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2012-13

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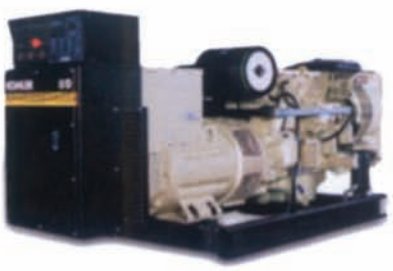

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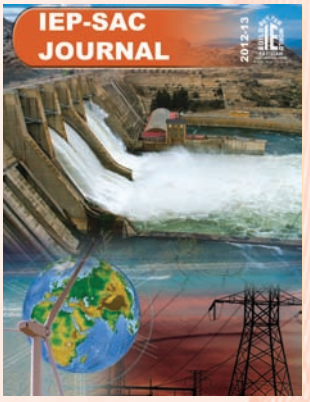

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IEP-SAC Journal is published yearly by the Institution of Engineers Pakistan, Saudi Arabian Center (IEP-SAC), Riyadh, and distributed to the engineering community in Saudi Arabia. To promote discussion of issues in the field of engineering and ensure coverage of all responsible points of view, conflicting opinions and views may appear, however, IEP-SAC cannot accept any liability for such views nor for any errors or omissions.

Designed By: Rana Omer Farooq
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...Milestones

Dear Engineers

السلام علیکم و رحمة الله و برکاته

This is the fourth consecutive issue of our annual IEP-SAC Journal since 2009 when we revamped the publications committee. The new editorial board introduced a paradigm shift towards a colorful, professionally-designed, and a momentous Journal that really suited a professional organization's premiere publication. Much improved contents along with the state-of-the-art printing have given an unprecedented uplift to the Magazine. I am confident that this issue will be yet another milestone in our Editorial Board's pursuit of excellence.

The Journal 2012's cover theme is on the global water and energy crisis which has been aptly summarized in the paper by Malik et al. The other theme paper is on the wind power potential in Pakistan. In addition to the theme papers, the paper by Kirmani highlights another burning issue, namely, the impact of waste management on safety, health, and environment. The paper by Hanif discusses application of atmospheric correction factor in dielectric dry tests in accordance with the applicable international standards. The paper by Asad et al introduces fuzzy logic control into automatic generation control. For our "Someone You Should Know" series, the EB has this time chosen Engr Tariq Barlas who has really made a difference not only in the world of engineering entrepreneurship but also in serving Pakistani engineers. These papers along with a number of interesting fillers, IEP-SAC organizational details, reports, messages, scenes from our activities, and the directory of Pakistani engineers working in Saudi Arabia—all make up the current issue, which we hope will once again be met with a warm applaud.

A landmark achievement during this year was the preparation of the IEP-SAC Bye-Laws which have been approved by the Council and promulgated effective 11 May 2012. Thanks to the Bye-Laws drafting committee which worked tirelessly for about 16 months under the leadership of our General Secretary to finalize the document. Engr Syed Zafar Ahmad's contribution to the drafting of Bye-Laws is greatly appreciated. We will henceforth be operating under the guidance of the Bye-Laws and with immediate effect are launching our membership drive. We request fellow engineers or associates to please enroll as members/associate-members and enjoy the benefits of networking, professional development, and social get-togethers. The membership application form is included in this Journal.

Finally, I extend my accolade to our council members for their dedication and commitment towards the IEP-SAC cause. Special mention is due to our General Secretary who has worked diligently and relentlessly throughout the year. Above all, I would also like to thank each and every engineer for supporting IEP-SAC as well as for the Saudi Council of Engineers (SCE) for their cooperation.

Engr S M Jaleel Hasan, Chairman

IEP-SAC

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From The AMBASSADOR

AMBASSADOR

It gives me great pleasure that the Institute of Engineers Pakistan, Saudi Arabian Center is taking out its annual magazine. The Institute deserves credit for this as well as for holding seminars on topics of immense importance to engineers in the Kingdom. I am confident that such publications and seminars serve to promote excellent professional standards among participants.

As Pakistan's Ambassador to the brotherly Kingdom of Saudi Arabia, I am proud of the contribution of Pakistani engineers, architects and twon planners in the development of the Kingdom. They have earned appreciation not only for themselves but for their country and the entire Pakistani community due to their professional hard work and dedication.

I am also glad that the Institute works to bring the Pakistani engineers on a single platform and provides them a forum where they can share their experiences and knowledge with each other for the benefit of both Pakistan and Saudi Arabia.

I take this opportunity to wish the Institute of Engineers Pakistan, Saudi Arabia Center and the Pakistani engineer's community all success in their future endeavours. I assure them of the full support of the Embassy of Pakistan in their activities for the benefit of the engineers' community.

Mnaeem.

(Muhammad Naeem Khan)
Ambassador

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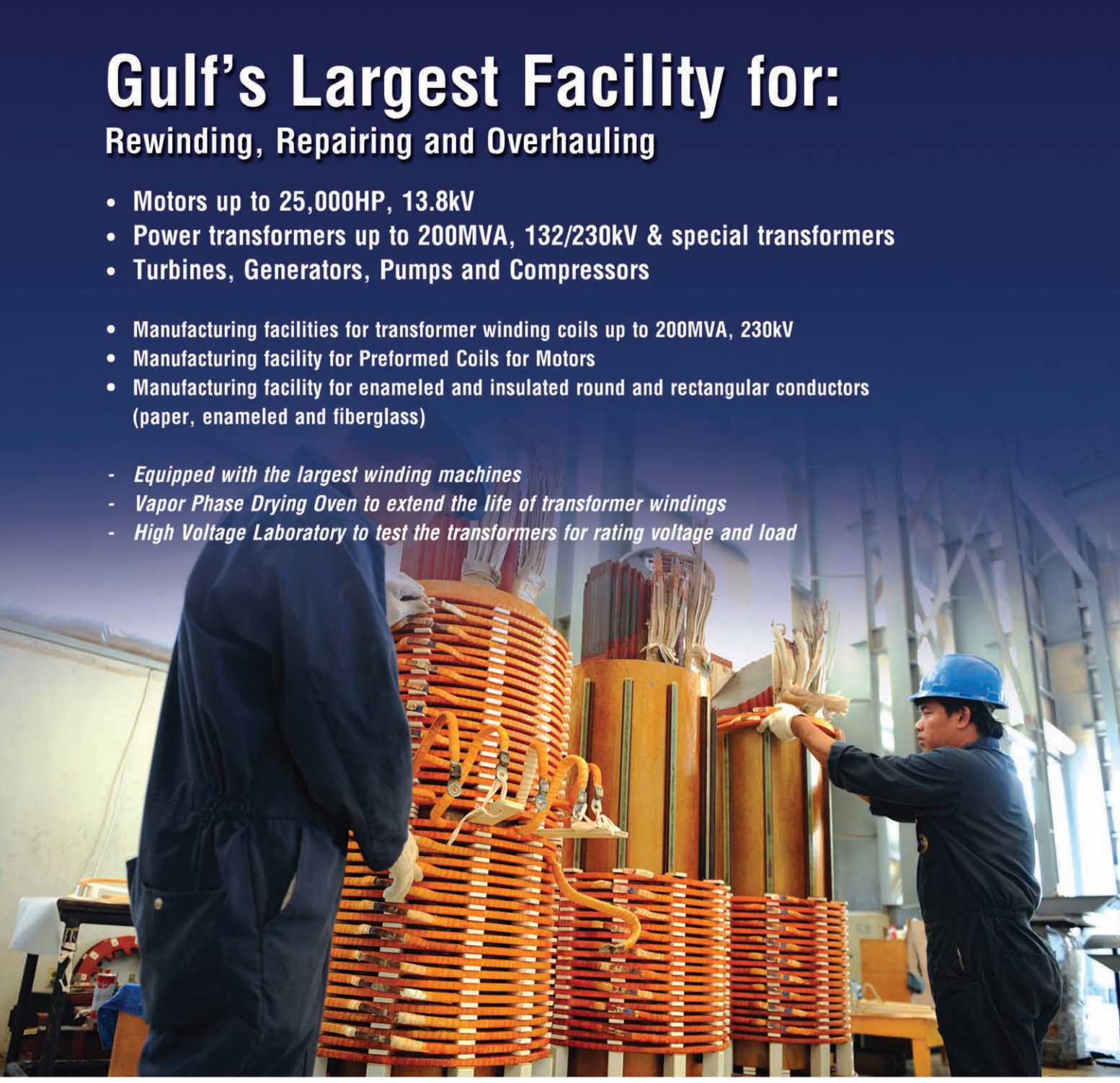

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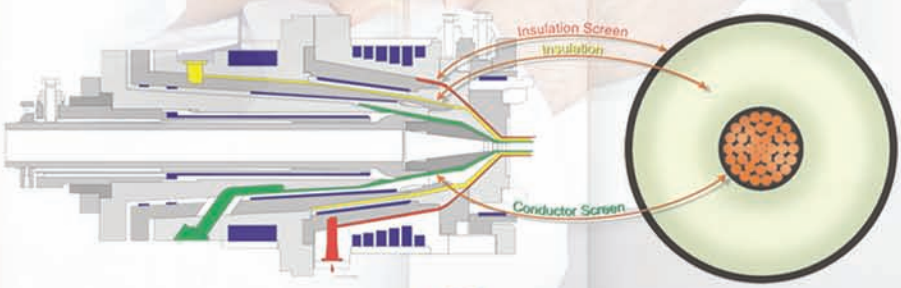

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I am pleased to learn that the Institution of Engineers Pakistan Saudi Arabian Center (IEP-SAC) is bringing out its annual publication, the IEP-SAC Journal 2012-13, on the occasion of its 37th Technical Seminar to be held on 31st May 2012. I congratulate you on organizing professional development activities such as this seminar on the "Philosophy of Product Development in Engineering".

I am thankful to the leadership of IEP-SAC for keeping us at the Saudi Council of Engineers (SCE) abreast of their activities. This coordination between the two professional organizations is central to the advancement of engineering profession in the Kingdom.

SCE recognizes the contribution by Pakistani engineers to the development of Saudi Arabia over past decades. This contribution is the direct result of the special relationship and ties the people of the two countries enjoy among themselves. For example, a Memorandum of Understanding (MOU) was signed between SCE and your parent organization, the Institution of Engineer Pakistan (IEP), in 2008 in which both organizations expressed their wish to develop an active bilateral relationship through the development of professional services in the fields of engineering accreditation, continuous development training programs, engineering events, and exchange of experience between the two brotherly Islamic countries.

It is a well established fact that employers rely heavily on engineers to increase productivity and elevate the quality of goods and services. This trend is anticipated to continue and, as a result, the overall employment in the engineering sector is expected to grow by 10 percent per annum over the next decade.

Although the current global financial crisis and recession is predicted to continue, overall job opportunities in engineering sector are still expected to grow, in general, and in certain specialties, in particular. Some engineering disciplines like high-tech engineering, electronics and aerospace engineering will probably be affected by the economic slowdowns. These trends highlight the importance of the engineering-discipline development through organizations such as SCE and IEP as they provide a much needed interaction and networking platform to their members. These organizations play an all important role of addressing the challenges faced by the engineers in their profession.

The Saudi Council of Engineers is a professional body that aims to promote the engineering profession and endeavors whatever is necessary to develop and upgrade its standards and those practicing it. The main responsibilities of the Council are setting criteria and standards of practicing and developing this profession, which include licensure terms and conditions; prescribing necessary rules, regulations, and examinations for professional degrees; preparation and publication of studies and researches; and organization of Engineering courses, conferences, and symposia related to the profession. Promoting engineering profession in the KSA is the main objective of the Council.

Please accept my warm wishes for the success of IEP-SAC in organizing events that promote knowledge and awareness of its members on the current trends and practices in engineering and technology. I hope that our two organizations will continue to cooperate for the mutual cause of uplifting the profession of engineering in the Kingdom of Saudi Arabia.

Engr Saleh A Elamr, CEO

Saudi Council of Engineers

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FROM THE GENERAL SECRETARY

As a General Secretary of IEP-SAC, I am pleased to update you on our initiatives and activities during the year 2011-2012.

Gentlemen,

With the advent of high technology in Engineering profession and its impact on Socioeconomic issues in the human life, the need of development of the human intellectual capital has become unprecedented. The real motive-force which would impel us to observe the canons of success would be emphasis on science and engineering but within the sanction of moral values.

IEP-SAC is committed to:

- Maintain their competence
- Work within professional ethics, and
- Participate actively within the profession.

Our scholarship program for the needy students in the public sector engineering universities of Pakistan, technical seminars, publication of technical papers, interaction with other professional organizations, especially with Saudi Council of Engineers (SCE) have been some of our achievements. A brief report concerning our technical and social activities is as follows:

COORDINATION WITH SAUDI COUNCIL OF ENGINEERS

Keeping abreast of the latest development concerning registration of Pakistani engineers with the SCE, it would be worth mentioning that IEP-SAC has developed a protocol in cooperation with SCE to exchange knowledge, and information for the best use of engineering profession. IEP-SAC and SCE have mutually agreed to update and sign the existing MOU, which represents a set of objectives and outlines the probable actions that will be required to address the key issues facing by Pakistani engineers working in KSA, particularly the registration issue with SCE for renewal of IQAMA.

SEMINARS AND ANNUAL CONVENTION

Last year IEP-SAC organized its annual convention and 35th technical seminar on May 26, 2011. Topic of the seminar was, “Professional Project Management Culture – Benefits, Obstacles and Solutions.” The presentation was made by Mr Wolfang Hellriegel, Manager partner TCI (Transformation consulting international). The presentation covered useful guidelines on the project management and was well received and enhanced the audience’s awareness. Our annual seminars always include a technical exhibition of Saudi Engineering Companies to introduce and display their products and services.

The 36th technical seminar was organized on January 06, 2012 on the topic, “The Global Energy and Water Problems and the Role of Renewable in the 21st Century.” The presentation was made by Engr Dr Nazar Malik, Chair Professor, Saudi Aramco Chair in Electrical Power, King Saudi University, Riyadh, with collaboration of Dr Julian Blanco Galvez. The presentation elaborated the water scarcity in 2000-2005 and its causes. Extensive detail was given about renewable and sustainable energy sources. Presentation was very much appreciated by the audience.

ANNUAL MAGAZINE

On the occasion of Annual Seminar on May 26, 2011, IEP-SAC published its Annual Journal featuring technical papers and Directory of Pakistani Engineers working in KSA, which is a useful source of information for engineers and engineering organizations. The getup and contents of 2011-2012 Journal were very much appreciated by the engineering community. I am confident you will equally appreciate our new Journal for 2012-2013. Publication committee and its convener deserve commendation for their contribution.

SCHOLARSHIPS

It is a matter of great satisfaction and thanks to Almighty Allah that our scholarship program is progressing and has attained unprecedented achievement. During 2011-2012 session, IEP-SAC provided 102 scholarships to the needy students but

academically on merit in eleven public Engineering Universities and colleges in all provinces of Pakistan and Azad Kashmir.

Our scholarship program is primarily funded through individual donations and sponsorships. We are actively seeking funding sources at this time, so please let us know by e-mails if you are interested in participating in this noble cause. The success of our scholarship program is also due to devotion, dedication, and follow-up of our scholarship committee. We are thankful to all committee members.

FAMILY PICNIC

Our largely attended social event is our Annual Family Picnic which was organized on February 17, 2012. More than 700 guests including engineers and their family members enjoyed full day in a relaxing and entertaining environment.

Indoor and outdoor games for children, men and women were very well organized and executed. Our literary program, "BAIT BAZI" is always a source of entertainment besides literary appreciation. IEP-SAC always endeavors to give attention in providing good food and facilities and rewarding experience to our engineering community. Prize and Raffle gifts distribution kept all participants enthusiastic and motivated. More than 120 Raffle gifts including air-tickets for Umrah, 48 inches LCD TV, Washing machine, Microwave Ovens, Vacuum cleaners, and the like were among the gifts.

All Council members, particularly Social activities committee, catering committee, and reception committee remained committed to extending every assistance to our guests. I congratulate them all.

AWARDS AND CERTIFICATES

Special awards were offered to the co-sponsors for their contribution to facilitate our scholarship program. Certificate of appreciation were presented to the authors of technical papers published in the previous year's IEP-SAC Journal. Special certificates were also presented to all attendees of the seminar for their commitment to the engineering profession.

In recognition of valuable contribution to engineering profession, IEP-SAC is actively working on the proposal to give special ward to the most read Technical paper(s) published in IEP-SAC Journal by visiting IEP-SAC web-site.

IEP-SAC WEB-SITE

IEP-SAC web-site is functional and updated. By visiting www.iep-sa.org, it will keep you abreast of the latest development related to IEP-SAC program, updated Directory of engineers in KSA, previously published papers and organization of IEP-SAC. I wish to extend our deep appreciation to all members of web-site committee.

ACTIVITIES OF SUB-CENTRES

IEP-SAC sub-centers in Eastern region (Dammam) and Western region (Jeddah) remained very active during this period and arranged useful seminars and symposiums. A brief report of their activities is included in this Journal.

GRATITUDE

IEP-SAC expresses its gratitude to the Custodian of Two Holy Mosques, King Abdullah Bin Abdul-Aziz and the Government of the Kingdom of Saudi Arabia for facilitating Pakistani Engineers to contribute their share in building mega projects and development of our brotherly country, KSA.

IEP-SAC gives prime importance to the continued patronage and support of HE the Ambassador of Pakistan and Pakistan Embassy in exercising its aims and objectives. We are thankful for this continued support and appreciation.

I wish to extend our appreciation to Eastern sub-centre and its Chairman Engr Rizwan Ahmad for his vibrant performance in raising funds for our scholarship program. My personal appreciation is for our Chairman Engr Jaleel Hasan for his continued support and encouragement. Lastly, I avail this opportunity to facilitate the engineering community in KSA, sponsors, advertisers, press and media personnel for their cooperation.

Engr S M H Kirmani

General Secretary IEP-SAC

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AWARDS AND SCHOLARSHIPS COMMITTEE

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النَّبِيّٖنَ ۚ وَاٰتَى الْمَالَ عَلٰى حُبِّهٖ ذَوِي الْقُرْبٰى وَالْيَتٰمٰى وَالْمَسٰكِيْنَ وَابْنَ السَّبِيْلِ ۙ وَالسَّآئِلِيْنَ وَفِي الرِّقَابِ ۚ .... ﴿۱۷۷﴾

اِنْ تُبْدُوا الصَّدَقٰتِ فَنِعِمَّا هِيَ ۚ وَاِنْ تُخْفُوْهَا وَتُؤْتُوْهَا الْفُقَرَآءَ فَهُوَ خَيْرٌ لَّكُمْ ؕ وَيُكَفِّرُ عَنْكُمْ مِّنْ سَيِّاٰتِكُمْ ؕ وَاللّٰهُ
بِمَا تَعْمَلُوْنَ خَبِيْرٌ ﴿۲۷۱﴾

"But Al-Birr (righteousness, piety) is the quality of one who believes in Allah, and the Last Day, and the Angels, and the Book, and the Prophets and distributes his wealth, in spite of love for it, to the kinsfolk, and to the orphans, and to the needy, and to the wayfarer, and to those who ask, and to the ransom of prisoners." (Al-Baqarah-177)

" If you disclose your (acts of) charity, it is well, but if you conceal it, and give it those (really) in need, that is better for you; it will remove from you some of your (stains of) sins and Allah is well acquainted with what you do." (Al-Baqarah-271)

By the grace of Allah the Almighty, the IEP-SAC scholarship program for needy and academically sound students in the Engineering Universities and Colleges of Pakistan was launched 16 years ago in the year 1996. With the joint efforts of IEP-SAC Local Council members, it has been expanding ever since and presently a number of students from the listed below 11 public-sector universities and colleges are being benefited from this program.

1. University of Engineering and Technology, Lahore
2. University of Engineering and Technology, Taxila
3. University College of Engineering and Technology (Baha'uddin Zakariya University), Multan
4. Institute of Chemical Engineering and Technology (University of the Punjab), Lahore
5. Dawood College of Engineering and Technology, Karachi
6. NED University of Engineering and Technology, Karachi
7. Mehran University of Engineering and Technology, Jamshoro
8. Quaid-e-Awam University of Engineering Sciences and Technology, Nawabshah
9. NWFP University of Engineering and Technology, Peshawar
10. Balochistan University of Engineering and Technology, Khuzdar
11. Mirpur University of Science and Technology (Must), Mirpur (AJ&K)

This scholarship program serves all the four provinces of the Islamic Republic of Pakistan and the State of Azad Jammu and Kashmir. The rules and regulations, selection criteria and application forms can be accessed and printed from IEP-SAC website (http:/www.iep-sa.org). By the blessings of Allah the Almighty, 15 batches have been launched so far, benefiting meritorious/needy students from this scholarship program who have been serving the humanity and our homeland after graduation.

The continuity of IEP-SAC scholarship program is not only maintained during last 16 years, but it has also been expanding gradually with the help of financial contributions from various philanthropists, individuals, and organizations in Saudi Arabia. I take the opportunity to offer the readers of these lines in general and the Pakistani community and engineers in particular to join hands with us in this noble and just cause. It is a great service to the humanity in Pakistan. Let us put our maximum efforts in contributing and expanding the scholarship program to the needy engineering students. Your suggestions to improve the program further will be most welcomed. Please do not hesitate to contact any of the members of IEP-SAC Awards and Scholarships Committee or Local Council for any suggestion or information.

Engr Shaikh Akhtar Hussain, Convener
IEP-SAC Awards and Scholarships Committee

IEP–SAC Local Council 2012

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35th IEP–SAC Technical Seminar, "Professional Project Management Culture – Benefits, Obstacles and Solutions", 26 May 2011, Prince Salman Social Center, Riyadh

SCENES FROM IEP–SAC Activities

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35th IEP–SAC Technical Seminar, "Professional Project Management Culture – Benefits, Obstacles and Solutions", 26 May 2011, Prince Salman Social Center, Riyadh

SCENES FROM IEP-SAC **Activities**

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36th IEP-SAC Technical Seminar, "The Global Energy and Water Problems and the Role of Renewables in the 21st Century", 06 January 2012, Al-Mutlaq Hotel, Riyadh

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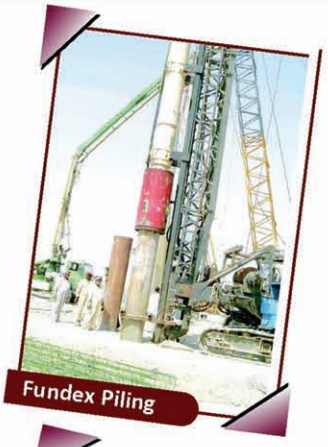
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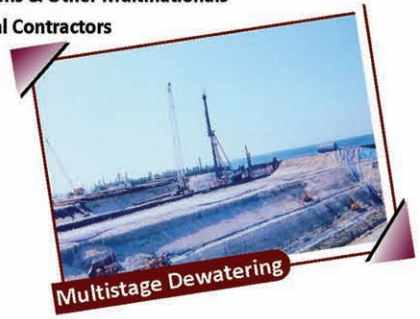
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Family Picnic, 17 February 2012, Istraha Al-Rushd, Riyadh











SCENES FROM IEP-SAC **Activities**

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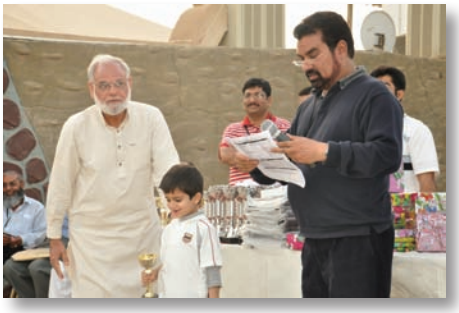
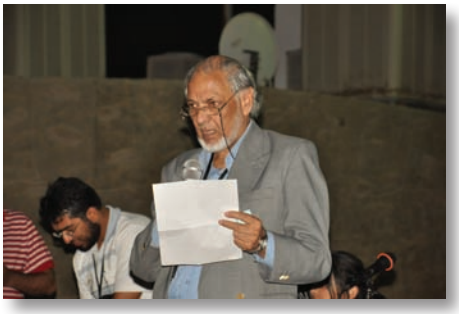
Family Picnic, 17 February 2012, Istraha Al-Rushd, Riyadh












FROM EASTERN REGION

The slogan of Institute of Engineers Pakistan (IEP) , “Build Better World” was given to us by the father of the nation Quaid-e-Azam Muhammed Ali Jinnah when it was established in 20th June 1948.

The “Overseas Chapter” of IEP is bringing this slogan to life globally. This is especially seen / put to work in the most respected brotherly Kingdom of Saudi Arabia.

The global engineering industry forms the fabric of today’s modern world.

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We are striving to collect, connect, combine and share our Engineering expertise with not only Pakistani engineers but with all engineers of different nationalities in KSA.

IEP-SAC-EP has launched a web site with the name “Engineerspk.com” for developing a data base of Pakistani Engineers within Pakistan and abroad. This is intended to provide help and assistance for job opportunities to Pakistani Engineers inside or outside Pakistan. This dynamic website is Database Driven and is inclusive of User Registration Modules, Data collection Modules and Extensive Search Modules based on different criteria. Thank to Engr.M.Tariq Barlas who has financed this project.

We have driven a long dedicated campaign to enhance data base of Pakistani Engineers in Eastern Province. Mr. Syed Iftikhar Uddin Shah was assigned for this task; he worked very hard to contact and update data base of EP engineers. It needed a lot of patience and persistence to accomplish this task. We appreciate his efforts and endless follow-up.

We would like to thank and appreciate Mr. Saleh F. Al-Nazha President, Tasnee Petrochemical’s Complex for his support to IEP-SAC-EP and accepting to be chief guest of our technical seminar “Environmental Impact due to Industrialization” in Jubail and his hospitality extended to IEP-SAC-EP delegation in his office. Thank to Mr. Mutlaq M. Naba Al-Qahtani, President & CEO of Naba International to arrange IEP-SAC-EP meeting with Tasnee President in Jubail. Mr. Said Mohammed Bajodah Senior Vice President Finance and Admin of Saudi Chevron Phillips Jubail (S-Chem) for his support and assistance as well.

We have worked closely with Saudi Council of Engineers, Dammam office, Jordanian Engineers Association and Philippines Institute of Civil Engineers (PICE), Eastern Province, Saudi Arabia. Engr. Pervez A. Naushahi IEP-SAC-EP Executive Council Member was the keynote speaker in the technical seminar held by Philippines Institute (PICE) titled as “ Innovative Foundation Design Techniques For Land Mark Projects in Challenging Soils”.

IEP-SAC-EP has awarded special scholarships to various deserving candidates who approached us in dire need for help. This is in addition to our regular contribution in IEP-SAC main stream scholarship scheme.

IEP-SAC-EP is pleased to express its gratitude to the Kingdom of Saudi Arabia for its continued hospitality to the Pakistani engineering community. We appreciate and thank our valued sponsors for helping us progress towards our goals. IEP-SAC-EP Council members deserve special mention for their dedicated volunteer work carried out tirelessly with enthusiasm and commitment without which our widespread activities would not have been organized so successfully as they were. I thank them all.

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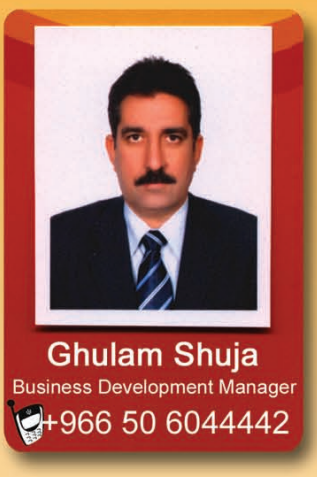

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- New132kV Network Connections for Riyadh industrial area BSP S/S# 9027 (Turnkey) — 41.8KM
- Reinforcement of 132kV Network in Asir Cnt.10931184/00 (Turnkey) — 24KM
- 132kV Network Reinforcement (OHL Portion for Substation 9013 Cnt.10931185/00 (Turnkey) — 15.5KM
- Reconductoring of 110kV OHL in Madinah South Airport Cnt.10931186/00 (Turnkey) — 24KM

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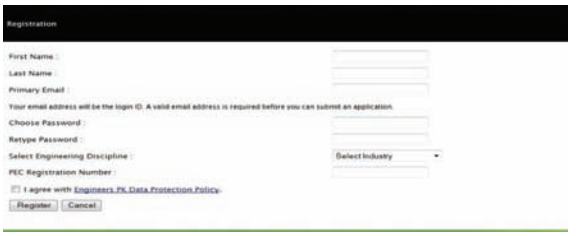

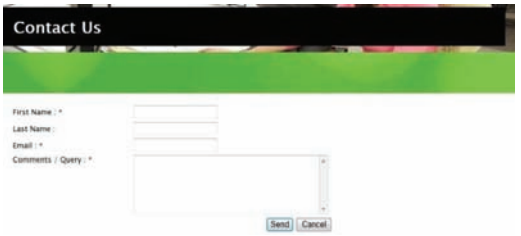

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Engr Muhammad Tariq Barlas

It's a great pleasure to introduce someone, who by virtue of his dedication, strong enthusiasm, passion, honesty and sincerity transformed an abandoned small steel factory, auctioned at only 100,000 Saudi Riyals (SR) in 1989, to a multi-national holding company, worth 13.5 billion SR, in 2008. He was the first employee and the founder member of Al-Tuwairqi Company: Engr Mohammad Tariq Barlas, who later on became the Vice Chairman and Chief Executive Officer (CEO) of Al-Tuwairqi Holding Company.

Engr Tariq Barlas belongs to a small village of Dalowali near Sialkot Cantonment, started his education at a primary school in Sialkot, which was managed by his father. Afterwards, he completed 12th grade from Murray College, Sialkot, and finally obtained a BSc in Chemical Engineering from the University of Engineering and Technology (UET), Lahore, in 1969. He started his professional career in 1970 as a Production Engineer at Sandoz, Jamshoro, being promoted to the position of Planning Engineer in 1975. But his thirst of seeking self-empowerment never quenched so he started his own trading and contracting business in the field of chemical engineering.

A successful person is the one avails the opportunity with sincerity and optimizes it with hard work. "It is not up to a person to get an opportunity for himself, but to utilize it in the best possible manner is up to the individual", says Dr Hilal H Al-Tuwairqi (Abu Khalid), Chairman of Al-Tuwairqi Holding. The opportunity knocked at the doors of the young chemical engineer, Tariq Barlas, in 1979 in the form of an employment offer from Dr Al-Tuwairqi, and he availed it in an exemplary way. Although it was only a two hours flight from Karachi to Dammam, however, "Tariq could not come out from the 'jetlag' for several days", recalls Dr Al-Tuwairqi. Today Abu Khalid has his own private jet and owns a multi billion Steel empire. Tariq was given with a chauffeur driven car and an envelope containing 100,000 SR and was empowered by Al-Tuwairqi to establish a business as he liked. Nothing will be questioned for one year.

The chemistry of the empowerment, patience and trust of Al-Tuwairqi with hard work and sincerity of Tariq worked well and resulted in a Steel tycoon of Middle East with thousands of employees and seven plants in Dammam, Jeddah, Dubai, Pakistan, and UK.

Initially, Engr Tariq started the business of Tuwairqi with trading, developed it into switchgear manufacturing, and finally concentrated on steel manufacturing in early 90s. He worked day and night to grow the business and never felt tired; rather, he'd always feel personal satisfaction and enjoy working with passion and empowerment. He never took rest on weekends except Eid holidays. This is his dedication, which boosted the production capacity of Al-Tuwairqi Steel from 1000 tons per year to a cumulative capacity of 4.5 million tons per year of different types of steel products.

Engr Tariq Barlas has a vision to utilize the capabilities of Pakistani Engineers and develop in-house expertise by creating an engineering establishment in Pakistan.

Engr Tariq Barlas has set a remarkable example of serving Pakistan, which should be followed by Pakistani engineers and businessmen working in Saudi Arabia. He convinced Al-Tuwairqi Holding to invest more than 300 million US dollars (approximately 1.1 billion SR) to build the first Direct Reduced Iron (DRI) plant at port Mohammad Bin Qasim, Karachi, Pakistan. The establishment is known as Tuwairqi Steel Mills Limited (TSML) and has the capacity to produce 1.5 million tons per year DRI.

Engr Tariq implemented his vision by establishing an engineering design office, named TSML Engineering (TSMLE), under the umbrella of TSML Karachi. TSMLE's main objectives are engineering design, fabrication, and erection of industrial projects related to oil and gas, fertilizers, petro-chemicals, power generation, steel manufacturing and other process industries. TSMLE has a competent team of multi-disciplinary professionals on board, most of whom being Pakistanis, with full-fledged design office and a state-of-the-art fabrication facility. TSMLE is not only generating profit for its parent organization, but also providing employment to a huge number of Pakistani professionals, skilled and non-skilled workers, and creating business for several other small Pakistani companies associated with it.

TSMLE has completed the first industrial Greenfield project of Al-Tuwairqi Holding in Pakistan. TSMLE has carried out "outside-the-licensor-scope" design and more than 50 % fabrication of the TSML DRI plant, a state-of-the-art steel manufacturing complex in Pakistan. TSMLE is equipped with modern engineering tools, software, codes/standards, necessary international certification, and the like, to perform engineering, procurement, and construction services for in-house and outer circle's projects. Some of the modern software utilized in TSMLE are:

1. Process Simulation: HYSIS, Hydraulics, Pipe Floe Expert, KORF.
2. Mechanical: Ceasar (piping stress analysis), PV Elite

(PV and HX design).

3. Structure: Tekla Structures (X-steel), SAP 2000, ETAB, SAFE.
4. Electrical: ETAP, Emerson software, DocWin, Ecodial, Fisher First, ToolKit, Flowel.

Engr Tariq had a dream to build an expert team of Pakistani engineers and professionals, consolidate their capabilities, and utilize them for the development of engineering based process industries, not only in Pakistan, but all over the Middle East and the world. His dream became true in the form of TSMLE and now he leaves it as an asset for the new generation to grow it further.

He is always very enthusiastic and keen to create new horizons for the development of skills to world class standards and provide golden carrier opportunities to Pakistani engineers. He tried to introduce Pakistani engineers at every platform so that the organizations in Middle East can get benefit from their skills and capabilities. He has financed a website, which is being launched with the name of "*http:www.engineerspk.com*" for developing a data base of Pakistani engineers serving within Pakistan and abroad with the help of IEP-SAC (Eastern Province).

"In order to achieve a high goal, at first you've got to have a dream, then make clear vision, plan a strategy, develop full team of required professionals, continuously monitor and guide the team, make quick decisions on the spot, and finally leave the results to Almighty Allah—success will be at your feet." (Engr Tariq Barlas)

He believes that target completion, achievement, and success are more important than money. Self satisfaction cannot be attained by money, but only by sincerity and hard work. Money will come to you automatically as the by-product of success.

Engr Tariq Barlas has over forty years of valuable experience in the fields of chemical engineering, metallurgy, trading, construction, fabrication, operation, maintenance, steel manufacturing, and management. He is proactively involved in the strategic and operational decision-making of Al-Tuwairqi Holding and has led the development of the strategies and operations since its inception. He possessed good management and negotiation skills and utilized them to steer the projects of the group, which have now become successful ventures since their establishment.

With his outstanding management skills, strong technical background and teamwork, Al-Tuwairqi Holding is now among the top twenty companies of Saudi Arabia. Its chairman has been recognized as the World Finance's Man of the Year in 2011. The award has been given in recognition of the outstanding entrepreneurial skills and a track record of developing profitable business ventures. The company has also been judged as the best company of the year 2011 in the economic block of Gulf Cooperation Council (GCC). Engr Barlas is the playback singer of this music.

In his opinion, the great success is achieved by unique synergy, trust, and the freehand techno-commercial authority i.e., empowerment given by the owner. The major reasons for the success of company are following golden rules:

1) Making all the decisions not for the individual, but always for the benefit of the whole company/entity.
2) Keeping all activities transparent.
3) Building a professional team for the group selflessly without any individualism.

Engr Tariq has made a big change in the status of Al-Tuwairqi holding in 30 years, which has attained the heights of excellence and prosperity due to his great vision, creativity, optimized implementation of the ideas, and untiring efforts. But, he himself did not change at all and still loves to work on his 30 year old table in his office and lives in the same place since then.

Engr Mohammad Tariq Barlas is someone we should know and get inspiration from his phenomenal contribution to the profession of engineering and to the community.

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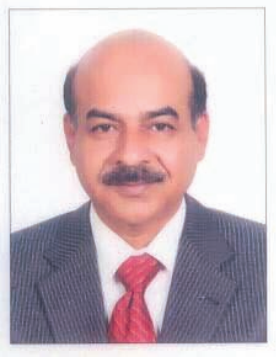

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WASTE MANAGEMENT ISSUES AND SOLUTIONS

by
Engr S M H Kirmani

Abstract

This paper describes different types of waste being generated, their health hazards on the population and sustainable comprehensive waste management which include the collection, transport, processing, recycling or disposal, managing and monitoring of waste.

Introduction

With the advent of industrial revolution, waste management became a critical issue. Increase in population and massive migration of people to industrial cities from rural areas during 18th century played a tremendous role in growth of various types of waste. The most fundamental step in waste management is quantifying and qualifying the different types of waste being generated. It is important to have a system for the collection and analysis of basic information about wastes. The data should include:

- The source of waste.
- The quantities of waste generated.
- Composition and characteristics of waste.
- Seasonal variation and
- Future trend of generation of waste.

Waste has played a tremendous role in history. The Bubonic plague, cholera and typhoid fever were diseases that altered the population of Europe and influenced monarchies. They were perpetuated by filth and foul that harbored rats, and contaminated water supply. It was not uncommon for Europeans to throw their waste and human wastes out of the window which decomposed in the street. It took a century to overcome this hazardous situation which could have been done in ten years, simply because of the resistance of the mass of the middle and upper classes, even the civilized and educated people opposed to install sanitary piping to their buildings [1-2].

The comprehensive waste management includes the following steps:

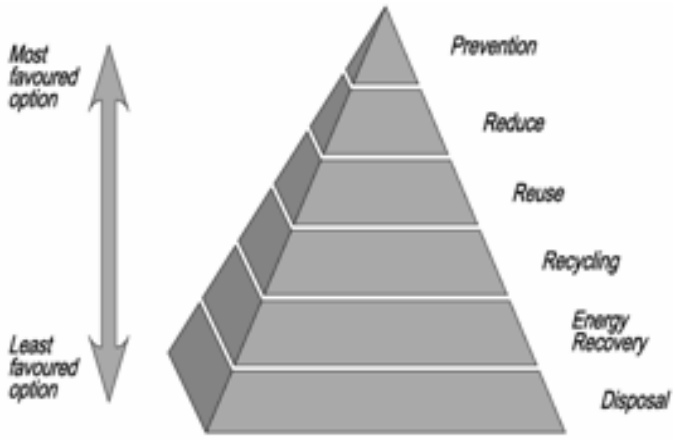
1. Reduction of source.
2. Collection – sorting – transport.
3. Recycling and re-use.
4. Waste to energy and green house gas (GHG) reduction.
5. Mechanical and biological treatment.
6. Sanitary land fills.
7. Dump site closure and site remediation.

Waste Management Concepts

There are a number of concepts about waste management which vary in their usage between courtiers or regions. Some of the most general, widely used concepts include [3].

Waste hierarchy

The waste hierarchy refers to “3Rs” that is, reduce, re-use and recycle, which classify waste management strategies according to their desirability in terms of waste minimization. The waste hierarchy remains the cornerstone of waste minimization strategies. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste. Figure 1 explains the concept of 3Rs



Extended Producer Responsibility (EPR)

It is a strategy designed to promote the integration of all costs associated with the products throughout their life cycle (including end-of-life disposal cost) into the market price of the product. Extended producer responsibility is meant to impose accountability over the entire life cycle of products and packaging introduced to the market. This means that firms which manufacture, import, and/or sell products are required to be responsible for the products after their useful life as well as during manufacturer.

Polluer (Responsible for Pollution) Pays Principle

The Polluer Pays Principle is a principle where the polluting party pays for the impact caused to the environment with respect to waste management; this generally refers to the requirement for a waste generator to pay for appropriate disposal of the waste.

Municipal Solid Waste (MSW)

According to the Chapter 21.3 of Agenda 21 (United Nations Conference on Environment and Development, Riode Janeiro, June 14, 1992), MSW is defined as: "Solid waste – include all domestic refuse and non-hazardous waste as commercial and industrial wastes, street sweeping and construction debris, sludge from sewage treatment plant or other discarded material, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining and agricultural operations and form community activities. Solid waste does not include solid or dissolved materials in domestic sewage, solid or dissolved materials in irrigation return flows, or industrial discharges" [4].

Types of Solid Waste

Non-hazardous waste		Hazardous solid wastes (According to EPA the Environmental Protection Agency of USA, a waste is considered as hazardous if it is dangerous or potentially harmful to human health or the environment)	
Source	**Type**	**Source**	**Type**
Residential, commercial institutional, Horticulture and Municipal services.	Food scraps, papers, cardboard, packaging, plastic bags, containers, glass bottles, furniture, tires, electrical and electronic items and metals.	Household hazardous wastes	Used and leftover household products that contain corrosive, toxic, ignitable or reactive constituents. For example, medical waste, used oil, paints, cleaners, batteries, pesticides, and light bulb/lamp. Proper and safe management of hazardous wastes is important in the collection reuse, recycling, and disposal as specified by EPA.
Industrial waste	Organic chemicals, inorganic chemicals, iron, steel, plastics and resins, stone, clay glass, concrete, pulp and paper, food and kindred products. [N.B: Industrial waste does not go into the municipal solid waste stream and is processed separately or land filled [5].	Industrial hazardous wastes	The primary generators of hazardous wastes in any region are industrial facilities, manufacturing and processing units, workshops and maintenance units, nuclear facilities, chemical units etc. The four main types of industrial hazardous wastes are [8]: • F-list: This is waste mainly generated from industrial or manufacturing process or other different industrial sectors, also called non-specific source wastes. • K-list: This is generated from specific industrial sources such as petroleum refining, wood treatment, pesticide manufacturing, inorganic pigment or chemical manufacturing, metal and cake production, and veterinary pharmaceutical industries. • P-list and U-list: These are discarded or intended to be discarded commercial chemical products that have listed generic names, container residues, and spill residues. P-list refers to acute hazardous and U-list to toxic wastes.

Non-hazardous waste		Hazardous solid wastes (According to EPA the Environmental Protection Agency of USA, a waste is considered as hazardous if it is dangerous or potentially harmful to human health or the environment)	
Source	**Type**	**Source**	**Type**
Construction and demolition waste	Debris generated during the construction, renovation, and demolition of buildings, roads and bridges. Often heavy building materials consisting of concrete, wood waste, asphalt from roads and roof, gypsum, metals, bricks, blocks, glass, plastics, building components like, doors, windows and fixtures, trees, earth and rock etc. Being bulky and heavy materials, a proper waste management can improve resources.	Universal waste	Hazardous wastes such as batteries, pesticides, mercury containing equipment and light bulbs/lamps are designated as universal wastes. This is the way to streamline them separately and control and facilitate proper collection, storage, recovery or treatment, and disposal that encourages reducing the quantity of such wastes going to landfills and incinerators and thereby increases recovery and recycling rates.
Treatment waste	Treatment waste consists of sludge, by-products which include slag, fly ash, co-products which include metals such as lead produced during the copper refining process. Scrap metal wastes include sheet metal, wire, metal tanks and containers, scrap automobiles and machine shop turnings that are generally non-hazardous in nature [6].	Characteristic waste	These wastes are defined based on their specific characteristics of ignitability, corrosity, reactivity and toxicity. For example, corrosive waste like battery acids are characterized by their pH value. Reactive wastes include lithium sulphur batteries and explosive that can cause explosions, toxic fumes or gases and toxic wastes that are harmful to human health.
Medical waste	Medical and biomedical waste consist of all waste materials generated at healthcare facilities including hospitals, clinics, dentists and veterinarians, blood banks, funeral homes, medical research facilities and laboratories. According to the medical waste tracking Act of 1988 [7], medical waste is: “Any solid waste that is generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto in the production or testing biological”.		
Special waste	Six categories of waste were given deferral from hazardous waste requirements by EPA under proposed hazardous waste management regulations: 1. Cement kiln dust 2. Mining waste 3. Oil and gas drilling, muds and oil production brines. 4. Beneficiation and processing waste from phosphate rock miming. 5. Uranium waste, and 6. Utility of fossil fuel combustion waste.		

Trends in Solid Waste Generation

Waste generation rates are affected by socio-economic development, degree of industrialization and climate. Generally the greater the economic prosperity and higher %age of Urban population, greater the amount of solid waste produced.

The United States

Figures 2 and 3 indicate the trends in the solid waste generation and its recycling in the United States from 1960 to 2010. These two figures suggest that while the solid waste generation has increased from 3.66 to 4.43 pounds per person per day (1.63 to 1.98 kg/person/day) between 1980 and 2010, the recycling rate has also increased from less than 10 % of MSW generated in 1980 to about 34 % in 2010. Disposal of waste to landfill has decreased from 89 % of the amount generated in 1980 to about 54 % of MSW in 2010.

Figure 2: US Solid Waste Generation

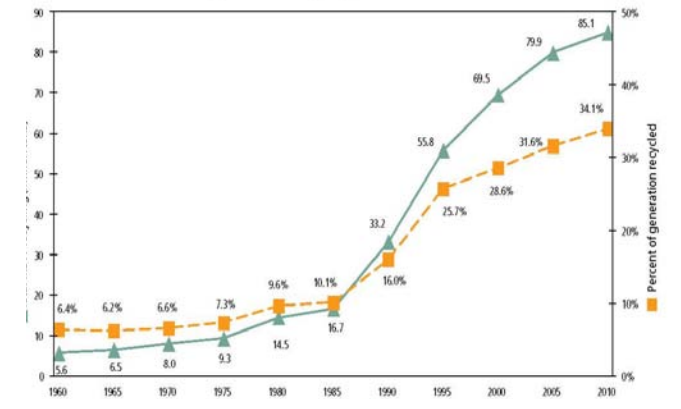


Figure 3: Recycling in the United States

Figure 4 indicates the recovery rates of selected products as a result of re-cycling. In 2010, newspapers' mechanical papers recovery was about 72 % (7 million tons) and about 58 % of yard trimmings were recovered. Metals were recycled at a rate of about 35 %, which is about 8 million tons of metal including aluminum, steel, and mixed metals. Green house gas (GHG) was reduced by more than 26 million metric tons of carbon dioxide equivalent (MMTCO2E). This is equivalent to removing more than

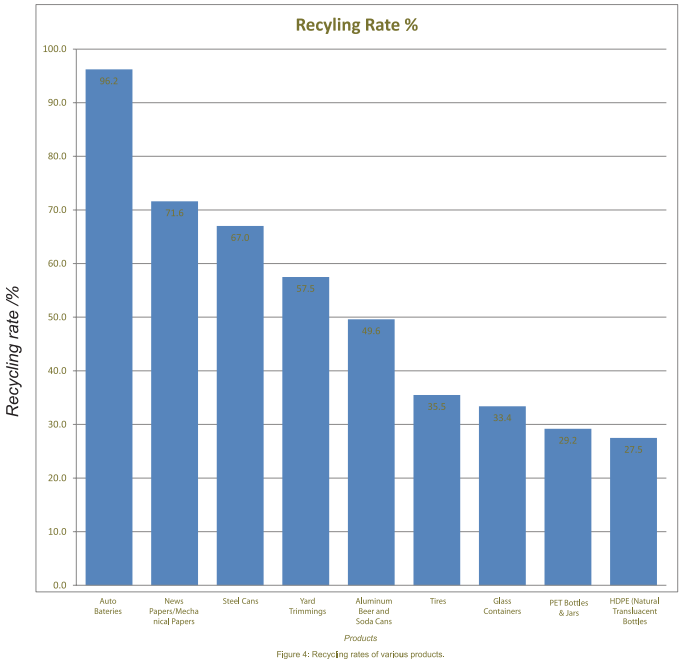


Figure 4: Recycling rates of various products.

5 million cars from roads in one year. Figure 4 does not include combustion with energy recovery.

Other Developed Countries

Canada ranks in the last place out of 17 developed countries in the municipal waste generation indicator. Canada's municipal waste generated per capita has been steadily increasing since 1980. In 2007 Canada produced 900 kg/capita/year, more than twice as much as the best performer, Japan. In the same year, the US produced about 780 kg/capita/year, UK produced 580 kg/capita/year, Switzerland 700 kg/capita/year, Sweden 500 kg/capita/year, Netherlands 610 kg/capita/year, Australia 615 kg/capita/year and Japan 400 kg/capita/year respectively. Canada's per capita income and average household disposables income have been steadily increasing since the 1980s, leading to increasing household consumption rates. Municipal governments in Canada spent more than $1.8 billion on waste collection, transport and disposal in 2008 [9]. However, Canada needs to further integrate waste management system while making reduced environmental impact a top priority.

Developing Countries of Asia

Following table derived from the United Nations 1995 report on solid waste management in Asia, reflects MSW generation in different Asian countries in 1995 and corresponding projected values in 2025.

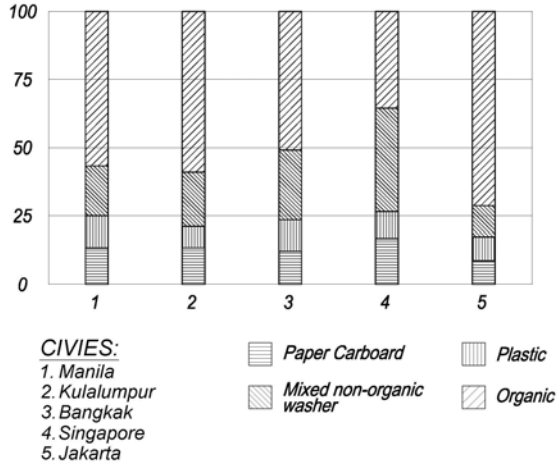
Country	GNP Per Capita/ US $		Urban population/ % of Total		Urban MSW Generation Per Person/ (kg/d)	
	1995	Projected in 2025	1995	Projected in 2025	1995	Projected in 2025
Low income group:	490	1,050	27.8	48.8	0.64	0.6 – 1.0
Nepal	200	360	13.7	34.3	0.50	0.6
Bangladesh	240	440	18.3	40.0	0.49	0.6
Myanmar	240	580	26.2	47.3	0.45	0.6
Vietnam	240	580	20.8	39.0	0.55	0.7
Mongolia	310	560	60.9	76.5	0.60	0.9
India	340	620	26.8	45.2	0.46	0.7
Loo PDR	350	850	21.7	44.5	0.69	0.8
China	620	1500	30.3	54.5	0.79	0.9
Sri Lanka	700	1300	22.4	42.6	0.89	1.0
Middle income group:	1410	3390	37.6	61.1	0.73	0.8 – 1.5
Indonesia	980	2400	35.4	60.7	0.76	1.0
Philippines	1050	2500	54.2	74.3	0.52	0.8
Thailand	2740	6650	20.0	39.1	1.10	1.5
Malaysia	3890	9400	53.7	72.7	0.81	1.4
High income group:	30 990	41 140	79.5	88.2	1.64	1.1 – 1.45
Korea	9700	1760	81.3	93.7	1.59	1.4
Hong Kong	22 990	31 000	95.0	97.3	5.07*	4.5
Singapore	26 730	36 000	100.0	100.0	1.10	1.10
Japan	39 640	53 500	77.6	84.9	1.47	1.3
(* Hong Kong generates enormous quantities of construction and demolition wastes, which explains their exceptionally high per capita MSW generation rate in comparison with other countries)						

Figure 5 reflects approximate composition of MSW in some Cities of ASEAN member countries. Accordingly, organic matter varies from 35 % in Bangkok to 73.92 in Jakarta and about 24.5 % of paper and cardboard in Singapore. Plastic varies from 8.0 to 10.9 %.

Scenario in Pakistan

The estimated current population of Pakistan (2011) is 187 343 000. The GNP per capita (2005) is $689.0 [10]. Urban pollution constitutes 36 % of the total. Dramatic social changes have lead to rapid urbanization and emergence of mega Cities. During 1990-2003, Pakistan sustained its historical lead as the second most urbanized nation in South Asia.

The report on the National study on privatization of solid waste management in eight cities of Pakistan, EPMC, 1996, revealed that the role of average daily waste generation per person from all type of municipal controlled areas varies from 0.283 kg/d to 0.613 kg/d. The total waste generated is estimated to be 54 888 tonnes per day or 20 034 120 tonnes per year (2004). Typical composition of solid waste in Pakistani cities is:



Food waste	= 8.4 % to 21.0 %
Leaves, grass, straw, fodder	= 10.2 % to 15.6 %
Fines	= 29.7 % to 47.5 %
Recyclables	= 13.6 % to 23.55%
Plastic & Rubber	= 3.6 % to 8.2 %
Paper & Cardboard	= 3.5 % to 6.5 %
Glass	= 1.3 % to 1.6 %

Presently the domestic waste in Pakistan has not been carried out in a sufficient and reliable manner in collection, transportation, and disposal, regardless of the size of the city. MSW as a whole is quite inefficient as it collects only 51- 69 % of the total waste generated. Hazardous hospital and industrial wastes are being simply treated as ordinary waste. Open burning of waste especially non-degradable components like plastic bags are adding pollution to air.

Status in Kingdom of Saudi Arabia

Saudi Arabia's annual waste production has reached to 12 million tonnes with average rate of generation of 1.4 kg/d per capita. The Kingdom's rapid industrialization and urbanization as well as numerous construction of infrastructure have led the waste generation to alarming level, thus intensifying the need for more effective and advanced recycling waste management solutions. In 2008, KSA allocated SR 17 billions for municipal services including water drainage and waste disposal. "The Recycling and Waste Management Saudi Arabia" organized 2nd International Recycling and Waste Management Exhibition in November 2009 and evaluated a comprehensive lineup of solutions related to integrated recycling process including recycling containers, compost turners, waste management computer software, compactors, dumpers and other equipment. Emphasis was also given to raise public awareness on the protection of environment as a social responsibility. Waste management of Saudi Arabia, has started implementation on various recommendations adopted in 2009.

Summary of Solid Waste Management in Asia

- Solid waste data is largely unreliable.
- The urban areas of Asia spent about US $25 billion in 1995 on solid waste management. This figure will increase to at least US $50 billion in 2025 (UN report 1995).
- The waste components requiring priority in Asia are organics and paper.
- Countries belonging to middle and high income groups in Asia are facing the greatest waste management challenges based on the projected waste generation rates and relative affluence to deal with the problems.
- Asia should pursue regional approaches to many solid waste management problems, for example packaging regulations and import/export rules.
- It would be worth mentioning that industrial countries contain 16 % of world's population but use 75 % of the world's paper supply, but the recycling rate of paper is about 72 % in US (see Figure 4).

Waste Management Solutions

Waste Handling and Transport

Waste collection methods vary widely among different countries and regions. Domestic waste collection services are often provided by local authorities, or by private companies. Some areas, especially those in less developed countries, do not have a formal waste collection system. Example of waste handling and sorting system include:

a) In Australia, curbside collection is used. Every urban domestic household is provided with by the municipality three bins: one for recyclables, another for general waste and another for garden materials. In Europe and few other places around the world, a few communities use a proprietary collection system know as Envac, which conveys refuse via an underground conduit using a vacuum system. In Canadian urban centers, curbside collection in selected bags is the mot commonly used, whereby the City collects waste and/or recyclables and/or organics on a scheduled basis.

b) In some countries, the City government charges its households and industries for the volume of rubbish they produce. Waste will only be collected by the City if waste is disposed in government issued rubbish bags. This policy has successfully reduced the amount of waste the city produces and increased the recycling rate.

c) A Biosystem has been developed according to which trash is directly taken from the collection trucks and separated in organic and inorganic materials through gravitational settling, screening and hydro-mechanical shredding. This system is capable of sorting, huge volumes of solid waste, salvaging recyclables, and turning the rest into biogas and rich agricultural compost. This system is used in California, Australia, Greece, Mexico and United Kingdom.

Disposal

a) Modern land fills. Landfills are technically designed areas where waste is disposed scientifically. They are characterized by liners that prevent seepage of leachates into the ground water. See Figure 6.

• Over 500 landfills in USA currently convert landfill gas to energy.

• About 100 kg carbon is stored in landfills for every metric ton disposed.

• Total landfill green house gas emissions:

- National average (US) = 35 kg CO2e/Mg
- State of the art = -240 kg CO2e/Mg

b) Waste-to-energy combustion or incineration. It is a disposal method in which solid organic wastes are subjected to combustion so as to convert them into residue and gaseous products. This process reduces the volumes of solid waste to 20 to 30 % of the original volume. Incinerations are common in countries such as Japan where land is scarce. Waste-to-energy (WTE) or energy-from-waste (EFW) are broad terms for facilities that burn waste in a furnace or boiler to generate heat, steam, or electricity.

• Around 90 WTE facilities (in US):

- Treat 29 million tons of waste each year.
- Generate about 19 billion kwh of electricity.
- Emits 0.56 kg CO2e/kwh, whereas
  - Coal emits 1.02 kg CO2e/kwh
  - Oil emits 0.89 kg CO2e/kwh
  - Natural gas emits 0.44 kg CO2e/kwh
  - Nuclear emits 0.03 kg CO2e/kwh)
- Reduces fossil fuel use and landfill space.
- Recovers over 700 000 tons of ferrous annually [11].

c) Recycling and recovery. Recycling refers to the collection and reuse of waste materials such as empty beverages, paper, glass, polyethylene, newspapers, copper wire, steel, food and aerosol cans, corrugated fiberboard boxes, PVC, and other resins. The materials from which the items are made can be reprocessed into new products. Material for recycling may be collected separately from general waste using dedicated bins and collection vehicles, or sorted directly from mixed waste stream.

- Benefits of recycling vary greatly by material.
- Transportation distances and final uses can greatly affect benefits as well.

Material	GHG (Green House Gas) Savings Kg CO2e/Mg
Paper	-3000
Aluminum	-5000
Ferrous	-1000
Glass	-400
Plastic (PET/PE)	-3000

Adopted from www.iwm-model.uwaterloo.ca

d) Composting. Composting is the aerobic degradation of organic waste, such as food scraps, paper products, plant material, agricultural and animal waste, to produce a stable end product called manure or mulch which is used as a fertilizer, see Figure 7.

• Nearly 60 % of yard waste is recovered via composting (as is 2.5 % of food waste).

• Aerobic degradation should lead from little to no methane emissions.

• finished compost is very useful:

- Stores carbon in the soil.
- Provides nutrients to plants.
- Suppresses weeds.
- Can replace mineral fertilizers or peat use.

e) Anaerobic digestion (AD). Organic ingredients intended for composting can alternatively be used to generate biogas through anaerobic digestion, see Figure 8.

• AD consists on aerobically degrading organic waste in a controlled manner to reach nearly 100% collection of the produced methane.

• There are 100 AD facilities operating in Europe, but few in North America.

• AD produces renewable electricity as well a useful soil amendment with benefits similar to aerobic compost.

• Most environmentally beneficial treatment of food waste.

Conclusions

An integrated and sustainable waste management is a key component of a safe and healthy environment of a country. Integrated waste management using LCA (Life cycle analysis) gives the most benign options for waste management. For mixed MSW a number of broad studies have indicated that waste administration, then source separation and collection followed by reuse and recycling of the non-organic fraction and energy and compost/fertilizer production of the organic waste fraction via anaerobic digestion is the most favoured path.

At waste management, safety is far more than just a program or strategy. “Mission to zero” or M2Z as it is commonly referred to as, was initiated in 2001. It means zero tolerance for unsafe actions, unsafe decisions, unsafe conditions, unsafe equipments and unsafe attitude. M2Z is broad based operational excellence strategy.

In this regard, Asian countries like Pakistan are for behind the targeted goal. The rules and regulations that are yet to be introduced in most of the under-developing countries are:

- Basic recycling rules.
- Waste management rules.
- Guidelines for environmentally sound collection and disposal.
- Guideline for model landfill sites and control.
- Development of environmental performance indicators (EPI).
- Public teaching and awareness on the protection of the environment as a social responsibility.

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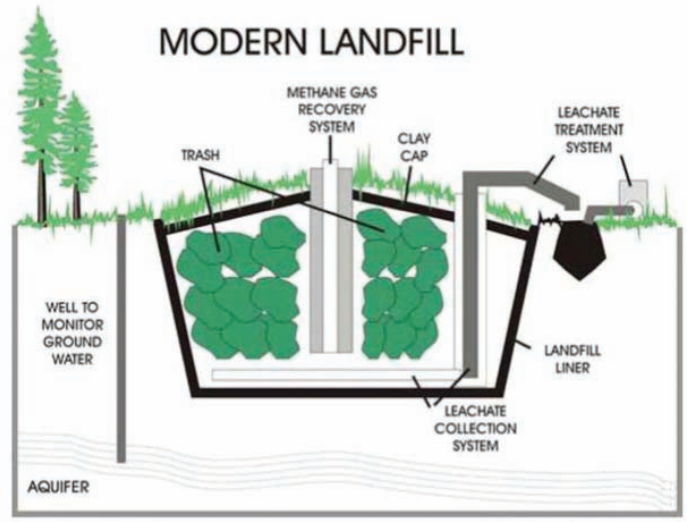

Figure 6: Modern Landfill

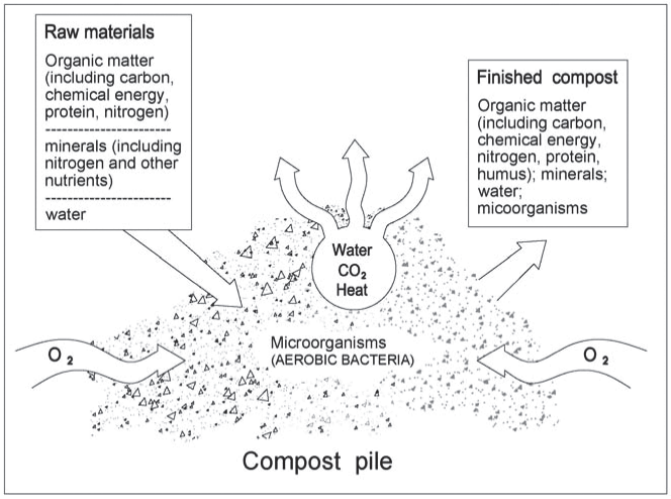

Figure 7: Compost

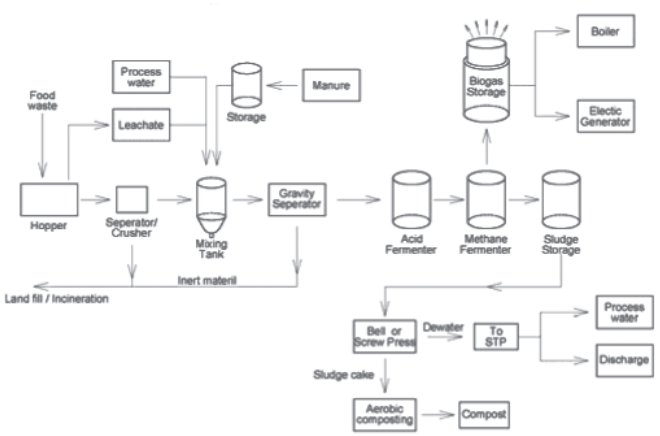

Figure 8: Anaerobic digestion Schematic diagram

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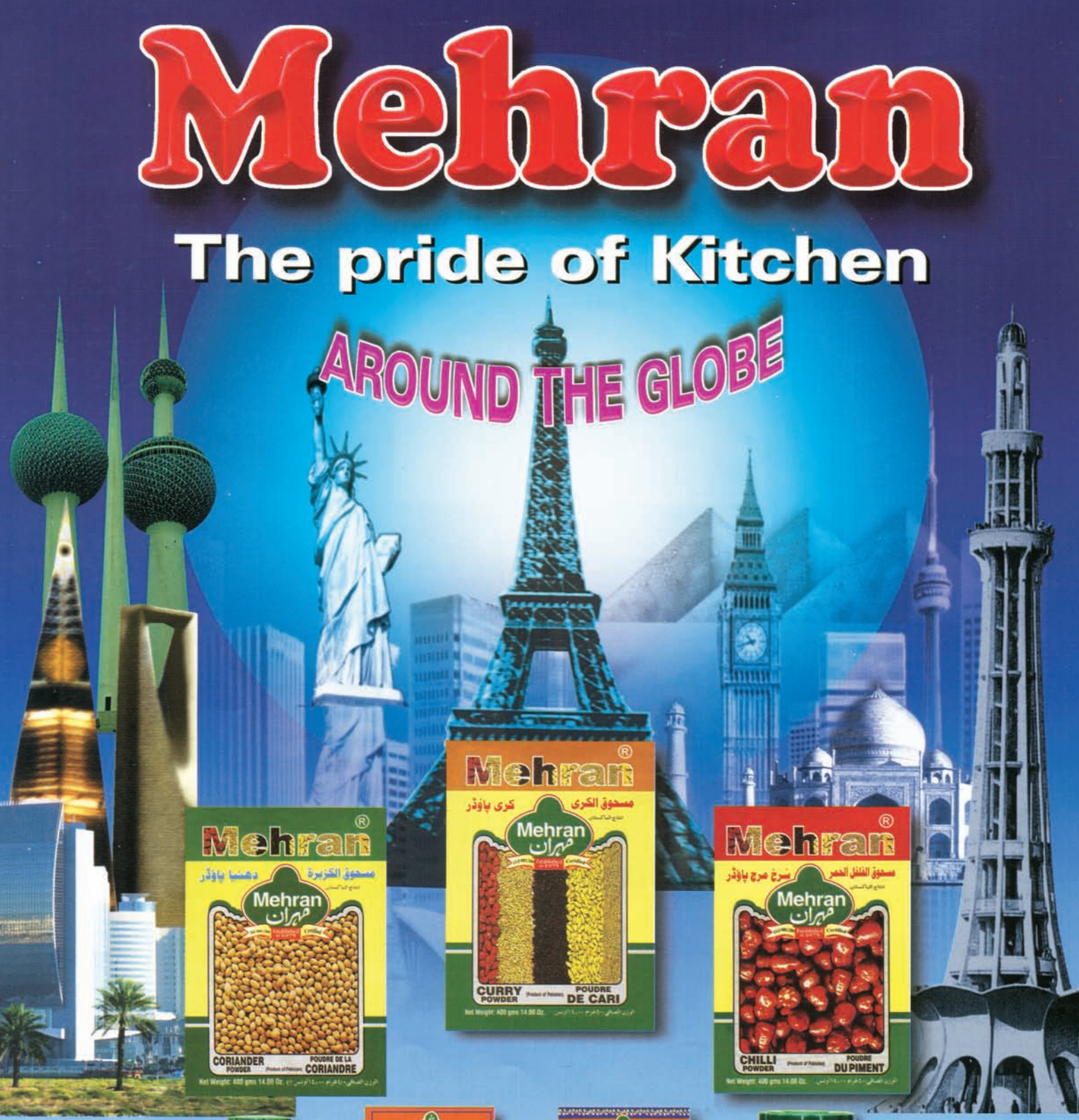

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Atmospheric Corrections in Dielectric Dry Tests

by

Muhammad Hanif

ABSTRACT

The disruptive discharge of external insulation depends upon the atmospheric conditions. The dielectric strength of air is influenced by air density and humidity. Such effects need to be taken into account when external insulation is designed and tested. By applying correction factors, a test voltage specified for given reference conditions can be converted into the equivalent value under the test conditions. During dielectric dry tests where external insulation in free air is of main concern, the atmospheric correction factor shall be applied and test voltage shall be corrected. This paper discusses application of atmospheric correction factor in dielectric dry tests as per relevant IEC standards.

INTRODUCTION

The dielectric stresses during service life of electrical equipment are due to power frequency voltage, temporary overvoltage, switching overvoltage and lightning overvoltage. For a given stress, the behavior of external insulation is affected by the atmospheric conditions. The influence of the atmospheric conditions can be considered by using correction factors. This allows tests under different atmospheric conditions but with the same external insulation stress to be performed.

The standard atmospheric conditions for which the standardized test voltages apply are an air temperature of t_o = 20 °C, an absolute pressure of p_o = 1013 hPa (1013 mbar) and an absolute humidity of h_o = 11 g/m^3 according to IEC 60071-1 [1] and IEC 60060-1 [2]. The actual pressure, temperature and humidity at the instant of measurement are denoted by *p, t* and *h*. The atmospheric correction factor K_t has two parts, the air density correction factor k_1 and the humidity correction factor k_2.

When test voltages are applied without considering atmospheric conditions during dielectric dry tests, insulation systems may be subjected to excessive stress or understress. If insulation systems are overstressed then probability of failure of dielectric dry tests will increase which may also cause aging and generate defects in the internal insulation. On the other hand, if insulation systems are understressed then it will not be tested fully.

ATMOSPHERIC CORRECTIONS FACTORS

To confirm dielectric integrity of an air insulated switchgear at reference atmospheric conditions, atmospheric correction factor shall be applied. As an example, for a 36 kV, 60 Hz, 3 phase load break switch panel for a Basic Impulse Level (BIL) of 170 kV, atmospheric correction factor will apply. As per IEC 62271-1 [3], Table 1a, the rated power frequency and impulse withstand voltages for 36 kV rated switchgear are:

Rated power frequency withstand voltage (rms):

- to ground and between phases: 70 kV at 60 Hz, 1 minute
- across isolating distance: 80 kV at 60 Hz, 1 minute

Rated impulse withstand voltage (peak):

- to ground and between phases: 170 kV, 1.2/50 µs
- across isolating distance: 195 kV, 1.2/50 µs

The technical data of switchgear shows that pole distance for load break switch is 360 mm and creepage distance for the insulators used in the switchgear panel is 385 mm.

The applicable IEC standards for dielectric dry tests on a switchgear panel under discussion are IEC 60265 [4], IEC 62271-1 [3], and 60060-1 [2]. According to these specifications, the switchgear should be tested for appropriate insulation strength using the appropriate voltage waveforms at standard reference atmosphere. For a given phase under test, the required number of impulse voltage applications for each impulse polarity is a sequence of 15 standard lightning impulses of positive polarity as well as negative polarity. After successful impulse test, AC power frequency withstand voltage test shall be performed. The power frequency testing requires each situation should be tested so that line to ground; line to line and open switching devices are tested.

Testing Setup

Figures 1 and 2 show the test setup and connections for impulse voltage and power frequency voltage test on a 36 kV rated switchgear panel.

Figure 1: Test setup for impulse and power frequency voltage tests on switchgear panel

Figure 2: Test connection on switchgear panel

Correction Factors k_1 and k_2

The disruptive discharge of external insulation depends upon the atmospheric conditions. Usually, the disruptive discharge voltage for a given path in air is increased by an increase in either air density or humidity. However, when the relative humidity exceeds about 80 %, the disruptive discharge voltage becomes irregular, especially when the disruptive discharge occurs over an insulating surface.

By applying correction factors, a disruptive discharge voltage measured in given test conditions (t, p, h) may be converted to the value, which would have been obtained under the standard reference atmospheric conditions (t_0, p_0, h_0). Conversely, a test voltage specified for given reference conditions can be converted into the equivalent value under the test atmospheric conditions.

The disruptive discharge voltage is proportional to the atmospheric correction factor K_t, which results from the product of two correction factors; the air density correction factor k_1 and the humidity correction factor k_2. It is expressed by the following equation:

$$K_t = k_1 k_2 \qquad (1)$$

The voltage U to be applied during a test on external insulation is determined by multiplying the specified test voltage U_0 by K_t as per the following equation:

$$U = U_0 K_t \qquad (2)$$

The test report shall always contain the actual atmospheric conditions during the test and the correction factor applied.

Correction Factor Components

The atmospheric correction factor components are air density correction factor k_1 and Humidity correction factor k_2.

The air density correction factor k_1 depends on the relative air density δ and can be generally expressed by the following equation:

$$k_1 = \delta^{m} \qquad (3)$$

Where m is an exponent obtained from Table 1. Atmospheric parameters such as temperature, pressure and humidity influence the breakdown voltage of a gap. It is found that an increase in the absolute temperature which causes an increase in the average distance between molecules has the same effect as a decrease in pressure and vice versa.

The influence of the two variables can be combined in the relative air density factor (δ) which is defined as:

$$\delta = (p / p_0) \times [(273 + t_0) / (273 + t)] \qquad (4)$$

In general, an increase in relative air density causes an increase in breakdown voltage. The correction is considered reliable for $0.8 < k_1 < 1.05$.

The humidity influences some physical discharge parameters such as the ionization and the attachment coefficients of air. Consequently, the breakdown voltage values are influenced by the changes in the absolute air humidity (h), which is usually expressed as the weight of water molecules present per unit of air volume (g/m^3). Generally the breakdown voltage increases with h over the practical range of $2 \leq h \leq 25$ g/m^3. The humidity correction factor may be expressed by the equation:

$$k_2 = k^{w} \qquad (5)$$

Where w is an exponent obtained from Table 1 and k is a parameter that depends on the type of test voltage and may be obtained as a function of the ratio of absolute humidity, h, to the relative air density, δ, using the following equation:

AC: $k = 1 + 0.012(h/\delta - 11)$

for $1 \text{ g/m}^3 < h/\delta < 15 \text{ g/m}^3$ (6)

Impulse: $k = 1 + 0.010(h/\delta - 11)$

for $1 \text{ g/m}^3 < h/\delta < 20 \text{ g/m}^3$ (7)

DC: $k = 1 + 0.012(h/\delta - 11) - 0.00022(h/\delta - 11)^2$

for $1 \text{ g/m}^3 < h/\delta < 15 \text{ g/m}^3$ (8)

Exponents m and w

As the correction factors depend on the type of pre-discharges, this fact can be taken into account by considering the parameter g as given below.

$$g = (U_{50} / 500)\, L\, \delta\, k \qquad (9)$$

Where U_{50} is the 50 % disruptive-discharge voltage (measured or estimated) at the actual atmospheric conditions, in kilovolt peak, L is the minimum discharge path in meter at the actual relative air density δ and k is the dimensionless parameter. In the case of a withstand test where an estimate of the 50 % disruptive-discharge voltage is not available, U_{50} can be assumed to be 1.1 times the test voltage, U_0.

The exponents, m and w, are obtained from Table 1 or graphs in Figure 3 and 4 for the specified ranges of g.

g	*m*	*w*
<0.2	0	0
0.2 to 1.0	$g(g-0.2)/0.8$	$g(g-0.2)/0.8$
1.0 to 1.2	1.0	1.0
1.2 to 2.0	1.0	$(2.2-g)(2.0-g)/0.8$
>2.0	1.0	0

Table 1: Values of exponents, m for air density correction and w for humidity correction, as a function of the parameter g

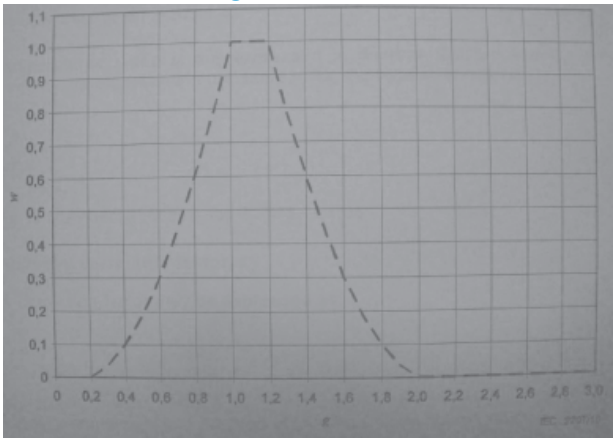

Figure 3: Values of m versus g

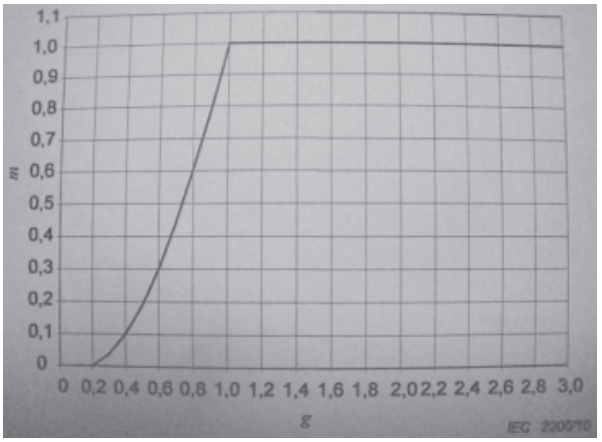

Figure 4: Values of w versus g

As per guidelines of IEC 62271-1, clause 6.2.1, for switchgear and controlgear of rated voltage of 52 kV and below, it can be assumed that:

- m = 1 and w = 0 when the absolute humidity is higher than that of the reference atmosphere, i.e. when h > 11 g/m^3;
- m = 1 and w = 1 when the absolute humidity is lower than that of the reference atmosphere, i.e. when h < 11 g/m^3.

For switchgear and controlgear having external and internal insulation, the correction factor K_t shall be applied if its value is between 0.95 and 1.05. However, in order to avoid overstressing of internal insulation, the application of the correction factor K_t may be omitted where the satisfactory performance of external insulation has been established. When the correction factor is outside the range of 0.95 and 1.05, details of dielectric tests shall be subject to agreement between manufacturer and user.

If K_t is above 1.0 then to fully test the external insulation system the internal insulation will be overstressed and steps may be necessary to prevent overstressing the internal insulation systems. If K_t is below 1.0 then to test the internal insulation system fully, the external insulation will be overstressed and steps may be necessary to prevent overstressing the external insulation systems.

The atmospheric correction factor shall be applied for each type of test voltage. The impulse test voltage will be "rated impulse voltage multiplied by the correction factor" and power frequency test voltage will be "rated power frequency voltage multiplied by the correction factor" calculated from measured values of *p*, *t* and *h*.

Calculation of Correction Factor and Applied Test Voltages

In the view of above discussion the correction factor and applied test voltages for lightning impulse and power voltage are calculated as under:

The assumed values of *p*, *t* and *h* for calculation purpose during the test on the switchgear panel are 950.1 hPa, 26 °C and 8.3 g/m^3 respectively. The k_1, k_2 and K_t are calculated which are 0.919, 0.976, and 0.897 respectively. The correction factor K_t is 0.897 which is below than 0.95, therefore, this value may be taken if mutually agreed between manufacturer and user, otherwise 0.95 may be taken for calculation. The applied test voltages when K_t is considered 0.95 will be as follows:

The impulse voltage (peak) will be 161.5 kV for ground and between phases and 185.2 kV across isolating distance. The power frequency rms voltage will be 66.5 kV for ground and between phases and 76 kV across isolating distance.

CONCLUSIONS

The withstand capability of external insulation is affected by the atmospheric pressure, temperature and humidity. Withstand values given in IEC 62271-1 Table 1 and 2 [3] are valid for standard atmospheric conditions. The atmospheric conditions at the testing place may deviate from the standard reference condition and it is necessary that correction factors may be applied for pressure, temperature, and humidity. The voltage applied during a test on external insulation is then determined by multiplying the specified test voltage by the atmospheric correction factor. The application of atmospheric correction factor ensures insulation systems are tested at correct voltages at normal stress. Therefore, risks of failure of dielectric tests and insulation aging are reduced if it would be overstressed as well as risks of un-identifying the defects in the insulation are minimized if it would be under stressed.

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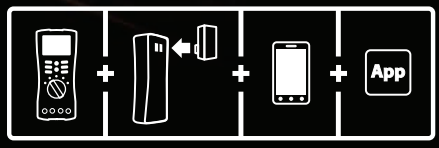

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Implementing Fuzzy Logic Controller for Automatic Generation Control

by

Muhammad Mateen Asad, Uzair Javaid, and Muhammad Asghar Saqib

ABSTRACT

In recent years a number of efforts have been made to incorporate fuzzy logic control into *automatic generation control (AGC)* and many fuzzy logic controllers (FLCs) have been proposed. This paper aims at implementing a fuzzy logic control system for AGC. The implemented system calculates the area control error (ACE) and its rate of change and feeds it to the fuzzy logic controller which then calculates the change in output. Digital circuits are preferred for implementation because of their low cost and robustness. *Field programmable gate arrays (FPGAs)* are ideal for this type of implementation as the controller can be re-designed easily without raising cost. However, credibility is an important aspect in designing these computer based systems and products are often perceived to be less credible than humans. In this paper criteria for a practical and credible system at each stage was developed and evaluated accordingly.

Keywords: Automatic generation control, fuzzy logic controllers, field programmable gate arrays (FPGAs) and Verilog HDL

INTRODUCTION

Power demand has been increasing tremendously over the years and, as a result, major changes need to be made to the existing power systems. The change in load beyond a permissible limit is accompanied by the changes in the system frequency and voltage. The power utilities install *'automatic generation control (AGC)'* and '*automatic voltage regulator (AVR)'* systems to overcome this problem. The AGC monitors and corrects the frequency and real power delivered to the system while the AVR regulates the voltage and reactive power.

Broadly speaking the power systems can be connected in radial or interconnected fashion. In an interconnected power system different generation areas are connected to one another. Today almost all generation utilities have tie-line interconnections to neighboring utilities. These interconnections allow sharing of generation resources in emergencies and for the economic operation of the system. The power system is controlled by dividing it into small control areas, and these control areas conform to the boundaries of one or more utilities [1].

The idea of Fuzzy Logic was proposed by Lofti. Zadeh in 1965. His proposed new set theory emphasized on modeling human intuition. Fuzzy logic control is based on heuristics and, therefore, human intuition and experience can be incorporated in it. Fuzzy logic controllers have shown better dynamic responses for AGC and are becoming more popular.

The simplest implementation of a digital fuzzy logic controller can be done using a microprocessor or a microcontroller. However McKenna and Wilamowski showed in [2] that a '*field programmable gate array (FPGA)*' has several advantages over a microprocessor or microcontroller system. Firstly, fuzzy controller implemented on a microprocessor or microcontroller produce relatively raw surfaces. Secondly, if a microcontroller needs to be reprogrammed the entire system will be taken down, the microcontroller will be reprogrammed and only then the system can be brought back up on line. An FPGA has the ability of being programmed on the fly hence there is no downtime of the system. Furthermore, FPGA's can be programmed while they are running, because they have reprogram times on the order of microseconds. This short time means that the system will not have to be shut down. Using an FPGA means that the controller will be running as an '*application specific integrated circuit (ASIC)'* for fuzzy logic control. When a piece of hardware is custom made for an application the design will run much faster than a general-purpose microprocessor that operates from the software downloaded [2].

FUZZY LOGIC CONTROL SYSTEM AND AUTOMATIC GENERATION CONTROL

The PI controller for the use in AGC for a generation excitation system has been comprehensively reported in [3]. Various researchers have theoretically implemented the fuzzy logic controller for the AGC of a two-area hydrothermal system incorporating various constraints and features of this system [4], [5], [6]. The fuzzy logic controller in all these reports has the same block diagram which is shown in Fig. 1. The inputs to the controller are the area control error (ACE) and its rate of change with respect to time i.e., its derivative (dACE). [4], [5], [6]. The output of the fuzzy logic controller is actually the change in output signal (Δu) [3]. The fuzzy logic controller designed by Anand and Jeyakumar in [6] is the most comprehensive one as it incorporates all the linearity's and the constraints of a two-area hydro-thermal system. Hence it was chosen for these studies and was implemented.

The system implemented on FPGA includes an input interface which calculates the ACE and its derivative, and the fuzzy logic controller. Fig. 2 shows the block diagram of

this fuzzy system.

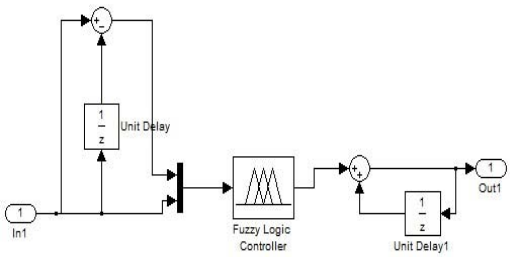

Figure 1: Block diagram of fuzzy logic controller for automatic generation control [1].

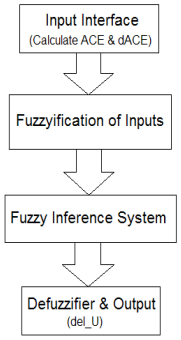

Figure 2: Structure of the fuzzy system implemented on an FPGA.

The Membership Functions and the Quantization Process

The inputs and the output are divided into seven triangular membership functions. Their labels are negative big (NB), negative medium (NM), negative small (NS), zero (ZO), positive small (PS), positive medium (PM) and positive big (PB) [6]. The inputs and the output are 8-bits in length, hence each input or output is quantized to take up a value from $0x00_h$ to $0xFF_h$ [7]. This can be done by using the following formula [8]:

$$\frac{\text{ACE}+0.06}{0.06-(-0.06)} \times 255 = \text{Decimal Value} \quad (1)$$

The decimal value is actually the quantized value of the input which can be converted into hexadecimal value. To get the quantized value of dACE, ACE will be replaced with dACE in equation (1). Similarly, for the quantized value of the output we can use:

$$\frac{\text{del\_U}+3\times10^{-3}}{6\times10^{-3}} \times 255 = \text{Decimal} \quad (2)$$

The membership functions and their corresponding quantized values are illustrated in Fig. 3.

THE FUZZY SYSTEM ON FPGA

Various components of the fuzzy system implemented on a FPGA are described in this section.

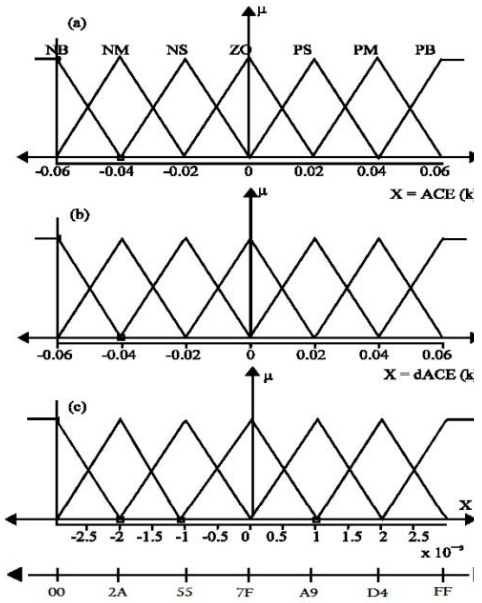

Figure 3: Triangular membership functions for (a) ACE, (b) dACE, and (c) output variable, Δu [6] [7].

The Input Interface

The only external signal input to the FPGA is the area control error (ACE) and its derivative is calculated by the FPGA itself. To understand how this is done we refer to the theory of a PI controller, which can be expressed in the form of an equation as:

$$\frac{du_{pi}}{dt} = K_p \cdot \frac{dACE}{dt} + K_i \cdot ACE \quad (3)$$

For a discrete-time system the controller described in [3] can be modified as:

$$u(kT) - u(kT-T) = K_p \cdot [e(kT) - e(kT-T)] + K_i \cdot e(kT) \quad (4)$$

$$del\_U = K_p \cdot dACE + K_i \cdot ACE \quad (5)$$

'del_U' is the change in u over one sampling period and dACE is the change in ACE over one sampling period.

Hence, a memory space stores the previous value of ACE. 'dACE' is calculated by finding the difference between the present and the previous value of the input. However, we also must make sure that the value of dACE is mapped to the proper membership function.

Referring to Fig. 3, we see that the values greater than $0x7F_h$ correspond to negative values of dACE and vice versa. So, the following algorithm was applied:

If ($ACE_{present}$<ACE_{past})
ACE = $0x7F_h$ - (ACE_{past} - $ACE_{present}$)
Else,
ACE = $0x7F_h$ + ($ACE_{present}$ - ACE_{past})

Fuzzification of ACE and dACE

After the inputs have been calculated they must be fuzzified. This involves the calculation of the slope, which

uses hexadecimal values. The membership degree is 8 bits in length. Since the membership functions are equally spaced all positive and negative slopes are of same value which comes out to be 5_h. FF is present instead of 1 because the degree is an 8-bit hex value. The obtained slope value of 5h is multiplied with the difference of the input and the first partition. The result is the membership degree for the fuzzy set. The fuzzification process is summarized in Fig. 5. This degree is not accurate as the slope is a 4-bit value. Hence FF is multiplied with 100 for a more precise value of slope. This gives a slope value of $5EE_h$. The final membership degree is divided by 100 to get the value in 8 bits. The positive slopes of all the fuzzy sets are calculated in a similar fashion. The calculation of negative slopes uses the same slope formula with the condition of taking the absolute difference of the values [8]. The algorithm can be generalized and expressed as:

If (ACE is between a_i and b_i) then

$d1 = (a_i - ACE)*5EE_h$

$A\_i = d1\ [16:8]$

If (ACE is between b_i and c_i) then

$d1 = (a_i - ACE)*5EE_h$

$A\_i = d1\ [16:8]$

Else $A\_i = 00_h$

Here d1 is 16-bit register and i varies from 1 to 7. Moreover, clock and resets are not required.

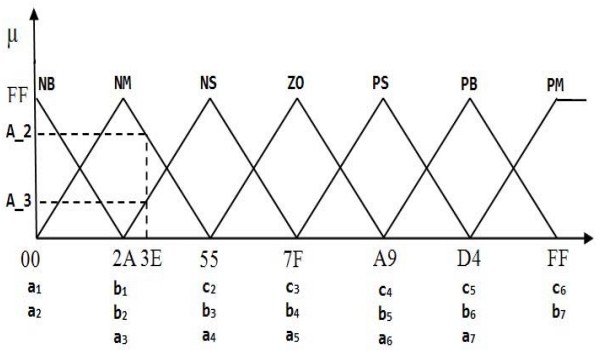

Figure 5: Fuzzification and membership degrees [3], [8].

Fuzzy Inference System (FIS)

To delve further into the topic let us first recall the rule-base [6], given in Table I, which is associated the present system.

dACE	ACE						
	NB	NM	NS	ZO	PS	PM	PB
NB	PB	PB	PB	PB	PM	PM	PS
NM	PB	PM	PM	PM	PS	PS	PS
NS	PM	PM	PS	PS	PS	PS	ZO
ZO	NS	NS	NS	ZO	PS	PS	PS
PS	ZO	NS	NS	NS	NS	NM	NM
PM	NS	NS	NM	NM	NM	NB	NB
PB	NS	NM	NB	NB	NB	NB	NB

Table 1: Rule base of the fuzzy logic controller.

dACE	ACE						
	A_1	A_2	A_3	A_4	A_5	A_6	A_7
dA_1	R1	R8	R15	R22	R29	R36	R43
dA_2	R2	R9	R16	R23	R30	R37	R44
dA_3	R3	R10	R17	R24	R31	R38	R45
dA_4	R4	R11	R18	R25	R32	R39	R46
dA_5	R5	R12	R19	R26	R33	R40	R47
dA_6	R6	R13	R20	R27	R34	R41	R48
dA_7	R7	R14	R21	R28	R35	R42	R49

Table 2: Rule memories and their corresponding inputs.

Fuzzy inference used in this system is the min-max inference which is a two step process [9], [10]. First the value of each rule is evaluated by using the min operator; the value of the rule is equal to the minimum of each input to the rule. For this we allocate 49 memory spaces which represent 49 rules and the value of each rule is assigned according to Table II. For example, the value of R1 will be the minimum of A_1 and dA_1.

For max evaluation we compare Table I and Table II, and determine which rule corresponds to which membership function of the output. The fuzzified value of the output membership function will be the maximum value of all the rule memories that correspond to that membership function. For example, for ZO R5, R25 and R45 are used and the value of ZO will be the maximum of the values of R5, R25 and R45 [3].

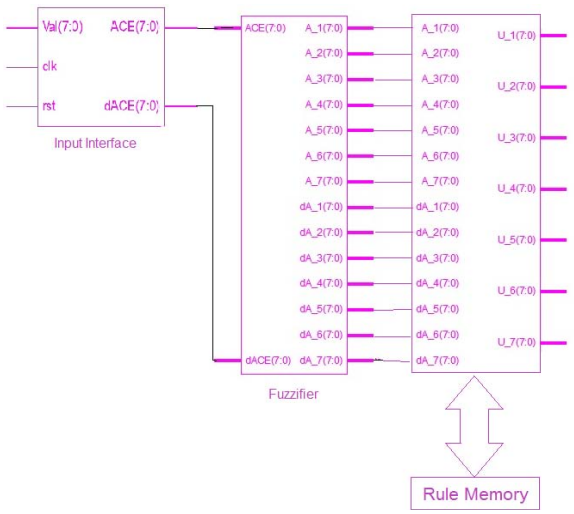

Figure 7: Block diagram of fuzzy inference system and with the rule memory interface: U_1 to U_7 represent the fuzzified values of the output membership functions.

The Defuzzifier and the Output Interface

The defuzzifier converts the fuzzy values into a definite output. There are different methods for defuzzification. The center of gravity method was chosen due to the ease of implementation on a digital system.

$$Numerator = \sum L_i * U\_i \quad (5)$$

$$Denominator = \sum U\_i \quad (6)$$

CREDIBILITY OF THE SIMULATION & IMPLEMENTED SYSTEM

Credibility is the quality of a person or entity to be believable. Firstly, credibility is a perceived quality; it doesn't reside in an object, a person, or a piece of information. Next, credibility perceptions result from evaluating multiple dimensions simultaneously. Although the literature varies on how many dimensions contribute to credibility evaluations, the vast majority of researchers identify trustworthiness and expertise as two key components of credibility. The trustworthiness dimension of credibility captures the perceived goodness or morality of the source. The expertise dimension of credibility captures the perceived knowledge and skill of the source. It should be noted that trust and credibility are not the same concept. Although these two terms are related, trust and credibility are not synonyms. Trust indicates a positive belief about the perceived reliability of, dependability of, and confidence in a person, object, or process [11].

Credibility in Human-Computer Interaction Systems

Apart from properly developing the concept of credibility it is also important to know when credibility actually matters. For example credibility is not a major issue when the computer device is invisible or when the possibility of bias or incompetence is not apparent to users. However, in many situations computer credibility matters a great deal. We propose that credibility matters when computer products act as knowledge sources, intended to be instructive, act as decision aids, or run simulations etc [11]. This paper aims on implementing a fuzzy logic controller successfully on a FPGA hence the computer system (i.e., the FPGA) will be at the fore front.

Simulating and Implementing a Credible System on FPGA

The research in [11] suggests that the assumption that computers are automatically incredible is a myth as there is no empirical evidence to support it. Many researchers have worked on developing credible simulation systems for complex and non-complex biological systems [12], [13] as well as telecommunications systems [14]. Fogg and Tseng have presented a thorough survey on credibility for computer systems in [11]. Their work compiles research on this topic from 1971 to 1999 and covers all related topics. This was comprehensive enough to be used in this paper to implement a credible system.

IMPLEMENTING THE SYSTEM: SIMULATIONS AND FPGA RESULTS

The implementation was divided into three stages, i.e. coding, simulation and implementation and at each stage all factors affecting credibility mentioned in [11] were evaluated and most significant factors were then noted. Each stage was then executed to evaluate if the system fulfilled the criteria signed for Xilinx Spartan-3 FPGA Xinlinx ISE 10.1

Simulation Using ModelSim

Credibility was most important at this stage as simulation determined if the implemented system was practical or not. It was determined that the familiarity of the user with the subject matter [11] was important when choosing a hardware description language (HDL). Hence Verilog HDL was used. The software used had to fulfill the three new views of credibility, namely reputed, surface and experienced credulity [11] to give believable results. Mentor Graphic's ModelSim 6.3f is specialized software for simulating code written in HDL languages. It is the number one choice for all professionals and is extensively used professionally. Therefore it fulfilled the criteria completely and was chosen.

All the modules i.e. input interface, fuzzifier, FIS and defuzzifier were comprehensively tested individually before they were interconnected for the fuzzy system. Waveforms of A_1 through A_7, dA_1 through dA_2, U_1 through U_7 and del_U were observed for various values of ACE and dACE. This was done to analyze each block and its individual constrains.

Testing the output interface, it was found that it took one cycle to calculate the output. Testing the input interface showed that it took another cycle to calculate the ACE and dACE. And processing all interconnected blocks showed, as predicted, that the time difference between input and output was 4 clock cycles. Hence, a delay of 2 cycles was placed between each processing during implementation. Fig. 8 shows a sample waveform for ACE = $0x00_h$ and dACE = $0x7F_h$ (ACE = -0.06 & dACE = 0).

وَعِنْدَهٗ مَفَاتِحُ الْغَيْبِ لَا يَعْلَمُهَآ اِلَّا هُوَ ؕ وَيَعْلَمُ مَا فِى الْبَرِّ وَالْبَحْرِ ؕ وَمَا تَسْقُطُ مِنْ وَّرَقَةٍ اِلَّا يَعْلَمُهَا وَلَا حَبَّةٍ فِىْ ظُلُمٰتِ الْاَرْضِ وَلَا رَطْبٍ وَّلَا يَابِسٍ اِلَّا فِىْ كِتٰبٍ مُّبِيْنٍ ۝

He has the keys to the realm that lies beyond the reach of human perception; none knows them but He. And He knows what is on the land and in the sea; there is not a leaf which falls that He does not know about and there is not a grain in the darkness of the earth or anything green or dry which has not been recorded in a Clear Book (6:59).

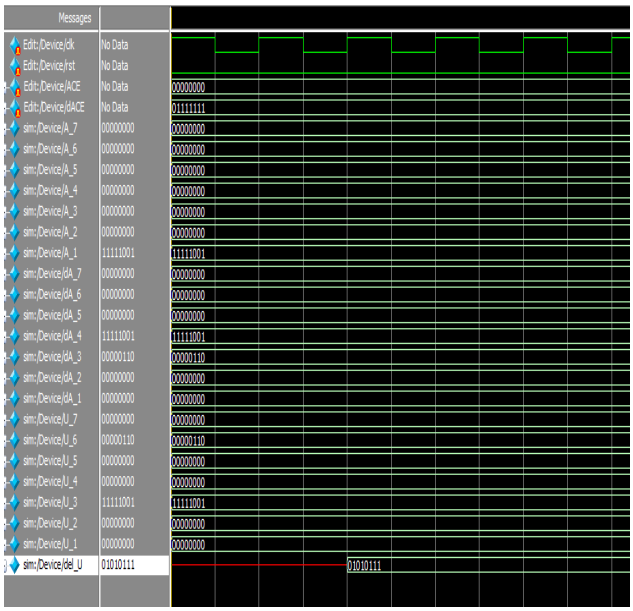

Figure 8. Simulation results for ACE=-0.06 & dACE=0.

Implementation and Results

Spartan-3 FPGA Starter Kit provides a low-cost, easy-to-use development and evaluation platform for Spartan-3 FPGA designs [14]. Since similarity leads to credibility [11], fabricating a new system or using an unfamiliar FPGA development kit could have affected credibility. Hence an already familiar system was used. Thus using Spartan-3 Starter Kit Board ensured that the criteria for credibility were fulfilled.

The Starter board is equipped with many peripheral devices to aid development and evaluation. Full details of these components and features can be found in [14]. However, since small errors can have disproportionately large effect on perceptions of credibility [14] care been taken regarding which feature to use. Although the Board had a 7 segment display it was not used. Since the output was in 8-bit result was displayed on 8 LEDs, which turned on and off to display the output in binary numbers; on meant 1 and off meant 0. This way it was ensured that there was no extraneous errors and the system could be judged for purely as a hardware fuzzy logic controller.

Table III shows the quantized values of del_U obtained for various quantized values of ACE and dACE from both MATLAB and FPGA. First, values from MATLAB were calculated and converted into quantized decimal value. The results were compared in quantized values for a better comparison. Observing these results we can see that except for a few odd cases, the error predictably is '1_h'. Hence the system also fulfills the criteria to regain credibility by making predictable error and also showing good relatively good performance over the range of inputs [14]. To check the seriousness of some abnormal error, percentage error was calculated. Tolerance of 5% is usually acceptable in such applications and as we can see the root mean square error is less than 2% and actual error is even as low as 0% as shown in Table IV.

ACE	dACE	del_U (MATLAB)	del_U (FPGA)	% Error
0	127	85	87	-2.35294
21	160	106	106	0
42	200	85	85	0
85	62	193	192	0.518135
111	95	141	141	0
127	127	127	127	0
159	160	113	109	3.539823
190	7	202	201	0.49505
212	62	170	169	0.588235
233	95	149	148	0.671141

Table 3: Real values of ACE, dACE and del_*u*

ACE	dACE	del_U (MATLAB)	Del_U (FPGA)	Error
-0.06	0	-0.001	-0.001	0
-0.05	0.015	-0.0005	-0.0005	0
-0.04	0.034	-0.001	-0.001	0
-0.02	-0.031	0.001	0.0015	-2E-05
-0.0078	-0.0153	0.00033	0.00033	0
0	0	0	0	0
0.0148	0.015	-0.00035	-0.0004	-5.4E-05
0.029	-0.0567	0.00176	0.00173	-3E-05
0.04	-0.031	0.001	0.001	0
0.0496	-0.0153	0.00051	0.00048	-3.6E-05

Table 4: Comparison of del_U values of MATLAB and FPGA (All values in quantized decimal). Root mean square error is 1.4 %.

CONCLUSION

This paper describes a successful implementation of a credible and practical fuzzy system for the automatic generation control using an FPGA. The system first calculates the values of area control error and its derivative, then feeds these to the fuzzy logic controller which calculates the change in output over one sampling period. We exercised care so that the values of time derivative of area control error were mapped to the right membership functions. Verilog HDL was been used for writing the code. Xilinx ISE was used to write the code, ModelSim SE 6.3f was used for simulation and verification and the system was implemented on Xilinx Spartan-3 FPGA using Xilinx Spartan-3 Starter kit. Special focus was placed on credibility. Even though the system had occasional small errors, yet it also showed the capability of regaining credibility. The system can be further improved by using better defuzzification techniques such as *centre of area (CoA)* or *centre of gravity (CoG)* methods.

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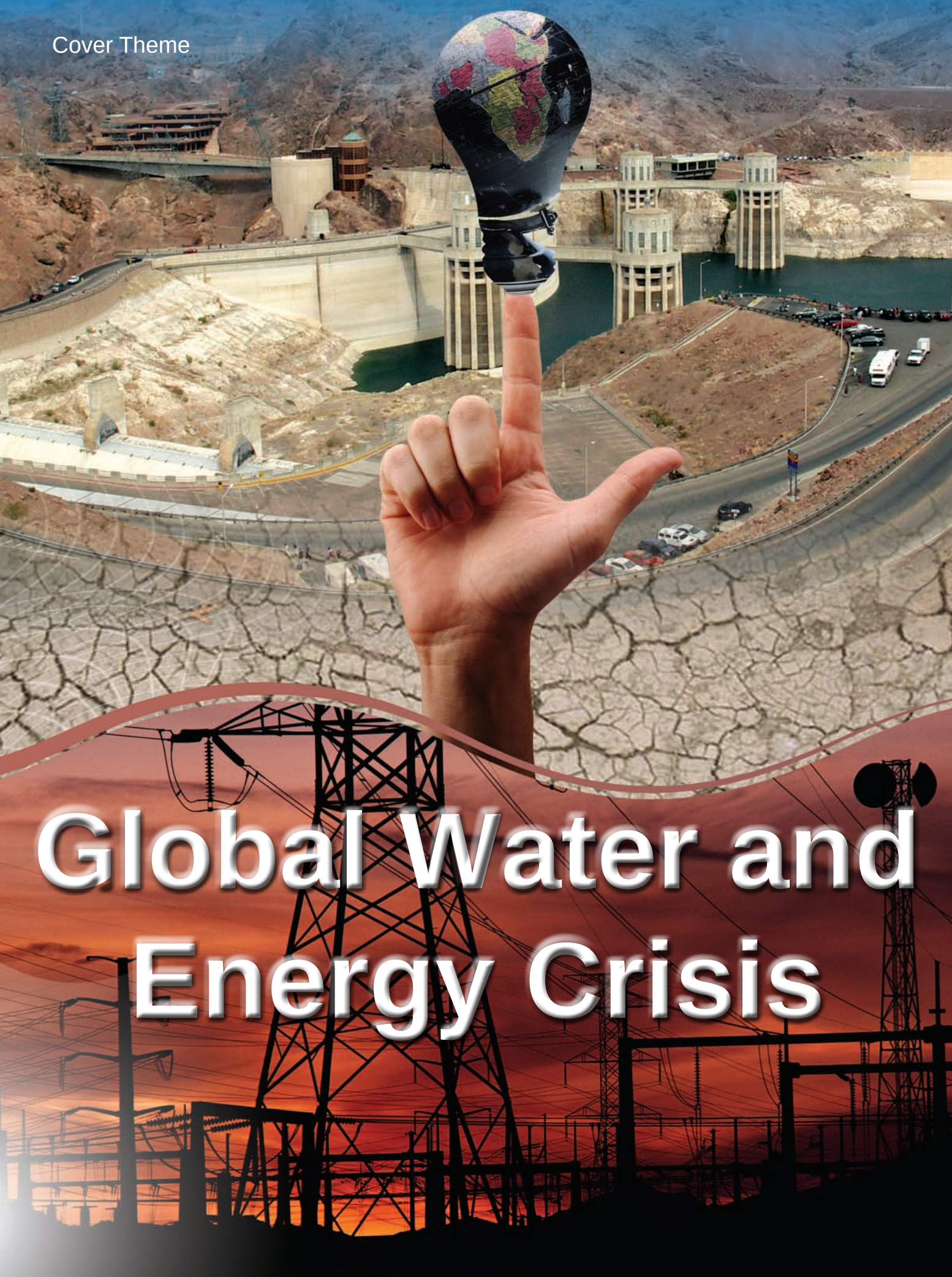

Global Water and Energy Crisis

Global Water and Energy Problems and Role of Renewables in Future

by

Nazar H Malik, Syed Qaseem Ali, and Imran Ijaz

ABSTRACT

World population is increasing at an ever increasing rate. The high population, coupled with increased industrialization and development has put tremendous challenges for the supply of water and energy to human societies. This paper presents a brief overview of the challenges faced in supplying the global requirements of energy and water. Different possible options are reviewed and it is argued that the use of renewable energy and integrated approach in planning of water and energy sources can play an important role in the twenty first century.

INTRODUCTION

Water and energy supplies are two of the most important elements which are used in the normal functioning of modern societies. Clean water like clean air is a basic necessity of life. In earlier times, the power of human or animals was used for most of the work. However, with the rapid industrialization and urbanization, a lot (if not most) of activities are performed by machines of all types which need huge amount of energy to sustain modern life and economic activities. Consequently, the demand of water and energy is continuously increasing. In addition, there has been a high growth rate of human population over the last century. These factors are posing serious challenges on a global basis for supply of energy and clean water to the global population. This paper aims to provide a brief overview of the main challenges and some factors which are contributing to make these challenges more severe. It examines various options available to mankind and suggests that the use of renewable energy can help meet some of these challenges. The paper further suggests the need of cooperation of the entire global community to meet the upcoming challenges.

WORLD POPULATION GROWTH

In the year 600AD, the estimate of global population was 500 million [2]. It took about 1200 years for the population to double to 1 billion in the year 1800AD, see Figure 1. However, from 1800AD to 1930AD, only in 130 years, the population increased from 2 to 4 billion. This trend continues and in 1999AD, human population reached the 6 billion mark. In year 2011AD, the population surpassed 7 billion. It is projected that by 2050AD, the global population will surpass 9 billion. In order to appreciate the extent of this dramatic growth of the population, consider the fact that the increase of global population in the past 51 months is about 375 million. This is more or less the combined population of Saudi Arabia, Egypt, Libya, Algeria, Morocco, Iran, Iraq, UAE, Kuwait and Turkey. This dramatic growth of human population is a result of increased industrialization, developments in science, technology, economic and agricultural activity, and other sectors, more widespread availability of better food, health care and related facilities and many other factors. The net effects are that (i) the population is increasing at dramatic rates; (ii) there is tremendous pressure on the availability of water, energy and other required resources to sustain the modern human communities, and (iii) there are serious concerns about the effect on environment due to increased use of energy and water. Due to these reasons, it is useful to examine the availability of some of the required resources and highlight the important challenges that we all face as human beings.

GLOBAL WATER DISTRIBUTION AND CHALLENGES

It is well known that water is an essential life resource on earth. Total water hydrosphere on earth is 1386 x 10^6 km^3 [3-4]. However, 97.5 % of this water is salty and in the oceans, while total global volume of fresh water is about 2.5 % or 35.2 x 10^6 km^3. It is estimated that 68.7 % of freshwater is in the form of glaciers, 0.8 % in permafrost and the remaining 30.1 % is ground water. Major part of the ground water i.e., 67.4 % is present in freshwater lakes, 1.6 % in rivers, 12.2 % in soil moisture, 9.5 % in the atmosphere and 0.8 % in plants and animals. Thus, it is clear that even all of the fresh water is not available for human exploitation and use. In fact, according to estimates, total freshwater available to mankind is only 0.11 x 10^6 km^3 or less than 0.01 % of the total hydrosphere. Thus, there is limited water quantity available. Moreover the available quantity is not uniformly distributed across the globe. Daily water availability varies from as high as 550 liter per person in USA to as little as less than 10 liter per person in some African countries [5-6]. To look into this aspect, it is useful to define the following terms:

The global physical and economic water scarcity status is summarized in Figure 1. Where the first item in the legend shows regions of actually existing water scarcity, while the second item shows the areas which will become water scarce in the coming years. The third item shows areas which are not actually water scarce but no investment has been made on infrastructure to facilitate the availability of water. The fourth item shows areas that enjoy little or no water scarcity.

**Most of the material contained in this article is based on a lecture by Dr. Julian Blanco at King Saud University [1].*

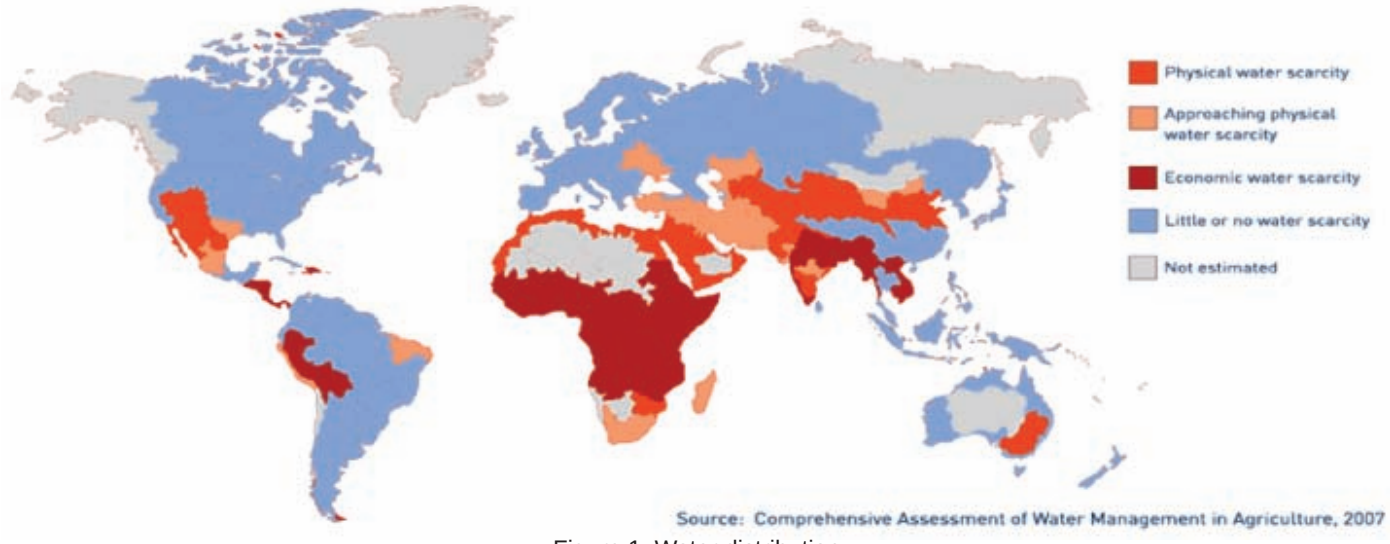

Figure 1: Water distribution

Figure 2 summarizes the trends of water availability in developed countries, developing countries with humid weather and in arid developing countries. Figure 2 also shows the trends of population growth and projected availability of water up to 2020. The figure clearly suggests that freshwater available per person is expected to decrease significantly in future and therefore we must plan properly to make the best use of available water resources in a judicious and intelligent manner.

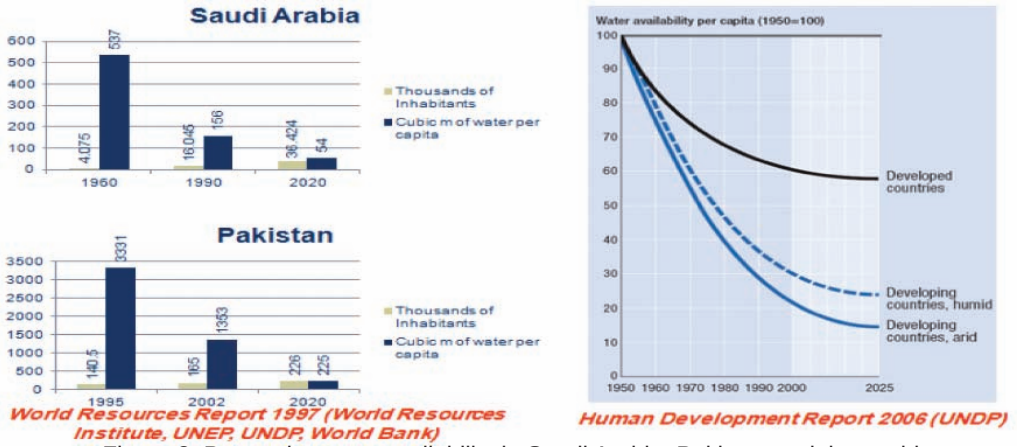

Figure 2: Per capita water availability in Saudi Arabia, Pakistan and the world

At present nearly all surface water is already in use in many parts of the world and over exploitation of ground water is increasing. Even today about 600 million people face water scarcity. Depending on future rates of growth between 2.7 and 3.2 billion people may be living in either water scarce or water stressed conditions by the year 2025 [7]. Figure 3 shows the expected trends in this respect across the globe.

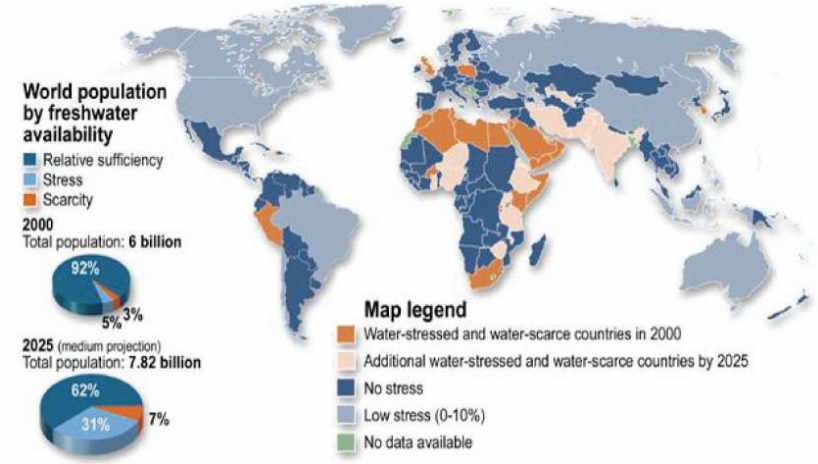

Figure 3: Expected water scarcity in future

There are many possible reasons for the declining freshwater availability, such as increased urbanization, more sophisticated life styles, and dramatic increase in the irrigated farming. In fact 70 % of all the water is used for agriculture activity in order to produce about 40 % of global human food. The irrigate surface in 1970 was 2574 million of hectares which needed about 165 km^3/ year of water. By year 2000, the corresponding numbers increased to 3940 million hectares and about 275 km^3 per year [8]. Due to the increasing diversion of fresh ground water for agriculture purposes, some large water bodies e.g., Chad Lake and Aral Sea have practically disappeared or are on the brink of disappearance over just the last half century. These figures clearly point out the need for proper planning and efficient utilization of available water resources in order to minimize the negative impact of the emerging water scarcity issues in many countries including Pakistan and Saudi Arabia.

ENERGY SCENARIO

Modern life is sustained by the use of a lot of energy. As per International Energy Agency (IEA) reports, the primary energy supply in year 2008 was 12.297 x 10^6 tonne of oil equivalent which corresponds to 14.2 x 10^9 GWh of energy [9]. This translates to continuous use of 16.29 TW round the clock. It should be noted that 1 TW equals to continuous consumption of 10^{12} W during one full year. It equals using 1000 power plants of 1000 MW each working continuously nonstop for the entire year. This energy comes from different sources such as coal (27 %), oil (33.2 %), gas (21.1 %), nuclear (5.8 %), hydro (2.2 %), combustible renewables e.g., wood and waste (10 %) and others (0.7 %). Thus, we can note that over 81 % of energy consumed is in the form of fossil fuels which have fixed supplies and are gradually depleting. Once used, these cannot be renewed.

Similar to the water issue, the energy used by mankind is on the rise as well. In 1973, the total energy use was 8.01 TW which more than doubled in just 35 years and in year 2008 the total energy use became 16.29 TW. At present, the increase per year is about 400 GW i.e. humans are practically adding 400 power plants per year, each of 1000 MW and these plants are working continuously round the clock. Thus, one has to examine carefully how such massive use of energy can be sustained. According to several estimates, the world's total proven oil reserves are about 1.2 x 10^{12} barrels. If we consider the consumption as 32 x 10^9 barrels per year (≈ 87.7 million barrels per day), then the proven supplies are sufficient for about 37.5 years [9-13]. The association for the study of Peak Oil and Gas [14] suggest that oil production in many countries including USA, Pakistan, and Saudi Arabia have already peaked and the production is declining or will decline in future. The increasing demand and declining supplies are therefore pushing the global oil prices upward as seen over the recent years.

Whereas present energy consumption is about 16 TW, it is estimated by IEA, that by year 2050, the expected energy requirement will reach 30 TW. Then, the question arises that from where this energy supply will come? If we examine the available existing options, nuclear fission energy comes to mind. However, in spite of all efforts, little advancements have been made to resolve the safety handling of residues and cost issues associated with this form of nuclear power. Nuclear calamities such as the one that occurred in Chernobyl, Ukraine (former USSR) in 1986 due to an accident and in Fukushima, Japan, in 2011, due to natural disasters have further eroded confidence about this option. In addition, the required nuclear technology is available to only a few selected countries. Moreover, due to dual use of such technology, powerful countries do not want less powerful ones to achieve and embark on this path. Thus, it can be safely stated that the nuclear option will have a limited contribution in the global energy mix of the future. Moreover, the fuel supplies are limited even for nuclear fission. The other nuclear option i.e. nuclear fusion looks very distant from possible practical applications.

FOSSIL FUELS AND GREENHOUSE GASES

In the light of the above discussion, the other possible source that can be considered is coal, which still has a lot of untapped global reserves in many countries including Pakistan. However, coal triggers environmental concerns since coal combustion produces CO_2, and other gases that result in greenhouse effects and acid rain. Scientific studies show that a very strong correlation exists between the amount of CO_2 in the atmosphere and global temperature if data for the last 420,000 years is analyzed. Thus, there are fears that extensive dependence on coal will lead to global warming unless better technologies are developed and used. All evidences suggest that our planet will be hotter in the current century. Depending on different scenarios, it is anticipated that the increase of average global temperature during the 21st century can range from 1.5 °C to more than 4 °C. CO_2 emissions are on the rise and, at present, China and India are adding more CO_2 to the atmosphere than the largest historical polluter i.e., the USA. IEA reports suggest that India and China will rely heavily on coal to meet the growing demand of energy for their massive population. Although, clean energy technologies like coal gasification, coal liquefaction and coal blending may be available, but the cost required is very high and thus these will not be exclusively used by all countries. Hence, the CO_2 concentration is expected to rise with a potential forecast of 5 °C to 6 °C increase in the average global temperature. The control and limits on CO_2 emissions are being attempted by some countries; however, considering differing national interests and political views and will power, this question is expected to remain unresolved for many years to come. Hence, the global temperature is expected to increase. Therefore, it is important to consider the implications of global warming [15-16]. These implications can be summarized as follows:

- Increase of 2 °C will result in irreversibility limit of the process, with serious consequences to the environment and mankind.
- Increase of 4 °C will cause Serious problems of security due to the collapse of social structure (hundreds of millions persons are expected to be displaced, mainly due to the lack of water).
- Increase of 6 °C will lead to absolute terrifying consequences to the planet with the disappearance

of a high percentage of biodiversity.

- At present, there is an increase of 0.8 °C (with respect to 1900 temperature). Thus, it is clear that heavy dependence on oil, gas and coal, even if those energy supplies are available economically, will have very serious concerns for global weather and life on earth and one must examine different possible options to formulate suitable policies for further global well being.

ENERGY EFFICIENCY

Some important measures that can help to cope with the emerging challenges for both water and energy are the reduction of wastage, rationalization of use of these essential sources and increase of efficiency of utilization of energy in every field. For water, this can be done by the use of more efficient methods of crop irrigation, by reducing water usage for domestic and industrial applications, by recycling waste water and by better management of existing water resources and development of new resources etc. For energy, it is important to increase energy efficiency in transportation, domestic as well as commercial sectors. This means designing of vehicles with improved gas mileage, design of more efficient lighting, more efficient heating/cooling devices, better use of natural light and atmosphere heat for maintaining comfort in the buildings and a whole range of other measures. At present, there is a wide gap between energy usage in different societies even when they have same human development index (HDI) as seen in Figure 4 [17-18]. Whereas part of this difference may be due to extreme weathers in some countries, part is related to extravagance and wastage and every effort should be made by all the societies to eliminate or at least minimize such wastage.

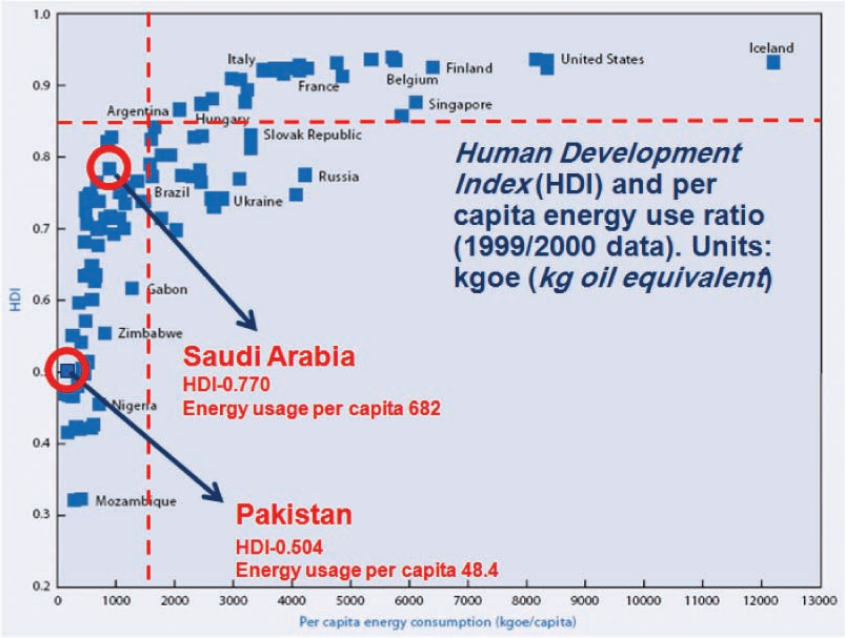

Figure 4: HDI and per capita energy consumption of some countries

RENEWABLE ENERGIES

To meet the energy demands, there has been an increased focus on the use of renewable sources of energy. These include solar, wind, waves, tides, hydraulic, geothermal, and biomass. Table 1 gives the estimated yearly global potential of different renewable energy sources. Kindly note that 1 TW is equal to continuous consumption of 10^{12} W i.e., 1000 power plants of 1000 MW each for one full year (8760 hours) and thereby providing total energy of 8760 TWh. This table shows that there is a large potential of such energy and technically 85 TW is feasible [19]. At present about 7 TW is economically feasible. The current installed capacity of such energy sources is between 2 and 3 TW. Thus, there is significant potential of exploitation of renewable energies and many countries are working aggressively to make use of such resources. For Saudi Arabia, solar energy has the most potential. For Pakistan, solar, wind, hydro and biomass are of considerable significance.

Global Figures	Theoretical Total Power	Technically Feasible	Economically Feasible	Installed Capacity (2003)
Biomass	8 - 14 TW	6 - 8 TW	No data (*)	1.6 TW
Hydro	4.6 TW	1.6 TW	0.8 TW	0.65 TW
Geothermal	66 TW	11.6 TW	0.6 TW	0.054 TW
Wind	20 TW	2 TW	0.6 TW	0.006 TW
Solar	600 TW	60 TW	0.15 – 7.3 TW	0.005 TW
Tidal	234 TW	No data	No data	----
TOTAL	**1030 TW**	**85 TW**	**7 TW**	**2.3 TW**

Table 1: Renewable Energ Potential [9]

However, to recap the benefits of these natural resources, there is a strong need to have a policy document or a roadmap to develop these resources and to develop technical expertise for benefiting from these untapped renewable sources. For the next few decades, renewable energy harvesting and its integration into the network will be a major focus of technical initiatives across the globe. Figure 5 shows some renewable systems.

fresnel collectors (LFC). A category of solar thermal plants use high temperature concentrated solar power employing central receivers system (CRS), parabolic dishes, or solar furnaces. Much work is going on in developing these and other technologies to utilize the solar energy.

Direct conversion of sunlight to electricity is achieved using conventional photovoltaic (PV) systems or concentrated photovoltaic (CPV) systems. These technologies are still

Figure 5: Some Renewable Energy Sources

WATER – ENERGY – POPULATION INTERACTIONS

The preceding discussion suggests that increase in population is a major cause for upcoming potential water and energy crises. Global warming may aggravate the situation further since it will affect energy as well as water supply requirements and availability. In general, there is a clear link between water and energy. For example, if energy is easily available water problems can be significantly reduced. However, if energy is also unavailable, the situation becomes even more difficult. It is obvious that at present oil is the most important individual factor in the world economy that is at the root of many conflicts of today. In the future, water could very easily occupy this position. In any case, both energy and water are already considered as major security issues. Since there is a close relationship between these two, energy and water issues must be addressed together in a comprehensive manner in every society. An interesting coincidence is the fact that most of the arid and semiarid regions have abundant availability of solar radiation. This solar energy, if harnessed properly, can lead to availability of not only the needed energy, but also contribute to the reduction of water problems.

Solar energy can be used either directly for passive heating applications or converted to electricity. To generate electricity from sunlight, there are solar thermal plants using medium temperature concentrated solar power systems by parabolic trough collectors (PTC) or linear

in infancy, and we will certainly hear a lot more about these in the coming years and decades [20]. Many countries are working aggressively to develop these technologies for a better future.

NEED OF SUSTAINABILITY

In the 20th century, the human population grew four times, the use of water increased nine times, and the use of energy grew 16 times. In addition, the population needs were met with significant degradation of natural resources and the environment. This is obviously non-sustainable. Thus, the developments in the 21st century must be sustainable, where we meet our present day needs without risking the needs of future generations. Hence, in planning the future strategies, sustainability should be a cornerstone. To achieve sustainability, we will need innovative ideas, new technologies, political will and cooperation among different segments of one society as well as cooperation among different nations of the globe. To further such cooperation, a correct understanding of the issues is important and engineers can play an important role to achieve these objectives.

CONCLUDING REMARKS

The challenge of supplying clean water and affordable energy supply to the increasing global population must be met without degrading the environment and without risking the well being of the future generations. This requires careful planning and focused approach to achieve

sustainable development. Renewable energy sources can play a vital role in this and there is a strong need to develop policies, technologies, and infrastructure to harness and use these sources for the benefit of the entire mankind. All the potential challenges can be met by developing new opportunities and by reducing waste and mismanagement of available resources.

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فَلَا وَرَبِّكَ لَا يُؤْمِنُونَ حَتَّىٰ يُحَكِّمُوكَ فِيمَا شَجَرَ بَيْنَهُمْ ثُمَّ لَا يَجِدُوا فِي أَنفُسِهِمْ حَرَجًا مِّمَّا قَضَيْتَ وَيُسَلِّمُوا تَسْلِيمًا ﴿٦٥﴾ وَلَوْ أَنَّا كَتَبْنَا عَلَيْهِمْ أَنِ اقْتُلُوا أَنفُسَكُمْ أَوِ اخْرُجُوا مِن دِيَارِكُم مَّا فَعَلُوهُ إِلَّا قَلِيلٌ مِّنْهُمْ ۖ وَلَوْ أَنَّهُمْ فَعَلُوا مَا يُوعَظُونَ بِهِ لَكَانَ خَيْرًا لَّهُمْ وَأَشَدَّ تَثْبِيتًا ﴿٦٦﴾

But no, by your Lord, they cannot become true be-lievers until they seek your arbitration in all matters on which they disagree among themselves, and then find not the least vexation in their hearts over what you have decided, and accept it in willing submission. Had We enjoined upon them: 'Slay yourselves', or 'Leave your habitations', very few of them would have done it; yet if they had done as they were admonished, it would have been better for them and would have strengthened them;

Wind Power Potential of Pakistan and Overview of Comparison of Different Wind Energy Conversion Systems

by

Ammar Anwar Khan and Syed Arslan Abbas Rizvi

ABSTRACT

Pakistan has entered the phase of utilization of its wind energy resources. With the penetration of Wind Energy Conversion Systems (WECS) in the electric power system, there will be a need for a set of the rules for electric network operator and turbine manufacturer for safe and reliable supply of electric power. This paper presents the overview of different WECS, the potential and the progress of Pakistan in this field so far. Pakistan has good potential to exploit this power. Two companies have taken the initiative to commission wind farms and it is hoped that further progress in this field of energy will take place in Pakistan soon.

Keywords: DFIG; Wind energy conversion systems; Wind corridor, Gharo.

INTRODUCTION

Wind energy is one of the most abundant sources of green energy available on Earth. It is the fastest growing energy source these days. Countries like Germany, Sweden, Denmark etc. have excelled in this area. Creator has gifted Pakistan with a wind corridor that extends from Gharo to Keti-Bandar [1]. Zorlu Enerji Pakistan Ltd. and Fauji Fertilizer Company Energy Ltd. took an initiative to build a 50MW wind farm and commissioning is still in progress [1]. The proposed wind corridor site is located in the south-eastern part of Pakistan between Hyderabad and Karachi, approximately 100 km inland from the coast in a semi-desert area with rare vegetation. The nearest settlements are Jhimpir (2.5 km southeast) and Nooriabad (22 km north-west).

Several studies on wind power potential of Pakistan have been conducted [2-4] which show that the annual average wind speed varies between 3.96m/s to 11.34m/s. These studies and other wind data reveal that there is a large volume of untouched wind power available that if utilized effectively can fulfill the base power requirements of Pakistan. This study presents the wind potential of Pakistan and different wind energy conversion systems that are commonly used in world.

ENERGY IN PAKISTAN

Resource Potential

The wind map developed by National Renewable Energy Laboratory (NREL), USA, in collaboration with USAID, has indicated a potential of 346,000 MW in Pakistan. The Gharo-Keti Bandar wind corridor spreading 60 KM along the coastline of Sind Province and more than 170 km deep

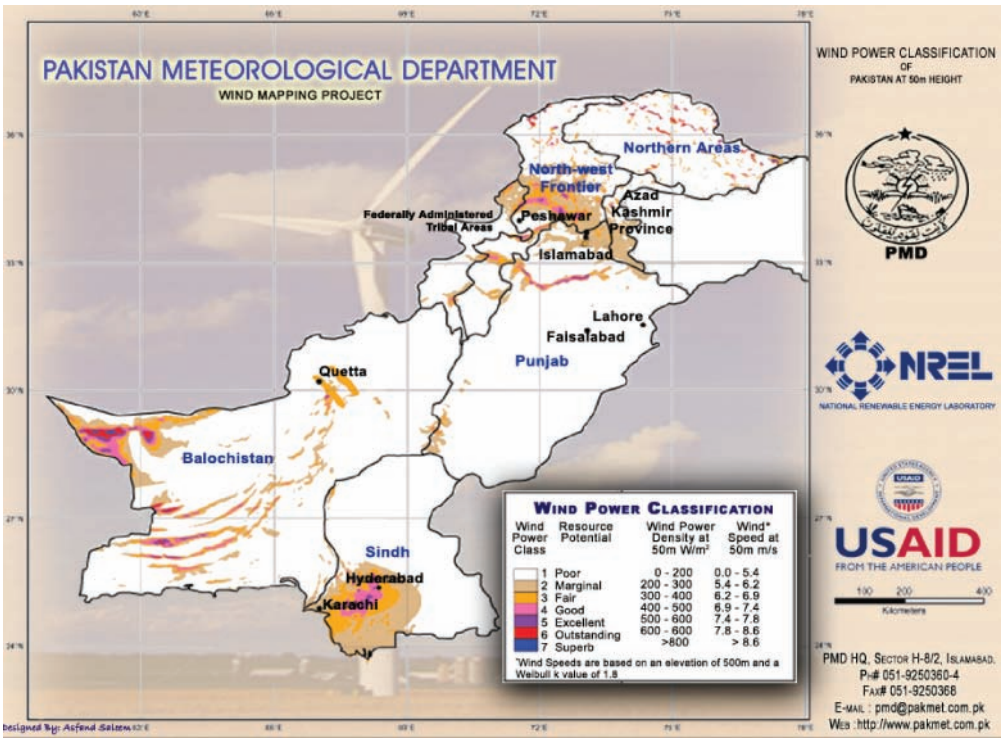

Figure 1. Wind power potential distributed all over Pakistan

towards the land alone has a potential of approximately 50,000 MW. 30 % - 32 % capacity factor estimated in Gharo -Keti Bandar area. 41 Licenses of Intent (LoI) have been issued to different companies. Figure 1 shows the wind power potential of Pakistan.

Feasibility Study

Feasibility studies for 50 MW wind power projects submitted by thirteen (13) IPPs namely:

1. Green Power Pvt. Ltd.
2. Beacon Energy.
3. New Park Energy.
4. Tenaga Generasi Ltd.
5. Zephyr Power Pvt. Ltd.
6. Dawood Power Ltd.
7. Zorlu Enerji Pakistan Ltd.
8. Fauji Fertilizer Company Ltd.
9. Arabian Sea Wind Energy Pvt. Ltd.
10. Makwind Pvt. Ltd.
11. Master Wind Energy (Pvt.) Ltd.
12. Lucky Energy Pvt. Ltd.
13. Sapphire Wind Power Company Pvt. Ltd.

Generation License

NEPRA has so far issued Generation License to following IPPs:

1. Green Power Pvt. Ltd.
2. New Park Energy.
3. Tenaga Generasi Ltd.
4. Dawood Power Ltd.
5. Zorlu Enerji Pakistan Ltd.
6. Arabian Sea Wind Energy Pvt. Ltd.
7. Fauji Fertilizer Company Energy Ltd.

Applications for issuance of Generation License of Sunnec Wind Power Generation Pvt. Ltd. are in process at NEPRA.

Energy Purchase Agreement (EPA)

The standard draft EPA, prepared by AEDB, is under negotiations with NTDC by several IPPs, namely:

1. Green Power Pvt. Ltd.
2. Zorlu Enerji Pakistan Ltd.
3. Beacon Energy Ltd.
4. Fauji Fertilizer Company Ltd.

The standard draft prepared by AEDB is being negotiated with several IPPs.

Letter of Support (LOS)

Two IPPs have submitted Performance Guarantees and subsequently acquired LOS from AEDB, namely;

1. Zorlu Enerji Pakistan Ltd. (56.4 MW).
2. New Park Energy Ltd. (50 MW).

SELECTION OF WIND TURBINES

The annual average wind speed in the Gharo–Keti-Bandar wind corridor varies between 3.96m/s to 11.94m/s [2-4]. The meteorological wind data [4] shows that annual diurnal variation is from 5.9m/s to 8.5 m/s at 50 m height with standard deviation of 3.88 which means that the selection of wind turbine system should be such that it operates within the range of wind speed data. Following is a brief description of different wind turbine systems.

Wind turbines can be broadly classified as fixed speed and variable speed wind turbines. There are different concepts for wind turbines which include fixed speed wind turbine with squirrel cage induction generator, variable speed wind turbine with doubly fed induction generator and variable speed wind turbine with direct driven permanent magnet synchronous generator [5].

Fixed speed concept with SCIG

The fixed speed concept is based on a wind turbine with a multiple stage gearbox and a squirrel cage induction generator (SCIG) connected to the grid through a transformer. This concept is called fixed speed because the SCIG can operate in a small range of speeds around the synchronous speed. The fixed speed concept has following advantages:

- Simple construction.
- Simple maintenance.
- Low cost.
- Direct connection to power grid.

Apart from above advantages, there are some disadvantages which are listed below:

- Requires reactive power.
- Requires soft start device for initial connection to the grid.
- Applicable only for fixed turbine speeds.

"The intellect has little to do on the road to discovery. There comes a leap in consciousness, call it intuition or what you will, and the solution comes to you and you don't know how or why."
Albert Einstein

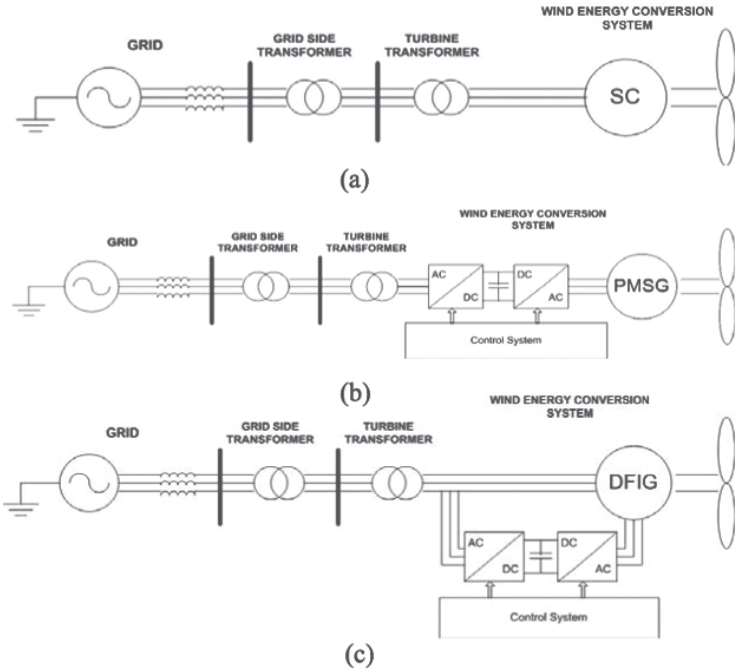

Figure 2: (a) Fixed Speed with Squirrel Cage IG (b) Variable Speed with Permanent Magnet Synchronous Generator (c) Variable Speed Doubly Fed Induction Generator.

- Requires a gearbox.
- Cannot be used for large number of poles.
- Prone to high mechanical stresses.

Variable speed concept with doubly fed induction generator

The variable speed concept has its basis on the doubly fed induction generator which is simply a wound rotor induction generator whose stator is directly connected to the grid. The rotor winding is connected to the grid through a partial scale power converter. The converter provides four-quadrant operation and controls the active and reactive power fed to and by the DFIG.

This approach has following advantages:

- Significantly reduced power rating and cost of the converter.
- Possible speed regulation for optimal utilization of energy; typically ±(20% to 25%).
- Reactive power for magnetization of the machine is provided by the power converter.
- Sub-synchronous and super-synchronous operation is possible.

Following are the disadvantages of this approach:

- Slip rings and brushes, wear and tear and maintenance requirement.
- Complex control of the entire unit.

Variable speed concept with permanent magnet synchronous generator

This concept is also called the direct drive concept. The basis for this concept is a multi-pole permanent magnet synchronous generator connected to the grid through a full scale power converter. The variable speed concept with permanent magnet synchronous generator has following advantages:

- Simple rotor with no parts prone to wear and tear.
- Very low rotor losses.

The disadvantages are:

- High cost of permanent magnet.
- Possibility of demagnetization.
- Insufficient experience in construction and installation.
- High cost for full scale power converter.

Keeping in view the advantages and disadvantages of the three concepts one can easily infer that the selection of fixed speed concept is out of question because the statistics of wind corridor of Pakistan show that wind speed varies frequently with a standard deviation of 3.88 at a height of 50m [4] which may cause mechanical stress on a fixed speed wind turbine [5]. PMSG and DFIG are suitable for wind conditions of Pakistan. PMSG based wind farms have a high initial setup cost as compared to ones with DFIG but in long terms both have almost same economic aspects as the maintenance cost of DFIG based wind farms is slightly higher than that of PMSG. Either of the two can be used when considering the wind conditions of Pakistan.

CONCLUSION

Pakistan has a significant resource of wind energy that can be exploited for meeting the energy needs. In this paper selection of wind turbines based on wind conditions has been discussed and it is proposed that PMSG or DFIG based wind farms are suitable for variable wind speed of wind corridor. Pakistan is listed in the moderate wind regions and significant energy can be harnessed if properly

exploited. Government of Pakistan has taken initiative to progress in this field and many licenses have been issued to prospective companies. With the penetration of WECS in power system, both the network operator and turbine manufacturers are liable to the requirements which must be defined for efficient operation of WECS.

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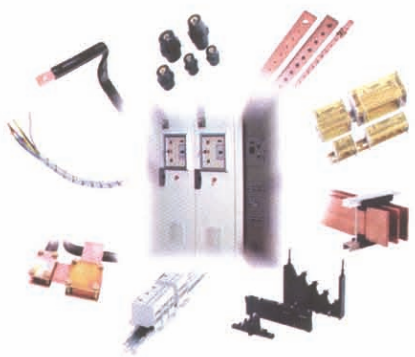

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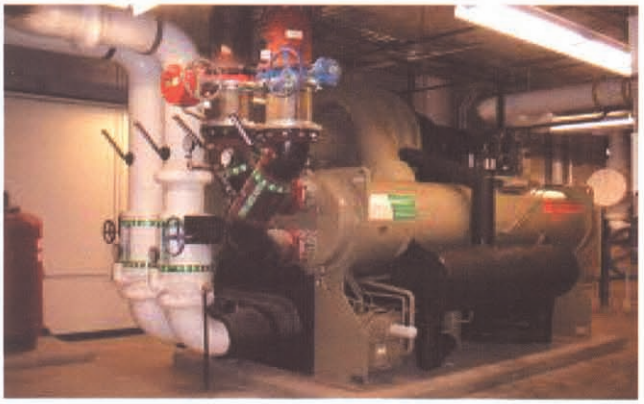

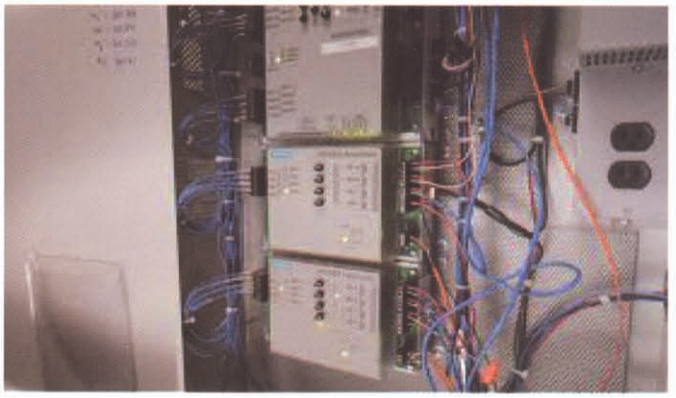

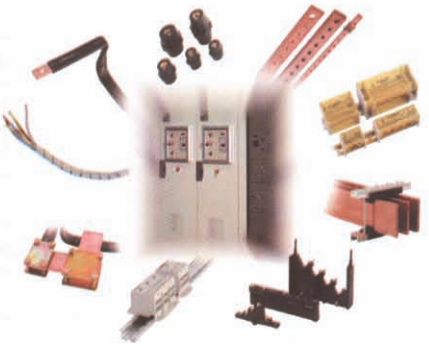

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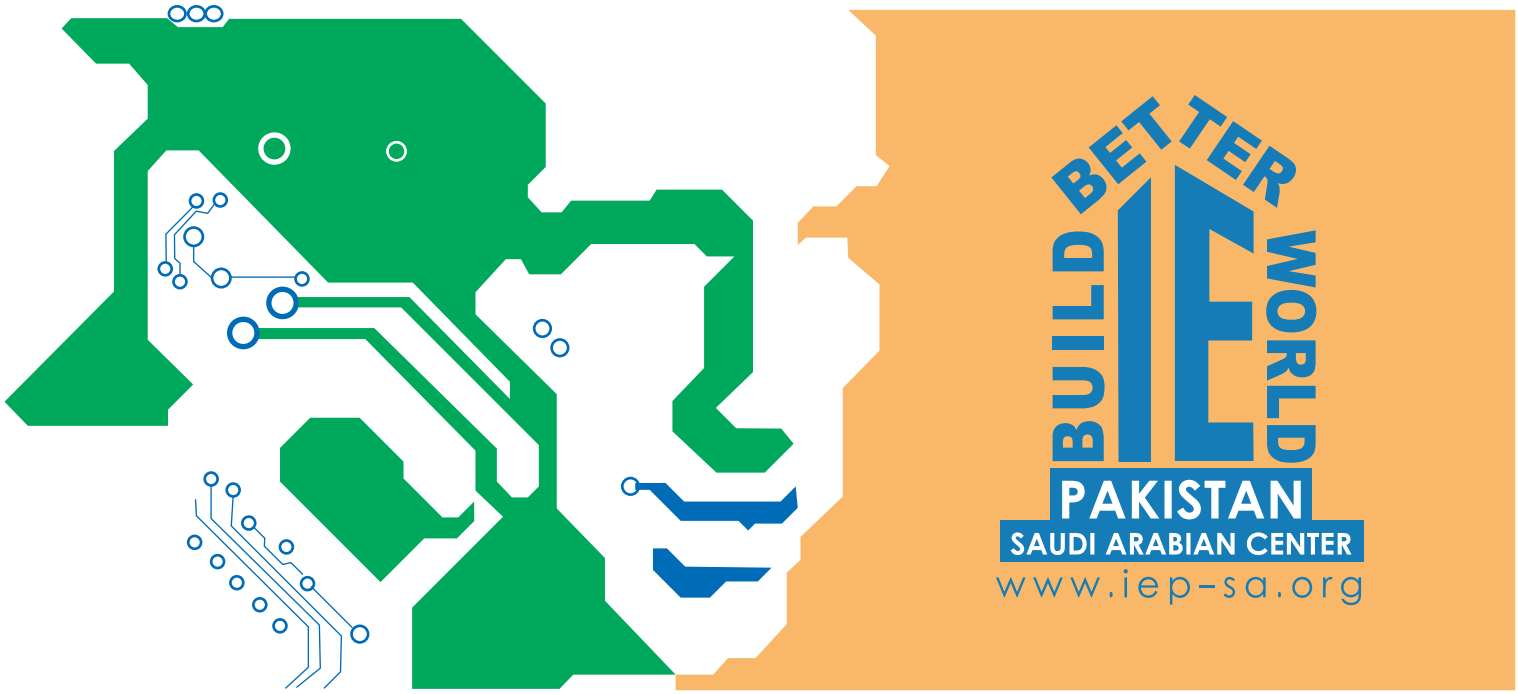

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Murphy's Laws

Murphy's Law ("If anything can go wrong, it will") was born at Edwards Air Force Base in 1949 at North Base. It was named after Capt. Edward A. Murphy, an engineer working on Air Force Project MX981, (a project) designed to see how much sudden deceleration a person can stand in a crash. One day, after finding that a transducer was wired wrong, he cursed the technician responsible and said, "If there is any way to do it wrong, he'll find it." The contractor's project manager kept a list of "laws" and added this one, which he called Murphy's Law.

1. Nothing is as easy as it looks.
2. Everything takes longer than you think.
3. Anything that can go wrong will go wrong.
4. If there is a possibility of several things going wrong, the one that will cause the most damage will be the one to go wrong.
5. If anything simply cannot go wrong, it will anyway.
6. If you perceive that there are four possible ways in which a procedure can go wrong, and circumvent these, then a fifth way, unprepared for, will promptly develop.
7. Left to themselves, things tend to go from bad to worse.
8. If everything seems to be going well, you have obviously overlooked something.
9. Nature always sides with the hidden flaw.
10. It is impossible to make anything foolproof because fools are so ingenious.
11. Whenever you set out to do something, something else must be done first.
12. Every solution breeds new problems.
13. The legibility of a copy is inversely proportional to its importance.
14. Things get worse under pressure.
15. Everything goes wrong all at once.
16. When there is a very long road upon which there is a one-way bridge placed at random, and there are only two cars on that road, it follows that: (1) the two cars are going in opposite directions, and (2) they will always meet at the bridge.
17. Matter will be damaged in direct proportion to its value

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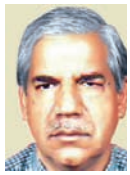

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FALLACY

A fallacy is a mistake in reasoning. Here are some examples of common fallacies:

Affirming the consequent

Inferring that P is true solely because Q is true and it is also true that if P is true, Q is true.

The problem with this type of reasoning is that it ignores the possibility that there are other conditions apart from P that might lead to Q. For example, if there is a traffic jam, a colleague may be late for work. But if we argue from his being late to there being a traffic jam, we are guilty of this fallacy - the colleague may be late due to a faulty alarm clock.

Of course, if we have evidence showing that P is the only or most likely condition that leads to Q, then we can infer that P is likely to be true without committing a fallacy.

Begging the question (petito principii)

In arguing for a claim, the claim itself is already assumed in the premise. Example: “God exists because this is what the Bible says, and the Bible is reliable because it is the word of God.”

Composition (opposite of division)

The whole is assumed to have the same properties as its parts. Anne might be humorous and fun-loving and an excellent person to invite to the party. The same might be true of Ben, Chris and David considered individually. But it does not follow that it will be a good idea to invite all of them to the party. Perhaps they hate each other and the party will be ruined.

Denying the antecedent

Inferring that Q is false just because if P is true, Q is also true, but P is false.

This fallacy is similar to the fallacy of affirming the consequent. Again the problem is that some alternative explanation or cause might be overlooked. Although P is false, some other condition might be sufficient to make Q true.

Example: If there is a traffic jam, a colleague may be late for work. But it is not right to argue in the light of a smooth traffic that the colleague will not be late. Again, his alarm clock may have stopped working.

Division (opposite of composition)

The parts of a whole is assumed to have the same properties of the whole. It is possible that, on a whole, a company is very effective, while some of its departments are not. It would be inappropriate to assume they all are.

Gambler’s fallacy

Assumption is made to take some independent statistics as dependent. The untrained mind tends to think that, e.g. if a fair coin is tossed five times and the results are all heads, then the next toss will more likely be a tail. It will not be, however. If the coin is fair, the result for each toss is completely independent of the others. Notice the fallacy hinges on the fact that the final result is not known. Had the final result been known already, the statistics would have been dependent.

Genetic fallacy

Thinking that because X dervies from Y, and Y has a certain property, X must have the same property also. Example: “His father is a criminal, so he must also be up to no good.”

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FIBONACCI NUMBERS

Fibonacci was known in his time and is still recognized today as the "greatest European mathematician of the middle ages." He was born in the 1170's and died in the 1240's and there is now a statue commemorating him located at the Leaning Tower end of the cemetery next to the Cathedral in Pisa. Fibonacci grew up with a North African education under the Moors and later travelled extensively around the Mediterranean coast. He then met with many merchants and learned of their systems of doing arithmetic. He soon realized the many advantages of the "Hindu-Arabic" system over all the others. He was one of the first people to introduce the Hindu-Arabic number system into Europe-the system we now use today- based of ten digits with its decimal point and a symbol for zero: 1 2 3 4 5 6 7 8 9. and 0.

The sequence, in which **each number is the sum of the two preceding numbers** is known as the **Fibonacci series:** 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, 610, 987, 1597, 2584, 4181, ... (each number is the sum of the previous two).

The ratio of successive pairs is so-called **golden section** (GS) - 1.618033989 . . . . . whose reciprocal is 0.618033989 . . . . . so that we have 1/GS = 1 + GS.

The **Fibonacci sequence,** generated by the rule f1 = f2 = 1 , fn+1 = fn + fn-1, is well known in many different areas of mathematics and science.

It is quite amazing that the Fibonacci number patterns occur so frequently in nature (flowers, shells, plants, leaves, to name a few) that this phenomenon appears to be one of the principal "laws of nature". Fibonacci sequences appear in biological settings, in two consecutive Fibonacci numbers, such as branching in trees, arrangement of leaves on a stem, the fruitlets of a pineapple, the flowering of artichoke, an uncurling fern and the arrangement of a pine cone. In addition, numerous claims of Fibonacci numbers or golden sections in nature are found in popular sources, e.g. relating to the breeding of rabbits, the spirals of shells, and the curve of waves The Fibonacci numbers are also found in the family tree of honeybees.

One example is the **number or arrangement of petals on a flower**. If we were to do so, we would find that the number of petals on a flower, that still has all of its petals intact and has not lost any, for many flowers is a Fibonacci number:

- 3 petals: lily, iris
- 5 petals: buttercup, wild rose, larkspur, columbine (aquilegia)
- 8 petals: delphiniums
- 13 petals: ragwort, corn marigold, cineraria,
- 21 petals: aster, black-eyed susan, chicory
- 34 petals: plantain, pyrethrum
- 55, 89 petals: michaelmas daisies, the asteraceae family

Some species are very precise about the number of petals they have - e.g. buttercups, but others have petals that are very near those above, with the average being a Fibonacci number.

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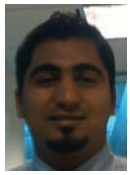

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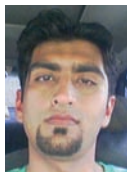

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Quaid-e-Azam (Muhammad Ali Jinnah) Quotes & Sayings.

"Come forward as servants of Islam, organise the people economically, socially, educationally and politically and I am sure that you will be a power that will be accepted by everybody."
Presidential Address at the All India Muslim League, Lahore
March 23, 1940

"I have always maintained that no nation can ever be worthy of its existence that cannot take its women along with the men. No struggle can ever succeed without women participating side by side with men. There are two powers in the world; one is the sword and the other is the pen. There is a great competition and rivalry between the two. There is a third power stronger than both, that of the women."
Speech at Islamia College for women
March 25, 1940

"The prosperity and advancement of a nation depend upon its intelligentsia, and Muslim India is looking forward to her young generation and education classes to give a bold lead for our guidance and a brilliant record of histrorical achievements and traditions. Islam expect every Muslim to do this duty, and if we realise our responsibility time will come soon when we shall justify ourselves worthy of a glorious past."
December 24, 1940

"No nation can rise to the height of glory unless your women are side by side with you. We are victims of evil customs. It is a crime against humanity that our women are shut up within the four walls of the houses as prisoners. There is no sanction anywhere for the deplorable condition in which our women have to live."
Speech at a meeting of the Muslim University Union, Aligarh
March 10, 1944

"Pakistan not only means freedom and independence but the Muslim Ideology which has to be preserved, which has come to us as a precious gift and treasure and which, we hope other will share with us"
Message to Frontier Muslim Students Federation
June 18, 1945

"Our object should be peace within, and peace without. We want to live peacefully and maintain cordial friendly relations with our immediate neighbors and with the world at large."
Lahore

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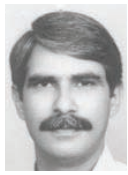

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Puzzle

Switch A turns lights 1 and 2 on/off or off/on

Switch B turns lights 2 and 4 on/off or off/on

Switch C turns lights 1 and 3 on/off or off/on

= ON

= OFF

Switches C, A and B are thrown in turn with the result that Figure 1 turns into Figure 2. Which switch does not work at all?

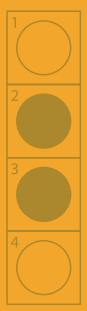

Figure 1

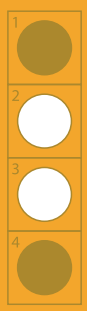

Figure 2

Answer: Switch A is faulty

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PUZZLES TO PUZZLE YOU

Q1: A family I know has several children. Each boy in this family has as many sisters as brothers but each girl has twice as many brothers as sisters. How many brothers and sisters are there?

Q2: Supposing a clock takes 7 seconds to strike 7, how long will the same clock take to strike 10 ?

Q3: There is a number which is very peculiar. This number is three times the sum of its digits Can you find the number ?

Q4: There is a number, the second digit of which is smaller than its first digit by 4, and if the number was divided by the digits' sum, the quotient would be 7. Can you find the number?

Q5: Two identical trains, at the equator start travelling round the world in opposite directions. They start together. run at the same speed and are on different tracks. Which train will wear out its wheel treads first?

Q6: The product of three consecutive numbers when divided by each of them in turn, the sum of the three quotients will be 74 What are the numbers ?

Answers

A1: Since the boys have as many brothers as sisters, there must be 1 boy more than the number of girls.
If we try 2 and 1, 3 and 2, and 4 and 3, we will find that 4 boys and 3 girls is the solution to fulfil the requirement that each girl has twice as many brothers as sisters.

A2: While striking 7, the clock strikes its first gong at 70' clock and it strikes 6 more at regular intervals. These 6 intervals take 7 seconds so that the intervals between gongs is 7/6 seconds. However, to strike 10 there are 9 intervals each taking 7/6 seconds, for a total of 10 ½ seconds.

A3: The number is 27,2 + 7 = 9, 9 x 3 =27

A4: The number is 84.

A5: Naturally, the train travelling against the spin of the earth. This train will wear out its wheels more quickly, because the centrifugal force is less on this train.

A6 : 4.5 and 6.

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Space to attach 2cm x 2cm photo

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Needed for the category of membership as stipulated in Clause 5.2 of Appendix-'B'. Use separate sheet
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7) For IEP-SAC office use only.

7.1) Recommendations of IEP-SAC liaison committee:

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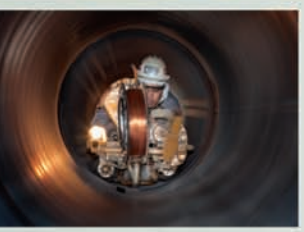

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