



# Newsletter

COMSATS Energy Research Centre





## RECTOR CIIT MESSAGE

It gives me great pleasure to note that the COMSATS Institute of Information Technology in addition to its expanding academic activities across its 8 campuses, including 40 undergraduate and 57 graduate programs, has also emerged as a platform for undertaking research activities in areas as diverse as climate, Islamic finance, Biomedical materials, Policy Studies and advanced drug research etc. The latest addition of the Energy Research Centre (ERC) was made in view of the need for providing a forum to offer research based solutions to face the challenges posed by the energy crisis in the country. Energy is now a multidisciplinary field and an integrated and holistic approach based on inputs from engineers, economists, management and legal experts and administrators will be needed to tackle the issues. The ERC, in a short period, has been proactively engaging in various research related activities. Apart from working closely with the industry and academia, ERC's efforts at supporting the Government organizations like the Punjab Energy Department, AEDB, PCRET etc., in promoting renewable and non-traditional sources of energy will be serving a long felt need for close collaboration between the academia and other stakeholders.

I congratulate COMSATS Energy Research Center (ERC) on their initiative to publish the ERC newsletter. I hope, this publication will be found useful by the academicians, researchers and policy makers and will help in furthering collaboration among them. I am confident that the ERC will fully harness the rich talent pool available in various faculties and campuses at CIIT. I wish best of luck to the Director, Lahore Campus, Head Energy Research Centre and their team members on this new venture and hope to see more such productive initiatives to be launched in future.

Dr. S.M. Junaid Zaidi, H.I., S.I.  
Rector CIIT



### QUICK FACTS

- Pakistan has the total installed Capacity of 22,408 MW
- Solar Power Potential of 2.9 Million MW
- Quaid-e-Azam Solar Park is the largest solar Power plant with capacity of 1,000 MW having 400,000 Solar Panels spread over 200 hectares
- Wind Power Potential of 346,000 MW
- Jhimpir Wind corridor has the potential of 50,000 MW
- Hydel Potential of 59,000 MW
- Tarbela Dam is Largest Earth filled Dam in the World and 5th Largest by structural Volume
- Pakistan contains 16th Largest Coal Reserves in the World with 184.5 billion tonnes
- A single Thar Coal Reserve Of Sindh is about 850 Trillion Cubic Feet, which is more than combined Oil Reserves Of Saudi Arabia & Iran.



## DIRECTOR CIIT, LAHORE MESSAGE

It gives me great pleasure to learn that the Energy Research Centre is actively engaged with various public and private sector organizations to achieve the objectives for which the centre was setup. Their activities and efforts at acting as a bridge between the Industry, Government and academia are steps in the right direction which will help promote applied research in the relevant fields. The ultimate aim for all such research activities will be to come up with practical solutions in resolving the current energy crisis faced by the country.

The Energy Research Centre has been recently established at the CIIT Lahore campus with the objective of undertaking and promoting research and education in the energy technologies, energy management, energy policy and regulations. The ERC, working in close collaboration with other Faculties has already developed a number of research proposals and is also in touch with various national and international institutions to attain its goal of becoming a centre of excellence in the energy research. In addition to the working paper series which is being published by the ERC on their website, the quarterly energy newsletter to be brought out by the ERC will be useful in disseminating knowledge on the latest developments in the energy technologies, policies and practices in the country and across the globe. I congratulate the Head ERC and his team for taking this initiative and wish them best of luck on this endeavor.



Prof. Dr. Qaisar Abbas  
Director CIIT, Lahore

## HEAD ENERGY RESEARCH CENTRE MESSAGE

The Energy Research Centre (ERC) was established at the COMSATS Lahore campus in November 2014. As energy is a multi-disciplinary subject, therefore, the Centre in collaboration with various CIIT Faculties has established energy research groups in twelve energy technologies which are working on research and development. ERC is also working for developing laboratory infrastructure to undertake research on various energy technologies. The Centre would undertake programs on energy that would integrate with national programs on energy having vital implications for the industry and other sectors while generating economic activities in the country. Apart from preparing a number of research projects and proposals, some of which have already been approved for funding, the ERC is actively engaged in collaborating with a number of national and international organizations in the energy related activities. We have been regularly organizing conferences, seminars and brain-storming sessions on various topics. Some of our recent seminars, for example, focused on the energy efficiency and conservation issues, energy auditing, potential of bio mass, mini and micro hydel power generation, solarisation of tube-wells etc.

The ERC website [www.comsatslahore.edu.pk/erc](http://www.comsatslahore.edu.pk/erc), also publishes research articles and papers by our researchers on a number of topics. We are now launching a quarterly Energy Newsletter In order to share information on the latest trends in energy technologies, best international practices and the ongoing research work and other activities at the ERC. And other Faculties across all, I request all our researchers in the COMSATS to come forward and contribute their energy related research articles to this Newsletter. We at the ERC are grateful to Dr.S.M. Junaid Zaidi, Rector, COMSATS and Dr.Qaiser Abbas, Director, Lahore campus for their continued guidance and support in all our efforts. I congratulate ERC Team, Dr. Ghaffar Doggar, Engr. Fawad Azeem and Ms. Kanwal Bilal for their untiring efforts to launch this newsletter within a very limited time. I am confident that the work carried out by them will be useful for academicians, researchers, policy makers and private sector.



Mr.Khalid Saeed  
Head Energy Research Centre (ERC)



# CONTENTS

## COMSATS ENERGY RESEARCH CENTRE NEWSLETTER

COMSATS ENERGY RESEARCH CENTRE	01
ACTIVITIES AT A GLANCE	02
ERC and CERAD to Collaborate for Research and Development Projects	03
ERC to Assist Punjab Energy Department in Energy Efficiency and Conservation	04
COMSATS enters into collaboration with Pakistan Council of Renewable Energy Technologies (PCRET)	05
Great Potential for Growth of Biomass! ERC Arranges Seminar on Development and Utilization of Biomass Energy in Pakistan	06
COMSATS/ERC Team Participates in National Instruments Day in Beirut, Lebanon	07
Head ERC Mr. Khalid Saeed, delivers Keynote Address at "Roundtables on Energy: Role of Regulatory Authorities: Focus on NEPRA and OGRA"	08
ERC Launches its Website	09
ENERGY RELATED NATIONAL NEWS	
Work On Iran-Pakistan Gas Pipeline Project to Start Soon	10
TAPI pipeline to help overcome energy shortage	11
Government of Pakistan: Go-ahead to Thar Coal Power Project	12
ENERGY RELATED INTERNATIONAL NEWS	
Tiny red crystals dramatically increase biogas production	13
Europe's largest floating solar array is coming to London	14
A GLIMPSE OF ONGOING FUEL CELL RESEARCH	
Fuel Cells: Clean Energy Research Group key for future sustainable growth	15
Future Targets:	17
Pakistan's Power Sector Crisis by Dr. Talat Anwar and Khalid Saeed*	18

**Editor:** Engr. Fawad Azeem

**Co-Editor:** Ms Kanwal Bilal



## COMSATS ENERGY RESEARCH CENTRE

The Energy Research Centre (ERC) was established at the COMSATS Lahore campus in November 2014. As energy is a multi-disciplinary subject, therefore, the Centre in collaboration with various CIIT Faculties has established energy research groups in twelve energy technologies which are working on research and development in energy technologies. ERC is also working for developing laboratory infrastructure to undertake research on various energy technologies.

ERC aims to build strong relations with other Universities / Institutions abroad, International / National Non-Governmental Organizations, Government and Private Agencies, Energy Entrepreneurs and Professionals and this opportunity is being used to bring all the stakeholders together from academic research to field level activities for the sustainable development of Renewable Energy Technologies. In this regard, ERC aims to bring together all concerned organizations and individuals to work together in the educational field to achieve common objective for the welfare of the people of this country.

### Vision

The ERC vision focuses on building an internationally recognized Centre of Excellence by fostering inter-disciplinary research as a leading institution in energy research and designing and implementing educational programs in clean and efficient energy technologies. The Centre would undertake programs on energy that would integrate with national programs on energy having vital implications for the industry and other sectors while generating economic activities in the country.

### Objectives

The specific objectives of the Centre are:

- To provide sustainable support for the integration of higher engineering education with its energy related research activities;
- To assist in building the national capability in different aspects of the energy sector;
- To increase the capability of technical and managerial personnel involved in the energy sector and assist in its effective utilization and mobilization;
- To conduct relevant training programmes in required field relating to the energy sector;
- To establish relations with foreign Universities and other related institutions for achieving the objectives of the centre;
- To carry out research and development studies related to energy matters



## ACTIVITIES AT A GLANCE

ERC Arranges Seminar on Development of Small Hydro Power Generation in Pakistan: Potential Utilization and Constraints (MSHP).

A Seminar on “Development of Micro and Small Hydro Power Generation (MSHP) in Pakistan: Potential, Utilization and Constraints” was held on 7th March, 2016 at Inter Disciplinary Research Centre for Biomedical Materials (IRCBM) conference room, COMSATS Institute of Information Technology (CIIT) Lahore. The seminar was organized by the Energy Research Centre, COMSATS Institute of Information Technology Lahore in collaboration with Trident Energy Private Limited. The seminar was well attended by renowned experts on energy technologies, researchers, industry representatives, federal and provincial organizations, private organizations and other research institutes.



Seminar Participants

## Collaboration with Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Mr. Khalid Saeed Head ERC had a meeting with GIZ Renewable Energy Expert, Mr. Herald Flohr, on 19th Feb-2016 at CIIT Energy Research Centre in which collaboration with GIZ and German Institutions as well as energy proposals of mutual interest were discussed.

## ERC and CERAD to Collaborate for Research and Development Projects

A meeting was held with Dr. Waqar Mahmood Director, Centre for Energy Research and Development (CERAD), UET Lahore along with team members, on 18th February 2016 at COMSATS Energy Research Centre, Lahore. Mr. Khalid Saeed, Head ERC and team members also participated in the meeting. Both the institutions shared research and development work in respective centres and decided to explore research areas where both institutions can work together. In the meeting activities from both sides on energy research were shared and proposals to strengthen working relationship between the ERC and CERAD were discussed. A number of activities and projects proposals on renewable energy technologies were identified and it was decided that further meetings of energy experts shall be held to identify specific projects for strengthening the interaction between the two institutions.



ERC and CERAD participants during meeting

## Seminar on Energy Master Planning in Punjab

Mr. Khalid Saeed Head ERC and Dr. M.G. Doggar PSO ERC attended the Seminar on Energy Master Planning of Punjab which was held on 3.2.2016 at the AVARI, Lahore. The seminar was arranged by the Hydro Corporation China and Punjab Power Development Board. In the seminar initial draft of Master Plan was presented by Hydro Corporation China and discussed. The participants questioned the authenticity of data used for assessing the potential of solar, wind, biomass and hydro power etc. in Punjab province and made suggestions for improvement i.e. validating the data on renewables energy resources through surveys. It was also offered that COMSATS Energy Research Centre and UET CERAD can assist in preparing the master plan by Hydro Corporation China, through our energy experts and surveys can be conducted subject to provision of resources.



## Vcs Forum on Energy Technologies at UET, Lahore

Dr. Muhammad Ghaffar Doggar Principal Scientific Officer ERC along with Dr. Sobia Baig Head of Electrical Engineering department and Dr. Mujtaba Jaffery (Assistant Professor, Electrical Engineering) attended the meeting of “VCs Forum on Energy Technologies” which was held on 29.1.2016 at UET Lahore. In the meeting strengths of universities in specific energy technologies were identified and universities were categorized to extend services for testing and certification in specific technology to Punjab Government, Energy Department. The COMSATS was proposed to be included in Energy Efficiency and Auditing, Biomass Energy, Micro-hydel, Fuel Cell and Storage, and Feasibility Studies on energy technologies.

## Representation of Energy Research Centre (ERC) at Seminar on Gas Distribution and Costs – Gas Sector Reforms

Dr. Muhammad Ghaffar Doggar PSO ERC attended the seminar on Gas Distribution and Costs – Gas Sector Reforms on 14th Jan 2016 at Marriot Hotel Islamabad. The Seminar was arranged by SDPI and an NGO “Raaftar”. In the seminar, governance and regulatory reforms and issues related to gas supply, losses and costs were discussed by experts and recommendations were made for improvements.

## ERC to Assist Punjab Energy Department in Energy Efficiency and Conservation

Mr. Khalid Saeed, Head ERC along with CIIT Team attended meetings with Dr. Jahan Zeb, Additional Chief Secretary (Energy) Govt. of Punjab on 18-Nov-2015 and with the Secretary Energy on 12-Jan-2016 to explore the prospects for close collaboration between ERC and energy department for various initiatives of the Punjab government in the energy sector. The energy department of Punjab welcomed the opportunity to work with the ERC and it was agreed that CIIT shall work on energy efficiency and conservation measures and energy auditing in collaboration with Punjab Energy Department.



## COMSATS enters into collaboration with Pakistan Council of Renewable Energy Technologies (PCRET)

Director General Pakistan Council of Renewable Energy Technology (PCRET) Islamabad signed an MOU with CIIT Energy Research Centre Lahore on 18-Jan-2016 to work on research and development and promotion of renewable energy technologies.. Through MOU it was decided that ERC and PCRET will jointly work on renewable energy based research projects in future and will prepare research plans for joint development and promotion of energy technologies including Solar PV, solar thermal, biomass, biogas and micro hydro power. It was also decided to undertake joint research projects, share research outputs, commercialization and utilization of RE equipment systems by private sector, industry and common people and to facilitate research students to conduct labs research and provide technical assistance for successful completion of research work..



Director, CIIT Lahore Campus Dr. Qaisar Abbas exchanging the MOU with Director General PCRET Dr. Sohail Zaki Farooqui

## ERC Arranges Seminar on Energy Efficiency and Conservation

A Seminar on “Energy Efficiency and Conservation (EE&C) Measures in Agriculture and Industrial Sectors of Pakistan” was held on 14th October, 2015 at Inter Disciplinary Research Centre for Biomedical Materials (IRCBM) conference room, COMSATS Institute of Information Technology (CIIT) Lahore. The seminar was organized by the Energy Research Centre, COMSATS



Seminar Participants



Institute of Information Technology Lahore in collaboration with the Government of the Punjab, Agriculture Department (Field Wing). The seminar was attended by renowned experts on energy technologies, researchers, industry representatives, agriculturists, members of academia, representatives from the ENERCON and the Punjab Energy Department.

## Great Potential for Growth of Biomass! ERC Arranges Seminar on Development and Utilization of Biomass Energy in Pakistan

A seminar on Biomass Energy “Development and Utilization of Biomass Energy in Pakistan” was held on 12th June 2015 at COMSATS Institute of Information Technology (CIIT) Lahore Campus. The seminar was attended by renowned experts from industry and academia. Mr. Khalid Saeed, Head Energy Research Centre (ERC), CIIT Lahore, welcomed the participants and briefly explained the prevailing energy crisis in Pakistan, importance and role of biomass energy in power generation and mitigation of energy crisis, need for efficient governance, and objectives of the seminar. Biomass experts gave talks and presentations on specific topics related to biomass energy. The participants deliberated on biomass resource potential and technology, issues in biomass collection, treatment and transportation and utilization at biomass power plants.



Seminar Participants



## COMSATS/ERC Team Participates in National Instruments Day in Beirut, Lebanon

Mr. Khalid Saeed, Head Energy Research Centre (ERC) along with the Heads of Electrical Engineering and Physics departments and a group of students of COMSATS, Lahore attended the National Instruments Day held in Beirut, Lebanon on 15th May, 2015. The Head of Energy Research Centre availed this opportunity to visit the NI Headquarters along with the Heads of EE, Physics departments and had a meeting with Mr. Michel Haddad, Managing Director National Instruments Middle East region to review the ongoing collaboration between the Energy Research Centre and the Electrical Engineering departments of COMSATS and National Instruments. The meeting was briefed by the head, Energy Research Centre about the ongoing work of the Energy Research Centre, which is being planned and carried out in the ERC, COMSATS. Mr. Michele indicated the interest of NI to collaborate with the ERC and their industrial outreach program and in particular mentioned the proof of concept of project which was recently launched by the NI in CIIT, Lahore Campus, which could be replicated by the industry in an effort to audit and manage their energy needs for saving energy and hence, solving the energy problems of the country. The Managing Director of the NI was also invited to visit the CIIT, Lahore campus and have meetings with the Director, CIIT Lahore Campus as well as the Rector to discuss further the projects. The NI DG further indicated that NI and COMSATS could jointly work out on projects for multi-lateral funding for development of various laboratories in COMSATS.



Mr. Khalid Saeed Head ERC, Dr. Sobia Baig HoD Electrical Engineering Department, Dr. Saleem Farooq HoD Physics Department at NI Head Quarters along with Mr. Michel Haddad Managing Director National Instruments (Arabia)



## Head ERC Mr. Khalid Saeed, delivers Keynote Address at “Roundtables on Energy: Role of Regulatory Authorities: Focus on NEPRA and OGRA”

Mr. Khalid Saeed, Head ERC was invited as a keynote speaker to address a seminar on “Roundtables on Energy: Role of Regulator Authorities: Focus on NEPRA and OGRA” jointly organized by Hans Seidel Foundation and Centre for Policy Studies, COMSATS Institute of Information Technology, Islamabad. During his address Mr. Khalid Saeed discusses the Energy policy 2014 and emphasizes the implementation of policy to reduce energy crises. According to Him energy crisis are the results of wrong policies and plan which needs certain time to get resolved. Mr. Khalid Saeed also discusses some basic hallmark traits of a good regulator around the world. He also discusses the present role of power producers and their future to effectively contribute in the energy generation.



Mr. Khalid Saeed Addressing Seminar

## IEEE (Institute of Electrical and Electronics Engineers) Annual Meeting

Mr. Khalid Saeed was invited as Chief Guest in the ceremony of AGM - 2015, held at FAST University, Lahore on 31st January 2015. As Chief Guest and key note speaker he was invited to present a talk/presentation on Energy Policy/Current Situation/Opportunities and Challenges in Energy Sector.



## ERC Launches its Website

COMSATS Energy Research Centre launches its Website on Sept. 2014, which is now fully active and can be visited [www.ciitlahore.edu.pk/erc](http://www.ciitlahore.edu.pk/erc). Developed Website shall contain latest information regarding ERC upcoming and future events, achievements working research paper series.



**Energy Research Centre**  
COMSATS Institute of Information Technology,  
Lahore Campus



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Meeting with National Instruments Team

### Highlights

COMSATS launched the Centre for Energy Research (CER) in April 2014 in view of the proliferating energy crisis and the critical role played by the energy sector in the industrial and economic development of the country. CER is a basic and applied research platform committed to developing local resources and technologies and policy recommendations leading to accessibility of economical energy to the residents of Pakistan. The Centre aims to collaborate with energy industry ... [More](#)

Mr. Khalid Saeed  
Advisor, Centre for Energy Research

**Welcome to the Energy Research Centre**

Our vision is to build an internationally recognized Centre of excellence by fostering interdisciplinary research, developing visibility for ERC as a leading institution in energy research, and creating educational programs in energy technologies. We welcome your participation in our Centre as an engineer, physicist, student, researcher, outreach partner, or in another capacity. The Centre intends to have vital implications for the industry and country regarding the need to find new renewable energy solutions and the advancement of Pakistan's economy and national security.

## ERC in discussion with International institutions, Universities for Working Together in Research and Development Projects

Mr. Khalid Saeed, Head, ERC had a meeting with Ms. Sharne Proctor, Director, International Office Durham University UK. In the meeting a brief introduction of the Energy Research Centre (ERC) and proposal for developing collaboration between the Durham University Energy Institute (DEI) and the COMSATS Energy Research Centre (ERC) were discussed. It was agreed that collaboration in the areas like joint research projects and training of manpower on Renewable Energy Technologies, Energy Efficiency and Conservation Measures, Smart grids and Energy Policy Research can be developed.



## ENERGY RELATED NATIONAL NEWS

### Work On Iran-Pakistan Gas Pipeline Project to Start Soon

Ministry of Petroleum and Natural Resources is hopeful that work to lay pipeline on Pakistani side for Iran-Pakistan gas project would start soon after lifting of international sanctions. "The ministry is hopeful that in the wake of removal of international sanctions on Iran, it will agree to Pakistan's proposal to finalize a workable implementation schedule," official sources in Ministry of Petroleum and Natural Resources told. They said Pakistan was committed to execution of the project and practical work was expected to start soon following clarity on the sanctions.

The sources informed that international contractors and financiers were unable to initiate work on the project due to the sanctions. They said Pakistan was continuously in touch with the government of Iran and counterpart Iranian Gas Company regarding development on the project and had also completed design of the project.

Official Ministry of Petroleum and Natural resources said Foreign office was currently evaluating latest developments and the ministry was expecting its guidelines to move forward for execution of the project. They said the Iranian side had already been requested to revise the timelines for the completion of the project through amendment in the Gas Sales and Purchase Agreement (GSPA).



## \$3bn invested in renewable energy sector in one year

An amount of \$3 billion has been invested in the field of renewable energy over the past one year, indicating the investment potential and interest of investors in the sector. This was said by Chief Executive Officer of the Alternative Energy Development Board (AEDB), Amjad Ali Awan, on Sunday.

He said that Pakistan had become a choice destination of investors because of the potential in this sector, robust policy framework, lucrative tariff structures and bankable security documents. "The government is taking steps to harness the potential of renewable energy, diversify energy mix and ensure energy security."

## TAPI pipeline to help overcome energy shortage

Chairman Board of Investment (BOI) Dr. Miftah Ismail Friday said that Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline project would help Pakistan in overcoming its energy shortage. The chairman said Pakistan would get 35 percent gas from TAPI pipeline with an initial investment of five percent. Miftah said Pakistan would get more than 750 MCF gas daily through the project and will increase its shares with more investment in the project in future.

He said two Liquefied Natural Gas (LNG) terminals were being set up in the country and gas from these terminals would be provided to power sector for enhancing electricity generation capacity to meet the growing demand. He said gas supply from TAPI project would be provided to all sectors including power, industrial and domestic. Replying to a question regarding security of the pipeline, he said a monitoring system of modern technology would be used.





## Government of Pakistan: Go-ahead to Thar Coal Power Project

The Pakistan government has finally given a much-awaited sovereign guarantee to the Thar coal mine and power generation project, pushing it a step closer towards its financial close that had been in the pipeline for some time. The \$2 billion project will see billions of tons of coal put to the one use that Pakistan so desperately needs — addressing the power crisis that has for long been the country's most consistent enemy. Coal reserves in Thar were discovered in the 1990s, and it has taken Pakistan over two decades to come this far, with bureaucratic red tape, indifference, inefficiency and corruption of successive governments, and lack of confidence and scepticism about coal being an energy source being among the hurdles.

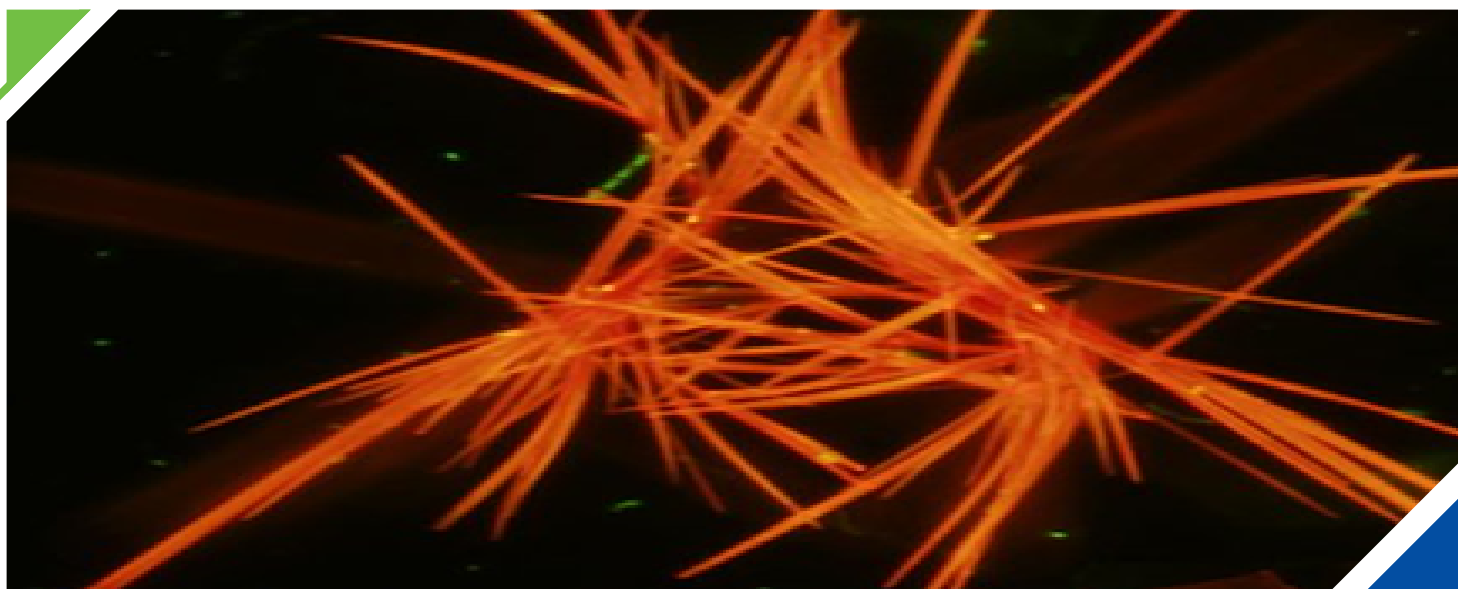




## ENERGY RELATED INTERNATIONAL NEWS

### Tiny red crystals dramatically increase biogas production

Researchers have discovered a way to produce a tenfold increase in the amount of methane gas emitted by naturally occurring microbes living in coal seams and on food waste. The innovation could benefit the environment by extending the lifespan of coal seam gas wells, as well as improving the economics of using woody crops and left-over food as commercial sources of biogas.



Crystals of a synthetic dye called neutral red can dramatically increase the amount of methane gas emitted by naturally occurring microbes living in coal seams and on food waste.

### India's Solar Catching UK with over 9 GW Seen Online by March

India's installed solar capacity will probably cross the 9 GW thresholds by March, bringing the country closer to Prime Minister Narendra Modi's ambitious renewable energy targets, according to a government website. India added about 5.25 GW of new solar capacity to the grid as of Jan. 31 after ending the previous year with 3.7 GW of installed capacity, according to data on the Ministry of New and Renewable Energy's website. An additional 1.5 GW were installed at the Jawaharlal Nehru National Solar Mission.

Modi's campaign to generate 100 GW of solar power by 2022 is elevating India into the ranks of the world's top solar-power-producing nations. At 9.1 GW, the U.K. was the eighth biggest solar-power producer last year, according to Bloomberg New Energy Finance. India's investment push has attracted companies including the SunEdison Inc, SoftBank Group Corp and Fortum OYJ. Another 3.8 GW of solar projects should be commissioned by March 31, almost all of which will be through state-led policies, according to the website. The government said an additional 12 GW of capacity will be added in fiscal-year 2017, which begins April 1.



## Europe's largest floating solar array is coming to London

Thames Water has announced that it is building the largest floating solar array in Europe on a reservoir in London. These projects join a growing list of floating solar installations around the world. At first floating solar arrays seem like a strange idea. Why build them on water when you can build them on land?

There are actually a few good reasons. One is that there are areas where a wide expanse of land is hard to come by, like in Japan where cities are dense and agricultural land is limited, solar takes a backseat when it comes to available space. London is another dense city where solar has to either go on a rooftop or, in this case, on a reservoir.

Another reason is that the water keeps the solar panels cool, which helps the solar panels to perform better and last longer and the water itself benefits from the panels being there. In the case of reservoirs, the panels block out sunlight so it keeps algae growth to a minimum and reduces water evaporation to keep the reservoirs full.

The London project is being constructed on the Queen Elizabeth II Reservoir near Walton-on-Thames and will see 23,000 solar PV panels cover one-tenth of the large body of water, equal to about 8 football pitches. It will have a capacity of 6.3 MW and is expected to generate 5.8 million kilowatt hours in its first year -- roughly the yearly consumption of 1,800 homes.

The electricity generated will help power the nearby water treatment plant and will go towards Thames Water's goal of generating 30 percent of its own energy from renewable sources by 2020.





## A GLIMPSE OF ONGOING FUEL CELL RESEARCH

### Fuel Cells: Clean Energy Research Group key for future sustainable growth by Dr. Rizwan Raza

#### Introduction

The purpose of this document is to present a brief overview of what is going on in “Clean Energy: Fuel cells” group under the umbrella of Physics department, COMSATS Lahore.

The deployment of 'Fuel Cells' offers promise for a truly sustainable economic development with minimal environmental consequences. The uses include those at homes, in grocery stores, warehouses, commercial and industrial buildings etc. There are three main markets for fuel cell technology: stationary power, transportation power, and portable power. Stationary power includes any application in which the fuel cells are operated at a fixed location, either for primary or for backup power, or for combined heat and power. Transportation applications include motive power for cars, buses and other fuel cell passenger vehicles, specialty vehicles, materials handling vehicles (e.g. forklifts) and auxiliary power units for highway and off-road vehicles. Portable power applications use fuel cells that are not permanently installed at a location or fuel cells installed in a portable device.

The project in hand, takes cognizance of the above, and establishing a Research Centre at COMSATS Institute of Information Technology. It is an important step in contributing towards achieving the above cited objectives of the Government of Pakistan. The research and development activities and the development of products expected to be developed from the Centre proposed to be established under the project in hand will play an important role in meeting the future energy scenario of Pakistan. It will also promote collaborative interactions of the highly qualified faculty members working in Pakistan with the researches abroad by carrying out joint research projects.

The aim is to complement the initiatives of the Government to provide high quality research and development facilities in the institutions of higher learning in the emerging disciplines of fuel cell technology.

The major Objective is to overcome current energy crisis of Pakistan:

Our group is focusing on following objectives

- To design high efficient and more stable materials through DFT approach
- To develop functional nano composite materials for Fuel cells and Li-Ion batteries
- Development of cost effective energy storage devices like: batteries, super-capacitor etc.
- To develop prototype of energy conversion devices
- To find investments from industries for commercialization of the technology
- Investigation and feasibility of quantum-dot-based materials in new-generation fuel cells
- To develop Fuel cell based Hybrid & Polygeneration system

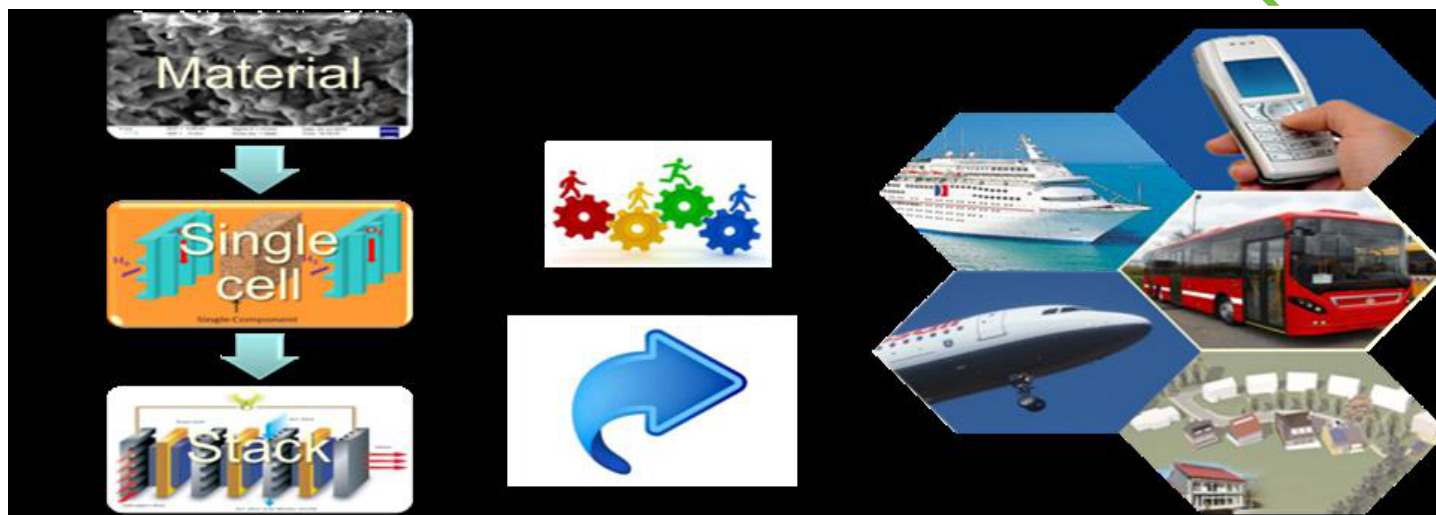


Figure: Theme of the FC group

## Research Group members

- |                           |   |
|---------------------------|---|
| 1. Dr. Rizwan Raza        | 7. Dr. Nadeem Akram (on study leave)          |
| 2. Dr Ghazanfar Abbas     | 8. Mr. Muhammad Sufyan Javed (on study leave) |
| 3. Dr Muhammad Saleem     | 9. Mr. Kaleem-Ullah, Lecturer                 |
| 4. Dr Farah Alvi          | 10. Mrs. Asia Iftikhar, PhD Scholar           |
| 5. Dr Saif-ur-Rehman      | 11. Mr. Amjad Ali, PhD Scholar                |
| 6. Dr Muhammad Ajmal Khan | 12. Mr Naveed (MS)                            |

## Current Targets:

This includes the testing of fuel cell performances, polarizations and efficiencies in various fuels (syngas/bio-ethanol, bio-methanol, Biogas) for 1-10 watt.

## Activities in the Lab:

1. Preparation of electrolytes materials from different methods
2. Preparation of electrode materials from different methods
3. Growth of thin films of electrolyte and electrode materials
4. Fabrication of the cell with film for 1-10 watt
5. Testing the fuel cell performances, polarizations and efficiencies with hydrogen, syngas, bio-ethanol, bio-methanol, and Biogas.
6. Publishing of obtained results in international Impact factor journals.



## Future Targets:

This work includes the Materials and devices of Explore fuel cell for polygenerations will be successfully developed based on both theoretical and technical efforts. The following work and facilities are going on in our research group.

- 1: Rig Frame and Safety Measurements
- 2: Design and construction of SOFC stack for 1kW/5kW. (Theoretical study)
- 3: Design and development of bipolar plates, interconnects for SOFC stack 1kW/5Kw
- 4: Design a LTSOFC system for polygeneration (1kW) for Heat and power system
- 5: Design and integration of SOFC with micro gas turbines to get higher efficiencies (Theoretical study)
- 6: Lab scale (1-10 watt) Testing the fuel cell performances, with various fuels.
- 7: Development of Biomass (solid, carbon, lignin etc) fuelled SOFC and analysis
- 8: Pre-commercial Prototype SOFC (100W ) unit installation for demo developments
- 9: Integration of Prototype SOFC with Biomass Gasifier and micro turbines for demo developments
- 10: Measurements and testing of the complete SOFC Polygeneration system and performances
- 11: Develop polygenerations demo unit (1kW) for Heat and power system

## Collaboration:

We have national and international collaborations e.g. National (BZU, Multan, Quaid-e-Azam University, Islamabad, PNEC, NUST, UET, Lahore) and International (KTH, Sweden, Aalto-Finland, UCL-UK, Nigde-Turkey, Tianjin-China, University of Minho-Portugal,)

## Fuel Cell Laboratory facilities:

We have a well-equipped Fuel cell research laboratory. It is one of the earliest fuel cell research Laboratory in Pakistan. The R&D activities of laboratory are mainly focused on the engineering fundamentals of advanced materials, core components, system integration, and process control in the areas of fuel cells and solar cells. The major equipments in the Lab are, EIS analysis (PARSTAT 4000-USA), 4-probe conductivity (Keithley), Fuel cell testing set-up and all necessary synthesis tools and equipments



## Pakistan's Power Sector Crisis by Dr. Talat Anwar and Khalid Saeed\*

### 1. Introduction

Pakistan faces severe shortages of energy which have emerged as major risks to the economy and the living standards of the people. The rising energy shortages have deteriorated the quality of life of citizens and impeded economic growth, employment generation and poverty reduction. While country has nearly sufficient installed power generation capacity to meet the demand, the increasing shortfall in electricity generation has emerged because of lack of good governance and mismanagement in the energy sector.

In this context, the objective of this policy brief to assess energy sector crisis as well as the governance in the power sector of Pakistan and recommend policies to improve governance and achieve financial and technical sustainability in order to overcome the crisis.

### 2. Performance of the Energy Sector

Power sector's performance remained highly dismal over the last few years with poor governance. There are huge and growing shortages of power about 4,000-7,000 MW a third of peak demand for electricity. The sector is heavily dependent upon the government support with subsidies of around 2% of GDP in order to cover operating costs and the investment in the sector. The energy shortages have constrained growth of productive activities since 2008 resulting in a loss of 2% of GDP, impacting employment, exports and poverty adversely. Due to poor governance and mismanagement, the generation capacity further declined to 18,499 MW in 2014-15 while peak load continued to increase to 23,242 MW in the NTDC system leaving the country with a deficit of 20% of its peak demand.

Table 1 indicates year-wise projected summary of power generation capability, NTDC peak demand and the resulting deficit or surplus of power. Based on the government capacity addition planning and NTDC projected peak demand, the power deficit will increase initially from 4,743 MW in 2014-15 to 4,920 MW in 2015-16 but will decline to 2,371 MW by 2017-18 or 9.1% of peak demand.

The peak demand is projected to be 26,105 MW in 2018 (See Table 1). This scenario is disappointing since the power deficit will persist beyond 2018 even with conservative growth rates. To overcome the power deficit, the

Present government is required to increase its planned capacity from 18,499 MW in 2015 by adding 5,235 MW by 2018 in the system in order to eliminate the power shortages which require concerted efforts by the government. Given the high prioritization to the roads and highways, the power deficit is likely to persist during the tenure of the present government.

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\*The authors are respectively, Advisor, Centre for Policy Studies, COMSATS Institute of Information Technology (CIIT), Islamabad and Head, Energy Research Centre, CIIT, Lahore.

**Table 1:** Projected summary of annual power balances

Financial Year	NTDC peak Demand (MW)	Capacity Addition per Year in NTDC System (MW)	Deficit /Surplus Power (MW)
2014-15	23,242*	18,499	-4,743
2015-16	23,711	18,791	-4,920
2016-17	24,471	20,304	4,567
2017-18	26,105	23,734	-2,371
2018-19	27,408	26,480	-928
2019-20	28,773	29,895	1,122

Source: State of Industry Report 2014, NEPRA, Islamabad

\*Export of 650MW to K-Electric is not considered

### 3. Electricity Generation Mix

The country's current electricity generation mix is unsustainable since it heavily relies on imported gas and imported fuel oil. Imported energy remained around 30% of the total energy mix during the last few years. The total power generation capacity was 20,556 MW in June 2009. Out of this total power generation capacity, 65.8% was thermal 31.8% was hydroelectric, and 2.2% was nuclear. The electricity generation mix<sup>1</sup> continued to deteriorate further due to the neglect of the renewable energy between 2009 and 2013. Though the total power generation capacity increased in 2013, but increase was mainly due to expansion in thermal generation. As a result, the share of thermal generation after some fluctuations increased from 65.8% in 2009 to 67.6% in 2013.

There is a need for diversification of energy mix. The energy mix can be diversified by increasing reliance on domestic sources. Currently, it comprises only 9% of the energy mix. Though government is planning for 10,000 MW coal power projects under the China-Pakistan Economic Corridor Project, the energy demand is going to increase further during the construction of CPEC. The country has huge coal potential for power generation. Pakistan has coal with estimated reserves of 217 million tons in Baluchistan, 235 million tons in Punjab, and 90 million tons in Khyber-Pakhtunkhwa. Sindh has huge estimated reserves of 185 billion tons which are sufficient to generate 100,000 MW. The government needs to make concerted efforts for utilization of this potential to increase the share of coal in the primary energy mix.

### 4. Circular Debt

Pakistan's energy sector is not financially sustainable because electricity tariffs notified by the government remain below the cost recovery level. The federal government has been subsidizing tariffs by providing tariff

<sup>1</sup> State of the Industry Report 2013, National Electric Power Regulatory Authority



differential subsidies which it frequently underestimates in its annual budget. In addition, the government does not fully pay the TDS to the DISCOs on time due to fiscal constraints which contributes to a serious problem of the inter-company circular debt.

Circular debts are created when customers both public and private sectors do not fully pay their electricity bills to distribution companies and the government do not fully pay subsidies to distribution companies. While the government failure to pay the subsidies on time is one of the major causes of circular debt, there are other factors that also contribute to its occurrence. The circular debt is the amount of cash shortfall within the CPPA that it cannot pay to power supply companies. This short fall is an outcome<sup>2</sup> of (i) the difference between the actual cost of providing electricity in relation to revenues realized by the power distribution companies (DISCOs) from sales to customers plus subsidies; and (ii) insufficient payments by the DISCOs to CPPA out of realized revenue since they prioritize their own cash flow needs. The revenue shortfall spreads through the entire energy supply chain, from power generators to fuel suppliers, refiners, and producers causing reduced fuel supply to the public sector thermal generating companies (GENCOs), reduced power generation by Independent Power Producers (IPPs), and an increased hours of load shedding in the country. The circular debts at the end of fiscal year 2006 that were estimated at Rs111 billion, increased rapidly to more than Rs872 billion or 4% of GDP by end of 2012. The current government soon after assuming power cleared Rs480 billion circular debt in the last week of July 2013.

During 2013 the Government of Pakistan injected US\$ 3.8 billion as equity in the Discos to clear their outstanding losses. The Government stands committed to the World Bank, IMF, Asian Development Bank and other donors under Pakistan's sustainable Energy Sector Reform Program to eliminate all subsidies by 2016, except for those to low income customers who consume up to 200 units of electricity per month. However, the achievement of this target will be difficult unless the performance of distribution companies is improved through controlling their losses and improving recoveries. The total amount of subsidies to the power sector by the government over the past 4 years is more than Rs 1.0 trillion which is equivalent to 1.6% of the GDP last year.

## 5. Poor Governance

The persistence of power crisis is mainly owing to the poor governance in this sector. Many of the causes like high transmission and distribution losses, poor recoveries are all directly linked with the management and governance issues. On top of it there is no political will for reform. There is a fragmentation of energy functions between government ministries. The creation of a unified Ministry of Energy (MOE) has been proposed by various task forces and committees to ensure that all the government ministries are on the same page in pursuit of the goal of augmenting cheaper power generation. In the absence of either a MOE or some higher forum resolving the inter-ministerial squabbles on energy related issues, the country will continue to face the issues like inadequate gas allocation for the power sector that leave the country to depend on generation of expensive power from diesel and furnace oil. The recently witnessed worst ever petrol crisis throughout the

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<sup>2</sup> For details see USAID (2013)



country in January, 2015 is a reflection of fragmented responsibilities and accountabilities between government ministries.

The poor governance in the energy sector is also reflected by the fact that all the provincial governments failed to develop a political consensus on the future strategy for the national energy security to supplement power generation, improve transmission and distribution network and ensure availability of reliable and affordable power supply to the country's industry, agriculture, commercial and household sectors. The Council of Common Interests (CCI) at the apex chaired by the prime minister including all provincial chief ministers is mandated to decide on energy related issues but failed to evolve a consensus on the key issue of construction of hydel projects to exploit the full potential of this cheapest source of power generation. Similarly, the issue of hydel profit royalty dues to KP provincial government remains unresolved. Though the previous government approved a very generous dispensation for KP, there is a need for all the parties to agree to a formula whereby KP including the provinces generating cheaper hydel power are duly<sup>3</sup> compensated. The current dispensation proved to be impracticable particularly after the last NFC Award, the federation does not find it possible to keep its commitments and the issue will remain a bone of contention between the federal and KPK governments.

The current plight of country's power sector today mainly owes to a dilemma of its acceptance to ill-advised policies sponsored by the World Bank under structural reforms program for the power sector in 1992. The concept of handing over the management of power distribution companies to the private sector after unbundling of WAPDA, in particular, was needed to be weighed in very carefully manner in the country. The decades' old power theft culture by individuals and businesses, the ingrained inefficiency and corruption among the WAPDA<sup>4</sup> staff and the outdated and poor distribution and transmission infrastructure were the legacies that the newly corporatized distribution companies (DISCOs) were to inherit.

To worsen the situation, the newly corporatized DISCOs were not structured in a truly corporate style as WAPDA and the Ministry of Water and Power still exercise strict control over them. DISCOs were never allowed to follow the code of corporate governance. The government still retains the power to hire and fire the CEOs, who is usually former employees of WAPDA and come with the same work ethics and culture of corruption which were the main causes of the demise of WAPDA. Similarly, NEPRAdoes not have adequate administrative control over the power sector entities to persuade them to reform. Above all, the political interference by the successive governments have been forcing the newly constituted companies to induct thousands of unwanted employees in poor performing and cash starved DISCOs and public sector Generating Companies (GENCOs) that keep on adding more parasites to eat into the meager earnings of these companies. In the absence of effective control to curb theft of electricity, the T & D losses mainly owing to theft in some DISCOs like KESC, HESCO and PESCO shot up to over 35 percent.

## 6. Mismanagement in Power Generation and Distribution Companies

The poor governance is an important factor for the dismal performance of public sector's generation, transmission and distribution. On the generation side, the public sector generation companies' (Gencos) plants are poorly maintained and inefficiently run. Having outlived their useful lives, the capacities of these plants have been deteriorated. Most of these



plants have already lost 20% to 30% of their efficiency due to poor maintenance. Overall, the public sector Gencos' capacity had degenerated to 3,580 MW in 2012 compared with the designed and installed capacity of 4,664 MW.

The power generation from these plants has also suffered due to delayed payments to Gencos because of circular debt resulting in delayed procurement of parts, poor housekeeping and lack of financial and administrative autonomy even for routine maintenance.

Corruption is yet another important factor contributing to the poor financial health of the Gencos and Discos. According to a study by NEPRA in 2010, the pilferage of furnace oil in the public sector Gencos' resulted in an estimated siphoning off of around Rs25 billion worth of furnace oil in collusion with transporters.

The worst manifestation of maladministration resulting in colossal losses for the country's economy is visible in the operations of the distribution companies (Discos). The dismal performance of the DISCOs is reflected in the high distribution losses and poor recovery rate of their dues, mainly due to theft of electricity with the involvement of or negligence of the Discos' employees. There is clearly a sufficient room for improvement to cut down these losses. In 2012, the overall T&D losses of Pakistan's power sector stood at 23% while the collection of billed amounts was at 86%. No substantial improvement in the power sector financial position is possible without controlling the unbridled T&D losses by Discos and improving the recoveries of their dues.

## 7. Policy Recommendations

The paper analyzes the power sector crisis of Pakistan with a particular focus on governance sector. Based on the analysis some policy recommendations are as follows: First, power load shedding should be minimized significantly by utilizing the full existing capacity of power generation, which can be made possible by improving financial management and addressing the issue of circular debt. For this purpose the government need pay the tariff subsidy to the distribution companies on time which would enable the CPPA to make timely payments to the fuel companies (gas companies, refineries) and the IPPs. Second, the government should reduce the tariffs by reducing the cost of power generation through a reduction in theft of electricity and line losses which are very high compared with international standard. The high transmission and distribution losses in the power system can also be brought down by updating the system. The high power tariffs are not only making country's exports uncompetitive but also resulting in increased theft of electricity.

Third, energy sector's governance is fragmented. There is a need for integrated planning which requires merger of existing Ministries of Water & Power and Petroleum & Natural Resource into a single Ministry of Energy to ensure integrated sector policy development, planning, and implementation. Corporate governance in the energy sector should be improved by providing financial and administrative autonomy to energy companies.

Fourth, while the successive governments have failed to undertake any serious effort in electricity conservation measures, it is now essential to educate and incentivize the public for saving electricity. Finally, there is a great need for diversification of energy mix by exploiting substantial untapped coal potential for power generation.

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<sup>5</sup> NEPRA State of Industry Report:2012



Considerable efforts are required to increase the share of coal in the primary energy mix. Government should also develop consensus among provinces for construction of mega dams so as to increase country's hydel as well as the water capacity.

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