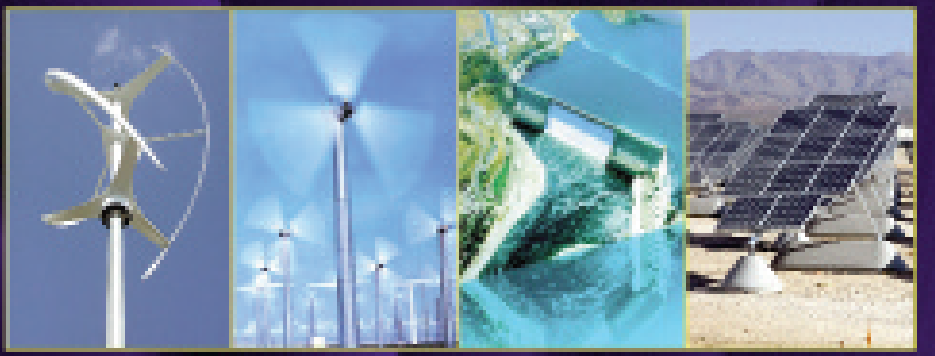


TOWARDS A PROSPEROUS PAKISTAN

Exploring Our Energy Resources

Greenwich University
KARACHI – PAKISTAN

TOWARDS A PROSPEROUS PAKISTAN

Proceedings of the
Online International Conference on
'Energy Crisis Management'
organized by
Greenwich University
on June 07-08, 2011

Dedicated to

All those who are contributing
to Making Pakistan
a Self-Reliant Country

We do not have the right to happiness without producing it

A modest contribution by Greenwich University towards making Pakistan self-sufficient in Energy with the help of Academia, professionals and the energetic youth of Pakistan

CONTENTS

* **PAPERS**

Preamble

DR. S. SULTAN
Convener of the Conference

Z.I. SAIFI
Coordinator of the Conference

The purpose of the International Conference on Energy Crisis Management is an effort toward realizing our problems, suggesting solutions and implementing ideas to explore and promote alternative and renewable technologies in Pakistan on fast track basis. The country needs integrated energy policy encompassing development of local electricity, gas, coal etc. prepared with meaningful participation of government and different other stakeholders including general public. Whereas the role of the government should be restricted to policy making and the rest may be left to the private sector.

The next generation of energy is likely to be renewable and not exhaustive. Coal, oil and gas remain in exhaustive category while solar, wind and hydro are dependent on the phenomenon of global warming and climate changes, so most important of tomorrow's winner will be the countries that can be competitive by adapting and changing viz-a-viz natural resources. The challenge for the energy sector is to meet the twin objectives of meeting the demand and decarbonizing the energy mix to limit the climate impact. For energy crisis management we need to explore what we can do as a nation to conserve energy. Secondly, exploring the major areas of conservation and thirdly, finding short term and long term solutions.

We must explore possibilities to make our own power houses by means of solar, wind, biomass etc. Prima-facie renewable energy may appear a bit costlier than the conventional source of energy but looking at the benefit of continuous power availability and great contribution against global warming, it is worth it. Companies in renewable energy business today are growing as

fast as Microsoft did in the 80's. Developed countries from Europe, USA, Australia, Japan, China and many others have laid down intensive planning and action to use renewable energy resources to generate total energy requirements by 2025 which will create 5 million new job opportunities in various areas of renewable energy.

The government through its various agencies should strive to attract foreign direct investment in power sector by reviewing our long term energy plan. New projects should be set up under public private partnership. The existing power plants in the private sector should be offered incentives to convert their plants to cheaper fuel and also refurbish them to improve the efficiency.

It is essential to explore and increase energy generation and distribution capacity in a sustained and orderly manner in the coming years and the basic responsibility for this lies with the apex institutions in energy sector which should handle the affairs honestly, transparently and efficiently. Additional physical infrastructure is required despite the political and social resistance, more investment toward oil and gas exploration and long term investment in renewable technologies is in dire need.

According to a study depending upon the input from several scientific laboratories around the globe, renewable energy could supply the equivalent of 50-70 percent of current energy use by the year 2030. Biomass and hydropower already supply about 20 percent of the world energy needs. Biomass alone meets 35 percent of developing countries' total energy needs. Steady advances have been made since the mid 70's and in the 90's in a broad array of renewable energy technology and processes that could provide energy in a solar economy are now economically competitive with fossil fuel. Further reductions in cost are expected in this decade as technologies continue to improve.

Pakistan, being a developing country is in dire need of research & development in independent energy sector which may enable continuous fuel supply at very economical rates.

Message from

Seema Mughal

Vice-Chancellor, Greenwich University

Energy crisis and the need for a clean and safe environment are major factors affecting the people living around the world. There exists many data on most renewable energy source but the aim of Energy Crisis Management Conference 2011 at Greenwich University is to present a discussion specially about those sources available in this part of the world that is our country and if possible promote hybrid system which may ensure a better performance and cost effectiveness.

Energy crisis is severely affecting economic activities in the country including the production sector where growing power tariff has affected the manufacturing cost. Alarming population growth and in turn ever increasing consumption of energy is leading to its depletion. We need to involve multiple private and public agencies, industry, and the masses in general to understand and confront the prospect of decline in world oil production.

Innovation was inherent to all scientific and technological ideas presented at the Conference which took place on June 7-8, 2011. More than 20 submissions entered the process representing various national and international universities and we are proud to have hosted some of the brightest scientists, engineers and industrialists from around the world. It is an opportunity to gain knowledge and learn best practices from professionals, create networks for discussing common challenges and solutions, and share information and strategies.

We would like to thank all participants for pursuing research to develop renewable energy at this exceptional scientific forum animated by high level experts and national and international researchers. It would also provide opportunities to students and young engineers to have an interaction with national and international experts which in turn will help them to pursue further research in the field.

Greenwich benefitted enormously from faculty, staff, students and sponsors who offered their talents and resources to the Conference. I would like to extend my heartfelt thanks to all and would end with the words that, together as we achieve our goals, we edge a step closer to excellence.

Message from
Engr. Shams-ul-Mulk
President, Board of Governors, GIK Institute
Former Chairman WAPDA

BISMILLAHIR RAHMANIR RAHIM
ASSALAM-O-ALAIKUM

"I am very grateful to the organizers of this workshop and to the Greenwich University for having invited me to speak on a subject which is the core of Pakistan's problems.

I am very grateful to the participants who have expressed their desire to hear me and I must express my gratitude to them and my regrets to them that because of my ill health I could not be here today be with you physically but I will say a few words and my views shall be with you.

At the very beginning let me express to you my views that I do not represent any lobby, I only represent the lobby of the people of Pakistan and the four federating units, so please understand that there is no conflict or distortion in my views due to any personal interest.

Ladies and gentlemen, let me say that at the very first instance, Pakistan is not a country which should have an energy crisis because the resources that we have been endowed with are immense. The energy crisis therefore, is man made, and hence, artificial.

There must not be any load shedding in Pakistan. The electricity prices should not be Rs.10/unit in Pakistan and the people of Pakistan should not be so helpless that 2000 poor Pakistanis lost their lives and around 2 crore Pakistanis have become homeless and beseech for shelter. All this is happening to us because of our own deeds and our own weaknesses and prejudices and short sighted self-interest.

Ladies and gentlemen, on 14th August 1947, we created Pakistan and we cannot thank Allah enough that He gave us our homeland, but unfortunately it never got independent. After the British left our country, it was then attacked by vested interests, and this attack by the vested interests still prevails in Pakistan. I still remember that 20 years ago when I was in WAPDA, we used to wonder what we would do with so much of electricity that we had that time. Here I am talking about 1959 to 1961 when we were building Tarbela and Mangla and the Planning Commission members used to question us, "Where are you going to use so much of this electricity in the future?" And we used to have very serious discussions on this and we went on to think that railway should continue using electricity as a fuel since we had it in excess.

We are fortunate that Allah has given us plentiful resources, resources to produce electricity with approximately 40000 to 50000 megawatt of capacity to produce and generate through water, but we are producing only 6000 megawatt and let me tell you that we are producing electricity only through Ghazi Barotha which has 1400 megawatt of capacity developed by WAPDA and the rest is built by World Bank and not us. I am not talking about this for my own benefit, but this electricity that is produced today costs Rs1.02 per unit on generation as compared to the powerhouses using oil which costs Rs12.04 to Rs20 per unit.

Pakistan does not lack resources, in fact Pakistan has mashaAllah plenty of capacity for energy generation. But we lack revenue of the oil that is required in energy generation. We are paying the cost of not building Kalabagh dam. It is a tragedy that since 20 years we are bearing this cost and trying to find a substitute of Kalabagh dam and eventually we are paying Rs12 to Rs20 per unit which we could have easily availed for Rs1 to Rs3 per unit. But unfortunately we missed to choose the right path and we chose the one which requires heavy investment and hence we are unable to pay for it. Consequently, we are unable to make use of our powerhouses. Even today Pakistan has power houses and stations to produce electricity but they are closed and not in use because we are unable to pay for the oil that is required in electricity generation.

I can talk a lot on this issue but I will restrict myself since I am here just to convey my message. Now lets move onto the management. When we were in WAPDA, we felt fortunate that Allah has blessed us with two very essential natural resources for electricity production; hydel and Thar coal. But so far no progress has been done on the coal resources and we

have gone astray. Now when we are under electricity crisis, we are developing more power houses that would run on oil and therefore we would not be able to utilize them when the need arises. Only people who do not care about the wellbeing of the nation of Pakistan can do such a thing. I regret to say that the problem that lies with Pakistan is that decision makers of our country are never found to be the victims of their own false decisions. The victims of those decisions are always the people of Pakistan.

Our main issue in the power crisis is not the unavailability of power resources or powerhouses. The government should work upon the efficiency and improvement of the electricity powerhouses, should control the wastages and most importantly the government should pay heavy subsidies to bring energy saving devices in Pakistan and put them into work to save the electricity consumption as this is the most effective medium globally to save electricity. Energy savers are not just used in houses today but also in electrical motors etc.

Secondly, we should share load shedding. Load shedding should not just be restricted for the common people, rather president houses and Prime Minister Houses and other government workplaces should share at least 2 hours of load shedding without using generators because the cost of these heavy generators is paid by the government which belongs to the people of Pakistan.

Therefore to tackle this issue we need effective leadership to realize that this electricity crisis is an issue of the whole nation and everyone should bear it equally. If the people of Pakistan suffer 8 to 12 hours of load shedding then the higher official's residents, president houses, Prime Minister Houses and governor houses should also bear at least 2 to 3 hours of load shedding. I think we need to take immediate steps for the future. Producing 4000 megawatt in the next ten years would not help because with time the requirement will increase to 8000 to 10000 megawatt. Therefore more dams should be built immediately to tackle the issue.

Moreover Kalabagh dam would take another seven years and it should be built. It is the need for Pakistan. I am very sincerely telling you that Kalabagh dam would not damage any region of Pakistan; it would help to curb this crisis. I have no personal benefit from this but for the benefit of Pakistan we need to start working on Kalabagh dam as it would take 6 to 7 years to be fully operational. Kalabagh would help us to produce 4000

megawatt of electricity at a low cost. The cost of production would be higher initially but once we will repay all the debt, electricity could be produced at considerably low cost. That is what we need. We do not want expensive electricity, we do not want to spend Rs12/unit on electricity which we can avail at a lower price, we do not want load shedding, and we do not want to see our people being helpless during the floods. We want that people of Pakistan should be safe and protected from the floods, people of Pakistan should be provided with cheap electricity and people of Pakistan should not suffer load shedding.

I pray that this workshop becomes a success and this problem which has paralyzed our country could be minimized. It feels awful to see the businesses suffer, to see the people suffering and especially to see the decision makers making no efforts, as I mentioned above, they are not being affected by their own false decisions."

Thank you very much!

Message from
Muhammad Anwar Ali
Secretary
Alternative Energy Development Board

We were proud to be associated with Greenwich University in organizing the online conference to address an issue that had rung alarm bells all around the world and Pakistan is no exception.

Conference on energy crisis management was certainly a right and timely step towards realising our problem, suggesting solutions and implementing ideas. The researchers who participated in the conference very rightly pointed out that Pakistan has a number of alternative energy resources that not only can solve today's crisis but also can meet the needs for the times to come.

This conference is definitely in line with the objectives of AEDB, one of which is to promote alternative and renewable energy technologies in Pakistan on fast tracks basis.

AEDB appreciates your esteemed institution for arranging an online International Conference on Energy Crisis Management, and now compiling the research articles in this post publication, which indeed would support and help the government of Pakistan to identify and promote alternative energy resources.

We assure you of our assistance and support in carrying out such productive and meaningful endeavours in future.

Message from
Tabish Gauhar
Chief Executive Officer
Karachi Electric Supply Company Ltd. (KESC)

We appreciate the efforts of Greenwich University in bringing academia and corporate sector including KESC together to share their ideas on the platform of a conference on 'Energy Crisis Management'.

The experts from Pakistan and abroad enlightened us with their innovative ideas to cope with the looming shadow of power shortage. We found quite a few ideas useful for our organizations that are practicable and economical. I am sure it will benefit people from entrepreneurs to policy-makers in Pakistan to take steps in the light of researches presented in the conference.

The conference symbolizes 'hope' that we must adhere to in order to overcome the problem. Above all, the participants suggested doable solutions some of which have already been tested and implemented in various parts of the world. Moreover, the convenience and affordability of the alternatives will certainly motivate the people to invest and use them in Pakistan.

I congratulate the Vice-Chancellor, Greenwich University and Management for organizing a research conference on an issue which might threaten our generations to come.

I thank you for inviting us to represent KESC with the conference and look forward to collaborating with your university in future.

Message from

Muhammad Jarjees Seja

Chief Operating Officer
ARY Digital Pakistan

I would like to extend my sincere gratitude to Greenwich University for allowing ARY News to be their media partner in the International Online Conference on Energy Crises Management.

The event was witnessed by millions of people in and out side Pakistan due to its significance for not only industrialists and governments but also for common people who are equally suffering from this menace.

Lack of seriousness about this issue on the part of the government has led the old and prospective investors to shift their capital and industries to other countries where they don't face energy crises to such an extent. More adversely, it will create a vacuum in employment there by increasing poverty in the country.

We, at ARY Digital, also aim at spreading awareness among the masses on various issues that directly or indirectly affect their lives.

We are proud to be associated with Greenwich University as media partner of the conference because our objectives seem to converge.

I hope that the post-conference publication will reach our wider audience, who will benefit from the ideas given by the Researchers, Scientists and students of Greenwich University.

We are keen on collaborating with Greenwich University on any such event that can serve the interest of the people of Pakistan.

Message from

Syed Shabir Rizvi

Programming Manager
Hot FM 105

We appreciate the holding of International Conference on Energy Crisis Management, which was the need of the hour. The conference will go a long way in creating awareness about the problem of energy crisis. At the same time, we are very happy to be the media partner for the conferences on issues of national interest.

Please allow me to congratulate you. On behalf of Infotainment World (Pvt.) Ltd., I would like to take this brief opportunity to express our appreciation for your contribution and immense support for HOT FM 105 – Infotainment World (Pvt.) Ltd. It was HOT FM 105's pleasure to be your media partner; we definitely foresee a healthy and a long relationship.

Your efforts and contribution helped us to maintain our present level of operations. But clearly, to keep up with the competition, more has to be done.

You are therefore strongly urged to be relentless in efforts to improve on our service quality and productivity, as you have been, through pro-actively learning new skills and accepting job enlargement.

The management certainly looks forward to your continued support and cooperation in maintaining our competitive edge in the difficult time ahead.

A Brief Look at the Conference

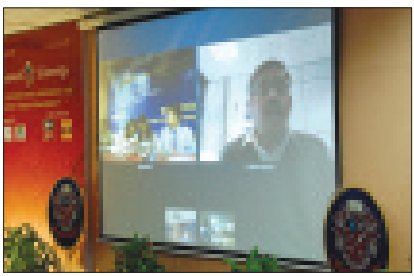
Ms Seema Mughal, Vice-Chancellor, Greenwich University addressing the audience

Mr Shamsul Mulk, former Chairman WAPDA Online Message

Mr Kalim A. Siddiqui, President, Byco Petroleum Ltd., presenting his paper

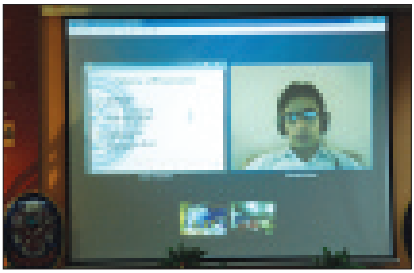
Mr Syed Ehtesham-ul-Haque, CEO, Ceres Alternate Energy, presenting his paper

Mr Talat Mahmood, Vice-President, KCCI sharing his thoughts



Dr Hoorani, High Energy Physicist, presenting his paper through video conference from CERN

SCHOLARS PRESENTING THEIR PAPERS



Mr Isfandyar Hassan Khan, Electrical Engineer, on video conference

Dr. Qazi Ahmed Kamal, Chairman, Public Utilities and Gas Sub Committee (KCCI)

Mr Syed Ali Hyder, Director Corporate Strategy & Business Development (KESC)

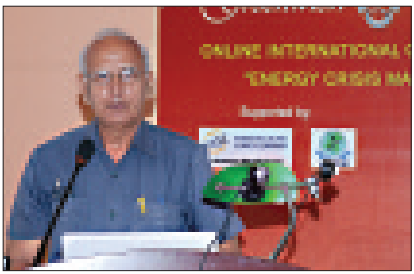
Mr Akhtar Ali Syed
Author & Mechanical Engineer

Prof. Dr Khalid Anis, Head of Applied Sciences and Graduate Studies, Bahria University

Mr Muhammad Ali Saeed, Lecturer
Greenwich University

Audience listening to the proceedings of Conference

SCHOLARS & STUDENTS PRESENTING THEIR PAPERS

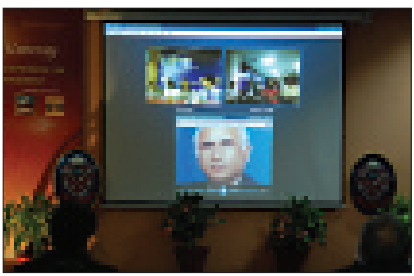


Mr Muhammad Bashir Chaudhry
Development Banker

Mr I.R. Kazmi
Senior Journalist, giving online message

Dr. Sultan Mughal, Associate Dean, Faculty of MGMT Sc. & Inf. Studies sharing his views

Dr Najiya Amanat Khan
Director, Gulf Lighting Solutions

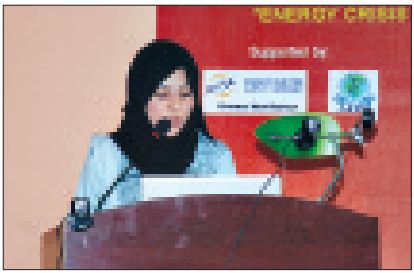


Mr. Rashid Zahir, Chairman, Islambad Stock Exchange and Former CEO, Saudi Pak (SAPICO)

Mr. Saroosh Siddiqui
online

Ms Seema Mughal, Vice-Chancellor, Greenwich University, and Mr Kalim A. Siddiqui, President, BYCO Petroleum during the inaugural session

STUDENTS PRESENTING THEIR PAPERS



Ms. Hira Arshad
BS25 2943

Mr. Syed Zainuddin Ahmed
BS 34 2840

Mr. Fahad Zafar Sobani
BS31 2574

Ms. Sawera Siddiqui
MS13 172

Mr Salman Rafiq Manai
MS40 3567

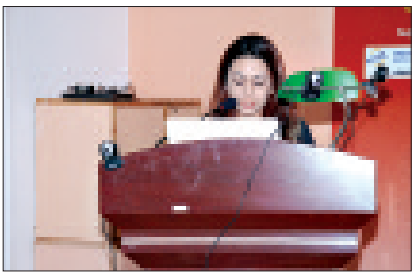
Mr. Muhammad Maroof Hussain
MS32 2695

The audience at the Conference.

STUDENTS PRESENTING THEIR PAPERS

Ms. Moomal Sara
BS30 2479

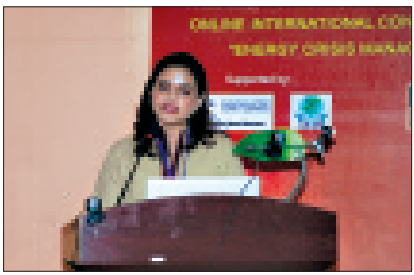
Mr. Muhammad Abdul Rahim
MS24 1831



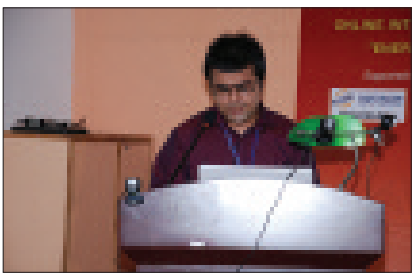
Ms. Ishah Rayees Butt
BS31 2573

Mr. Zohaib Malik
MS35 2975

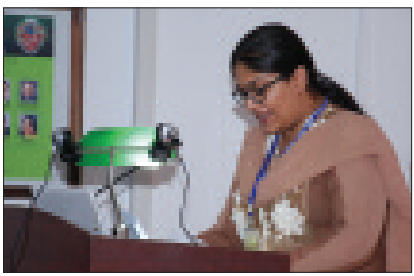
Ms. Unfal Shah
BS33 2815



Ms. Ayesha Malik
BS 2 222



Mr. Nasir Ali Sheikh
BS26 1984



Ms Farwa Shah
BS29 2325

QUESTION – ANSWER SESSION

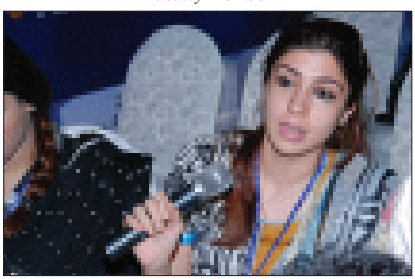
Mr. Shamyl Mooraj
Faculty Member

Mr. Iqbal Jamil
Faculty Member

Mr. Syed Ehtesham-ul-Haque
Guest Speaker

Ms. Farhat Saleem
Faculty Member

Mr. Karim Ismail Teli
BS20 1929



Ms. Sara Salman Rafiq
BS26 2000

The Vice-Chancellor Greenwich University (C)
alongwith Vice-President KCCI (R)

Mr. Hassan Khan
BS27 2135

QUESTION – ANSWER SESSION

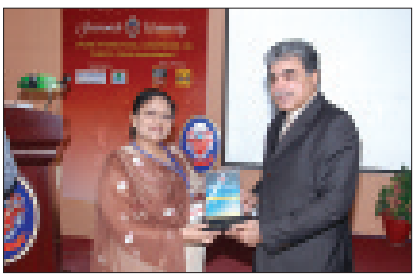
The audience listening to the proceedings of conference

Mr. Muneeb Gulzar
BS29 2302

Mr. Shifa Rahman
BS29 2375

Mr. Badar Khalid
BS27 2129

Vice-President, KCCI (L) with Vice-Chancellor and Director Administration (R) in his chamber

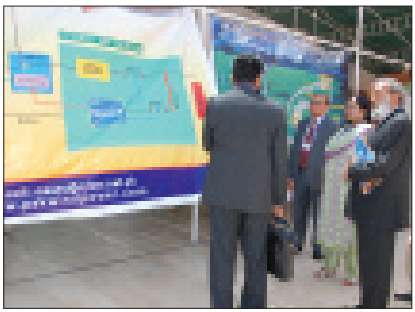


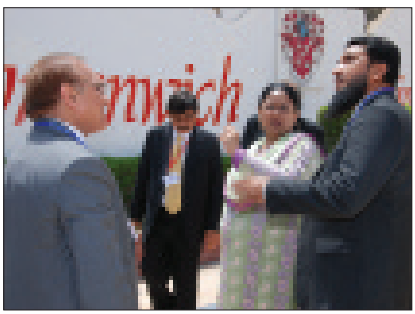
The Vice-chancellor presenting the shield to Mr Talat Mahmood, Vice-President, KCCI

A view of the Conference

VISIT TO THE STALLS SET UP ON THE CAMPUS





Views on the Conference

An excellent initiative on behalf of Greenwich University to organize an "Online Conference" on "Energy Crisis Management". Good participation from Students and Guest Speakers alike. Management needs to be congratulated for their efforts.

– Kalim A. Siddiqui
President Petroleum Marketing
Byco Petroleum Pakistan Ltd.
Karachi.

An international conference on "Energy Crisis Management" was held at Greenwich University on June 7th and 8th. I had the honor to present a paper on "Load Shedding vs Culminating Forex" and delivered in person on 8th June 2011.

While presenting the paper and during the question answer session, I noticed an involved audience both from student body and faculty. I was asked very relevant questions, which reflected the high level of understanding of the most pressing issue in Pakistan right now.

The conference was streamed live on the internet to international audience also. The conference room was well equipped with all types of technology and multi media facilities. This was my first visit to the University's DHA campus and was impressed with the campus buildings, services and layouts, which shows it was well planned

infrastructure. In the end, I would congratulate the university on conducting such an informative and useful conference on Pakistan's Energy Crisis and look forward to other future events at Greenwich University both on Energy Crisis and other topics.

– Syed Ali Hyder, KESC

It was indeed my honour and pleasure to be a part of your conference. The event was overall very well managed and launched. The same reflects the efforts and endeavour you and your team had put in to make this event a success.

And thank you very much for all the support and appreciation from your side.

– Sarosh Siddiqui

I would like to thank very warmly the organizers of International Conference on Energy Crisis Management for their incredible work and efforts which contributed to the success of the conference. Hosting of such an event of national importance is really a milestone achievement towards the cause of energy management. All of my participating students have really gained invaluable knowledge and experience.

I would like to reiterate my thanks for inviting us to the conference. Our participants were sincerely impressed with the organization of the event and we felt honored to attend the event.

I hope your quest for a better energy management of the country will continue and you will keep up the good spirits.

Once again my heartiest congratulation to all organizers.

– Dr Shafiq-ur-Rehman Qureshi

I was much impressed by your online energy conference

and the level of your students. This indicates the level of effort of the faculty that teaches the students. Please convey my thanks and congratulations to the VC as well.

– Akhtar Ali

I congratulate Ms Seema Mughal, Vice-Chancellor, Greenwich University on organizing a two-day conference on Energy Crisis.

I on behalf of myself and on behalf of KCCI congratulate all the faculty members of the University.

– Talat Mahmood
Senior Vice President
Karachi Chamber of Commerce and Industry

A good conference which has been managed very well. The papers read I hope will be printed and distributed widely. They should hold more such conferences in future also.

– Muhammad Bashir Chaudhry
Development Banker, (Ex-PICIC/NDFC)

I thank Ms Seema Mughal and all the Administration of Greenwich University as well as students who invited us to attend this conference. This is a very wonderful and beautiful university. Hope we all together organize a very effective work for students of Greenwich University.

– Fisun Aktug
Commercial Attache of Turkish Consulate

[01]

Scientific Program of SESAME Project

*Dr H. Hoorani**

Abstract

SESAME is a third generation light source with beam energy of 2.5 GeV, beam current of 400 mA, emittance 26 nm.rad and circumference of 133.2 m. It is under construction close to Amman – Jordan and will become the operational end of 2012 or beginning of 2013. SESAME contains 16 straight sections out of which 13 straight sections are available for placing insertion devices such as undulator and wigglers. An extensive scientific programme has been established with the help of Scientific Advisory Committee (SAC) and the Beamline Advisory Committee (BAC). From the beginning 7 beamlines are planned for Phase – I covering diverse areas of scientific interest such as: SAXS/WAXS, PX, IR, Soft X-ray, Powder Diffraction, XRF/XAFS and Atomic, Molecular spectroscopy (AMO) beamline. SESAME once operational will be a very competitive machine in the category of third generation light sources.

[02]

Pakistan's Energy Crisis: Time for Action

*Kalim A. Siddiqui**

Background

Pakistan is also one of those developing countries that had gotten some relief by the recent fall in crude prices. However, for a country that uses oil for almost 40% of its primary energy needs, the fact that crude prices are rising again is enough to remind it of the energy crisis that continues to haunt it.

With increasing demand from high growth countries like China, India in recent times, prices of all energy sources have seen a steep rise. Most affected has been oil, which after the seventies, has again reached threatening proportions. Pakistan's energy crisis thus majorly arises form an oil price crisis, apart from other social and economic factors.

[03]

Energy Crisis in Pakistan: Thar Coal as an Alternative Solution

*Faiz Muhammad Shaikh**
*Dr. Muneer Ali Shah***
*Dr. Anwar Ali Shah****

Abstract

This research discusses Thar Coal as an alternative solution for the energy crisis in Pakistan. Data were collected from various secondary sources and analyzed by using GTAP software. It was revealed that crude oil price is expected to remain high due to the policy followed by OPEC. Since Pakistan has no other alternative except to make use of coal obligatory by process industries, the GoP must announce a comprehensive Coal Policy immediately on the basis of the report prepared by the Experts Advisory Cell. It was further revealed that coal is the alternative for the energy crisis in Pakistan.

Key words: *Coal, Thar, Energy, Crisis*

[04]

Energy Crisis Management in Nigeria: Issues, Problems and Challenges

*Dr. Lawal Muhammad Anka**
*Faiz Muhammad Shaikh***
*Dr. Aijaz A. Khooharo****

Abstract

Energy Crisis in Nigeria is one of the greatest problems and challenges the country has been facing for over three and a half decades. Many reform programmes were implemented by the government to address energy problems so as to guarantee sustainable power supply in the country, we are yet to achieve this goal. The aim of this paper is to examine and analyse the current energy problems and recommend strategies of how to address the problems in the future. The major conclusions drawn from this paper were:- The dismal energy service provision has adversely affected living standard of the population. The persistent energy crisis has weakened the industrialisation process and significantly undermined efforts to achieve sustained economic growth and increase competitiveness of domestic industries. The install power generating capacity is about 6,000MW and operational capacity is less than 3,000MW. The State owned refineries have hardly operated above 40% capacity utilisation rate for an extended period of time in the last two decades. Well intentioned Power Holding Company of Nigeria has struggled to organise and distribute electricity in an efficient way but the goal is yet to be achieved. Government has recognised the need for more electricity yet it has had great difficulty funding and organising this endeavour. The increasing use of fuel wood is having a devastating effect on the forest thus causing erosion and deforestation. This paper recommends some strategies to address the problems of energy crisis in Nigeria.

[05]

Design and Fabrication of Single Phase Equivalent of STATCOM that can Absorb or Generate Reactive Power Viz. Improve Power Transmission Efficiency

*Isfandyar Hassan Khan**

Abstract

This paper reviews the work done to design and fabricate a single phase equivalent of a STATCOM. In recent years, the power transmission networks have been subjected to greater demands owing to the ever increasing population and the setting up of new industries every day. In addition, difficulty in acquiring new rights-of-way, environmental pollution, lack of long term planning, and cost problems delay the construction of both generation facilities and new transmission lines. The existing system in place thus becomes less secure and quality of the power supplied is reduced as they tend to be operated at their full capacities. Best solution would be to increase the capacity of existing lines and improve the stability and quality of the power systems. FACTS technology opens up new opportunities for controlling power and enhancing the usable capacity of present lines.

The Static Synchronous Compensator (STATCOM) is a shunt device of the Flexible AC Transmission Systems (FACTS) family which uses power electronics to control power flow and improve stability of power systems. It regulates voltage at its terminal by controlling the amount of reactive power injected into or absorbed from the power system. Our work presents a single phase equivalent of such a controller with simplified control circuitry, the aim of which is to demonstrate a model that can be set up in a laboratory to regulate a voltage across a single phase load. A single phase full-wave bridge voltage source converter using IGBT based inverter has been used which synthesizes a sinusoidal waveform from a DC voltage using Sinusoidal PWM. Automatic voltage regulation is performed by sensing the voltage across the

load using a potential transformer and based on that the output voltage of VSC is made to increase or decrease from the system voltage by changing the modulation index of SPWM. The basic synchronization with the system voltage is implemented using a PLL. The display consists of a console which shows the direction and magnitude of reactive power being exchanged between STATCOM and the system. Moreover a single phase π-equivalent model of transmission line with a non-linear load of variable parameters has been developed so that the performance of this single phase model can be demonstrated.

Key Words: *Power Electronics Equipment, Flexible AC Transmission Systems (FACTS), Power System Operation and Control, STATCOM, reactive power, Voltage Source Converter (VSC), voltage regulation, transmission line*

[06]

Energy Crisis Management

*Dr Qazi Ahmed Kamal**

Facts Regarding Energy Crisis

I have tried to present methods, ways and means to reduce the impact of energy crisis and it is now time to discuss the true nature of the energy crisis.

a) There is no power generation issue with regards to lack of units

There is no production issue in the root cause of the energy crisis. Our installed capacity is more than 21000 MW — quite enough to manage all our requirements.

[07]

Energy & its Relationship with Economics Today

*Muhammad Ali Saeed**

In today's modern times true independence is not limited to liberalization and policy frameworks for international trade, the future drivers of economic excellence will be a function of energy and food security, with global inhabitants to touch the 8.3 billion mark by 2030, the energy cascade is highly skewed towards certain geographic locations with limited population metrics and high energy to population ratios, most notably the MENA region.

[08]

Energy Crisis and Alternative Energy Development

*Farhat Saleem**

There has been an enormous increase in the global demand for energy in recent years as a result of industrial development and urbanization, population growth, climate change and global warming. The per capita energy consumption of China, India and other developing nations continues to increase as the people living in these countries adopt more energy intensive lifestyles. At present a small part of the world population consumes a large part of its resources. Man has become slave to energy. In the backdrop of the industrial revolution, the trend started to emerge in the West during the late nineteenth and early twentieth century.

[09]

Restructuring for Long Term Energy Security

*Muhammad Bashir Chaudhry**

Energy is basic to economic and personal well-being. Tariff, availability and quality of energy supplied, determine the extent of its beneficial impact. Low tariff will add to the competitiveness of our business and industry. Availability and quality of energy will be an added bonus. The government, at federal and provincial levels, has a major role in this important sector. Ideally, the role of the government should be restricted to policy setting and the rest may be left to the private sector. Looking at the level of our development, a sort of mixed arrangement for exploration, discovery, appraisal, commercial utilization, etc of energy sources particularly electricity may be suitable for the moment. However, we should agree on indicative milestones for devolution of vast oversight functions from federal government to provincial governments coupled with maximizing private sector involvement in the handling of different energy sources.

[10]

Energy Sector in Pakistan: Fault Lines and Future Course

*Muhammad Rashid Zahir**

In the modern world, energy is the chief driver of economy and social progress. In view of its importance governments accord high priority to energy planning. Investment in energy projects involves large capital outlay and long implementation periods and entails all types of risk normally inherent in such projects. It is often inadequate or faulty planning that causes mismatch of demand-supply, occasionally culminating into crises. The consequences of the mismatches as witnessed in Pakistan are disastrous. The critical ones include depressive business environment and the under utilization of industrial capacity which adversely affects production. The worst fallout of the energy crises occurs in social sector. Discontentment and frustration spreads as employment opportunities shrink; working efficiency of offices, schools, and hospitals drop to low level and the people are led to cope with long hours of load shedding. To the ordinary mortals this sad situation should not have been arisen when the assemblies with their elected representatives meet regularly and the giant Ministry of Water and Power with plethora of related institutions is operating with full fervor. This calls for accountability of the institutions responsible for huge financial and non-financial losses which have held back the potential of the nation.

[11]

Energy Crisis Management – A Holistic Approach

*Dr Moinuddin Ghauri**
*Usama Awan***
*Tariq Bashir****

Abstract

Escalations of living standards are integrally bound with energy consumption. Sustainable supply demands have become difficult to afford in conventional mode of use. Smart approach is inevitable and demands sensitive response to jump out of the scenario in a holistic approach and save our resources for further betterment and civic amenities. Corporate practices on energy management have developed smart benchmarks and earned fortune. Current study is to extract a holistic approach and facilitate learning upon lessons for integrated benefits of developing countries like Pakistan in particular and the world in general by managing energy crisis.

***Key words**: Energy crisis management, energy benchmarks, sustainable energy, renewable energy*

[12]

Experimental Study on Thermal Characteristics of a Looped Heat Pipe by Using Solar Water Heating System

*B.Sivakumar **
*Dr. M.Kannan***

Abstract

This paper describes the performance of a loop heat-pipe.

The assembly is divided into three sections, i.e. circular copper tube(Heat addition), adiabatic gap and condenser water tank. A circular solar collector of 0.003 miner diameter and 1.50 m length is housed on a collecting plate.

The inside circular copper pipe consist of a Loop Heat Pipe (LPH) and collecting plate.

The condenser water tank is made from a tank0.03 x 0.05m² zink sheet.

The Loop Heat Pipe consists of the collecting plate cover, with evaporator 1.50 m long, adiabatic gap and condenser 0.50 m long.

Ethanol and Water is used as the working fluid with filling ratio of 50%.

The LHP arrangement is aligned at an inclination angle of 18 degrees from the horizontal plane, with 6 turns. A 0.001 m thick aluminum sheet is used to make a collecting plate with 0.10 – 1.50 m² test area.

Efficiency evaluations were conducted during daylight hours over a one month period and included extensive monitoring and recording of temperatures with type-K thermocouples placed at key locations throughout the system.

The results confirmed the anticipated fluctuation in collector efficiency dependent on the time of day, solar energy irradiation, ambient temperature and circular tube surface mean temperature.

An efficiency of ethanol and water approximately 50.78% and 72% is expected, which correlates with the efficiency of the more expensive loop heat-pipe system.

The Loop Heat Pipe (LPH) system offers the additional benefits of corrosion-free operation.

Keywords: *Solar collector, Loop heat pipe, Radiation, Thermocouple, Filling ratio*

[13]

Carbon Capture and Storage

*S. Muzammil**

Abstract

Pakistan is an under developing state with various challenges, among them one is the menace of energy crisis. But still the country is fateful, as the land is being provided with treasures like natural resources, climatic conformity as well as geographical importance. These days how to become self sufficient in meeting the growing demand of power in the countries of great concern, as the conventional fossil fuel reserve are at the threshold point and depleting at very fast rate.

The Thar Coal reserve is the savior. The policy maker posses' enormous responsibility, that how enhanced and swift they utilize this natural asset. The technical aspect is not of great concern as the expertise is available. Worldwide coal is largest source of energy for thermal power, but using coal as a fuel also has certain penalties. The CO2 emission is one of them. The environmental hazards of CO2 are known to all, therefore responsible nation are acting accordingly. Vast R&D is going on to reduce CO2 emission to the environment. Carbon capture and storage is one solution. Carbon capture and storage (CCS) technologies are expected to play a key role in strategies to avoid dangerous climate change.

Although CO2 capture and storage (CCS) technologies are heatedly debated, many energy producers consider them to be possible technical option to mitigate carbon-dioxide from large point source. The paper discusses the concept, methodology and the cost factor of CCS. The developed countries like USA, China and Germany are generating most of their electricity from coal; hence they have adopted CCS technologies for reducing CO2 emissions.

[14]

Future of Electricity – Solar Cells

*Prof. Dr. M. Khalid Anis**

Energy has many forms. But at present, crisis of energy is electricity! How to produce it with less pollution. Cost conversion process can be based on

- Solar Power
- Wind Power
- Bio-Gas
- Fuel-Cell
- * Sea Waves
- * Hydro-Power
- * Geothermal
- * N-Power

Solar Power

This article is to introduce and discuss application of photovoltaic cells, which generate electricity from light energy. Photovoltaic is basically a Greek word "photo which means light" and "voltaic" from Italian scientist's name "volta" it used in English since 1849 [1].

[15]

Renewable Energy and Developing World – Sri Lanka a Role Model

*Waqas Ahmed**
*Shafiq R Qureshi**
*Waqar A Khan**

Abstract

In developing countries millions of people still lack access to basic energy service. This difference also dictates the policies and objectives of the energy security. Basic energy (i.e electricity) which is taken for granted in the developed countries but in many developing countries, is a luxury reserved mainly for privileged lot. Therefore objective of energy security is different in developing countries and its remedy must not be sought by following blindly the developed and modern world. There is no harm to accept that Renewable Energy is not in such state presently to replace or share large portion of energy but steps must be taken to improve cleaner energy to make our world a healthy place.

It should be kept in mind that conventional power plants are hazardous to environment but Giant Economy like USA, CHINA and INDIA are generating more electricity from Coal. Developing countries should take Renewable energies as a secondary and clean option for reducing the global warming but should not compare it to the conventional power plants because of high installing cost, low rate of return and intermittent nature of the source. Government of the developing countries need to launch incentive schemes in the rural areas to light their own houses with solar power or Wind turbine. In this paper approach of Sri Lankan government has been analyzed to ascertain the efficacy of incentive schemes launched in rural and less privileged areas to maximize the solar and wind energy utilization. Role of government has played an important role in energy management. Its approach and experiences can be taken as role model to attain sufficiency and sustainability in energy.

[16]

Load Shedding vs Culminating Forex

*Syed Ali Hyder**

Now-a-days, one of the most common questions asked is - What are current issues in Pakistan? Indeed it's a simple question but answers are not that simple, a long list of problematic issues – including plague ridden economic growth of the country, security, internal turmoil, uncertainty, and energy crisis.

[17]

Greenhouse Gas Mitigation and Energy Crisis Management

*Naseem Aziz**

Global climate change resulting from the widespread burning of fossil fuels is the most important environmental problem of our time, and the most serious that has ever confronted humanity. By the year 2100, according to the prestigious Intergovernmental Panel on Climate Change (IPCC), the Earth's average temperature can be expected to warm by 1 to 4 degrees Celsius. This is a modest increase, but likely consequences include: the spread of tropical diseases; disruption of agriculture due to drought and changes in rainfall patterns; elimination of many now endangered species; increasing numbers of deaths during summer heat waves; and increasingly severe tropical storms.

With the advent of global warming and the un-deniable proofs which are clearly apparent in form of the adverse climate change the world is presently experiencing it has become essentially important to focus international attention on Greenhouse Gas mitigation, before going deeper into this subject it would not be out of place to first explore the phenomena of global warming and why it has become such an important subject internationally.

[18]

Conventional and Sustainable Energy for Sindh, Pakistan

*Shahid Akhtar Mirza**
*Shafiq R. Qureshi***
*Nadeem Ahmed***

Abstract

The most rapid growth in energy demand takes place in developing countries, where investment resources are scarce and human capacity and inter-sectoral planning processes are often weak. Pakistan has faced perennial load shedding and frequent power outages over the past three decades. Sensitive issue of energy crisis is thought to be among the causes of declining economy, despite being a nuclear power.This situation has led us to electricity shortfall of approximately 5000 Megawatts (MW).

Pakistan is blessed with a enough natural energy resources in general and its Sindh province in specific has tremendous natural and renewable energy resources. The 175 billion tons Thar coal, the cheapest source of energy, is the fifth largest coal reserve in the world, can give 50,000 MW electricity for upto five centuries.

Lakhra coal field in Sindh, 48 kms from Hyderabad, is also an asset in this regard. Besides this, solar, wind and ocean energy resources are abundantly available which can be used for electricity and other energy requirements. In specific Gharo wind corridor has a potential of 43000 MW, which is major contender for provision of cheap and green/ renewable energy.

This paper presents a detailed survey of available options for sustainable energy for Sindh province. Importance of energy conservation and technological development is a key for the future of energy security for a country; this aspect has also been covered in the paper to some extent. In the wake modern technology and prevailing geopolitical situation, some solutions are recommended at the end to address present and future energy demand of the Sindh province.

Keywords: *Pakistan electricity shortfall, Sindh Province, Thar coal, Gharo wind corridor, Cheap and green/ renewable solar, wind and ocean energy resources.*

[19]

Energy Crisis: Finding Indigenous Solutions

*Dr. Parvaiz Naim**

Constructed with a comparable cost, the Ghazi-Barotha Hydropower Project generated 5.3 billion more electricity units than Hub Power Station in 5 years period (2005-2009). The average cost of electricity generated by Ghazi-Barotha Hydropower Project was Rs 5/unit cheaper than the electricity generated by Hub Power Station.

While Hub Power Station yearly needed about 2.5 million tons of imported furnace oil, the Ghazi-Barotha Hydropower Project generated electricity simply with the flow of water from the Indus River. The Ghazi-Barotha Hydropower Project thus saved no less than 35 million tons of carbon emission.

[20]

Grameen Shakti: An Exemplary Micro-Renewable Energy Program

*Dr Muhammad Asif**

Abstract

Grameen Shakti is a micro-generation renewable energy program that aims to meet energy requirements of the people of Bangladesh in a cost effective and environmentally friendly manner. It is one of the largest and fastest growing programs of its type in the world. Presently, Grameen Shakti deals with three technologies: solar home systems (SHS), biogas systems and improved cooking stoves (ICS). By exploring the prominent features of this program the article reflects upon the lessons that countries like Pakistan can learn from Grameen Shakti.

[21]

Energy Conservation Policies of Pakistan and India: An Analysis

*Masood Ahmed**
*Jaya S. Loungani***
*Ayesha Latif Shaikh****

Abstract

The yawning gap between the supply and demand of electricity is exacerbating the economic conditions of Pakistan. Moreover, the existing fossil fuel sources of energy are polluting the environment significantly. To bridge the electricity gap and arrest the climate change, the shortfall of energy supply and demand management needs to be simultaneously addressed. In Pakistan, considerable work is underway to increase the supply of electricity through renewable energy; however, demand side management remains untouched for the most part of it.

Demand side energy management is greatly necessary to decrease the amount of energy demanded in the future. This typically calls for making energy efficient choices today. And without political measure this wouldn't be possible because of the first high cost of energy efficient technologies in comparison to the existing polluting cheap alternatives in the market. In Pakistan, not much has been achieved in this arena only recently first National Energy Conservation policy 2010 was prepared.

Hence, this paper critically examines the National Conservation Policy 2010 of Pakistan and the Energy Conservation Act 2001 of India to identify the lessons that could be learnt from the successful Indian experience and replicate those policy measures in Pakistan to avoid further delay in implementation.

Key words: *Energy conservation, policy, India, Pakistan*

[22]

Wind Power Tariff Issue

*Akhtar Ali**

Considerable wind power capacities have been installed in the world, the total of which exceeds 150,000 MW today. China leads the world with an installed capacity of 44,733 MW, followed by the U.S. with 40180 MW, Germany 27214 MW, Spain 20,676 MW and India 13065 MW. Even smaller countries like Egypt and Turkey have respectively installed 550 MW and 1329 MW.

[23]

Conserving Energy through LED Lights

*Dr. Najiya Amanat Khan**

Everywhere we go today in Pakistan, we hear people complaining about load shedding as power shuts down not for hours but for days to even weeks. To the developed countries, such talks are unheard of as they have well developed energy infrastructure with provision of electricity 24-7. People have been forced to go out on the roads to make their cries heard. The news is filled with talks on demonstrations in various cities and power crisis in Pakistan. However, here I must say the fault is not only in the infrastructure, power companies, or the government. One neglected problem is that people are unaware of the concept of conserving energy. Therefore, we don't think of what we can do to get our country out of this energy crisis.

[24]

Harnessing Ocean Wave Energy in Pakistan

*Sarosh Siddiqui**
*Dr. Shafiq R. Qureshi***

Abstract

Global increased need for energy, reduction of conventional fossil-fuel, and critical environmental concerns are navigating the researchers towards renewable energy sources. Energy sources such as oil, coal, and gas are being quickly exhausted or have scarce reserves for future demands. Since the world today is experiencing a great shortage of energy, it should be captured, stored, conditioned, and utilized by alternative techniques. Ocean energy is one of these promising energy resources. The renewable energy source of ocean mainly is contained in waves, ocean current and offshore solar energy. The advantage of using this source is the availability of forecast for waves, which can help in designing the right elements. Moreover, improved computational techniques for modelling and simulation have made the studies of wave climatology and ocean energy converters more promising in future. A considerable research and execution of various projects has already been undertaken globally in this field. Many countries which include UK, Scotland, Ireland, USA, China, Portugal and India have launched various Wave Energy Conversion (WEC) models/projects and rapidly progressing towards cost effective solutions. Pakistan, with its geographical location has a great potential of extracting various energy resources, remains undersupplied and currently facing crisis with energy management. The most important factors are the slow progress towards research and adaptation to renewable energy resources in the country. Though, amongst renewable energy resources, the technology for Wind and Solar energy has generally been focused and has come a long way. In Pakistan, with a 170 km available creek system of Indus delta, ocean wave energy harnessing can play a vital role in eradicating the energy crisis. However, very fewer efforts have been made to harness this reliable and predictable resource in Pakistan. This paper at first, presents the

analysis of various Wave Energy Conversion techniques currently available and their advantages/disadvantages. In addition, major WEC models being employed globally by various companies, have been discussed in detail. Further, investigation of two novel concepts of on-shore and near shore wave energy extraction method, which are introduced by National University of Science and Technology, are also reviewed. In light of the existing energy crisis, the financial and technical restrictions in Pakistan, these methods are considered to be a cost effective solution and could turn into a viable project for adaptation by rural sector of Pakistan i.e. along the Sindh and Baluchistan coastlines. These concepts are designed for on-shore or near-shore application and are based upon total energy conservation, which utilizes both potential and kinetic energy of the waves.

[25]

Harnessing Alternative Resources for Generation of Bio Gas Energy

*Lubna Ahsan**

When we think and talk about Pakistan, which is now in desperate crisis, we must realize that when the chief resources are constrained, the cities are overpopulated, the government is ingrained in corruption and terrorism is a major threat, tackling energy crisis is a great challenge. We have many who always talk big and but do very little. Everyone wants their own end serve at the expense of the miseries of others.

Pakistan is facing serious energy crisis. Gas power and water supply crisis are playing hell here. We need to have a war-time-unity to combat and resolve it. We are living in an era of energy uncertainty. Gone are the days when cheap and abundantly available energy was available. Pakistan is running out of indigenous energy resources at a time of increased prices, diminishing resources and greater international competition for energy resources.

GLOSSARY & ABBREVIATIONS

Accelerator	In physics, a machine which makes particles (= small pieces of matter) move very fast
ADB	Asian Development Bank
ADP	Association for Development of Pakistan
ADP	Asian Development Programme
AEDB	Alternate Energy Development Board
AGECC	Advisory Group on Energy and Climate Change
Aggressive	Behaving in an angry and violent way towards another person
Alzheimer	A disease of the brain that affects especially old people, which results in the gradual loss of memory, speech, movement and the ability to think clearly
AMO	Atomic, Molecular spectroscopy
Anomaly	A person or thing that is different from what is usual, or not in agreement with something else and therefore not satisfactory
Archaeology	The study of the buildings, graves, tools and other objects which belonged to people who lived in the past, in order to learn about their culture and society
ATR	Auto Thermal Reforming
AWS	Archimedes Wave Swing
BEE	Bureau of Energy Efficiency
Biological	Connected with the natural processes of living things
Biomass	Dead plant and animal material suitable for using as fuel
CCS	Carbon Ccapture and Storage
CECM	Corporate Energy Crisis Management
CEOHP	Closed End Oscillating Heat-Pipe
CFL	Compact Fluorescent Light
CLOHP/CV	Closed-Loop Oscillating Heat-Pipe with Check Valve
Consolidated	To become, or cause something to become, stronger and more certain
CWET	Center for Wind Energy Technology
Deforestation	the cutting down of trees in a large area; the destruction of forests by people
Density	The number of people or things in a place when compared with the size of the place
Desertification	The process by which land changes into desert, for example because there has been too much farming activity on it or because a lot of trees have been cut down

Devastating	Causing a lot of damage or destruction
Diffraction	(a pattern caused by) a change in the direction of light, water or sound waves
ECBM	Enhanced Coalbed Methane Recovery
ECN	Electricity Corporation of Nigeria
ENERCON	National Energy Conservation Centre
EOR	Enhanced Oil Recovery
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
Equilibrium	A state of balance
ESCA	Electron Spectroscopy for Chemistry Analysis
Fabrication	To invent or produce something false in order to deceive
FACTS	Flexible AC Transmission Systems
Flux	Continuous change
Fossil	A bone, a shell or the shape of a plant or animal which has been preserved in rock for a very long period
G8	Group of Eight
Geology	The study of the rocks and similar substances that make up the Earth's surface
GSP	Geological Survey of Pakistan
GTCs	Grameen Technology Centres
GWEC	Global Wind Energy Council
HDIP	Hydrocarbon Development Institute of Pakistan
Hydrocarbon	A chemical combination of hydrogen and carbon, such as in oil or petrol
Hydropower	The production of electricity by the force of fast moving water; hydroelectric power
IEE	Initial Environmental Examination
IGCC	Integrated Gasification Combined Cycle
IMD	India Meteorological Department
Indigenous	Naturally existing in a place or country rather than arriving from another place
Industrialisation	The process of developing industries in a country
IPCC	Intergovernmental Panel on Climate Change
IPPs	Independent Power Projects
IRSD	Initiative for Rural and Sustainable Development
LNG	Liquefied Natural Gas
LOIs	Letter of Intents
LPG	Liquefied Petroleum Gas
LPH	Loop Heat Pipe

Management	The control and organization of something
MMSD	Mining, Minerals and Sustainable Development Project
MTOE	Million Tons of Oil Equivalent
MW	Megawatt Electrical
MWEC	Magneto-hydrodynamics Wave Energy Converter
NDA	Niger Dam Authority
NEPA	National Electric Power Authority
NEPA	Nigerian Electric Power Authority
NEPRA	National Electric & Power Regulation Authority
Nexus	An important connection between the parts of a system or a group of things
NGCC	Natural Gas Fired Combined Cycle
NTDC	National Transmission and Despatch Company
OCAC	Oil Companies Advisory Committee
Optimal	Most likely to bring success or advantage
OWCs	Oscillating Water Columns
Parabolic	A type of curve such as that made by an object that is thrown up in the air and falls to the ground in a different place
PCC	Point of Common Coupling
PCRET	Pakistan Council of Renewable Energy Technologies
PEPA	Pakistan Environmental Protection Act
PEPO	Pakistan Environmental Protection Ordinance
Perseverance	Continued effort and determination
PHCN	Power Holding Company of Nigeria
Plaques	A flat piece of metal, stone, wood or plastic with writing on it which is fixed to a wall, door or other object
PLF	Plant Load Factor
PMW	Pulse Width Modulation
Polarization	To cause something, especially something that contains different people or opinions, to divide into two completely opposing groups
PPP	Public-Private Participation
Radiation	A form of energy that comes from a nuclear reaction and that can be very dangerous to health
RAPS	Remote Area Power Supply
Renewable	Describes a form of energy that can be produced as quickly as it is used
ROI	Return on Investment
RPPs	Rental Power Projects

SARA	Scientific Applications & Research Associates
SEPA	Sindh Environmental Protection Agency
SESAME	Synchrotron Light for Experimental Science and Applications in the Middle East
SMB	Structural Molecular Biology
SRDC	Sustainable Development Research Center
SSGC	Sui Southern Gas Company
STATCOM	Static Synchronous Compensator
Systematic	Using a fixed and organized plan
SZABIST	Shaheed Zulfiqar Ali Bhutto Institute of Science and Technology
Tangent	A straight line which touches but does not cut into a curve
TCEB	Thar Coal Energy Board
TFSC	Thin-Film Solar Cell
TFVC	Thin-Film Photovoltaic Cell
UNDP	United Nations Development Programme
UPFC	Unified Power Flow Controller
Urbanisation	The process by which more and more people leave the countryside to live in cities
USEIA	US Energy Information Administration
USGS	United State Geological Survey
VSC	Voltage Source Converter
WAPDA	Water & Power Development Authority
Wastage	Natural wastage
WEO	World Energy Outlook
WSSD	World Summit on Sustainable Development
XANES	X-ray Absorption Near Edge Spectroscopy
XPS	X-ray Photoelectron Spectroscopy

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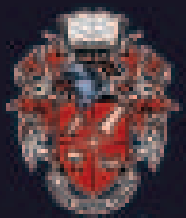

Greenwich University

A Top (19th Category) University in Pakistan

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