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COMSATS ENERGY RESEARCH CENTER

COMSATS Institute of Information Technology, Lahore

Contents

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Seminar on Coal Based Power Generation in Pakistan; Potential, Utilization and Constraints

A seminar on "Coal based Power Generation in Pakistan: Potential, Utilization and Constraints" was arranged by the COMSATS Energy Research Center in collaboration with the Kot Addu Power Company (KAPCO) on 29th March, 2017 at the CIIT, Lahore. The key objectives of the seminar were to deliberate on potential of coal energy in Pakistan, associated constraints and possible solutions. Mr. Khalid Saeed, Head ERC, in his welcome address elaborated on the current situation of Pakistan's energy sector and role of coal in country's energy mix. He stated that excessive reliance on imported furnace oil, subject to wide price fluctuation, depleting domestic gas resources and a complete absence of coal as a fuel for power generation have resulted in unsustainable costs for electricity generation. Mr. Khalid Saeed discussed the global coal utilization trends where 40% of the global energy needs are fulfilled using coal energy. He further stated that Coal is also an essential raw material in 70% of steel and 90% of world's cement production.

Despite serious environmental concerns raised in the developed countries, even today, coal still continues to hold an important place in the power generation mix for these countries. Mr. Khalid Saeed laid emphasis on the need for addition of coal as a primary fuel mix in pursuance of Pakistan's power policy 2014. He stated that with the growth of renewable energy and environmental issues regarding coal based power generation, there has been a growing concern about coal as a fuel for electricity generation due to its pollution and high emission of carbon dioxide. Notwithstanding these concerns, however, he stated that the recent efficiency gains in electricity generation from coal particularly by super critical and ultra-super critical technologies have contributed towards reduction of carbon dioxide emissions. The sustainability of power sector economy requires a due place for coal, a reliable and affordable material, as a base load fuel for our power generation. Discussing coal production in Pakistan, Mr. Khalid Saeed anticipated that with the ongoing work on the Thar coal project and also a number of other projects in the public and private sectors currently in various phases of implementation, it is expected that coal will be contributing around 18% to the country's power generation by 2020-2021.

In his concluding remarks, Mr. Khalid Saeed on behalf of COMSATS IIT Lahore and Team ERC presented vote of thanks to all the experts/speakers, audience and seminar collaborators (KAPCO) for their presence and participation at the event.

Professor Dr. Shahid Muneer, Director Coal Research Center, University of the Punjab discussed the prospects and challenges of indigenous coal. While discussing the local power situation of Pakistan, he stated that Pakistan has been facing acute energy crisis since 2005 due to unfavorable and expensive fuel mix. Furnace oil and gas has been utilized as a major fuel source for the country where hydel energy share gradually decreased over the years. Presently, Pakistan imports Rs. 9.7 billion worth furnace oil to meet its demand. It is worth mentioning that Pakistan is fast losing the natural gas reserves which will result in the depletion of gas reserves in near future. International Energy Agency has forecasted that total electricity demand of Pakistan will be 49078 MW in 2025. Talking about the indigenous coal reserves, he stated that, Pakistan is only utilizing 0.1% of the indigenous coal. Dr. Shahid identified some key drawbacks of the indigenous coal like high sulphur, moisture and ash contents. Nevertheless, these bottlenecks can be overcome by using state of the art efficient coal power plant technologies like ultra-critical and super critical plants. Discussing the magnitude of the indigenous coal reserves, alone Thar coal holds 175 billion tones coal reserves that can fulfill energy demand of the country for 500 years whereas this huge potential is more than the cumulative oil reserve of Iran and Saudi Arabia. Dr. Shahid made recommendations for the utilization of indigenous coal as follows;

- Existing oil based power plants be converted to coal.
- Punjab Government should get lease of at least one block in Thar and proceed for Open Pit Mining to extract coal out that can feed coal-fired power plants in Punjab for many decades. This strategy can not only enhance industrial growth in Punjab but also increase the rate of industrialization as well.
- After eighteenth amendment, Provinces can produce their own electricity. KPK can invest in the construction of small Dams under liberal public-private partnership policy. Baluchistan Government can invest in modern coal mining, coal up-gradation and power generation.
- For the realization of Pakistani coal in all the provinces other than Thar Coal, tunnel mining may be carried out for which a different kind of infrastructural development is required. According to SNOWDEN report, Punjab has at least 600 Million tons of Bituminous D grade coal. That means that it is sufficient to generate 5,000 MW for 20 years. SNOWDEN has declared this coal suitable for power generation. In this regard, our bottle neck is mining. Electricity cannot be generated unless coal is extracted out. Currently, we don't have the capacity, technology and skills to extract coal.
- A School of mines exists in Punjab that has lost its capacity to deliver. It is suggested to hire foreign faculty and equipment from Australia/China etc. to train miners.
- Pakistan is 5th largest producer of sugar cane in the world. Pakistan has approximately 24 million tons of bagasse & 22 million tons of cotton stalks that can generate about 3,000 MW of electricity. Sugar mills produce their own electricity from bagasse during sugar cane season. These biomasses should be co-fired with coal for electricity generation in sugar mills.

- Government should establish Coal Silos for storage and blending outside the coal-fired power plants along with Coal Testing Laboratories to ensure regular supply of coal with the requisite specifications to the power plants.
- For the transportation of coal to power plants at various locations, a strong coal supply chain management system will be required. For this purpose, there is a need to increase the role of the Punjab Mineral Company. For this, the role of NLC and Pakistan Railway would also be crucial.

Dr. Muhammad Javaid Ahmed from Kot Addu Power Company Limited (KAPCO) discussed the coal generation of Pakistan, its prospects and constraints. Dr. Javaid discussed KAPCO's contributions in the power sector of Pakistan. Being one of the biggest IPP, KAPCO generated approximately 6% of Pakistan's total electricity generation in 2013. Having an installed capacity of 1,600 MW, dependable capacity of 1,345MW, 10 Multi-Fuel fired Gas Turbines and 5 Steam Turbine. KAPCO has been contributing as one of the key power generation source in the country. Dr. Javaid also discussed the features of KAPCO'S tri-plant that can be operated on coal, furnace oil and natural gas.

A brief history of planned and installed coal power plants in Pakistan was discussed. Dr. Javaid also discussed global giant coal consumers where China ranked at top with the 669,259 MW generation through coal. Table shows the global coal consumption. Pakistan having 184 billon tons of Coal stands at the bottom with only 1 unit having generation capacity of 150 MW.

Table 1 Power Generation through coal

Country	Coal Power Units	Total Capacity MW
China	2929	669,259
United States	1368	336,332
India	809	100,540
Germany	273	51,071
Russia	487	50,456
Japan	155	41,031
South Africa	114	37,500
Australia	109	29,971
Korea	86	26,296
Poland	544	32,067
Pakistan	1	150

Discussing the advantages of the coal energy, Dr. Javaid put emphasis on the utility of indigenous coal reserves as it is cheaper than gas and furnace oil. Following advantages and concerns were highlighted.

Advantages:

- ✓ Cheap source of power generation, total levelized tariff will be less than other thermal plants.
- ✓ Utilized as a Base load power generation plant.
- ✓ Abundant fuel availability (Over 900 BT proven coal reserves).
- ✓ Relatively stable prices of coal over time compared to Oil and LNG.

Concerns:

- ✓ Coal transportation for imported coal projects.
- ✓ Water availability and effluent disposal for Thar projects.
- ✓ Environmental Concerns.

According to Dr. Javaid, coal should be the major part of fuel mix of Pakistan. Despite the fact that renewable power is cleaner source for the power generation, but it cannot be utilized as base load because of its inherent intermittent nature. In his concluding remarks, Dr. Javaid argued that there is a misconception that coal based power plants are shutting down, on the contrary, coal power shall still dominate as world's primary fuel mix even in 2040.

Ms. Sania Awais, Managing Director, Punjab Power Development Board, discussed the installation of coal based power plants in Punjab and associated logistics challenges and solutions. Apart from the coal composition and its characteristics Ms. Sania discussed the economic situation being affected while not adding the coal as a primary fuel mix of the country. Highlighting the economic significance of the Punjab province and its effect on the country's economy, Ms. Sania stated that, Punjab consumes 70% of the power where 60% of the industries are housed in Punjab, energy shortages in Punjab caused cut in exports in 2014 by at least $4-5 billion.

Discussing the pros and cons of the coal, Ms. Sania highlighted the following key pros and cons.

Advantages:

- Coal can be used as a base load with affordable tariff.
- Can be used as offset for less winter hydel generation.
- Comparatively clean technology is available for large coal power plants.

Disadvantages

- Transportation increases the cost
- No skilled personnel available
- No appropriate place at the port for coal handling

Ms. Sania also discussed the steps taken by Punjab government to overcome logistics issues. Discussing Sahiwal coal project, she stated that the following progress has been so far made

- Pakistan railway is constructing lines near ports where 4.5 km line has already been laid down
- PIBT terminal at PQA developed with 8-12 million ton/year coal handling capability.
- Marginal Wharf 3 & 4 at PQA is being rehabilitated - equipped with mechanized system for coal unloading from ships and loading into the Railway Wagons
- Pakistan Railways has reinforced its infrastructure, increased its rolling stock, and increased/trained its staff for these mega projects
- First ever Inland Coal Transportation Agreement between Pakistan Railways and M/s. Huaneng Shandong Ruyi Pak Energy (Pvt.) Ltd executed for the smooth transportation of coal for Sahiwal Project
- Installed Conveyor belt system – unloading ditch to stack yard
- The project of Sahiwal will start its operation by June 2017.

Prof. Dr. Fareed Malik, in his presentation, discussed the prospects of converting coal into synthetic gas. He highlighted the available 184 billion tons coal reserves of Pakistan and its composition. He also discussed the available coal reserves worldwide. Table shows the top countries rich in coal reserves where Pakistan is ranked # 2.

World's Coal Reserves

Country	Coal Reserves Billion Tones	Coal Reserves (%)	Oil Equivalent Billion Barrels
United States	274.00	24.0	887.00
Pakistan	184.00	16.1	480.00
Russia	173.00	15.1	560.00
China	126.00	11.0	407.00
India	93.00	8.1	301.00
Australia	90.00	7.9	291.00
Germany	73.00	6.4	236.00
South Africa	55.00	4.8	178.00
Ukraine	38.00	3.3	123.00
Kazakhstan	37.00	3.2	120.0

While discussing the reasons of present energy crisis, he stated that improper fuel mix in the energy policy has made us out of fuel. He further discussed that modern technological advancements have made coal comparatively cleaner source of energy then older units. While discussing the internationally deployed coal technologies, Dr. Fareed explained the integrated gasification combine cycle (IGCC) technology using TRIG system and elucidated that IGCC is the future for Thar coal. He also briefly discussed the details of coal power plant project installed at Longview Power West Virginia (WV), some key points for the project are;

- Supercritical pulverized coal fired boiler technology producing 700 MW net electric power
- Meets or exceeds Best Available Control Technology (BACT) standards by utilizing:
  - ✓ Low nitrogen oxide (Nox) burners and staged combustion
  - ✓ Selective catalytic reduction for final Nox control
  - ✓ Hydrated lime injection for acid mist control
  - ✓ 99% removal fabric filter bag house for particulate control
  - ✓ 99.5% removal of wet flue gas desulfurization (FGD) for SO_2 control
  - ✓ Lowest CO_2 emission of any coal fired plant in (WV)

Following conclusions were made by Dr. Fareed Malik

- ✓ With close to 1200 billion tons of global coal deposits it will remain an important energy resource in the future.
- ✓ Use of around 1000 million tons of Lignite coal annually calls for environmental sensitivities.
- ✓ Energy deficient nations like Pakistan have no option but to rely on their indigenous coal reserves reaching up to 30 – 40% of the mix.
- ✓ SNG will continue to be a viable option for coal rich countries like Pakistan.
- ✓ State of the art and environmental friendly technologies like IGCC hold promise for the future of coal.

Mr. Salman Rehman, Deputy Director, National Electric Power Regulatory Authority (NEPRA) discussed NEPRA's perspective on the coal based power plant. Mr. Salman introduced NEPRA, its objective, mission and vision. He further briefly discussed the energy mix of Pakistan. Mr. Salman highlighted the concept of generation cost and its significance in the power plant economics. He stated that the generation cost is the most important factor and advantage associated with indigenous coal is that it is cheapest in terms of generation cost and it can work as a base load generation. Solar energy is intermittent and cannot work as a base load though the price of solar power is decreasing but still it cannot work as base load.

Discussing the China Pakistan Economic Corridor (CPEC), Mr. Salman stated that 75% of the investment is planned for energy projects under the CPEC where major power plants are coal based. Another advantage is that we are adopting coal energy in the modern era where less pollutant and more efficient power plants are available which will cause less emissions. Discussing the NEPRA's view on coal Mr. Salman said that upfront tariff for coal was given by NEPRA in 2014. Mr. Salman also discussed the projects with license/tariff approval. Table shows that project awarded with license/tariff approval by NEPRA.

Projects Awarded with License/tariff Approval by NEPRA

Project Name	Source	Capacity	Location
Port Qasim Project (CPEC)*	Imported	1320 MW (660×2)	Port Qasim Karachi
HUBCO-SPIH (CPEC)		1320 MW (660×2)	HUB, Baluchistan
Grange Power		163 MW	PakPattan, Punjab
Sahiwal Power Project (CPEC)*		1320 MW (660×2)	Sahiwal, Punjab
KAPCO		660 MW (660 x1)	Muzaffargarh Punjab
K-ELECTRIC-DATANG		700 MW (350 x 1)	Karachi
JAMSHORO-ADB		1320 MW (660×2)	
Total		6803 MW	
Engro PowerGen Thar (CPEC)**	Thar	660 MW (330×2)	Thar Block-II Sindh
Thal Noval Power**		330 MW (330×1)	Thar Block-II Sindh
Hub Power **		330 MW (330×1)	Thar Block-II Sindh
Shanghai Electric (CPEC)		1320 MW (660×2)	Thar Block-I Sindh
Lucky Power		660 MW (660×1)	Port Qasim Karachi
Siddiqson Energy Limited		350 MW (350×1)	Thar Block-II Sindh
Total		3320 MW	
Total Combined		10123 MW	

Mr. Usman Zafar from Punjab Mining and Mineral department elaborated on the mining issues associated with the coal energy resources in Pakistan. Coal in Punjab has high sulphur contents whereas the depth is 100 to 200 meter. The estimated available coal reserves in Punjab province are given in the table below.

Punjab Coal Reserves

PUNJAB	DISTRICTS	SUB AREAS	RESOURCES (Mt)
Salt Range	Chakwal	Dandoot & Dalwal	8.47 + 139.01
		Ara-Bisharat	76.86
	Khushab	Padhrar	63.83
		Chambal	155.45
	Jhelum	Tilla Jogi	31.38
Trans-Indus Range	Mianwali	Makarwal	113.69

Current practices for mining coal are not up to the mark and there is no mechanization for the exploration of the coal which is a major hindrance in utilizing coal reserves as primary fuel mix of Pakistan. Further, the trained manpower at managerial and technical levels is required for mining. Hit and trial method has been adopted to explore coal in the salt range of Punjab which is economically not feasible. He also flagged the following issues related to the indigenous coal;

- Thin and irregular seam
- Water zones impeding access to coal
- Structural variations in geological formations
- Lack of mechanization
- Migratory labor
- Lack of infrastructure
- Lack of technological development

In his concluding remarks, Mr. Usman Zafar emphasized that semi mechanical mining is urgently required to increase the production of indigenous coal. He recommended that integrated coal processing power plants may be installed at the mine mouth and best available technologies must be deployed for better and cost effective mining. Some of the key recommendations made by Mr. Usman Zafar included;

- Introduction of Semi Mechanical Mining to increase Production
- Coal Processing
- Integrated Coal Processing and Power Plants at Mine Mouth
- Selection of best technology for Power Generation
- Coal Blending
- Collaboration of Academia with industry for R & D

Prof. Dr. Robina Farooq from COMSATS Institute of Information Technology, Chemical Engineering department discussed the environmental impact of coal based energy. She argued that despite its enormous potential, generation through coal has adverse effect on the environment. All the way from the exploration of coal till its combustion, the entire process is full of pollutants causing pulmonary disease, lungs infection, weakening the immune system and depleting the ozone layer. Dr. Robina argued that utilization of cleaner sources of energy is the need of the day to avert the adverse effects of so that power generation through coal energy.

Dr. Khurram Shahzad from COMSATS Institute of Information Technology, Chemical Engineering department presented his paper on clean coal energy technologies. Post combustion capture, Pre combustion capture and Oxy-fuel combustion are the clean coal technologies. According to Dr. Khurram Post combustion capture technology refers to capture of CO_2 from exhaust gases of combustion processes while Pre combustion capture involves gasification conversion of syn-gas. CO_2 is captured after conversion of syn-gas into CO_2.

Discussing the coal characteristic of Pakistan, he stated that the coal classified as lignite has high contents of moisture and other minerals and was, therefore, not suitable for direct combustion due to environmental impact so pretreatment methods are needed before its utilization. According to Dr. Khurram, gasification is considered as a best technology for the coal treatment in Pakistan. Gasification refers to a group of processes that convert carbonaceous fuels into a combustible gas. While discussing the advantages of gasification, following points were discussed.

- Gasification of coal offers certain important advantages over direct combustion.
- The volume of gas obtained from gasification is much less compared to that obtained from a combustion system.
- The reduced volume of gas needs smaller equipment, and hence results in lower overall costs. For small capacity power packs, a unit comprised of a gasifier and a compression–ignition engine is less expensive than one comprising a boiler, condenser, steam engine, etc.
- Thus, gasification provides an attractive option for remote locations.

The seminar was followed by a lively discussion on the pros and cons of a coal based power generation. Most of the participants felt that in view of the unfavorable fuel mix for power generation, Pakistan has been facing severe power crises for last many years. The situation needed to be rectified by induction of coal as a reliable, affordable fuel for base load generation to supplement the furnace oil, indigenous gas and LNG. However to reduce the adverse environmental impact of coal, the latest high efficiency low emission pollutants technologies needed to be deployed. The forum also highlighted the need for more research and academic activities in coal based power generation for training the manpower to the upcoming coal based power plants. All the important features in coal energy like overview, technological advancements, international and national coal power trends, production, policies and regulatory affairs were discussed in the seminar. Brainstorming session on policy developments and regulatory affairs were discussed in details among the experts. The seminar was a great occasion for students and researchers to listen from the experts / professionals from various public and private sector departments.

Conclusion and Recommendations

Based on detailed discussion among the participants on the various issues pertaining to coal based power generation in Pakistan. The following conclusions and recommendations evolved:

1. The past energy policies of the government failed to give due place to coal in power generation with the result that Pakistan continues to rely heavily on imported furnace oil which is expensive and also subject to international price fluctuations. Likewise, in the face of depleting domestic gas reserves, there was no alternate to induct coal as one of the base load fuels for power generation. The seminar noted that, notwithstanding the opposition of coal based power generation by developed countries mainly on an environmental grounds, the world even today heavily relied on coal as a base load generation, whereby more than 40 % of the global power generation still continued to be made on coal and both the developed and developing countries were still heavily relying on coal. For a developing country like Pakistan, there was no alternate but to induct coal as one of the base load fuels for power generation. The ongoing coal based projects in the pipeline in Pakistan are expected to contribute around 18% to the total power generation by the 2021-2022.
2. It was felt that Pakistan was blessed with the second highest coal reserves in the world which stood at 184 billion tons out of which Thar coal alone provided about 175 billion tons. There was an urgent need to adopt state of the art mining technology for fully exploiting this natural resource and to mine the indigenous coal including the Thar coal for power generation.
3. While, inducting coal as base load fuel, it was important that all the loose ends were tied in the first place, which included training sufficient manpower for manning coal based power projects and mining facilities; introduction of semi-mechanization and full mechanization in the coal mines; adoption of the latest technologies for conversion of coal to gas.

4. While acknowledging the environmental concerns of coal based power generation, the participants felt that we needed to still go ahead with inducting the coal based power generation. We've the advantage of leapfrogging the advancement in technology; whereby utilizing the super-critical and ultra-super critical technologies will not only give increased efficiency but also lower environmentally hazardous emissions. Accordingly, it was felt that all the power plants should be based on efficient and low emission technologies to minimize the environmental concerns caused by the coal based power generation.

5. There was need for more research and development activity in the field of coal based power generation and, accordingly, academia, researchers, public and private sectors should be encouraged to fully participate in research activities to widely disseminate the knowledge related to the coal based technologies. The participants felt that while the indigenous coal had higher sulfur, moisture and ash content but the latest technologies were available to make pit mouth power plants based on this coal economically feasible as experienced in the world.

6. In order to successfully run the coal based power plants particularly on imported coal, it will be important not only to ensure uninterrupted supply of coal to our ports but also to have adequate port handling arrangements and rails/ roads linkages to maintain a regular supply chain for supply of coal to the power plants.

7. It was recommended that the Punjab, with its emphasis on inducting coal may also apply for lease of afield in the Thar coal to ensure its future coal supplies from domestic resources as well. Another measure recommended for reducing the environmental hazards was to follow open pit mining of Thar coal through integrated gas combine cycle (IGCC) technology.

8. The participants felt that in order to modernize our mining sector and to effectively use the mined coal for power generation, the government may seek the assistance from the developed countries and setup model mines with the state of art technology to provide necessary training for all the coal mining industry here. It was proposed to develop at least 10 models mines (with state of the art technology) at different locations to educate the lessee. The lessee should be made bound to use the technology, procedures and practices demonstrated in model mines. A School of mines exists in the Punjab, however, it has lost its capacity to deliver quality training. It is suggested to hire foreign faculty and equipment from Australia/China etc. to train miners.

9. The oil power plants that can produce about 6000 MW of electricity should be modified to Coal-Fired Power Stations. Their furnaces and boilers should be replaced with Pulverized Coal-Fired Furnaces & Boilers. The key point is that these installations should be designed on lignite Coal-Firing basis with the specifications similar to the coal that is available in Thar. Initially, we can import coal of the grade similar to Thar coal and use in these power plants until Thar coal is extracted. After the extraction of Thar Coal, import can be stopped.

10. After eighteenth amendment, provinces can produce their own electricity. KPK can invest in the construction of small Dams under liberal public-private partnership policy. Baluchistan Government can invest in modern coal mining, coal up-gradation and power generation

11. For the realization of Pakistani coal in all the Provinces other than Thar Coal, Tunnel mining may be carried out for which a different kind of infrastructural development is required. According to SNOWDEN report, Punjab has at least 600 Million ton of Bituminous D grade coal. That means that is sufficient to generate 5000 MW for 20 years. SNOWDEN has declared this coal suitable for power generation. In this regards, our bottle neck is mining Electricity from coal cannot be generated unless coal is extracted out. Currently, we don't have the capacity, technology and skills to extract coal.

12. The challenges associated with Pakistan Coal other than Thar Coal is higher sulphur and ash content. It is advised to establish coal washing plants to upgrade coal. By water washing, sulphur and ash content can be lowered significantly. This will enable us to use local coal in coal-fired power plants by blending with coal having low sulphur and ash content.

13. For the transportation of coal to the Punjab plants, a strong coal supply chain management System will be required. For this purpose, there is a need to increase the role of the Punjab Mineral Company. NLC and Pakistan Railways will also need to closely monitor their operations to ensure un interrupted coal supply to the Power Plants.

14. Power plants using imported coal may be installed on shore to minimize the cost for loading, unloading and transportation. For existing coal power plants under construction, in Punjab, infrastructure should be strengthened to transport coal from ports to location of power plants within the shortest possible time. This requires establishment of new port /berths specifically for coal as well as rail network.

15. Coal may be converted into Synthetic Natural Gas (cheaper than LNG) which can be used for various industrial applications, thus import of LNG can be minimized. Underground gasification of Thar Coal is not recommended as already time and money has been wasted, rather, above the ground gasification is recommended (this is more viable and practicable).

16. Co firing of coal with bagasse/biomass for power plants may be used to ensure increased efficiency of plants.

Picture Gallery


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Seminar
Coal Based Power Generation in Pakistan: Potential, Utilization and Constraints
29th
March-2017

International Training on Energy Audit for Public Buildings

Four faculty members from COMSATS Electrical Engineering Department and one from COMSATS Energy Research Center attended the training program arranged by Punjab Energy Efficiency and Conservation Agency (PEECA) in collaboration with GIZ, Pakistan. Main objective of the training was to establish a team of trained Energy Auditors (Master Trainers) who will train local technical personnel for ensuring implementation of energy audits in the public sector buildings all over the Punjab Province.

Dr. Ingo Rudolphi and Mr. Roman Konieczny, trainers from Germany visited Pakistan and trained 25 Engineers from various public and private sector organizations and universities. The training included lectures on energy audit basics, techniques for conducting effective energy audits, walk through visits, Workshops, familiarization with the state of the art specialized simulation software and energy audit of the two hospitals, Jinnah and Services hospital Lahore.

Certificate distribution ceremony was held at the end of the training program where Secretary Energy Punjab, Dr. Asad Rehman Gilani distributed the certificates among the successful trainers.

ERC Participates in the Round Table Discussion on Energy Infrastructure of Pakistan at Lahore University of Management Sciences (LUMS)

Mr. Khalid Saeed Head ERC along with Dr. Ghaffar Doggar, PSO, ERC attended an Energy Roundtable discussion at the LUMS on 3rd Feb, 2017 in which leaders and experts from Government, Universities, Industry and Non-Profit Organizations participated and exchanged views on Future of Energy in Pakistan. The LUMS advisory board members Dr. Sally Benson, Professor of Energy Resources Engineering and GCEP Director Stanford University, and Dr. Khalid Aziz, Otto N. Miller Professor of Energy Resources Engineering in the School of Earth, Energy & Environmental Sciences (Emeritus) led the discussions. The participants presented their views and made following recommendations.

- ✓ Increasing electricity supply and improving reliability
- ✓ Extending access to national grid
- ✓ Use of more renewable energy resources
- ✓ Finding Solutions to provide electricity to the off-grid areas
- ✓ Expanding natural gas supplies
- ✓ Rationalizing fuel in power generation
- ✓ Rationalizing tariffs

While expressing his views, Mr. Khalid Saeed, Head ERC and former Chairman NEPRA stated that, unless the tariff structure in the country is rationalized to fully recover the cost of electricity services, the country will continue to face the issues of circular debt. Moving ahead, he stated, merely augmenting the power supply generation without addressing the financial sustainability issues will not resolve the energy crises. He also emphasized on the need to maintain the autonomy of the regulator and to strengthen its capacity to monitor and regulate the power sector to serve the national interest.

Renewable Energy Readiness of Pakistan

By Engr. Faiz Muhammad Bhutta – Premier Energy

Renewable energy resources include Solar Energy, Wind Energy, Hydro Energy, Bio-Energy and Geo-thermal energy. Pakistan is blessed with an abundance of natural resources which can be utilized for power generation through renewable energy technologies. Towards the North, the high mountain ranges and glaciers provide hundreds of potential sites for run-of-the-river small hydropower. The plains and desert lands in the central part of the country receive ample sunshine and solar irradiation levels go as high as 7.5 kWh/m^2. A wind corridor in the southern province of Sindh has already been identified whereas province of Baluchistan promises even more wind power generation potential. Being primarily an agricultural country, there is potentially tones of agricultural residue or 'biomass' which can be utilized for power generation.

We would like to analyze Renewable Readiness of Pakistan from the following five perspectives,

- Total installed base
- Policy and regulations
- Quality and standardizations
- Incentives
- Major issues and Way forward

Overall RE Sector

First Renewable policy was released by GOP in 2006 and since 2006, the progress has been remained slow and it is only last five years that investors interest has gained momentum particularly in Wind and Hydro sectors and more recently in solar sector. 2006 RE policy was developed as short term policy with the view to developing a medium and long-term policy as the market developed. However 2006 RE policy remained today the only policy that has been implemented and is currently applicable. There is need to review this policy in view of challenges and barriers in RE sector. In June 2006, State Bank of Pakistan announced a revised financing scheme for renewable energy. Under the scheme, concessionary financing will be provided to large renewable projects as well as small scale solutions in solar, wind, hydro, bio-gas, bio-fuels, bagasse generation. The scheme provides financing for

1. Renewable energy projects with capacity ranging from more than 1 MW up to 50 MW.
2. Domestic, Industrial and commercial consumers that want to install renewable energy sources for generation of electricity from 4KW to 1000KW for own use or for supply to distribution companies as per the rules set by NEPRA Distributed generation and net metering regulation 2015.

Overall growth of RE sector remained slow.

Solar Energy

Being geographically located close to the equator, Pakistan receives good solar irradiation throughout the country. Global Horizontal Irradiance (GHI) shows highest values in southwest Pakistan, gradually decreasing to the north and northeast of the country with minimum in the Himalayan Mountains. Maximum values of just over 2300 kWh/m²/year are reached in the southwestern region of Baluchistan. The estimated values only decrease gradually towards the northeast of the country and still in more than 90% of the land area values over 1500 kWh/m² are reached (WB ESMAP , 2014).

As per WB ESMAP 2014, The Direct Normal Irradiance (DNI) reaches highest values on dry plateaus or rock deserts when there is little or no dust advection from surrounding regions. Generally, high sums of DNI are available all over Pakistan, with the exception of Himalyian Mountains, estimated peak values exceeding 2700 Kwhr/m^2 can be found in north West Baluchistan while 83% of land area still exceeds the threshold of 2000 Kwhr/hr. 100MW solar PV plant has been recently installed at Quaid-e- Azam Solar Park Bahawalpur and another 900MW is in process through China-Economic Corridor Project and 1 MW solar Power Plant is operational at Federal Parliament House. According to estimates, 800 MW solar PV has been installed considering all kinds of small, medium and large solar systems (off-grid rural, on-grid and hybrid solar systems for domestic, commercial, Industrial, IPP, PPA etc.). The import of solar panels expected in 2016-17 will be close to 1000 MW. Investment in IPP based Solar power plants has slowed down because of continuous reduction of Tariff by NEPRA and power evacuation problems. From Policy and regulation point of view, there is no duty on import of solar panels but there is duty on import of Solar batteries and Inverters and AEDB's lot of efforts are being used in exercise of Commensuration (in what ratio panels, inverters and batteries in a system) rather putting effort on quality and standardization of Solar Industry and they are trying their best to get rid of Commensuration exercise. Low quality solar panels are being imported and there is no regulation to keep check on quality rather the check is on what proportion the solar components being imported. There is a need for accreditation of solar companies so that quality can be ensured in solar sector. Net metering SRO 892 has been issued by NEPRA in 2015 but the process is very tedious and lengthy that the whole process from submission of application to issuance of license takes about three to four months. In one year only 100 net meters have been installed so far out of the target of one Million Consumers. IESCO and LESCO are moving bit fast but other DISCOS have poor performance in the field of net metering. From incentive perspective there is zero incentive from the Government on deployment of solar systems at roof tops. On IPP and PPA front the speed is very slow because of tariff and land issues. Major issues are quality and standardization at import of solar equipment, accreditation of solar suppliers, Lack of solar skilled manpower, absence of certified installers, lack of low mark-up funding, lengthy Government process for issuance of Power Generation licenses, Lack of fast implementation of net metering, lack of solar development plans, Lack of power evacuation and grid inter-connectivity etc. The way forward is to develop three years short term and ten years

long term solar plans and its timely and efficient implementation. Solar thermal is yet untapped area.

Wind Energy

Wind map of Pakistan developed by NREL USA has identified that wind with good to excellent speeds is available in many parts of the country establishing a total wind potential of 340,000 MW. The gharo-wind corridor having approx. potential of 50,000 MW in the most attractive to investors at this point due to good resource potential as its close proximity to major load centers and the national Grid (AEDB 2013). The exact potential will be determined through ESMAP Wind Resource mapping project under which 12 wind masts of 80 meter height will be installed in whole of the Pakistan and this project has now completed and data monitoring has started and it is public now.

Installed Wind Capacity

Project name	**Installed Capacity (MW)**	**COD**
Zorlu Energy Pakistan Ltd	56.4	July-13
FFC Energy Ltd	49.5	May-14
Foundation wind energy-1	50	Apr-15
Foundation Wind Energy-II	50	Dec-14
Three Gorges wind farm (pvt) ltd	49.5MW	Nov-14
Total installed capacity	**255.4**	

PROJECTS UNDER CONSTRUCTION

Project name	**Installed Capacity (MW)**	**COD**
Saphire wind power company Limited	50	Dec-15
Metro Power Company Ltd	50	August-16
Yunas energy Ltd	50	June-16

Master Wind Energy Pvt Ltd	50	June-16
Tapal Wind Energy Pvt Ltd	50	June-16
United Energy Pakistan Pvt Ltd	50	June-16
Hydro China Dawood Power pvt Ltd	50	June-16
Tenaga Generasi Limited	50	June-16
Gul Ahmed Wind Power Limited	50	June-16
TOTAL	**479**	

Source: WWEA and HBS report on Wind Energy Market 2016.

The major issues are Grid Infrastructure, Land issues, Power evacuation, continuous tripping and forced shut down of Turbines, Operational efficiency of Government, Policy and regulatory frame work and availability of Finance. Way forward is to remove the hurdles and barriers improving the investor confidence.

Hydro Power

Perhaps the cheapest and most promising renewable energy resource in Pakistan is hydropower. In addition to large hydro power potential, the provinces of KPK, Gilgit-Baltistan and AJK possess enormous run-of-river hydropower potential. The canals of Punjab also offer several sites where small hydropower plants can be set up. The total identified hydropower potential in Pakistan as published by PPIB is 60,000 MW. But this figure also includes large dams. The highest share of hydropower potential is in the KPK province, which is being developed through both public and private sector projects. Over 10,000 MW of run-of-river hydropower potential has been identified in Gilgit-Baltistan, which can be developed in a relatively short time-frame but due to lack of connectivity to the national grid, this potential remains largely untapped. 1,000MW MHP potential has been identified in KPK. KPK government has divided its MHP Program in to four phases. In first phase 385 MHP are being developed in 12 districts with estimated installed capacity of 34 MW and Phase II shall comprise the installation of 1000MHP and phase III and IV remaining 2000 MHPS till 2025. Punjab Energy department has also embarked upon the completion of MHP plants and Solar off-grid systems under various programmers which includes solarization of 45000 schools, 3000 BHUs and some MHP Plants. Similarly Sind and Baluchistan Energy Departments are under the process of completion of various solar and wind power programs in their provinces. Besides large hydro, there is significant potential for development of small-mini-micro hydro power. The geographic layout

of the country with natural water flow systems and irrigation canals present ideal opportunities for hydropower development. The figures below identify total MHP Potential of 3,100 MW in the country.

KPK – 750 MW
Punjab – 560 MW
Gilgit Baltistan – 1300 MW
Sind – 120 MW
Azad Kashmir – 280 MW
Total – 3100 MW

Hydropower development in the northern part of the country is being done through numerous public and private sector projects. The large projects involving construction of dams is primarily being managed within the public sector, with the exception of two large run-of-river projects at Dasu and Bunji, of 4,300 MW and 7,100 MW respectively. Both projects are under development and will take about another 5-6 years to completion. Most other run-of-river projects are being developed in the private sector with the PPIB currently processing a cumulative capacity of about 15,000 MW.

Renewable in Rural Areas

31% of population has no access to modern energy sources and about 63% still rely on traditional biomass for cooking (AEDB 2014). There are more than 40,000 villages which are so far from the grid and it becomes costly and un-economic to extend the grid to these locations (UNDP 2013). Distribution companies are reluctant to expand grid into rural areas and revenues for tariffs cannot provide sufficient returns to recover the investment. Providing modern energy access to such villages through stand-alone off-grid solar systems or mini or micro-grids can provide them access to modern energy sources. ADB Clean Energy Access Investment Project (2017-2025) will bring substantial improvement in access of Renewable Energy in off-grid sector in Pakistan.

Conclusion

Energy crisis can only be solved by policy shift from conventional fuel based power generation to Renewable Energy based power generation and giving incentives to this industry. This will not only generate power but will help in reduction of Green House Gases and it is the only way to improve energy security of the country.

Pakistan has become the First Country to Benefit from Duly Validated, High-Quality Solar Maps

The new solar maps for Pakistan were unveiled by the Alternative Energy Development Board (AEDB) and the World Bank in Islamabad. According to the World Bank, Pakistan is now part of a small group comprising mainly developed countries with access to sustainable and affordable sources of indigenous energy. Led by the Energy Sector Management Assistance Program, a multi-donor trust fund administered by the World Bank, the initiative will "facilitate investors in making more informed project decisions.

The maps will help large solar power projects in obtaining commercial financing by reducing the resource risk," the press release further said. The World Bank project on solar mapping in Pakistan includes field data being generated by nine solar measurement stations installed two years ago across the country. The World Bank statement said, "The solar maps used the latest solar resource modeling techniques, based on 18 years of satellite and global atmospheric data from 1999-2016."

TAPI Gas Line Project Enters Implementation Phase

Turkmenistan-Afghanistan-Pakistan and India (TAPI) gas pipeline project entered into its implementation phase. The pipeline would pass through Afghanistan to provide gas to three energy-starved countries -Afghanistan, Pakistan and India. The inaugural ceremony of launching of Front and Engineering Design (FEED) was held in Islamabad.

TAPI pipeline project would meet the demand of the country to a great extent and Pakistan would be surplus in power and gas after completion of this project in 2020, Pakistan will receive 1.3 billion cubic feet per day gas under this project. Work on the project has been done as gas sales and investment agreements had already been signed. Several offers from financial institutions and private parties were received to fund this project. Work on gas field has begun and an agreement has been signed with Islamic Development Bank (IDB) to provide financing for the project.

NEPRA to Develop Upfront Tariff for Biomass-Based Power Projects

National Electric Power Regulatory Authority (NEPRA) has decided to develop upfront tariff for biomass-based power projects. For this purpose, the regulator has prepared a proposal for the stakeholders, according to which tariff for 1-10 years has been proposed at Rs. 7.2781 per unit, 11-30 years Rs. 5.7477 per unit, levelized tariff, Rs. 6.9819 per unit whereas the proposed tariff for 16-60 years is Rs 6.7435 per unit and levelized tariff at Rs 6.6758 per unit.

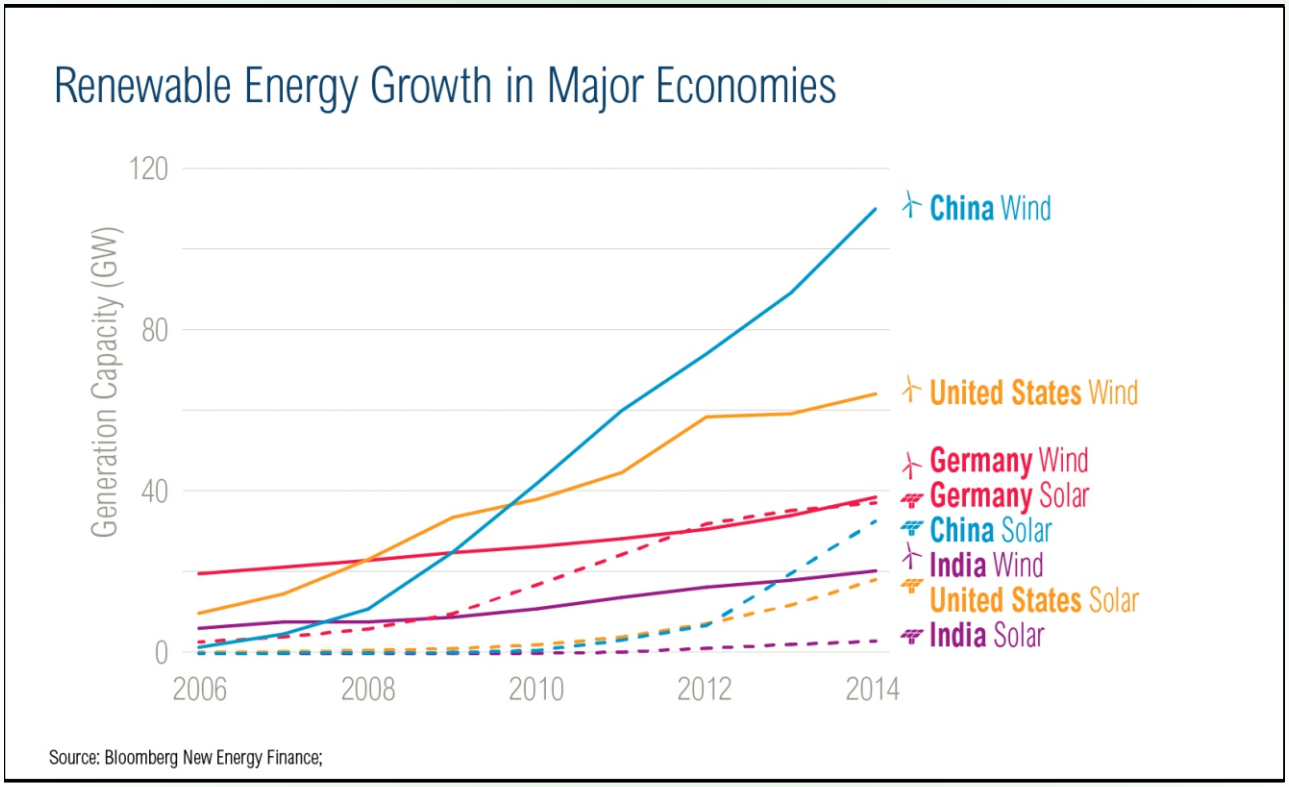
The generation tariff assumptions are as follows: (i) project cost has been assumed as US$ 0.8 million per MW; (ii) annual plant factor has been assumed as 80%; (iii) insurance has been assumed as 1% of EPC cost; (iv) the debt equity structure of 75:25; (v) IRR of 15%; (vi) Kibor of 6.53%; (vii) spread over Kibor as 3%; (viii) exchange rate parity of Rs 105/$; (ix) debt repayment period of 10 years, 15 years and WACC (11.33%) for 30 years; (x) efficiency of 29.24% (flat) Calorific Value of 12364.74 average of all biomass agricultural residue; and (xi) fuel price of Rs 5,000/ton, including freight. The power projects can use agricultural residue, ie, cotton stalk, wheat stalk, rice straw, rice husk, maize straw, maize husk, maize cob, wood, etc, for electricity generation.

Global Study into use of Wind, Solar Power on Ships

In co-operation with several shipping companies and technology partners, Eco Marine Power (EMP) has begun a detailed study focused on the practical applications of its patented EnergySail and Aquarius MRE technologies. The study will cover the engineering aspects of installing an EnergySail or Aquarius MRE based solution on a variety of ships and the expected Fuel Oil Consumption (FOC) and CO_2 savings that can be achieved in an operational environment. Energy storage options will also be studied including the possible use of fuel cells. More than a dozen ships will be included in the study ranging in size from coastal chemical tankers to large RoRo ships, bulk cargo carriers and LNG tankers. For each ship involved in the study a preliminary engineering design will be prepared along with an analysis of the ships operational profile. The engineering phase will include ship surveys, on-board data collection, analysis using Computational Fluid Dynamics (CFD) software and virtual wind tunnel simulations. Computer modeling of ships fitted with EMP's EnergySail and Aquarius MRE technologies will be also be performed. Additional tests and simulations will be carried out using a prototype version of the EnergySail connected to a computer system and sensors in a test lab in Osaka. These tests and simulations will assist in fine tuning FOC and CO_2 emission savings models. EMP's EnergySail is a rigid sail based device that can be fitted with a range of renewable energy technologies such as solar panels or wind power devices. It is a unique renewable energy platform specifically designed for shipping. Aquarius MRE is an integrated renewable energy system for ships that incorporates EnergySail technology along with other elements such as marine solar power, energy storage and a computer system to monitor ship performance.

China's Solar Power Capacity Doubles

China's installed photovoltaic (PV) capacity more than doubled last year, turning the country into the world's biggest producer of solar energy by capacity according to National Energy Administration (NEA). Installed PV capacity rose to 77.42 gigawatts at the end of 2016, with the addition of 34.54 gigawatts over the course of the year, data from the energy agency showed. Shandong, Xinjiang, Henan were among the provinces that saw the most capacity increase, while Xinjiang, Gansu, Qinghai and Inner Mongolia had the greatest overall capacity at the end of last year, according to the data. China will add more than 110 gigawatts of capacity in the 2016-2020 period, according to the NEA's solar power development plan. Solar plants generated 66.2 billion kilowatt-hours of power last year, accounting for 1 percent of China's total power generation, the NEA said. The country aims to boost the mix of non-fossil fuel generated power to 20 percent by 2030 from 11 percent today. China plans to plough 2.5 trillion yuan ($364 billion) into renewable power generation by 2020.



European Wind Power Investments Expected to Slow in 2017

Investment in new wind farms in Europe rose by more than a fifth last year, but activity is expected to slow in 2017 as governments revise subsidy policies and prices fall.

New projects attracted 43 billion euros ($47 billion) of investment in 2016, up 22 percent from the previous year, according to a report from the Brussels-based trade group WindEurope. Investment in the first quarter of this year was 1.8 billion euros, down sharply from a year earlier when the total was north of 20 billion euros, easily the busiest period of 2016.

The European wind market will slow significantly in 2017 because governments are embracing energy auctions to attract developers and are shifting away from feed-in tariffs. Germany announced its auction results in April, while the U.K. opened its tender for offshore wind. The Netherlands, France and Spain will also host them in the coming months. Investment is also coming down because prices are falling.

بجلی کا بِل کم کرنے کیلئے
آلات بدلیں۔ عادات بدلیں

حکومتِ پنجاب 3 بڑے پاور پراجیکٹس کے ذریعے بجلی کی پیداوار میں اضافے کیلئے مصروفِ عمل ہے
آپ بھی کفائیت سے اور صرف ضرورت کے مطابق بجلی استعمال کریں تا کہ سب کی ضرورت پوری ہو سکے

عام اے سی کی بجائے
ڈی سی انورٹر اے سی استعمال کریں
اور وہ بھی ضرورت کے وقت اور
ہمیشہ 26 ڈگری پر چلائیں

یو پی ایس ہرگز استعمال نہ کریں
بلکہ اشد ضرورت کیلئے صرف
ڈیجیٹل انورٹر استعمال کریں

عام پنکھوں کی بجائے صرف
پاکستان انرجی لیبل والے معیاری
پنکھے خریدیں جو 40% تک
بجلی بچاتے ہیں

موبائل فون اور
لیپ ٹاپ کی چارجنگ
مکمل ہوتے ہی سوئچ اتار دیں

عام لائٹس اور انرجی سیور کی بجائے
0.9 پاور فیکٹر کی
ایل ای ڈی لائٹس استعمال کریں

گرمی سے بچاؤ کیلئے
چھتوں اور دیواروں کی
انسولیشن کروائیں

بجلی کی زیادہ پیداوار اور زیادہ سے زیادہ بچت
روشن پاکستان کی ضمانت

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