. The economics and adaptability of each method of collection and treatment is to be analyzed. The bales can be transported to power plants to generate power and are the most common method of treatment.

Table 1: Biomass Yield Factors [3,5]

Crop	Biomass	Biomass Yield Factor
Wheat	Straw	100%
Sugarcane	Tops	20%
Sugarcane	Trash	10%
Sugarcane	Bagasse	40%
Cotton	Stalk	425%
Maize	Stalk	225%
Paddy	Straw	130%

Potential of Crops in Pakistan

According to Iqbal 2014, about 81 million ton of crops biomass is produced every year in Pakistan and up to 25-30% of the total residue [4] can be easily used for power generation. The resource potential for selected crops is discussed below:

l Wheat is the leading food grain and staple diet for the people of Pakistan. It accounts for 10.3% of the value addition in agriculture and contributes 2.2% to the national GDP. During the year 2012-13, 25.3 million ton of wheat was produced from 9.05 million hectare[1] which generated equal amount of wheat stalk. The wheat stalk is used as animals feed or burnt in field. Exact information on the amount of wheat stalk burnt in field is not available as such it is assumed that wheat crop residue shall not be available for power generation.

l Cotton is a major source of foreign exchange earnings and supplies raw material to local cotton ginning and textile industry. During 2012-13, 13 million bales @170 kg each, were produced which generated 9.42 million ton of cotton residue [1]. Pakistan earns about 10.4 billion US$ per annum by exporting cotton products and bales to other countries. The cotton sticks are also used for domestic cooking and burnt in brick kiln industry. According to Punjab Agriculture Department about 48% cotton sticks are net available for power generation (4.5 million ton), excluding local consumption [3].

l Rice accounts for 3.1% of the value addition in agriculture and contributes 0.7% to the national GDP. Pakistan earns foreign exchange @1.70 billion US$ per annum, from export of rice [1]. During 2012-13, 6.17 million ton rice was produced which produced 8 million ton of residue in the form of paddy straw and husk.

l Sugar cane crop is source of raw material to sugar industry. It accounts for 3.4% value addition in agriculture and have 0.7% share in the national GDP. During 2012-13, 63.75 million ton sugar cane was produced [1]with crop residue of 19.15 million ton per annum. The sugarcane trash is normally left in field or is burnt; it is also a free waste collected by needy people in rural areas. The trash constitutes 5%-10%, tops 15%-20%, bagasse 15% and remaining is juice content. Tops are also used as animal feed so it is assumed that 50% of trash and tops shall be available for power generation.

l Maize is an important food crop for the people of Pakistan and a major source for industry (producing as corn flour, pop corn and corn pastes etc.). It contributes 2.1% value addition in agriculture and 0.4% to the national GDP. During 2012-13, 4.22 million ton maize was produced which generated 9.7 million ton of stalk and cob.

Potential of Biomass Crops in Pakistan

Agriculture Department, Punjab Government conducted a survey on crops biomass resource base during the year 2013. A sample size of 7200 farmers from all over Punjab was selected using computer software. Information on crops biomass production, local consumption and net available was collected. The data on rice husk and cotton ginning wastes was also collected from all the industrial units located in the province. The collected data was analyzed using computer software and potential of biomass for each major crop was calculated as shown below:

Table 2: Crops Biomass Resource Potential in Punjab (MILLION TON)[3]

Description	Crop						
	S/Cane	Wheat	Rice	Cotton	Maize	TOTAL	
Production	Million	44.783	18.62	3.476	4.487	3.354	-
Residue		9.514	18.541	4.513	18.675	7.186	58.429
Local Consumption		3.526	12.27	2.880	8.723	3.169	30.571
Surplus Biomass		5.988	6.268	1.633	9.952	4.017	27.858

Another study on crops biomass in 8 districts of Punjab was conducted by GIZ for Masood Textile Mills Faisalabad [5]. It was concluded that about 10.8 million ton of crops biomass is available for power generation in these 8 districts and the data conforms with the data collected during survey by Agriculture Department from 36 districts.

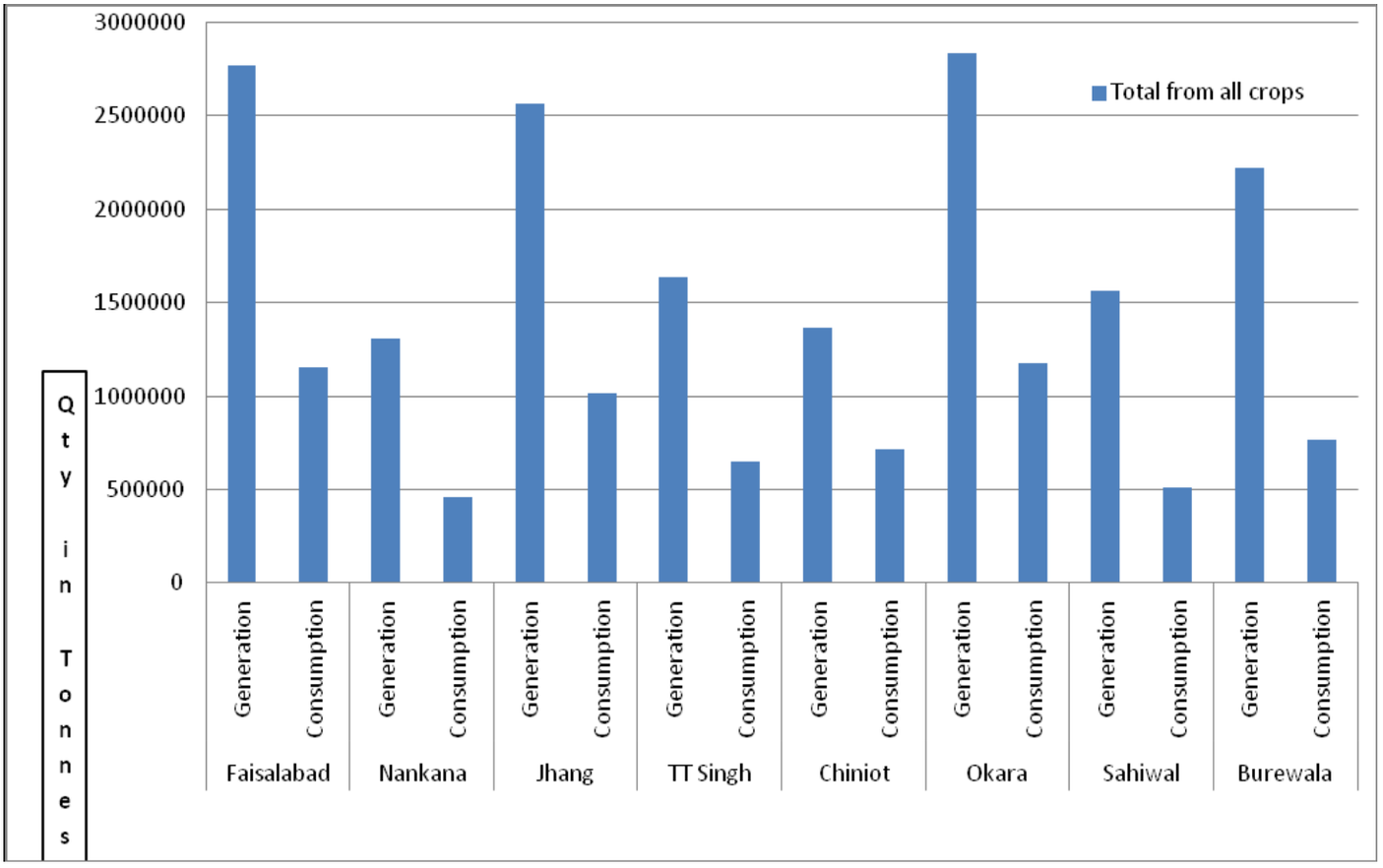


Figure 1: Biomass Resource Base Potential [5]

Seasonal Availability of Biomass Crops

There is a large variability in crop residues generation and their uses in different areas of Pakistan depending on the cropping intensity, productivity and crops grown. Seasonal availability of major and minor crops residue is shown in Table 3. Except for two months of February and March, major crops residue can be to power plants all the year. The minor crops can supply additional residue during February and March and in other months. Thus there should be no problem in operating biomass power plants all the year round.

Calorific Value of Crops Biomass

The calorific values of crops residue show the energy potential to generate power. The data is available in literature but best values can be obtained by labs analysis of crops residue of specific site under feasibility study. In this case the data analyzed by M/s Spectro Analytical Labs. New Delhi India during 2014 and by PCSIR labs. Pakistan using actual samples taken from Punjab Pakistan for feasibility of biomass power plants is presented.

Table 3: Seasonal Availability of Biomass Crops

Month	Wheat	Cotton	Rice	Corn	Mustard	Gram	Sunflower		
			Straw	Husk	Stalks	Cobs			
January	-	x	-	-	-	-	-	-	-
February	-	-	-	-	-	-	x	-	-
March	-	-	-	-	-	-	x	-	-
April	x	-	-	x	-	-	x	x	-
May	x	-	-	x	-	-	-	x	-
June	x	-	-	x	x	x	-	-	x
July	-	-	-	x	x	x	-	-	x
August	-	-	-	x	-	x	-	-	-
Sept.	-	-	-	x		x	-	-	-
October	-	x	x	x	x	x	-	-	-
November	-	x	x	x	x	x	-	-	-
December	-	x	x	x	-	x	-	-	-

Power Potential of Selected Crops

In order to estimate the biomass potential for power generation, information of biomass, its characteristics and calorific value and efficiency of power plant are required. Here we consider major crops for estimating power generation potential. Based upon the survey results (2013), 52% of the crops residue is utilized locally and about 48% is available for power generation. Based on 25% of net available crops residue the power potential has been calculated using the following relation:

Gwh of electricity = (LCV in Kcal per kg)* Crop Residue in Million Kg * 0.25/ (860)

Table 4: Calorific Values of Different Crops

Biomass	Lower Calorific Value (Kcal/kg)	MJ per kg	MJ per Ton	GJ per Ton	Kwh Thermal
Paddy straw	3388	11.4	10191	10	4.00
Rice husk	3200	11.5	9710	10	3.72
Sugarcane	3536	14.4	13435	13	4.11
Wheat straw	3118	14.4	11847	12	3.62
Cotton sticks	3957	17.8	18584	19	4.60
Maize stalks	3559	13.3	12489	12	4.14
Maize cob	3850	14.6	14831	15	4.48
Gawar straw	3436	15	13599	14	4
Gram stalk	3810	14.4	14476	14	4.43

1 Kcal per kg = 3.796 MJ/ton = 0.00379 GJ/ton, 1 KWh thermal = 860 Kcal/kg

Pakistan could produce about 12,000 GWh of electricity using 25% of the available crops biomass every year. If biomass is collected efficiently the power potential will increase proportionately.

Table 5: Power Generation Potential in Pakistan

Crop	Total Crop Residue (Million Ton)	25% of Total Production (Million Ton)	Power Potential (GWh)
Wheat	25.3	6.32	Not Available for power generation
Cotton	9.42	2.36	2720
Maize	9.7	2.43	2615
Sugar cane	19.2	4.8	4800
Rice	8	2	1970
Total:	71.62	17.9	12105

Biomass Power Plants in Pakistan

In Pakistan few industrial units have installed biomass combustion plants under captive mode, mainly to meet their electricity demand and avoid impact of load shedding on industrial output. The boilers of biomass power plants are multi fuels and can be operated on biomass and coal. Selected sugar mills have installed bagasse based plants to generate electricity. The location of power plants is well away from each other. The experience of biomass power plants concludes that prices of crops biomass are increased substantially i.e. Rs. 4000 to Rs. 10,000 per ton, after the power plants were operational [8]. There is no sustainable supply chain mechanism for collecting, treatment and supply of biomass from farmer's field to plant sites. The middle man is supplying the biomass in loose form, not baled straw, and is enjoying high profit margins. Adulteration - mixing of stones in biomass, is also being observed due to which the boiler tubes and other mechanical components are deteriorated and plants remained shut down over prolonged periods, hence affecting the output and loss to operators. Thus they are shifting from crops biomass to coal. The cost and quality of imported coals are better than crops biomass hence the operators prefer to use coal for their plants.

Table 6: Status of Biomass Power Plants in Pakistan [8,9,10]

Industry	Type	Size	Status
Nishaat Textiles Private Limited Lahore	Combustion, Multi fuels, Captive mode	12 MW	Operational since 2013
Engro Rice Mills S/puraMuredkey Road		4.5 MW	Operational since 2014
Al Rahman Gardens JaranwalaRoad,Lahore		5 MW	Operational since 2014
Packages Pvt. Limited Kasur		41 MW	Pipe line
ICI Private Limited		30 MW	Pipe line
Orient Power Pvt Limited		10 MW	Pipe line
JDW Sugar Mills Ltd (Unit-II), R.Y. Khan	Bagasse	26.35 MW	In operation
JDW Sugar Mills Ltd (Unit-III) at Ghotiki	- do -	26.35 MW	In operation
M/s Chiniot Power Ltd at Chiniot, Punjab	- do -	62.40 MW	Financial close achieved
M/s RYK Mills Limited Punjab	- do -	30 MW	Financial close under review

Conclusion

Pakistan can mitigate power crisis to great extent by utilizing 25%-30% of the available crops residue in the country. This will not affect the local consumption of crops residue for other purposes such as for domestic cooking and boilers heating etc. Punjab alone can supply 27 million ton of crops residue to power plants and can ensure sustainable supply all the year round. The installed power plants in Pakistan are mostly bagasse based and were established near sugar mills. Using crops residue of rice, cotton, maize and other crops, more power plants can be installed in groups of districts or zones. The Government should allocate areas / zones for installing power plants and prohibit shifting of crops residue to other zones. This will keep the supply of crops biomass to power plants at reasonable prices hence ensure producing cheap electricity. Awareness campaigns for collection, transport and storage of crops residue need to be carried out and farmers may be given training for using machinery for the purposes. The Government may offer incentives to firms and individual farmers for collection and supply of biomass so as to promote the culture of sale of crops residue to power plants.

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Bio Harvesting of Carbon Dioxide to Biofuel

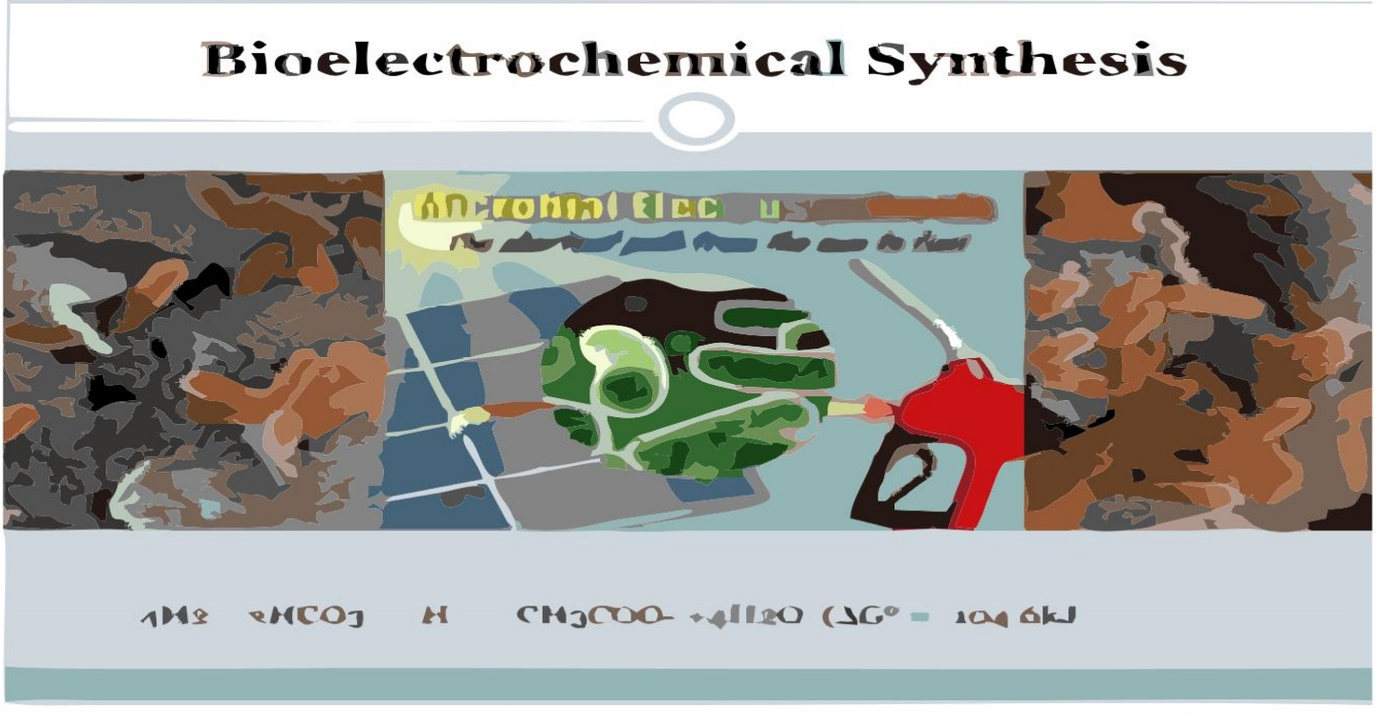
Gugan Jabeen, Dr. Robina Farooq

Department of Chemical Engineering, COMSATS Institute of Information Technology, Lahore, Pakistan

The drastic consumption of fossil fuels has increased greenhouse gases in air which is the main culprit for climate change dragging humanity to sever droughts in some areas and flooding in others, resulting in food scarcity and water shortage problems. Pakistan is one of the victim of yearly floods and recent episodes of droughts in Thar and in Cholistan. Solutions are required to fix greenhouse gases and convert them into value added products in the form of renewable chemicals and biofuels.

The depleting fossil fuel resources, non-transportable renewable energies and use of agricultural land for biofuel production, etc. require sustainable solution of globally declared major challenges faced by humanity. Different processes are being used to fix green house gases and to produce biochemical which includes electro-catalytic reduction of CO_2, fermentation, enzymatic catalysis, etc. The electro-catalytically reduction of CO_2 by using a range of different inorganic and organometallic catalysts are to fix atmospheric carbon dioxide to low chain organic compounds. No process has been successfully commercialized because the processes developed to date either have poor thermodynamic, low current efficiency, low selectivity, slow kinetics, poor stability and high cost of metal catalysts, etc. The electrochemical fixation of CO_2 is also plagued with electrode poisoning, high cost of electrodes, use of hazardous solvents for concentrating CO_2, fouling of electrodes by any byproducts, etc.

The fermentation process is used for the synthesis of chemicals but this process requires either the use of food commodities, agricultural land or fossil fuels. The use of enzyme as catalyst in electrochemical synthesis has limitations due to denaturing of enzyme. Therefore, the sustainable production of renewable bio-chemicals is presently fueling the debate on the sustainable synthesis of biofuels and bio-chemicals. Powering microbes with electricity to produce various organic like volatile fatty acids, alcohols and Polyhydroxyalkanoates (PHA) has recently gained much attention as a bio sustainable strategy to minimize our dependence on fossil fuels. Bio-electrochemical synthesis (BES) a beneficial key technique, has been extensively studied in the recent years. Bio-electrochemical synthesis is a technique in which electro autotrophic bacteria utilize electric current as a sole electron source from cathode to reduce CO_2 to extracellular multi carbon exquisite products through an autotrophic conversion.



The anaerobic and facultative acetogens like Sporomusaovata, Clostridium ljungdahlii and Cupriavidusnecator have been focused to convert waste greenhouse gas like CO_2 into volatile fatty acids, alcohols and Polyhydroxyalkanoates PHA. The synthesis of heptanoic acid, heptanol, hexanoic acid and hexanol first time by Clostridium ljungdahlii and Sporomusaovata was a remarkable achievement of bio-electrochemical synthesis.

This feature has potential to make these electrotrophs beneficial for biotech industry. Microbial bio-electrochemical synthesis was employed first time to yield high quality polyesters Polyhydroxyalkanoates (while fermentation process was followed before) merely from cheap and low cost substrates like molasses and waste greenhouse gas CO_2. The two stage strategy heterotrophic-autotrophic growth was integrated in this system for bio-mass and PHB production.

The intracellular Polyhydroxyalkanoates accumulates as granules inside the cells are environment friendly thermoplastics. The novel extraction techniques for the recovery of granules of carbon and energy reserves from cell dry mass has made PHA more attractive commercially for its medicinal use. These microorganisms were cultivated on the cathode of microbial fuel cell poised at -400mV by DC power supply at 30, 32, 370C and pH 6.8 respectively was studied for both batch and continuous systems. Bio-cathode development enhanced the electro activity of cells resulted in maximum extracellular products in less time duration.

The net outcome is the renewable energy which is stored in covalent bonds synthesized from waste greenhouse gas. The main aim of the research was to investigate the impact of low cost substrate carbon dioxide, the sugarcane molasses, sodium acetate, DSMZ media and supplement for bio-electrochemical synthesis of poly (3-hydroxybutyrate), P3HB, volatile fatty acids and alcohols. The exceeding cathode recovery range was attributed by bacterial reduction of carbon dioxide to multi carbon chemical commodities with electron driven from cathode. Reactor designing was simplified for cost effectiveness and to enhance energy efficiencies. The overall recovery was more than 90% due to the redox electro activity of autotrophs. The Coulombic recovery of ethanoic acid, ethanol, ethyl butyrate, hexanoic acid, heptanoic acid and hexanol was more than 80% proved the BES a remarkable technology.

Our studies showed that fixing of CO_2 not only has potential to reduce global warming but also help to reduce dependence on fossil fuels and provides solution for sustainable biofuel production. Extensive R & D is required before BES technology be used for the benefit of humanity.

Recent Research proves that Pak geothermal energy resources have potential to generate 100,000MW power

Pakistan is found to have been blessed with the potential of huge geothermal energy resources that could generate 100,000MW electricity at the cost of 5-10 cents per unit depending upon different locations of the power plants.

Geothermal energy is the energy stored in the form of heat below the earth's surface. Its potential is limitless in human terms and its energy is comparable to the sun. Geothermal heat and water have been used for thousands of years. The Romans, Chinese and Native Americans used hot mineral springs for bathing, cooking and for therapeutic purposes.

Today geothermal water is used in many applications such as district heating, systems which provide steam or hot water to multiple units as well as for heating and cooling of individual buildings, including offices, shops and residential houses, by using geothermal heat pumps. Moreover, it has industrial potential for raising plants in greenhouses, drying crops, heating water at fish farms and other industrial processes.

For close to 100 years geothermal energy is used for electricity generation, space heating and cooling of buildings, supply of hot water, green houses, fish farming and setting up of small industries requiring heat.

Facts and Figures of Energy Potential of Pakistan

- In only the Balochistan and Sindh provinces, sufficient wind exists to power every coastal village in the country. There also exists a corridor between Gharo and Keti Bandar that alone could produce between 40,000 and 50,000 MW of electricity.

- If 0.25% of Balochistan was covered with solar panels with an efficiency of 20%, enough electricity would be generated to cover all of Pakistan demand.

- Pakistan holds fifth largest coal deposits in the world that are enough to generate power for more than 70 years

- As is well known, hydroelectric power is the cheapest, cleanest and indigenous form of energy, Pakistan has identified potential of 65,000 MW.

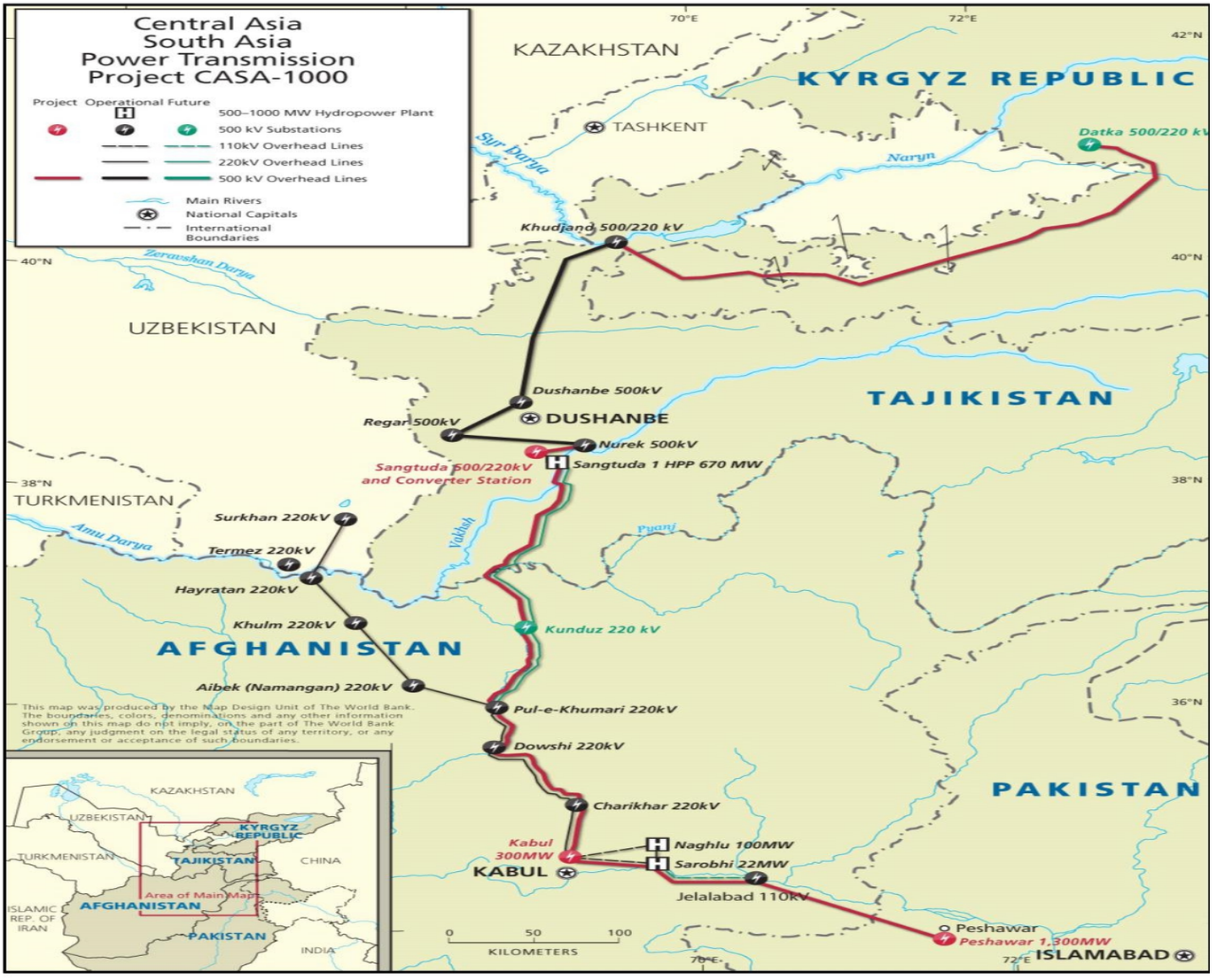
Untapped Micro hydro power potential of Sindh and Punjab on Canals and Barrages

Irrigation is the man-made supply of water to the land to encourage vegetation. It is a substitute for inadequate or erratic rainfall and is extremely essential for arid regions where there are no rivers and also in humid regions to improve crop output. In Pakistan, 75% of the agricultural land is under irrigation. Pakistan has one of the largest canal irrigation systems in the world. These canals are taken from dams and barrages and supply water to the fields throughout the year. In Pakistan there are 3 large dams, 85 small dams, 19 barrages, 12 inter link canals, 45 canals and 0.7 million tube wells to meet the commercial, domestic and irrigation needs of the country. Besides it important in agriculture sector, Canals have been utilized as a power generation source also. Specialize low head turbines are used for harnessing power through these canals. Pakistan as mentioned above has one of the largest canal irrigation systems in the world. As many as 591 potential sites at different river falls, canals and barrages, with medium and low head and high discharge, having a total capacity of more than 5,000 MW have been identified. Pre-feasibility studies for 35 raw-site projects of cumulative 350 MW capacities have been conducted. In addition, detailed feasibility reports of another 12 projects of about 50 MW total capacities are available. Whereas According to the sources of the Private Power and Infrastructure Board (PPIB), six potential sites of an estimated total capacity of 178 MW have been identified in Sindh province, with medium and low head, ranging from small to medium projects. These include Guddu Barrage Project of 33.5 MW capacity and Rohri Project of 16 MW capacity to be located at Rohri Canal—RD 15+000. Feasibility studies for these projects were completed almost ten years ago but implementation of these projects could not be undertaken. The raw site projects for which feasibilities are required to be prepared include, NaiGaj Fall Project of gross capacity 80 MW, proposed to be located at Gaj River in Kirthar Mountain Range. Three other raw sites known as Sukkur Projects, with cumulative capacity of 48.55 MW are proposed at the Indus River/Nara Canal, of capacities 22.51 MW, 18.15 MW and 7.85 MW.

Electricity Transfer Project CASA-1000 MW

To cope with the ever increasing power demand of Pakistan, 1,000 MW electricity transfer project has been taken on. Kazakhstan and Tajikistan will transfer 1300 MW of electricity to Afghanistan and Pakistan. The expected electric power in Pakistan is 1000 MW while 300MW will be utilized by Afghanistan.

Using CASA-1000 MW, 1,000MW would meet only 20% of shortfall of 5,000MW to 6,000MW. CASA-1000 will build more than 1,200 kilometers of electricity transmission lines and associated substations to transmit excess summer hydro power energy from existing power generation stations in Tajikistan and the Krgyz Republic to Pakistan and Afghanistan. This project would not only alleviate electricity shortages in Pakistan but would also replace fuel based electricity generation for Afghanistan and Pakistan, it would also establish Afghanistan as a viable transit country and offer transmission capacity for other countries during the off peak season.



MIT coal power plant cuts emissions to half

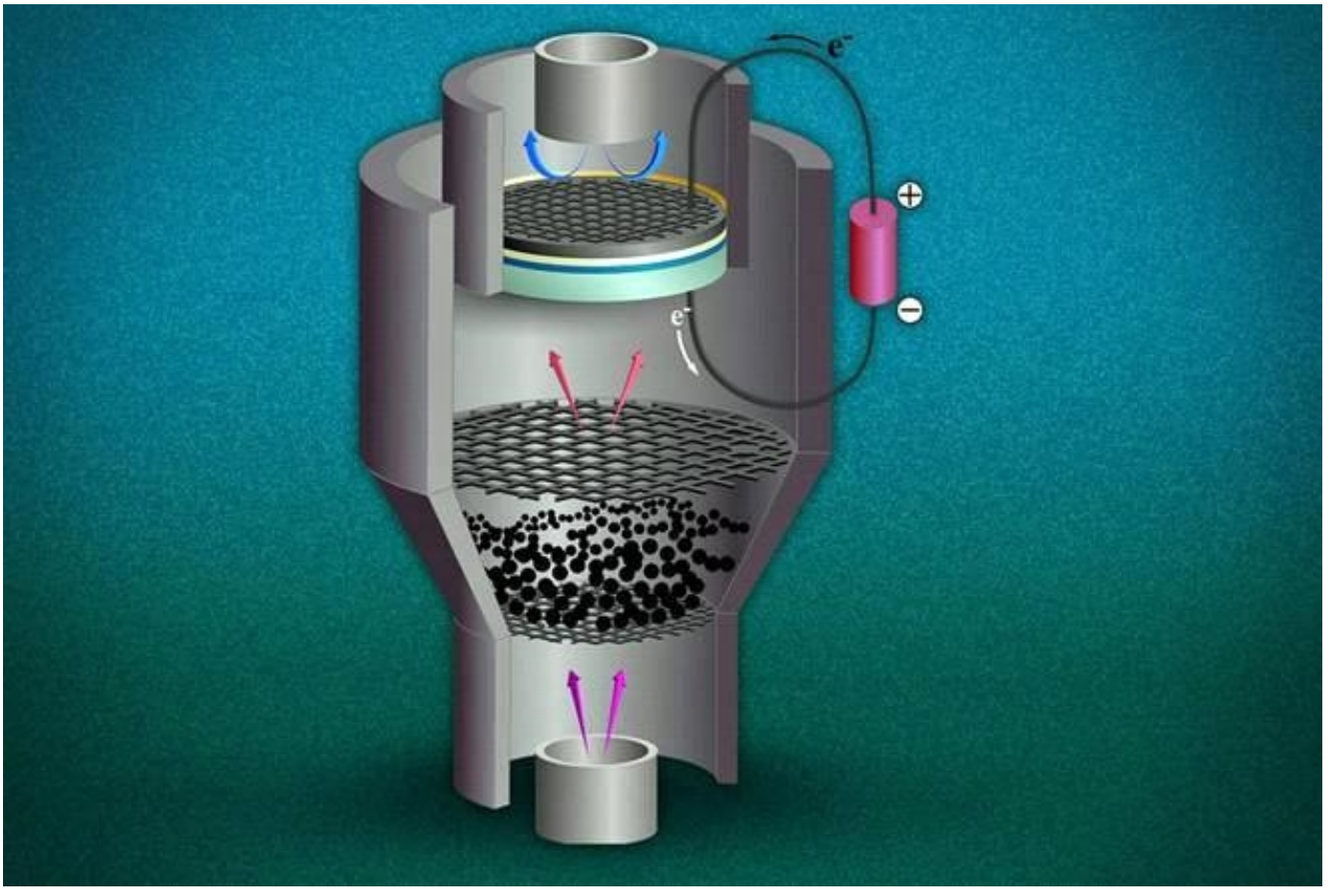
MIT researchers have brought efficient and comparatively better way to burn coal that will help to reduce pollutant emissions. Coal has been utilized as a major source of power generation from decades. Once coal has been mined and processed, the vast majority of it is sent to power plants. This is the second major phase in the dirty life cycle of coal. Coal burning power stations continue to speed up global warming by filling the atmosphere with vast amounts of carbon dioxide. Coal burning leads to acid rain and smog, and emits more than 60 different hazardous air pollutants such as a variety of toxic metals, organic compounds, acid gases, sulfur, nitrogen, carbon dioxide and particulate matter.

On average one 500-megawatt coal-fired power plant produces approximately 3 million tons/year of CO_2. Each plant's emissions depend on its size and efficiency. A single power station in Martins Lake, Texas emitted more than 21 million tons of CO_2 in 2006 - more CO_2 than Slovenia, Estonia, Bolivia or Afghanistan emitted in 2004. Worldwide, the 25 worst CO_2 polluting power plants all burn coal. According to CARMA, these plants are responsible for over 570 million metric tons of CO_2 emissions, the equivalent to the UK's yearly fossil fuel related CO_2 emissions. Coal-burning power plants are a significant source of Sulphur dioxide (SO_2) and nitrogen oxides (NOx), which are major players in acid rain and ground level ozone (smog).Nitrogen oxides are also greenhouse gasses that react with organic compounds to form smog, which damages plant life, making it vulnerable to disease and extreme weather. It can also impair human health by causing increased risk of asthma, lung damage and premature death.

Acid rain occurs when SO_2 and NOX interact with water, oxygen, and other chemicals in the air to form sulphuric acid and nitric acid. This toxin can fall from the sky in rain over a widespread area, killing fish and plants. Forests are also impacted via direct damage to foliage and where forest soils have been stripped of nutrients by acid rain. The shocking impacts of acid rain on forests around the world have led to progress, in curbing toxic rain in the US and Europe for example, but it is estimated that acid rain still falls on 30 percent of the land in China, and on hundreds of its cities. The fact remains that coal is still by far the single biggest source of sulphur emissions caused by power generation. In 2004, 95 percent of the 10.3 million tons of SO_2, and 90 percent of the 3.9 million tons of NOx, released into the atmosphere by US power plants came from ones fueled by coal.

MIT proposes a better way to 'burn' coal. MIT doctoral student Katherine Ong and Professor Ahmed Ghoniem suggest a smarter way. They have published a paper in the Journal of Power Sources, modeling of indirect carbon fuel cell systems with steam and dry gasification which shows that a new type of power plant could double the efficiency of power generation from coal. Doubling the efficiency means half the emissions for the same amount of electricity generated. That's all emissions, including the metals, smog, and other contaminants in addition to the greenhouse gases like Co_2.

The accompanying illustration demonstrates how more efficient coal use works:"At the bottom, steam (pink arrows) passes through pulverized coal, releasing gaseous fuel (red arrows) made up of hydrogen and carbon monoxide. This fuel goes into a solid oxide fuel cell (disks near top), where it reacts with oxygen from the air (blue arrows) to produce electricity (loop at right)." Many coal plants use gasification today, but send the gases to a combustion and steam turbine process for recovery of energy. Standard coal plants achieve only about 30% efficiency, rising to 38% in modern fully integrated plants with substantial heat recovery optimization. Simulation models by the MIT team indicate that efficiency of 55 to 60% could be achieved with their power plant.



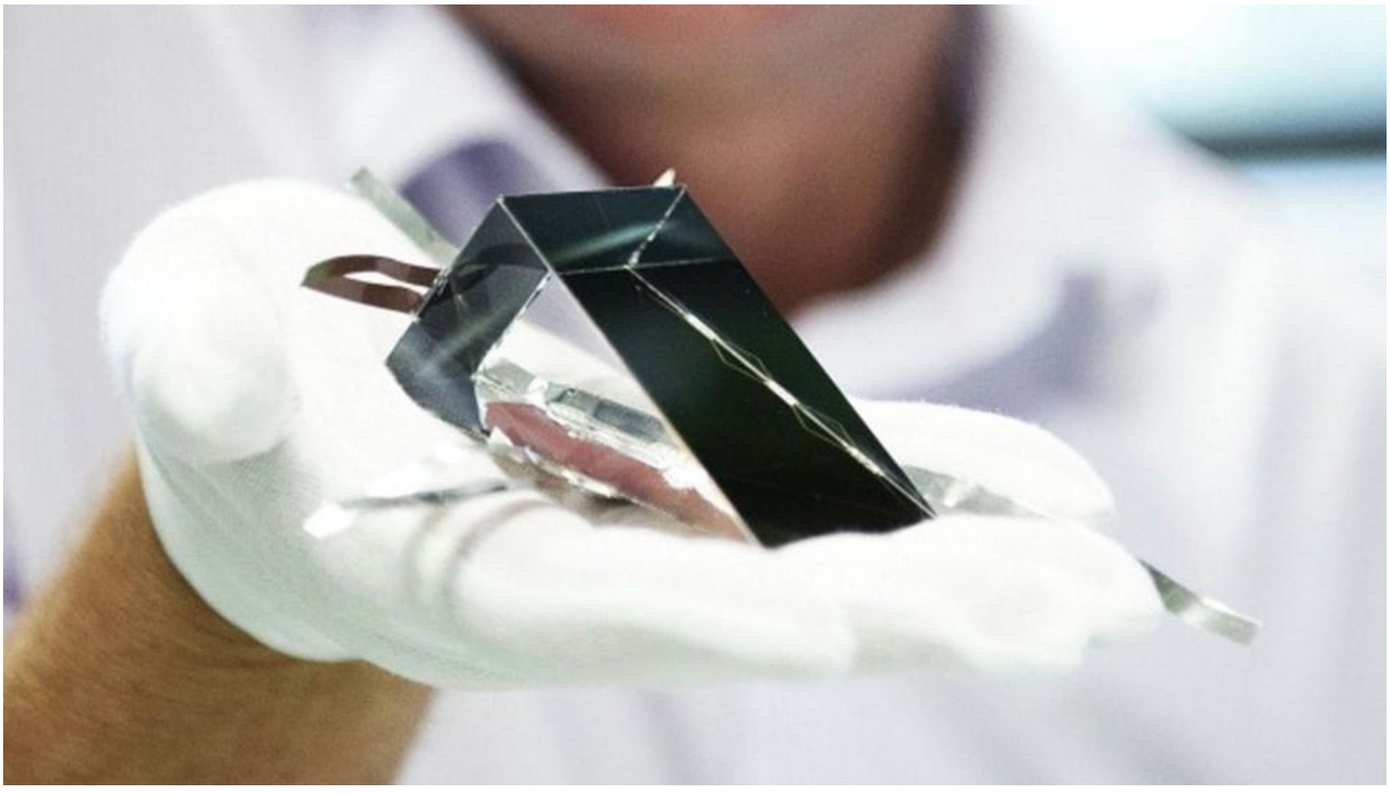
The technology would cost more up front, but the investment could be recouped in several years with the higher efficiency, making the proposal acceptable under most capital investment strategies.

UNSW, Australia Researchers Break Solar Efficiency Record for Unfocused Sunlight

Researchers at the University of New South Wales (UNSW) have utilized the light-trapping effects of a simple prism to dramatically boost the efficiency of solar cells.

Martin Green and Mark Keevers said the device they have built has set a world record for sunlight-to-electricity efficiency using "unfocused light" – the sort of sun that hits our roofs.

The UNSW team said its mini-module converts 34.5 per cent of received solar energy into electricity. The result, confirmed by the US National Renewable Energy Laboratory, has eclipsed the 24 per cent efficiency achieved by an 800-square-centimetre commercial module made by Alta Devices in the US. The UNSW module is 28 square centimeters. Typical efficiency for commercially available solar panels is 14 to 22 per cent.



Punjab Energy Efficiency & Conservation Agency Lahore

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