Unlocking the Potential of Renewable & Unconventional Sources of Energy in India

India Habitat Centre
Lodhi Road, New Delhi
August 11, 2018

A Seminar Organized by

EX-EXECUTIVES ONGC

Sponsored by

ओएनजीसी ONGC

ऑयल इंडिया लिमिटेड Oil India Limited
Conquering Newer Horizons

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Ex-ONGC Executives Welfare Association, New Delhi

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(भारत सरकार का उद्यम)
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A Tribute

To

Late S K Manglik

(April 2, 1937 – August 1, 2018)

Late Sushil Kumar Manglik, a doyen of modern energy industry and former CMD of ONGC left for heavenly abode on 1st August 2018 at the age of 81 years.

An alumni of Banaras Hindu University, Mr Manglik joined ONGC as a drilling assistant in 1958 and moved up to its highest position of the Chairman of Oil and Natural Gas Commission in 1993 and became the first Chairman & Managing Director of ONGC on 1st February 1994.

Mr. Manglik was instrumental in setting up India's first cryogenic LPG Plant in Uran and the first Gas Sweetening Plant in Hazira and bringing latest high-technologies in offshore operation enhancing production of oil and gas.

Though he superannuated on30th April 1995, he continued as a mentor to the Oil Industry. As a recognition of his immense contributions to the upstream hydrocarbon sector, hewas awarded the Life time Achievement Award by PETROTECH in 2009.

Mr. Manglik was steered our Ex- ONGC Executives Welfare Association initially as President and then continued as a Patron till the day of his life.

Mr. Manglikhas left indelible footprints for petroleum industry to follow.

---- Entire Family of Ex- ONGC Executives Welfare Association

Foreword

A K Hazarika
President
Ex-ONGC Executives Welfare Association

It gives me immense pleasure in greeting all the distinguished Guests, Invitees, Panelist, Chairpersons, Speakers, delegates and participants coming from various organisations to this Seminar, being organised on August 11, 2018, at IHC, Delhi. Last year at the same time precisely on 12th August 2017, our Ex-ONGC Executives Welfare Association had organised a Seminar on a theme 'E&P Strategies to cut oil import by 10% by 2022 'which was based on the directive of Hon'ble Prime Minister Sri Narendra Modi ji while addressing the audience in a conference of Energy Sector at Delhi in 2015. That Seminar was attended by eminent personalities of the Oil Industry shared their thoughts. Active participation by experts from ONGC, Oil India, OVL, Cairn, HOEC, DGH, Schlumberger, Mckinsey, PwC, and many others added value to the seminar.

After a daylong deliberations in that seminar it was realised that while the E&P companies are making their efforts to enhance oil and gas output from their respective areas of operation, but the demand of energy requirement of developing country like India cannot be met only by the effort of increasing the conventional sources of energy which is also very challenging from matured oil and gas fields of our country. India being a developing country the Energy demand is going to increase every year, as a result Oil import which is the major source of Energy continues to grow year after year. Therefore it become necessary to look forward to other Renewable sources of Energy like Solar, Wind Energy, Biomass, Small Hydro Power Etc. and also other unconventional source of energy such as CBM, Shale Gas, Underground Coal Gasification,Hydrate, Nuclear Energy etc. There has also been a lot of impetus given by the Government on development of these alternate and renewable sources of energy by providing various incentives. The GOI has set a target of generating 175 GW renewable Power installed capacity by 2022. This includes 60 GW from Wind Power, 100 GW from Solar Power, 10 GW from Biomass and 5 GW from small Hydro Power. India is the third biggest consumer of Energy behind China and USA with 5.6% of Total Energy Consumption by World during the Financial Year 2017-18. During the calendar year 2017, the Crude Oil consumption was 221 Mmt (29.34%) Natural Gas 46.6 Mtoe (6.18%), Coal 424 Mtoe (56.26%), Nuclear Energy 8.7Mtoe (1.15%), Hydro Power 30.7 Mtoe (4.075%) and Renewable Power from Solar, Wind, Biomass, Hydro etc. 21.8 Mtoe 2.89%. Total Energy consumption during the year 2017 was 753.7 Mtoe. If we look back on the figure of total Energy import during 2017 , Crude Oil 199MMt, LNG 25.7 Mtoe and Coal 130 Mtoe totalling to 355 Mtoe which is about 47% of total Primary Energy consumption of our country. This figure is also increasing year after year.

Our Association has, therefore, this time has chosen the theme of the Seminar, "Unlocking the Potentials of Renewable and Unconventional Sources of Energy in India "which is become very relevant at this point of time for our country. The deliberations at the Seminar are expected to crystalize an actionable plan to enhance the contributions of Renewable and Unconventional Sources of Energy towards the growth of Indian Economy in the coming years. I am very happy to say that in the Inaugural session of this Seminar will be graced by none other than former Cabinet secretary, Padma Bhutan Sri B. K. Chaturvedi, as Chief Guest, and as Key Note Speakers Sri Amitabh Kant, CEO of Niti Ayog, Sri G.C. Chaturvedi, Former Secretary Ministry of Petroleum and Natural Gas, Sri Anil Razdan, Former Secretary, Ministry of Power, Sri J.M.Mauskar, Former Special Secretary, Ministry of Environment and Forest. They are past and present Energy Policy maker of our Country. I am very grateful to all of them for accepting our request to deliver their thoughts as key note speaker in the Seminar. I am sure their thoughts on the Energy policy of the present and future of our country will set the tone for day long deliberation in the seminar and will be able to crystallise some actionable plan for meeting the objective of this seminar.

The souvenir published on this occasion contains thoughts of the eminent personalities in the Energy Industry. The articles which are very informative and analytical will add values to the theme of the Seminar.

I would like to place on record my sincere thanks on the behalf of the Association to ONGC, OIL, OVL and other companies for their continued support and encouragement to the Association in organising the Seminar and bringing out this Souvenir.
With best wishes for the success of the Seminar.

A K Hazarika

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EX-EXECUTIVES
ONGC

Message

Shashi Shanker
CMD, ONGC

I am delighted to know that Ex-ONGC Executives Welfare Association, Delhi is organizing a seminar with the theme "Unlocking the potential of Renewable and Unconventional Sources of Energy in India" and is releasing a souvenir on the occasion. The theme of the seminar is very apt and likely to throw many new ideas going forward for the Company as well as for the Country.

India has now attained global 4th and 6th position is global Wind and Solar Power installed capacity. It is a known fact that several steps have been taken to fructify Prime Minister Shri Narendra Modi's dream of a clean energy future for the ' New India'. The government is aiming to increase share of clean energy through massive thrust in renewables. Core drivers for development and deployment of new and renewable energy in India have been Energy security, Energy Access, Climate change etc. Various policy measures have been initiated for achieving the target of renewable energy capacity to 175 GW by the year 2022.

ONGC also has a small portfolio of renewables and unconventional. As an integrated energy company, ONGC is also committed to increasing its share of greener forms of alternate energy. We already have two wind farms operational- one 51 MW in Gujarat and the other 102 MW Rajasthan. On the Solar front, We have an installed capacity of 12 MW and few solar projects and under execution which will take the icapacity to 25 MW by end of this fiscal. ONGC Energy Centre has also taken up many R&D projects in the field of unconventional which are in various stages of research.
It gives me immense joy to witness the continued spirit of ONGCians even beyond their active association with ONGC. The way the continue to believe in and promote the company's activities and values, it makes us proud to be a part of this great family.

I convey my best wishes to the 'Ex-ONGC Executives Welfare Association', Delhi for their success in all their endeavors.

Shashi Shanker

Message

Utpal Bora
CMD, Oil India Ltd.

I am happy to learn that the Ex-ONGC Executive Welfare Association (EOEWA), Delhi, is holding a seminar with the theme 'Unlocking Potentials of Renewable and Unconventional Source of Energy in India' at NEW Delhi, on 11th August 2018.

As India makes rapid strides in economic development, the energy demand of the country continues to rise. Despite accelerated exploration and development for fossil fuel in the country particularly by the national companies, current demand for hydrocarbon and coal is more than the domestic production. As alternatives to fossil fuels increase in proportion across the global they are forecasted to play a larger role in the energy demand and to enhance the security and diversity of energy supplies.

The seminar will promote and disseminate knowledge on the various topics and technologies of renewable energy system particularly with reference to India. The experience and expertise of industry leaders, eminent bureaucrats, senior executives and retired officers will be one of the key features in the deliberations.

My compliments to EOEWA Delhi, which comprises of retired executives who over the years have conributed significantly to the growth of ONGC as well as the country's energy sector, in their endeavor and am confident that the event will witness very productive interaction and exchange of ideas.

I wish the seminar all the success.

Utpal Bora

Message

N K Verma
MD OVL.

The restructuring witnessed in the Oil & Gas industry subsequent to the prolonged and sustained fall of oil prices was not just about cost optimization and process re-engineering, it was a profound strategic restructuring at the industry level, and has fundamentally altered the way the industry will approach the business going forward. A disruptive component of this strategic change in mindset has been the advent of renewable, which has grown from an abstract concept, to a largely irrelevant marginal player, and now to a looming existential threat that can significantly alter the landscape and traditional business as we knew it, all in a space of three years .And this disruptive growth has forced traditional oil and gas producers, long inured to the peak oil mindset, to rethink their core business, as chasing not the hydrocarbon molecule along its entire value chain, but actually the energy molecule .

This changing paradigm is forcing us oil industry veterans to confront these fundamental disruptions in established ideologies. We live in a world where on one hand a Scandinavian counterpart has changed its name so as to remove all references to oil, where nations sign a COP 21 agreement agreeing to cap temperature rise to 2 degrees centigrade, where hitherto unheard of terms such as peak demand, unburnable carbon, stranded assets and green financing make their away into our lexicon. However, on the other hand, all ground parameters indicate the dominance of oil & gas as a primary energy source for several decades.

It is indeed commendable that the stalwarts of this great organization of ours, through EOEWA, have chosen to recognize this existential crisis that faces our industry today, and decided to organize a seminar on “Unlocking the Potential of Renewable and Unconventional Sources of Energy in India”. I hope the seminar will kick off a much-needed brainstorming exercise among the most seasoned veterans of the industry, and systemic policy interventions and tangible value drivers will emanate from such discussions, providing the government and the industry defined lampposts to turn this bewildering change into a sustainable opportunity.
I wish the seminar all success.

N K Verma

Message

B C Bora
Former CMD, ONGC

It is nice that Ex-ONGC Executives Welfare Association, Delhi is organizing a seminar in New Delhi on 11th August 2018 on the topic, Unlocking the potentials of Renewable and Unconventional Resources of Energy in India. With the accelerating growth of our economy and the consequent improvements in the standard of living of our people, the increasing energy requirements of the country are facing the challenges of constant, if not depleting, supplies and resources of conventional energy from indigenous sources. As a result, we have to take urgent measures to optimally tap the renewable and unconventional energy resources of the country. At the same time, looking at the wanton havocs very often created today by freak weather, air and water pollution in our country as well as in many others as a consequence of climate change and global warming, it will be absolutely necessary to exploit these resources in a socially and environmentally sustainable manner. I am sure these and many other issues will be discussed at the seminar and a road map for the future will be identified.

I convey my best wishes to the organizers and the participants for a very successful seminar and rewarding experience.

Bikash C Bora

Message

R S Sharma
Former CMD, ONGC

I am delighted that Ex-ONGC Executives Welfare Association Delhi is organizing a Seminar on "Unlocking the Potentials of Renewable and Unconventional Resources of Energy in India" on 11 Aug-18 at Habitat Center New Delhi.

I feel the theme of the Seminar is extremely topical to contribute towards energy security for our nation. The GOI has embarked upon a highly ambitious target to lead the economy towards double digit growth. A large number of initiatives have been taken in this direction. As it is, India is currently witnessing the highest GDP growth amongst major economies of the world. It becomes the cardinal responsibility of the every citizen to add value to this unique Govt initiative, in whatever form they can.

We all realize that energy is the prime mover for all economic activities. Currently India's per head primarily energy consumption is less than 1/3rd of the global average. Despite a call given by the Hon'ble Prime Minister in 2015 to reduce import dependence on crude oil by 10 % by 2022, our import dependencehas been steadily moving up from 78% in 2015 to 82% in the last fiscal. Likewise, despite a call to make India a Gas based economy, the contribution of natural gas in the primary energy basket has shrunk from 11% in 2009-10 to 6.5% in last fiscal. Imported gas in the form of LNG has been constantly going up reaching as high as close to 50% last year.

Hence, the expectation from Hydrocarbon Industry is to increase domestic production of all forms of energy. Currently renewables and unconventional resources of energy are contributing just about 6-7% of the primary energy basket. But we know the potential is huge. Solar power has already proven results much higher than the targeted levels, with constantly declining cost of production and power tariff. Wind power is yet to show similar results though it has the potential. Likewise unconventional hydrocarbon resources in the form of CBM, coal gasification & gas hydrates have huge potential. Technology driven IOR/EOR to improve the recovery factor in the ageing producing fields to global levels shall be a major achievement in this direction.

The subjects for discussions in the daylong Seminar on 11 Aug is quite interesting. The eminent Panelists and Keynote Speakers as per the program structure are of high caliber to contribute towards vibrant deliberations at the Seminar.

I am excitedly looking forward to join the Seminar and also participate in the Veterans Panel discussions to make my own contribution for the cause.

I wish the Seminar a grand success. I am sure the organizers would list out key takeaways from the Seminar and submit the same to the policy makers for due consideration.

With best wishes,
R S Sharma

Message

D K Sarraf
Former CMD, ONGC

I am immensely glad to know that Ex-ONGC Executive Welfare Association, New Delhi (EOEWA) is conducting a Technical seminar on **"Unlocking the Potential of Renewable and Unconventional Sources of Energy in India"** on 11th August, 2018. This seminar is the second in the series- the first was held in August, 2017 on the E&P strategy to cut hydrocarbon imports. I must compliment the Team EOEWA in organizing and organizing every year such quality seminars, and on their choice of the themes of these seminars. Theme of this year's seminar is very appropriate at a time when we deliberate on energy alternatives available to us. The choice of speakers as well as topics of discussion is excellent. Further, the initiative to document the thoughts a publication is laudable.

I am sure that at the end of the Seminar, the resultant collective wisdom would be of value to the Nation.

I wish the Seminar a great success.

Dinesh K Sarraf

Message

Sudhir Mathur
CEO, Cairn Oil and Gas

The Ex-ONGC Executives Welfare Association's Annual Seminar is a great initiative to bring together industry leaders to deliberate on the oil and gas sector.

Just as in last year, this year's theme "Unlocking the potential of Renewable & Unconventional sources of energy in India" is topical and relevant.

The Seminar provides an excellent platform to discuss new ideas and technologies in the unconventional energy sector, as these will play a pivotal role in enhancing India's hydrocarbon production. I convey my best wishes for the success of the Seminar.

Sudhir Mathur

Message

Dr Jauhari Lal
Former President Ex-ONGC Executive Welfare Association, New Delhi

This is to compliment Shri A. K. Hazarida, President, Shri Ashok Varma, Vice Presidents, Shri Kanchan Kumar General Secretary and all other office bearers of Ex-ONGC Executives Welfare Association, New Delhi for organizing timely the Seminar on 'Unlocking Potential of Renewal and Unconventional Sources of Energy in India' on 11th August, 2018. This is the second such a seminar being organized by the Association in big way in Delhi. I also note that the distinguished past and present captains of the Industry will be participating in the Seminar and thus expect a high level of deliberations.

Some of the advantages of such Seminar, are the across the industry there is opportunity of ex-changing views and reaching out to some conscientious to finding possible solutions to the issues confronting OIL and Gas Industry on one hand, stake holders and Govt. on the other. It is not always feasible by the companies to communicate to Govt. one some sensitive issues but the Association can communicate to Govt. the conclusions reached out in such seminars without any fear.

The seminar is also timely because the last few months, prices of crude oil had been climbing up. Earlier, the Govt. was in very cozy cushion when the crude oil prices were low. Now it appears that as in the past, the Annual budget of the Govt. Will greatly be impacted by the OIL price trend. It is therefore, necessary to find out ways and means to increase production on the hand reduce dependence on conventional sources of energy. OIL and Gas Industry and Govt. had been making efforts to combat this situation and the Govt. in the past formulated new policies such as HELP, OLAP etc.

Despite the positive moves to open up and liberalize exploration opportunities in india, it is likely that the new policy will have a small impact on India's oil and gas supply and demand balance. India's modest oil and gas production currently stand at 878,000 barrels per day of oil and 1,030 million cubic feet of natural gas. India is dependent on imports to meet its hydrocarbon needs, with around 80 percent of its oil needs met through imports. The existing oil fields have matured, and production at these fields has either plateaued or begun to decline. The India government's aim is to reduce its import dependence by 10 percent. domestic needs that can be met by any new production will only be a fraction of India's consumption needs, as India's resource base limits the potentioal for domestic production. Increasing domestic supply is but one part of a broader startegy to manage impost dependence issues, which also includes the buildup of strategic petroleum reserves and investment in upstream assest overseas. Hence, intellectual discussion on ground level on unlocking the renewal and unconventional energy is very timely.

Once again I compliment the team of Association and send my best wishes to the success of well-planned Seminar.

Dr Jauhari Lal

PROGRAM

Habitat Centre, Lodhi Road, New Delhi

August 11, 2018

09:00 – 09:25	Registration & Tea
09:20 – 09:30	Welcome of guests, lighting of lamp
09:30 – 11:00	Inaugural session
09:30 – 09:35	Welcome Address–Shri AK Hazarika, President, EOEWA
09:35 – 09:50	Key Note Address: Shri Amitabh Kant, IAS, CEO, NITI Ayog
09:50 – 10:05	Key Note Address: Shri GC Chaturvedi, IAS (Retd.), Former Secretary, Government of India
10:05 – 10:20	Key Note Address: Shri JM Mauskar, IAS (Retd.), Former Secretary, Government of India
10:20 – 10:35	Key Note Address: Shri Anil Razdan, IAS (Retd.) Former Secretary, Government of India
10:35 – 10:50	Inaugural Address: Shri BK Chaturvedi, (IAS Retd.), Padmabushan, Former Cabinet Secretary, Govt. Of India
10:50 – 11:00	Questions and Answers
1100 – 1130	**Tea**
11:30 – 12:15	CEO Panel: Shri Utpal Bora, CMD OIL, Shri NK Verma, MD OVL, Shri Shashi Shanker, CMD ONGC
12:15 –12:30	Questions and Answers
12:15 – 13:00	Technical Session-1 – Session Chair Shri Anil Razdan, IAS ONGC
12:15 – 12:30	Energy Efficiency :Shri Saurabh Kumar, MD EESL
12:30 – 12:45	Questions and Answers
12:45 – 13:45	**Lunch**
13:45 – 14:45	Technical Session-2 – Session Chair Shri Biswajit Roy, Director (HR and BD) OIL
13:45 – 14:00	Wind power: Shri Tulsi Tanti, CMD Suzlon wind Energy Corporation
14:00 – 14:15	Solar Power: Shri Sumant Sinha, CMD Renew Power
14:15 – 14:30	Natural Gas Hydrates Shri Pushpendra Kumar, Former GGM, ONGC
14:30 – 14:45	Questions and Answers
14:45 – 15:00	**Tea**
15:00 – 15:40	Technical Session-3 – Session Chair Shri SK Moitra, Director (Onshore)
15:00 – 15:10	Shri Vilas Tawde, Essar,
15:10 – 15:20	Shri Sudhir Jain, VP Reliance, ADAG
15:20 – 15:30	Shri Ravi Kumar Prekki, RIL
15:30 – 15:40	Questions and Answers
15:40 – 16:40	Veterans Panel: Shri BC Bora, Former CMD, ONGC, (Session Chair), Shri RS Sharma, Former CMD, ONGC, Shri SK Shrivastava, Former DGH and Former CMD,OIL, Shri RS Butola, Former MD, OVL & CMD, IOC Shri DK Sarraf, Chairman, PNGRB and Former CMD ONGC, Shri Atul Chandra, Former MD (OVL)
16:40 – 16:50	Questions and Answers
17:00 – 17:05	Vote of Thanks by Shri Ashok Varma, Vice President, EOEWA
17:05 – 17:15	Group Photograph

Session Speakers & Panelists

OUR ESTEEMED SPEAKERS

B K Chaturvedi
IAS, Padmabushan
Former Cabinet
Secretary, Govt.of India

GC Chaturvedi
IAS
Chairman, ICICI Bank
Former Secretary
Govt. of India

Anil Razdan
IAS
Former Secretary
Govt. of India

J M Mauskar
IAS
Former Secretary
Govt of India

Amitabh Kant
IAS, CEO
NitiAyog

Shashi Shanker
CMD, ONGC Ltd.

Utpal Bora
CMD, Oil India Ltd.

NK Verma
MD, ONGC Videsh Ltd

Saurabh Kumar
MD, EESL

Sumant Sinha
CMD, ReNew Power

Vilas Tawde
CEO, Essar CBM

Pushpendra Kumar
Former GGM
ONGC Ltd.

Sudhir Jain
Vice President
Reliance ADAG

VETERAN PANELISTS

B C Bora
Former CMD
ONGC Ltd

R S Sharma
Former CMD
ONGC Ltd.

R S Butola
Former CMD
IOC

AK Hazarika
Former Director
(Onshore), ONGC Ltd.,
President EOEWA

Atul Chandra
Former MD
ONGC Videsh Ltd.

S K Shrivastava
Former DG of
Hydrocarbons

D K Sarraf
Chairman, PNGRB,
Former Chairman,
ONGC Ltd.

Profiles of Speakers and Panelists

B.K. Chaturvedi

Shri B.K. Chaturvedi is a Former Cabinet Secretary, Government of India. He has served also as a Member, Planning Commission and a Member, Thirteenth Finance Commission He was awarded Padma Bhashan for his contributions to the civil services in 2010.

Shri Chaturvedi's experience is both rich, multifaceted and includes both Government and corporate world. He has been Secretary to the Government of India in several Ministries, including Finance, Human Resource Development (which includes Higher Education, Technical Education and Elementary Education) and Petroleum and Natural Gas for more than six years. The various assignments held by him in the Union Government include Chairman and Managing Director, State Trading Corporation of India and Executive Director, Trade Development Authority of India. He has been a member of the Boards of several Public Sector Undertakings, including MMTC Limited, Life Insurance Corporation of India, General Insurance Corporation of India and State Electricity Board of Uttar Pradesh. As Cabinet Secretary, he was also Member of the India's Atomic Energy Commission and Space Commission.

Shri Chaturvedi had a major policy-making role in initiating and building economic reform measures in several sectors. These include opening up of the Insurance Sector by Government of India, approval of policy for setting up of the Insurance Regulator, the passage of IRDA legislation and handling of its impact on LIC, GIC and other State insurance companies. Other segment of reforms related to dismantling of the Administered Pricing Mechanism regime under the Ministry of Petroleum and Natural Gas and Power Sector reforms in Government of Uttar Pradesh.

He holds a Masters Degree in Physics from Allahabad University, with specialization in Electronics. He started his career as an Associate Professor of Physics (1962-65) at the Motilal Nehru Regional Engineering College, Allahabad. Subsequently, he studied Public Administration from Manchester University, U.K. (1978).

Shri Chaturvedi has travelled very extensively overseas for international negotiations. He has represented Government of India on the Boards of UNICEF and UNDP, New York. He has published several research papers on public administration and governance.

Anil Razdan

Mr Anil Razdan is former Secretary Power and Special Secretary / Additional Secretary, Petroleum and Natural Gas to the Government of India. He has worked as Joint Secretary Power, Director Energy Management Centre (now Bureau of Energy Efficiency) and Director/Joint Secretary Atomic Energy, Government of India. He was Principal Secretary to the Government of Haryana in the Irrigation, Power, and Public Works Departments, besides Chairman Haryana Power Generation Corporation, Chief Administrator Haryana Urban Development Authority and Director Town and Country Planning, Director School Education, Director Public Relations (Information) and Tourism and Press Secretary to Chief Minister Haryana.
Mr Razdan has been Chairman-cum-Managing Director o f North East Electric Power Corporation, and a Board Member of Oil and Natural Gas Corporation, Gas Authority of India, Indian Oil, Powergrid, National Hydroelectric Power Corporation, Rural Electrification Corporation, Power Finance Corporation, Bhakra Beas Management Board, Haryana State Electricity Board, Tala Hydro Power Authority Bhutan, Bharat Electronics Ltd., Hindustan Petroleum Corporation and various other Corporations.

He initiated the 50, 000 MW initiative on Hydro Power 2003, and was instrumental in ensuring start up capacity addition of nearly 60, 000 MW between 2007 and 2009 in India. A National Science Talent Scholar alumnus of St. Stephen's College Delhi University in Physics, a University and National Merit Scholar in Law from Law Faculty, Delhi University, he is a recipient of HiralalDaga Gold Medal in Law.

Mr Razdan has also been a Visiting Fellow at the University of Oxford for Energy and Sustainable Development: Global & Indian Perspectives. He represented India at various international energy fora like IEA and CSLF. He chaired a global study on Energy for Megacities by the World Energy Council, and is Scientific Consultant for Energy Technologies to the Office of the Principal Scientific Adviser to Government of India and Independent Director, Power Trading Corporation of India, Minerals and Metals Trading Corporation. He is Chairman, Energy and Environment Foundation and Centre for Smart Grid Collaborative Research & Development, Chairman CEO Forum on DSM Shakti Foundation, Chairman Power Group India Energy Forum, Chairman National Expert Committee on Energy Indian Chamber of Commerce, Chair of India Energy Summit, Chair of Expert Appraisal Committee of Ministry of Environment and Forests GoI for Infrastructure and Coastal Projects, and member of the Permanent Monitoring Panel on Energy of the World Federa-

tion of Scientists, Erice, Italy. Leading Energy Personality Award, India Power Awards 2012 he is an eminent and sought after international energy expert, writer and consultant.

J M Mauskar

Mr. J M Mauskar is former Secretary, Government Of India. Spending more than 34 years as a Public Servant as an officer of the Indian Administrative Service he has had 'hands on' experience of International Trade, Investment Promotion, Overseas Investments, International Contracts, Dynamics of Petroleum Sector and Environmental issues, especially Climate Change. He has been closely associated with major policy and regulatory initiatives in the domain of trade, energy and environment for more than 15 years by virtue of his having occupied key positions in the Ministries of Commerce, Petroleum & Natural Gas and Environment & Forests. He has also been Chairman, Central Pollution Control Board. He has spent over five years as Director on the Board of major Public Sector Undertakings such as ONGC, OVL and OIL. Following his retirement he was associated with climate change negotiations and was a member of several Central Government Committees. He is Permanent Invitee to the Governing Council of the Indian Institute of Tropical Meteorology (IITM), Pune, under the Ministry of Earth Sciences, for the period 2012-2017.

Amitabh Kant

Mr. Amitabh Kant is presently CEO of National Institution for Transforming India (NITI). He is a member of the Indian Administrative Service, IAS (Kerala Cadre: 1980 batch). He is the author of Branding India - An Incredible Story. Mr. Kant has been a key driver of the "Make in India", Startup India, "Incredible India" and God's Own Country" initiatives that positioned India and Kerala State as leading manufacturing and tourism destinations. These campaigns have won several international awards and embraced a host of activities – infrastructure development, product enhancement, private-public partnership and positioning and branding based on extensive market research. Mr. Kant also conceptualized the "Atithi Devo Bhavah" – "Guest is God" campaign to train Taxi Drivers, Guides, immigration officials and make them stake holders in the tourism development process. Mr. Amitabh Kant was also the National Project Director of the Rural Tourism Project of UNDP which made a paradigm shift in spreading tourism to Indian villages which had core-competency in handicrafts, handloom and culture. In his capacity as Secretary (Industries) Govt. of India, Mr. Kant drove the Ease of Doing Business initiative and ranking of States on outcome parameters. He is the Chairman of the Committee to implement Digital Payment in India. Mr. Kant has been the recipient of Economic Time Policy Change Agent of the Year Award, the Bloomberg TV Personality of the year Award, the NDTV Administrator of the year Award and the Distinguished Fellowship of the Institute of Directors. He is the recipient of One Globe Award-2016 for leadership in Transforming Governance for the 21st Century. He is a Member of the Steering Board of "Shaping the Future of Production Systems" of World Economic Forum. He is also the recipient of Sir Edmund Hillary Fellowship award by the Prime Minister of New Zealand. He is also the recipient of Golden Peacock Award for leadership in Economic Transformation - 2017.

Mr. Amitabh Kant has worked as CMD – ITDC, Joint Secretary – Ministry of Tourism, Government of India, Secretary – Tourism, Government of Kerala, Managing Director, Kerala State Industrial Development Corporation, District Collector, Kozikhode and Managing Director, Matsyafed. During his tenure in Kerala, he structured the Calicut Airport as a private sector project based on User's Free and developed the BSES Power Project and Mattanchery Bridge under Private Public Partnership. He was also responsible for introducing new technology (fiberglass crafts and outboard motor) in the fisheries sector and launching beach level auctions which substantially enhanced returns to traditional fishermen.

Mr. Amitabh Kant did his schooling from Modern School, Delhi, graduation in Economics (Hons) from St. Stephens, Delhi University and M.A from Jawaharlal Nehru University. He is a Chevening Scholar.

Shashi Shanker

Mr Shashi Shanker is CMD, ONGC since October 2017. Prior to this, he was (T&FS) ONGC since 2012. Mr Shanker is an industry veteran with over 30 years of experience in diverse E&P activities.

He has progressed through senior management roles in various work-centers including Institute of Drilling Technology, Dehradun; West Bengal Project; Assam Project and Deep Water group at Mumbai. He was acclaimed for his performance in spearheading the deep/ultra-deep water campaign of ONGC which was christened 'SagarSamriddhi'.

Under his leadership, ONGC drilled the deepest deep-water well covering a water depth of 3174m, a world record. He also led the team to one of the finest Drilling performance in FY'17 when ONGC set a new record of drilling over 500 wells in 2016-17. This is the first time in 23 years that ONGC has crossed the 500-well mark.

Under his guidance, the Company has led the delivery of cutting-edge IT solutions that drive growth, streamline performance and promote efficiency. He has provided much needed support for effective use of ERP and SCADA platform for real time information. During his tenure, ONGC has conceptualized an ambitious companywide project called "DISHA" for creation of a paperless office platform, the implementation of which is now underway.
Shri Shanker is also the Director (In-charge) for ONGC Tripura Pow-

er Company (OTPC) and North East Transmission Company Ltd (NETC) besides being on the Board of ONGC Videsh. He is also the Director (In-charge) and Member of the High Powered Steering Committee for Government's flagship initiative 'Make-in-India'. He is a Petroleum Engineer from Indian School of Mines (ISM), Dhanbad. He also holds an MBA degree with specialisation in Finance. He has also received executive education from prestigious Indian Institute of Management, Lucknow and Indian School of Business, Hyderabad.

Utpal Bora

Mr. Utpal Bora is Chairman and Managing Director of Oil India Limited (OIL), India's second largest National Exploration & Production Company, since 18th July 2016.

Mr Bora has a rich and varied experience of over 33 years in the E&P Sector. He served in various capacities at ONGC Ltd. including OVL, the international branch of ONGC in activities related to artificial lift, well completion, testing, well control, reservoir management, crude transportation/quality assurance for refinery receipt, work over operations of onshore and offshore fields, planning, technical cell and at OVL he was specifically engaged in framing of policy directives and its implementation, co-ordination with national oil company of Venezuela, PDVSA under projects like Petrocarabobo and San Cristobal.

His latest assignment was as Executive Director- Asset Manager of ONGC's Mehsana Asset. Mr. Bora took over as Asset Manager, Mehsana on 1st October, 2014, which is the highest Onshore producing Asset of ONGC Ltd, where he was leading a team of about 2300 engineers and technicians to sustain production from brown fields with about 1800 operating wells, 07 drilling & 20 work over rigs, about 80 exploratory and development wells drilled per year and 38 surface installations. As Asset Manager he also oversaw Finance, Material Management, HR, CSR and coordination with statutory bodies and the Government of Gujarat. He is credited with turning around ONGC's highest producing onshore Asset and steering it towards newer heights. Under his leadership the Mehsana Asset received the Best Onshore Award of ONGC last year.

On the educational front, Mr. Utpal Bora holds the degree of Bachelor of Technology in Petroleum Engineering from the prestigious ISM, Dhanbad, an Advanced Management Certificate from IIM, Lucknow and has completed a Leadership Development Programme from ISB, Hyderabad.

Narendra K Verma

Mr. Narendra K Verma has taken charge at ONGC Videsh as its Managing Director today. Mr. Verma has been Director (Exploration) of the Maharatna ONGC since April 1, 2013 after having a long illustrious career spanning more than three decades with the oil major.

Prior to joining the Board of Directors of ONGC, he was the Director (Exploration) for ONGC Videsh Limited. At OVL, Mr. Verma was responsible for the growth strategy and business development at OVL with several high value acquisitions in last one year. He joined ONGC in 1980 and has been associated extensively with exploration and development related activities in a number of Indian and foreign basins. As an exploration geologist he has conceptualized exploration projects in a wide variety of basins including deep waters resulting in reserve accretion and evaluation of hydrocarbon potential.

Presently, he is also the Chairman of OTBL a joint venture company of ONGC and TERI which is in the business of bio-remediation. He has also been recently elected as Vice Chair & Member of Expert Group on Research Classification in United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009).

Mr. Verma obtained his M.Sc. in Applied Geology from Lucknow University and an M.Tech degree in Petroleum Exploration from Indian School of Mines, Dhanbad in 1986. Mr. Verma also holds a Masters in Business Administration in Finance. An accomplished geologist and manager, Mr. Verma is recipient of prestigious 'National Mineral Award', the highest recognition by the Government of India in the field of geosciences, mining and allied areas, for his outstanding contribution to Petroleum Exploration in Mumbai Offshore. He has also published more than 20 technical papers and over 40 technical reports.

R S Sharma

Mr. R S Sharma is the former Chairman and Managing Director of India's premier national oil company- Oil and Natural Gas Corporation Ltd (ONGC). He was also concurrently the Chairman of ONGC Videsh Ltd (OVL), Mangalore Refinery & Petrochemicals Ltd (MRPL) and five other ONGC Group companies during 56 month period May-06 to Jan-11. Earlier he was Director (Finance) of ONGC from March 02 to Dec 07.

Mr. Sharma was intensely associated with various industry associations and federations in responsible capacities during his tenure as CMD ONGC. Post superannuation, he has been on the Boards of various companies, besides Chairman Quality Review Board of the Institute of Cost Accountants of India for four years. He was also Chairman of Expert Committee for review of Maintenance of Cost Records & Cost Audit Rules, and member of Kelkar Committee for Roadmap for enhancing domestic production of Oil & Gas and sustainable reduction in import dependency by 2030.

He continues to hold the position of Chairman-FICCI Hydrocarbon Committee. Currently, he is Senior Advisor to Mckinsey & Co.

Ajit Kumar Hazarika

Shri Ajit Kumar Hazarika is Former Director (Onshore) ONGC Board. He continued as Director of ONGC Board for nearly 8 years and in between he had additional charge of Chairman and Managing Director for 8 months from February, 2011 to October, 2011.

He joined ONGC as Graduate Trainee in 1975 and after successful training of one year joined as Class I Executive Officer in March, 1977. He got initial posting at Assam Asset as Cementing Engineering and in due course of time, due to mere hard work and performance he was promoted to different levels and main highlight of his career growth was double promotion from the level of GM (Drilling) to Executive Director from 1.1.2003 when he was posted at Mumbai and was Head of Multidisciplinary Team (MDT) of Mumbai High Redevelopment Project, one of the most prestigious project of ONGC. Leading from the front as MDT Head he took several innovative decision, out of box thinking to reduce cost of the project and at the same time improved production of Oil & Gas, made many unviable sub-project viable. He served in Assam, Chennai, Mumbai Offshore and Delhi. Presently, working as Independent Consultant to Oil & Gas companies.

Shri Hazarika is a First Class Mechanical Engineering Graduate from Assam Engineering College, Guwahati, Assam.

Saurabh Kumar

Saurabh Kumar is the Managing Director of EESL since 2013. He is an Electrical Engineer from Indian Institute of Technology (IIT) Kanpur and Masters in Public Policy from National Graduate Institute of Policy Studies, Tokyo, Japan.

Mr. Saurabh Kumar is an Indian Revenue Service officer of 1992 batch. Mr. Saurabh Kumar has worked in various capacities in Income Tax Department, Ministry of Power, and Bureau of Energy Efficiency (BEE). He was Secretary, BEE during 2007-2010. He also handled environmental issues in Asia – Pacific region while on a UN Deputation to Bangkok.

Sumant Sinha

Sumant Sinha, aged 53 years, is the Chairman and Managing Director of ReNew Power. He holds a bachelor's degree in civil engineering from the Indian Institute of Technology, Delhi, a post-graduate diploma in management from the Indian Institute of Management, Calcutta and a master's degree in International Affairs from the Columbia University. He is also a CFA charterholder and a member of the Institute. He worked as an investment banker in the United States and the United Kingdom at Citicorp Securities and ING Barings Services Limited, respectively, before returning to India as Senior President, Finance, of the Aditya Birla Group and subsequently as the Chief Executive Officer of Aditya Birla Retail. Subsequent to this, he joined Suzlon in 2008 and served as the Chief Operating Officer until 2010.

In 2017, he held the office of Chairman of the Confederation of Indian Industry (CII) – Northern Region and has previously been the Chairman of CII's Renewable Energy Committee as well as CII's Solar Task Force. He is also on the Advisory Board of Columbia University's School of International and Public Affairs. He has recently been appointed to the Board of Governors of the Indian Institute of Management, Calcutta and the Indian Institute of Management, Sirmaur. He has won many awards including the "EY Entrepreneur of the Year, 2017" in the Energy, Real Estate and Infrastructure category. He was recognized as the "Industry Crusader" at Renewable Energy India Awards 2017 as well as the "Torch Bearer of the Year" at the India Solar Week Leadership Awards 2017. He was also the recipient of the prestigious "Renewable Energy Leader of the Year" award at the National Awards for Excellence in Renewable Energy in July 2015 and the "Global Excellence Award – 2015 in Renewable Energy" by the Energy and Environment Foundation in August 2015.

Ravi Kumar Prekki

Mr. Ravi Kumar Prekki is Business Unit head of RIL's Coal bed methane business with responsibility of end to end delivery of Land, project, Ops and other business functions. He is an experienced business professional with 25+ years of experience in the E&P, Refining &petrochemical industry. He is a Director on Board of RGPL - RIL's 100% subsidiary company. He has a B. Tech from NagarjunaUniversity and has attended Advance Management Program ai IIM, Bangalore.

Sudhir Jain

Sudhir Jain with 34 years of experience in Exploration & Production in both conventional & unconventional hydrocarbons started his professional journey as Geologist. He worked in areas of Well site Operations, Geological Assessment, Exploration Strategy Formulation & Implementation, Exploration Planning & Monitoring and in Business Development through exploration bidding from NELP-I to NELP-VI & participation in select Overseas opportunities during his 24 years of career with ONGC, before moving to Reliance Group in 2008.

During his association with Reliance Power Limited, he has been instrumental in discovering a large CBM fairway with optimal exploration inputs and cost through integrated G&G analysis. He has led E&P organization in building a successful upstream business. Currently, he is heading Oil & Gas Exploration and Production Business of Reliance Power Limited and is Member of board of directors of Reliance Prima Limited, Atos Trading Pvt Ltd and Atos Mercantile Pvt Ltd, fully owned exploration subsidiaries of Reliance Power Limited.

Unlocking the Potential of Renewable and Unconventional sources of Energy in India

By B K Chaturvedi

Let me start by congratulating the Ex-ONGC officers Association for organizing the conference on an area of energy which has gained centre stage in the last decade. A strong participation by former secretaries to government of India, eminent experts of petroleum sector, veterans of oil and gas and CEO of Niti Ayog is indicative of efforts to bring different stakeholders on one platform for a very vibrant discussion.

Let me at the cost of repetition emphasize why RE is crucial for the global community and for all of us sitting here.The trigger for developing this areawas a gradual realization about four decades back by the major nations of the world that development has to be sustainable.In 1987 the Bundtland Report "Our Common Future"was released. It defined sustainable development "as a mode that fulfils the needs of the present generation without compromising the ability of future generations to fulfil theirs". Increase in carbon footprints in the atmosphere is an irreversible process. We had to plan our present while safeguarding the futureSoon enough a series of reports prepared by different panels of UN Inter Governmental Panel on Climate Change(UNIPCCC) gave their findings and analysis. These presented a worrisomeglobal scenario. It was pointed out that CO2 and other carbon emissions were already unacceptably high and there was a need to control its growth in the atmosphere to slowdownlarge rise in atmospheric temperature across the globe and major weather changes which may have disastrous consequences. Indian and Chinese economies were growing rapidly. Both are large nations with nearly one third of the global population. Their energy needs were large and growing rapidly as per capita incomes went up sharply. This gave an urgency to the task of controlling carbon emissions which were primarily the outcome of use of coal and fossil fuels as energy source to ensure high level of growth.The search for alternative sustainable energy resources was now intensified.In the sector while Solar, Wind and Hydro were the major RE source, other sources like Ocean waves, Biomass, Geothermal, were also being used. But the cost of energy from main RE sources of solar and

B K Chaturvedi
Former Cabinet Secretary, GoI

Shri B.K. Chaturvedi IAS is Former Cabinet Secretary, Government of India. He has served also as a Member, Planning Commission and a Member, Thirteenth Finance Commission He was awarded Padma Bhashan for his contributions to the civil services in 2010.

Shri Chaturvedi's experience is both rich, multifaceted and includes both Government and corporate world. He has been Secretary to the Government of India in several Ministries, including Finance, Human Resource Development (which includes Higher Education, Technical Education and Elementary Education) and Petroleum and Natural Gas for more than six years. The various assignments held by him in the Union Government include Chairman and Managing Director, State Trading Corporation of India and Executive Director, Trade Development Authority of India. He has been a member of the Boards of several Public Sector Undertakings, including MMTC Limited, Life Insurance Corporation of India, General Insurance Corporation of India and State Electricity Board of Uttar Pradesh. As Cabinet Secretary, he was also Member of the India's Atomic Energy Commission and Space Commission.

Shri Chaturvedi had a major policy-making role in initiating and building economic reform measures in several sectors. These include opening up of the Insurance Sector by Government of India, approval of policy for setting up of the Insurance Regulator, the passage of IRDA legislation and handling of its impact on LIC, GIC and other State insurance companies.

He holds a Masters Degree in Physics from Allahabad University, with specialization in Electronics. He started his career as an Associate Professor of Physics (1962-65) at the Motilal Nehru Regional Engineering College, Allahabad. Subsequently, he studied Public Administration from Manchester University, U.K. (1978).

He has represented Government of India on the Boards of UNICEF and UNDP, New York. He has published several research papers on public administration and governance.

wind was high andnot acceptable to discoms.I recall CERC fixing Rs15-17 per unit as cost of solar energy. Wind power source were more competitive but still higher than coal fuel based power plants. It required a technological breakthrough. So as we sit here discussing RE, our major concern is the sustainable growth of our nation and the global community.

Around 2012-13 prices of RE sources particularly Solar became more competitive driven by large technological developments and economies of scale. Due to slow growth in 2000- 2010 RE capacities in India were only 14 GW in 2009-10 which was about 12% of the total power capacity. Growth in RE picked up once the solar prices fell. This led to a quantum jump in RE based power capacities in India and also globally. In India it increased sharply to 69 GWby June 2018which was about 20% of our total power installedcapacity. If we add to this the Hydro Power as is done by many nations, it was about 33% of the total power capacity. Last year we added 11.7 GW of RE capacity. While at this rate we may not reach 175 GW by 2022 which has been planned by the government, we may be able to add very substantial RE capacity in next four years and increase its share to 40% in our total capacity.Looking at the global picture, our capacity addition is quite impressive. During 2017, the global capacity addition of RE was dominated by three countries: China, USA and India. So first point I wish to make is that we are unlocking the potential of RE at a good pace. But then where is the worry?

This brings me to my second point. There are still large capacities waiting to be unlocked .In 2011-12 a team of Lawrence Berkley lab of USA had visited India and assessed that we have a potential of 2000 GW of solar and 1000 GW of wind capacities including off shore potential for wind .Many feel that it was a not well researched assessment. According to a study by IIT Kanpur published in March 2015 the RE potential in India was 1100 GW including 750 GW of solar and 302 GW of on shore wind. This could go up once off shore wind potential is added to it. Even if we take these more conservative potential figures, it is clear that so far we have been able to exploit only less than 6-7% of the potential. So 94% of it is still waiting to be exploited. There is a clear need to step up pace of RE capacity addition.

This brings me to the third issue which I wish to raise. This is about the absorptive capacity of our energy system to use this unlocked RE potential. This power by its very nature is infirm and has large variations during the day and in different seasons.As its share in our total power capacity increases further to 25% or 30% there will serious problems in providing continuous power to users unless we use larger balancing power and easy ramp up power plants to even out the variation in power generation fromRE sources. We may also need technology for energy storage. Power load dispatch management would be crucial to keep power flowing. Transmission of this power will raise a different set of problems.Due to the nature of RE generation plants, large investments will be needed in transmission capacities. This may add to the cost of power received by the users and may effect demand. Also, the cost of undeveloped RE potential may gradually go up reflecting difficult potential areas. Strong focus on technological developments will be needed to ensure that this power remains competitive. All these are areas which would need effective resolution for absorbing RE power.

Let me now focus on the fourth issue which is critical for economy as we unlock the potential. This relates to the oil companies. It is clear that demand for petroleum sector will slow down as renewable energy picks up.But all studies indicate that even by 2050 there will be use of this resource in sizeable volumes. Niti Ayog in its assessment of draft energy policy last June assessed that by 2040 the use of oil will be about 413 million tonnes which is nearly double of current consumption.IEA in its projection has assessed the demand as nearly 8 million b/day which is more than two times of current consumption. All this indicates that while the strategy for oil companies would have to include a strong focus on clean energy, there will continue to be a large oil sector segment. Some of the demand for transport of oil sector will be met by electric cars.There is a great focus globally on electric cars to control pollution in cities and government is planning a total switch over by 2030 according to various announcements. Even if we were to discount this as a bit ofoverambitious projection, it is clear that very large number of such cars will come in the market every year in the coming decade.Given the limited range of such cars, we will need charging stations across the country to enable smooth movement of these electric cars. Oil companies must see this as an opportunity and use their oil distribution network to distribute batteries for cars and provide charging facilities for such electric batteries. A lot of technical work will be required before this transition can take place. But this is doable. This only emphasizes the need for new business models as share of RE goes up.

There are also huge opportunities in providing power from Large Hydro plants and Nuclear Plants.Both these will provide clean energy with little emission of harmful gases.Nearly 50 GW or more of Hydro potential remains unused from north eastern states. Also pace of nuclear capacity expansion has been slow and we can expand these to 60 GW or more by 2040. The creation of new capacities will be constrained by our ability to complete work on these plants. Our initiative on fast breeder reactors will provide support to these initiatives.

There is clearly huge potential in the RE sector waiting to be unlocked. But the supporting infrastructure, absorptive capacity of the system and health of Discoms which will buy this power will be a constraint. Oil companies will need to reorient their strategy to continue to meet the market demand and be financially strong. They and the power companies will need to align with changing energy scene. That will be a major challenge for them. If they do so, our energy sector will become aligned with global and national needs. The unlocking would then be successful.

Unlocking the potential of renewable and unconventional sources of energy

By Bikash C Bora

If we look at the global scenario, it is definite that pressures to decarbonise the energy production and use is necessarily going to impact various industries over the coming decades as policies to reduce emissions, boost energy efficiency and promoting sustainable sourcing in the supply chain become more and more stringent. In fact, the governments, industry, consumers and even the general public are already under increasing social, investor, and regulatory pressures to lower emissions andto reduce any adverse environmental footprint.As a result, the corporate strategy of the industry (energy producers and consumers alike) is being reoriented in line with this growing focus on the new environmental policies in the making..

In the backdrop of the above reality, only those energy resources, whether renewable or unconventional, that are socially, economically and environmentally sustainable, will be the preferred, if not the only, option of tomorrow.

There are a wide variety of energy resources, but I shall confine my discussions to only a few, perhaps on account of my personal belief that each of these has the potential to contribute significantly to the energy basket of the future.

Renewable Energy

Solar and Wind Power

Out of the renewable sources of energy, solar and wind powers have to get priority over other resources and the unlocking of their potential optimally will require continuing R&D efforts backed by pilot scale work oriented towards targets such as improvement of efficiency, cost reduction, widening the scope of application, besides others. A number of R&D and pilot scale efforts are already under way in many countries of the world, e.g. improving solar panel efficiency, solar powered highways to generate clean power, finding affordable storage solution to make solar a sustainable source 24 hours a day.Similarly, blade-less wind turbines are being developed to double the efficiency over conventional 3 blade turbines and that too at half the cost. The wind resources offshore being higher in deep waters needing traditional sea bottom mounted foundations at uneconomic costs, innovative floating offshore wind technology solutions such as spar-buoy, semisubmersible or tension leg platforms at affordable cost are now being tried out for development.It is never too late for us in India to catch up and to put in place appropriate R&D programmes to bring in continuous improvements to efficiency and costs.

Hydro power

As regards hydro power, though the untapped potential may still be considerable for mega power projects, keeping in view the social and environmental impacts in a densely populated country like ours, it will necessarily be important to look into the overall sustainability, including the downstream aspects, very closely to decide on each project size, location, design parameters including safety provisions etc.. It may even be necessary in specific cases to opt for a series of small/mini hydro projects instead of a mega project. Fit for purpose innovative technologies have to be developed keeping in view this unique position of our country to tap both the kinetic and potential energies of our river resources in the most sustainable manner. Negative impacts arising from environmental changes, including in casesof resettlement and loss of livelihoods, potential adverse downstream impacts, heritage etc, pose long term sustainability problems for mega projects. At the same time, Hydropower offers energy, irrigation and drinking water,transportation, poverty alleviation, greenhouse gas reduction, proven technology, long biodiversity, fisheries etc. The extent of both the positive and negative impacts

Bikash C Bora
Former CMD,
ONGC & OIL

Mr B C Bora, a petroleum professional, has been associated with the petroleum sector spanning over a period of more than five decades since he joined the Assam oilfields of Oil India Ltd way back in 1962.

He superannuated from the position of Chairman & Managing Director of ONGC in 2001. Prior to moving to ONGC as the CMD in 1995, he was the CMD of Oil India Ltd from 1992 to 1995. Mr Bora continues to be associated with the Petoleum Industry and has been on the Boards of Governors of quite a few public and private sector companies and educational institutions as non-executive/independent Directors. He is also associated with a number of NGOs and industry bodies connected with the energy sector.

can be managed through choices around project siting, sizing and design, with close attention paid to recognising and addressing the social and environmental issues from the outset. It has tobe ensured that benefits are maximised and negative impacts avoided, minimised, mitigated and compensated. A third party certification and monitoring agency has to be created for this purpose besides efforts for continuing R&D work to increase efficiency and reduce costs.

Unconventional energy resources

Before going into these resources, if we look at the environmental impacts of the use of gas, oil and coal, we find that natural gas, the cleanest of the three, takes the following position with respect to:

Carbon dioxide emission: 71 % of Oil and 56 % of Coal.

Nox/SO_2 emission: 21 % of Oil and 20 % of Coal

Particulates: 8.3 % of Oil and 0.26 % of Coal.

It is true that in the immediate future the dependence on fossil fuels as a primary source of energy in India, and even globally cannot be wished away. However, it will be necessary to maximise the use of natural gas, the friendliest fossil fuel in the short term,say until 2030. Fortunately for us, three potential new sources of unconventional natural gasfrom indigenoussources, offer high promise to our country.As per my knowledge of the current status of technology development, these in order of priority aretight gas and HT/HP gas, shale gas and gas hydrates. Immediate actions should be taken in hand on to fill in the gaps in knowledgeand to establish the processes for both exploration and production of these in a sustainable manner in the foreseeable future. Simultaneously, efforts should continue to create an extensive gas pipeline network around the country as well as to import additional piped gas and LNG into the country.

In the interim however, oil and coal will continue to occupy a large part of our energy basket and as is being developed and introduced in many countries, gasification of these commodities will only offer considerable environmental benefits.Efforts are also under way in many countries to develop environmental friendly processes for the production of these two fossil fuels. We cannot be left behind in these matters and time bound actions have become an urgent necessity for our country.

Decarbonised energy future

The next step has to be to look beyond to a decarbonised world and to prepare ourselves well in time to switch over to totally green energy production and use in the future, perhaps by 2050. It is nowcertain that in view of the depleting fossil fuel resources globally, coupled with the increased compulsions to save the planet from irreparable damage, clean energy is going to be the only choice of tomorrow. Almost all the energy used for transportation, heating, cooling and manufacturing is still delivered using fossil fuel inputs. But with a few scientific breakthroughs, hydrogen, the most abundant element in the universe, could be the energy carrier of a future clean energy society.

At present the industrial method of producing hydrogen by steam reforming of methane, results in the release of CO2 into the atmosphere. Other methods utilize waste heat, such as from advanced nuclear power plants, or concentrated solar power, both of which face technical challenges to becoming commercially feasible. Another industrial process uses platinum as the catalyst to split water to produce hydrogen. Although platinum is a near-perfect catalyst, it is also expensive. A cheaper catalyst could make hydrogen a reasonable alternative to fossil fuels in transportation, and power fuel cells for energy storage applications. Hydrogen fuel cells can boost a clean energy economy in the transportation sector with the advantages of faster refuelling and larger vehicle range and can thus outpace electric vehicles. Hydrogen will also enable to store electrical energy produced by solar and wind far more easily and economically, and be another step forward to reaching the ultimate goal of a decarbonised world. Such low cost catalysts have reportedly been already developed in lab scale in China and USA. It is surely about time for us to catch up and make the breakthroughs.

Closing Remarks

As has been discussed above, continuing and focussed R&D and pilot scale efforts in each of the above areas have now become absolutely necessary for an energy starved, and yet high energy consuming country like ours. Instead of the business as usual approach of the past by trying to find solutions to new issues through multi-organisational committees, it will surely be important to create SPVs with clear individual mandates, budgets and organisational structures headed by competent persons to find time bound answers to these or any other evolving critical issues related to creating a sustainable energy future of our country. The government has to take the responsibility and .provide an enabling role.

City Gas Distribution Network (CGD) 9th Bidding Round – PNGRB's current focus

By D K Sarraf

Share of natural gas in India's energy basket is 6.4% against global average of 24.1%. It means, our proportionate usage of gas is just one-fourth of the global average. More worrisome is, gas in our energy basket has been reducing – it was 10.5% in FY 2012-13. In India itself, in the state of Gujarat, it's 25% - which is more than the global average, demonstrating that with appropriate focus and policy framework, India can achieve higher significance of gas in India's energy basket. We should be aware that Bangladesh, a country bordering us, has 76.5% gas in their primary energy basket.

Why should we have more gas in our energy basket? There are several reasons for this. Gas is more environment friendly than other fuels like coal as well as the liquid fuels. A major portion of our domestic fuel requirement (kitchens) in villages (more than two-thirds) is met by wood, cow dung cakes and agriculture waste. The pollution due to this is affecting the health of villagers, particularly ladies and children. As per a WHO study, one out of ten deaths occurring in India is due to domestic pollution. These kitchens need to be migrated to Piped Natural Gas (PNG). Gas emits less CO2 as compared with coal, petrol and diesel. It would help India to meet its commitment given in the Paris Convention in December, 2015 on reduction in carbon emission. Further, gas is more economical than other hydrocarbon fuels, both in transport sector as well as in domestic kitchen fuel sector. From country's perspective, the international price of LNG is lower than that of liquid petroleum products, in terms of dollars per MMBtu. That is, for an energy-deficient country like India, which has to significantly depend on imports for its energy requirements, can make large savings in switching from liquids to gas.

D K Sarraf
Former CMD,
ONGC

Shri Dinesh Kumar Sarrafis the Chairperson, PNGRB and Former CMD, ONGC. Shri Sarraf has hold many coveted positions in Oil & Gas Industry.

He carries three-and-a-half decades of experience in the oil and gas industry, having started his oil and gas career in Oil India Limited and in 1991,he moved to ONGC and handled various key assignments at corporate offices. During the years 1997-2000, Shri Sarraf worked for three years in Oil Coordination Committee of the Government of India. Shri Sarraf was elevated to the position of Director (Finance), ONGC Videsh in 2005 where he played key roles in negotiation and conclusion of significant acquisition transactions abroad. He was appointed as Director (Finance) ONGC and thenManaging Director and CEO of ONGC Videsh Limited in 2011. Shri Sarraf became the Chairman and Managing Director of ONGC and Chairman of its Group companies – ONGC Videsh Ltd; Mangalore Refinery and Petrochemicals Ltd; ONGC Petro-additions Ltd; ONGC Mangalore Petrochemicals Ltd; Mangalore SEZ Ltd; ONGC Tripura Power Company Ltd. and a director on the Board of Petronet LNG Ltd. He was also the President, Global Compact Network India and Chairman, Petrotech Society and Federation of Indian Petroleum Industry.

Shri Dinesh Sarraf graduated in Commerce from Shri Ram College of Commerce, University of Delhi and did his post-graduation from the same University. Shri Sarraf is an Associate Member of Institute of Cost Accountants of India and Institute of Company Secretaries of India. He was conferred Honorary Doctor of Philosophy (DPhil) Degree by the Amity University in 2017. He is also a member of the Governing body of CSIR – Council of Scientific and Industrial Research.

One can argue that in the context of the renewals which are catching up fast,why we need to encourage more of natural gas as compared with solar. On this, we need to understand that India is a large country. Even at one-third of global per capita energy consumption, it is the third largest energy consuming nation. Our energy consumption is growing fast – it would be double in next 15 years.

To provide energy to our country-men we require multiple sources of energy – we require liquids, we require gas, we require renewals, we also require 'unconventionals', bio-gas, coal, and so on. So, renewals, 'unconventionals' as well as natural gas would co-exist and grow together. It's not the case of gas vs. renewals – it's the case of gas and renewals amongst others.

Petroleum and Natural Gas Regulatory Board – PNGRB, at present, is

focused on increase in the share of natural gas in India's energy basket, in line with Government's vision to increase it to 15% as against existing 6.4%. We know that increase in gas consumption would require creation of gas infrastructure in the country in terms of more LNG terminals for import of natural gas in the liquid form, to have more cross country natural gas pipelines and also to provide last mile connectivity i.e. city gas distribution infrastructure which is pipelines to the households and also pipelines, gas compressing and dispensing facilities at gas stations for transport sector. Increase of gas consumption would also require establishment of a transparent and vibrant natural gas market which balances the interests of consumers, transporters, marketers and producers of natural gas.

The current focus of PNGRB is to authorise entities to build CGD infrastructure in specified areas across various states and make natural gas available to domestic, transport, industrial and commercial sectors.

Till now, 91 geographical areas (GAs) have been authorised in various parts of the country out of which 29 were existing even before PNGRB was established in 2006, 6 were mandated by the Government in terms of powers it has under the PNGRB Act and balance 56 were awarded by PNGRB in 8 rounds of bidding during the period from 2008 to 2016. These 91 GAs cover 11% of India's area and 19% of its population. These cover 102 complete and 28 in part districts. Despite this significant coverage piped natural gas (PNG) has reached only 42 Lakh households and we have only 31 Lakh CNG (compressed natural gas) vehicles which shows the penetration level has potential to grow multiple-times. PNGRB is now talking to the concerned authorised entities to significantly increase the penetration level.

PNGRB initiated 9th CGD Bidding Round in April 2018. This round comprises 86 GAs covering 174 districts (156 complete and 18 in part) spread over 22 States and Union Territories. These GAs cover 29% of India's population and 24% of its area. The speed at which we want to spread the CGD Network across the country is reflected in the fact that till now in 8 rounds of bidding (including pre-PNGRB and Government mandated GAs) only 19% of India's population was covered whereas in this 9th CGD Bidding Round on a standalone basis, 29% of India's population is covered. The bidding closed on 10th July, 2018.

To make this bidding round successful, not only in terms of participation by investors but also in terms of creation of infrastructure post-authorisation, PNGRB has revamped the bidding structure. E-bidding has been introduced for the first time to ensure processing a large number of bids expeditiously and also to ensure transparency and maintain integrity of data submitted by the investors. We now aim to issue LoI's for these GAs within a period of one month of bid closing i.e. by mid-August, 2018 against the initial target of end- October, 2018.

Earlier the main bidding parameter was tariff quoted by the potential bidder for post-exclusivity period. It was experienced that almost all bidders would quote close to zero tariff. The bidding parameters also used to provide that in case of tie, highness of quoted performance bank guarantee (PBG) would be considered. The bidders who quoted high PBG were thus successful. These were normally big corporates, stopping the entry of smaller companies. Also, it did not lead to creation of CGD infrastructure at a significant scale.

Considering the above and after an intense consultation with various stakeholders and prolonged internal deliberations, the bidding parameters were entirely revamped. PBG amount was capped at Rs.50 Crore. The new bidding parameters (bid evaluation criteria) concentrated on creation of infrastructure by giving 80% weightage to it (50% to number of domestic PNG connections, 20% weightage to number of CNG stations and 10% to laying of pipelines) and balanced 20% was kept for tariff for CGD and CNG. A minimum rate for CGD and CNG tariffs for bidding was prescribed so that the authorised entity is really able to share the infrastructure with new entrants after the exclusivity period. The tariffs were also made adjustable to the inflation (WPI). Further to ensure that the bidders do not quote abnormally high infrastructure, pre-determined penalty rates have been prescribed for non-achievement of targets committed for infrastructure creation.

PNGRB has visitedmajor State Capitals in India to meet the local industries, potential investors and government authorities. The response has been very encouraging. PNGRB got 406 bids for 86 GAs; 10 GAs attracted 10 of more bids each.

PNGRB is also revamping its own internal systems to monitor and support a large number of authorised areas. Today, PNGRB considers itself more as a facilitator than a traditional regulator. It hopes that with this approach, it would be able to create more infrastructure and inculcate self-discipline within the industry.

One of the problems the existing GAs are facing is availability of right of way (ROW) and permissions by various agencies like municipalities, road authorities (e.g. NHAI), railways, state governments etc. PNGRB has been of late in touch with various state governments making them realise that we are working for the governments to provide clean fuel in their states and that they are a major beneficiary. While we have received some success on this front, the process is still on. While with the efforts of PNGRB and other stakeholders we would resolve the issues of land, ROW, permissions etc., in a large democracy like ours, continued efforts of all stakeholders would be required for getting solutions.

PNGRB is also in touch with masses through various social media and advertisement campaign on usefulness of natural gas as a domestic fuel and as a preferred fuel for transport. This process is also never ending; PNGRB alongwith the authorised entities would continue to educate masses on superiority of natural gas over other fuels.

Hydro Energy Potential in India

By C R Prasad

Introduction

Hydropower or hydroelectricity refers to the conversion of energy from flowing water into electricity. It is considered a renewable energy source because the water cycle is constantly renewed by the sun.

India is the 7th largest producer of hydroelectric power in the world. As of 30 April 2017, India's installed utility-scale hydroelectric capacity was 44,594 MW, or 13.5% of its total utility power generation capacity. Additional smaller hydroelectric power units with a total capacity of 4,380 MW (1.3% of its total utility power generation capacity) have been installed. India's hydroelectric power potential is estimated at 148,700 MW at 60% load factor. In the fiscal year 2016-17, the total hydroelectric power generated in India was 122.31 TWh (excluding small hydro) with an average capacity factor of 33%.

Basic Principle of a Hydro Electric Project

In hydroelectric power station the kinetic energy developed due to gravity in the falling water from higher to lower head is utilized to rotate a turbine to produce electricity. The potential energy stored in the water at upper water level will release as kinetic energy when it falls to the lower water level. This turbine rotates when the following water strikes the turbine blades. To achieve a head difference of water hydroelectric electric power station are generally constructed in hilly areas. In the way of the river in hilly areas, an artificial dam is constructed to create required water head. From this dam water is allowed to fall toward downstream in a controlled way to turbine blades. As a result, the turbine rotates due to the water force applied to its blades and hence the alternator rotates since the turbine shaft is coupled with alternator shaft.

The main advantage of an electric power plant is that it does not require any fuel. It only requires water head which is naturally available after the construction of the required dam.
No fuel means no fuel cost, no combustion, no generation of flue gases, and no pollution in the atmosphere.

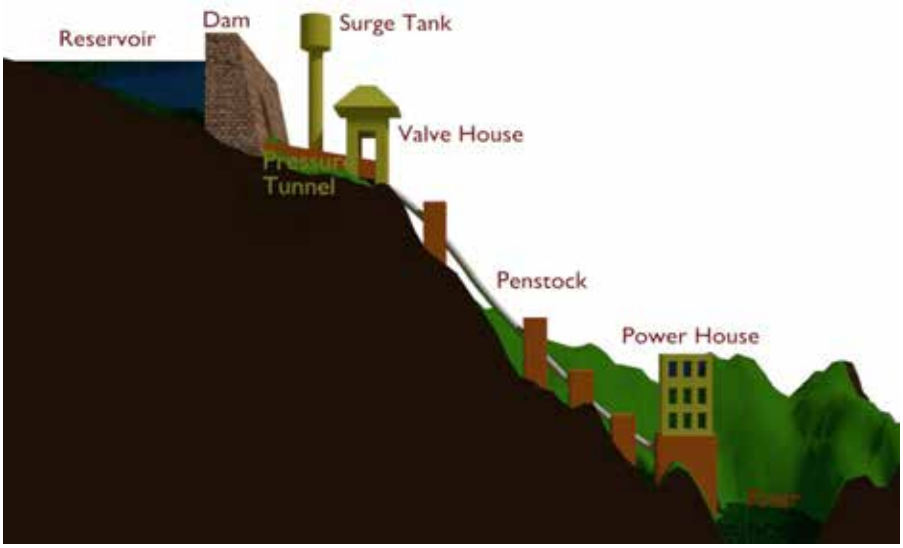


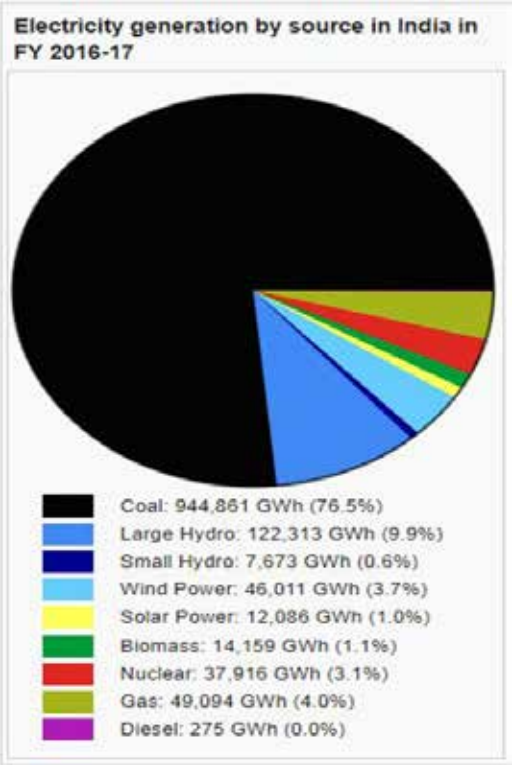
Fig. 1: Basic Layout of a Hydro Electric power plant

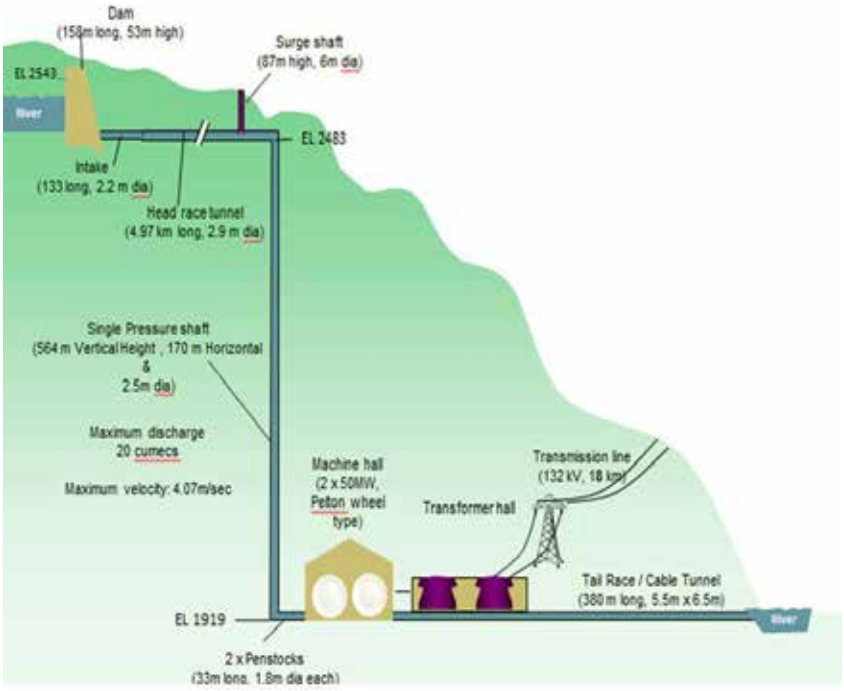
C R Prasad
Chairman & Managing Director, EPPL

33 years' association with Hydrocarbon industry in ONGC and GAIL since 1968 with thorough exposure to various facets of the industry such as Exploration and Production of Oil and Natural gas, Engineering and Construction of large oil/gas production complexes located offshore, setting up of mega petrochemical complexes, petrochemical production and marketing, transmission and distribution of natural gas across through cross-country pipelines, city gas distribution to the domestic/commercial/industrial consumers, Compressed Natural Gas (CNG) as fuel for automobiles, transmission of LPG through cross-country pipeline etc.

Due to the absence of fuel combustion, the hydroelectric power plant itself is very neat and clean. In addition to that, it does not produce any pollution to the atmosphere. Also from constructional point of view, it is simpler than any thermal and nuclear power plant.

The constructional cost of a hydroelectric power plant maybe higher than that of other conventional thermal power plants because of construction of a huge dam across the flowing river. The engineering cost in addition to the constructional cost is also high in a hydroelectric power plant. Another disadvantage of this plant is that it cannot be constructed anywhere according to





Current Total Installed Capacity = 343 Gigawatts.
Total Hydro Capacity = 130 GW (approx.)

the load centres.So, long transmission lines are required to transmit the generated power to the load centres. Thus the transmission cost may be high.

Current Scenario

The Government of India has taken many policy initiatives for sustainable hydro-power development. In 2008, the government came out with a Hydro Policy with an objective to achieve the implementation of these projects. The center and many states have initiated hydro projects through PPP to attract investors for the development of water resources in an environment-friendly manner and to generate revenue while ensuring project viability. Odisha adopted PPP policy in 2007, Arunachal Pradesh (2011), Uttarakhand (2012) and Andhra Pradesh & Gujarat had framed PPP policy. Many projects had been allotted under PPP, however, some of these projects have struggled in the past due to several reasons such as R&R issues, land acquisition problems, clearance and approval procedures, capability of developers, etc. These issues resulted in a declining share of hydropower in India's power mix by almost 32% in the last 50 years. For example, in Arunachal Pradesh, out of 120 MoUs (~40 GW) signed in last decade, most of the projects are at a standstill. India added 1824 MW of large hydropower capacity in 2015, most of these projects have a troubled track record in one way or the other that include issues like land acquisition, R&R, and cost escalations.

Hydro Energy Potential of our Country

The Central Electricity Authority (CEA) undertook reassessment of the hydropower resources of the country in 1980s. In this survey, theoretical and the economic hydro potential of the

Basin-Wise of Hydroelectric Potential of Indian River System

S.No.	Name of River	Number of Schemes	Firm Potential (MW)	Potential (MW) at 60% LF		Hydro Potential (MW)
				Economic Potential	Theoretical Potential	
1.	Great Indus	190 (including 23 storage)	11,992.8	19,988	50,172	33,832
2.	Great Brahmaputra	226 (including 76 storage)	23,951.9	34,920	146,170	66,065
3.	Ganga	142 (including 35 storage)	3,409.0	10,715		20,711
4.	West flowing river of South India	94	3,689.4	6,149	9,437	9,430
5.	East flowing rivers of South India	140	5,719.0	9,532	26,972	14,511
6.	Central Indian river system	53	1,664.2	2,740	14,888	4,152
Total		845	50,426.3	84,044	301,117	148,701

1	Name of the Project	Malana-II (100 MW) HEP
2	Type of the Project	River Valley (run of the river) Project
3	Clearance letter (s) OM No. & Date	
	a) Environment Clearance	Granted vide letter No. J-12011/21/2005-IA-I Dated: 21.06.2005
	b) Forest Clearance	Granted vide letter No. F.No. 8-18/2005-FC Dated 09.12.2005
		Clearance for diversion of additional forest land granted 09.12.2009.
4	Locations	
	State(s)	Himachal Pradesh
	District(s)	Kullu
	Latitude	Between 32°05'06''N to 32°02'15''N
	Longitude	Between 77°16'51''E to 77°15'26''E
6	Details of Environmental Management Plans.	• Provision of Community Kitchen. • Provision of Water Supply. • Sewage & Solid Waste Management. • Management in Road Construction. • Muck Management Plan. • Compensatory Afforestation. • Maintenance of Water Quality. • Health Delivery System. • Control of Air Pollution. • Sustenance of Riverine Fisheries. • Green Belt Development. • Road Side Plantation. • Environment Management Cell. • Catchment Area Treatment Plan.
7	Break-up of the project area. (land details) a) Submergence area. (forest & non forest) b) Others	3.5 ha of forest land is under submergence
8	Breakup of the project affected population with enumeration of those losing houses/ dwelling units only, agricultural land only. Dwelling units and agricultural land and landless labourers/ artisans. a) SC /ST /Adivasis. b) Others	Not applicable.
9	Financial details a) Project cost as originally planned and subsequent revised estimates and the years of price reference. b) Allocations made for Environmental management plans.	The completed project cost as approved by the Punjab State Electricity Regulatory Commission is Rs. 837.29 crores. Rs. 30.7853 Crores.

rivers was worked out. The potential was assessed by identifying specific suitable sites and water availability corresponding to a 90% dependable year. CEA had identified 845 economically feasible schemes in various river basin of the country. The firm energy was converted into hydroelectric potential by applying a suitable system load factor. On this basis, the total theoretical potential at 60% load factor was assessed as 301,117 MW and the economic potential at 84,044 MW.

Basin wise study of hydroelectric potential revealed that the current capacity addition of hydro based generation has up to 148 GW of potential. In today's energy mix it may be noted that a thermal-hydro mix in the ratio of 60:40 is considered as ideal.

Case Study: Malana – II Hydro Electric Project

This Project in Himachal Pradesh near Kullu is constructed and now supplying power to Punjab state of 370 MU per year.

Salient Features of Malana – II HEP

- Installed Capacity – 100 MW (2 Units of 50 MW each)
- Sale of Power – To PSPCL (Punjab State Power Corporation Limited)
- Annual Design Energy – 403.25 Million Units (1 Unit = 1 KWH)
- Turbine Type – Pelton Wheel turbine
- Evacuation of Power from NALAGARH CTU via CHHAUR (LILO) Substation
- Dam Site is 3Km up stream of Malana Village at an elevation of 2500m

Civil Structures of the Project

- Diversion Dam
- Head Race Tunnel
- Surge Shaft
- Pressure Shaft
- Power House
- Tail Race Tunnel
- Administrative Buildings

Conclusion

As it is brought out in the article above, that India has Hydroelectric power potential of 1,48,700 MW, out of which, about 40,500 MW is constructed and they are under generation. Still there is about 1,00,000 MW available which can be developed and they can be used for supplying peak load power. The industry is looking for a Hydro Policy to be issued by Government of India, so that both Public and Private Sector shall come forward to take up these projects.

Conventional energy sources are on their way out - Renewables are knocking at the door as opportunity for growth

By S K Chawla

Summary

Dramatic change in global society's mindset towards ENERGY as a crucial resource for prosperity has given a challenge to ingenuity application for bringing about a turnaround in its technological and management expertise.

India in particular, has a high percentage (50%) of younger generation less than 25 years. This resource, with an intense hunger towards education and skill development assures a strong will in the governance to attain self reliance in sustenance and growth of economy.

Yawning gap between Supply and Demand of Energy in our Economic arena, depleting conventional fuel resources (Coal and Petroleum in particular) are threatening, yet have created great opportunity to harness "Renewable Energy" (Solar, Wind, Hydro, etc.) The speed of changeover in adopting this mode is amazing as also a shield to climate change.*

In the following text we intend to bring out the impact of paradigm shift in sustainable development scenario due to very fast growth pattern of population and consumption of resources.

**Sustainable Development Scenario- examines what it would take to achieve the main energy related components of the "2030 Agenda for Sustainable Development" adopted in 2015 by member states of the United Nations. The three energy related goals are: to achieve universal energy access to modern energy by 2030; to take urgent action to combat climate change; and to dramatically reduce the pollutant emissions that cause poor air quality.*

In the pages to follow we will traverse the pathways already in vogue, worldwide as well as in India.

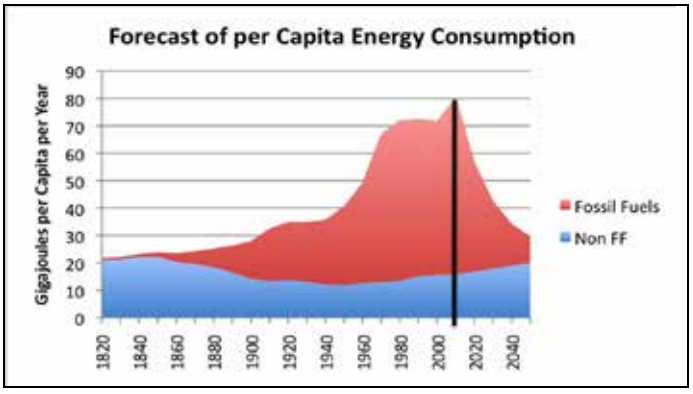
Turnaround

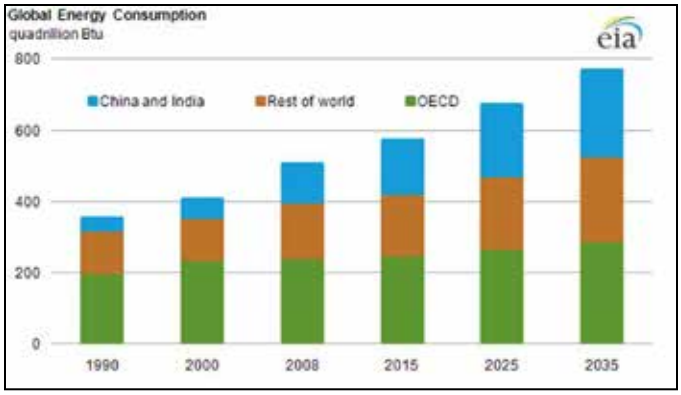
The following self explanatory graphs explain the comparison of switchover from conventional to non-conventional sources across the world.

Tony Seba in one of his presentations has used the term "disruption" instead

S K Chawla
Former GGM ONGC and Director Powergrid

Mr. S.K. Chawla, Petroleum Engineering graduate from First batch of IIT(ISM Dhanbad) and PGDM from ENI Italy, served ONGC from 1961 to 1993 and then on the Board of Powergrid Corporation till his superannuation in 1995. Thereafter he has been actively involved with Academia like S.P. Wahi Technology and Management Consultants, AMITY and UPES. Presently he is CEO of his family business in Solar Energy (Winnerspitch Energy Pvt. Ltd.). Settled with his son NeerajChawla in Gurgaon, he identifies himself as a "dreamer" and has ambition to continue contributing his mite to several social and cultural organizations.



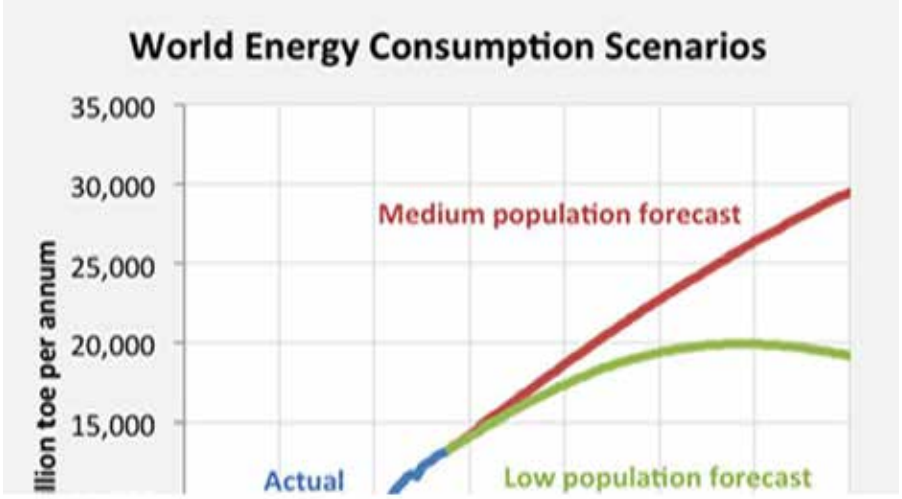


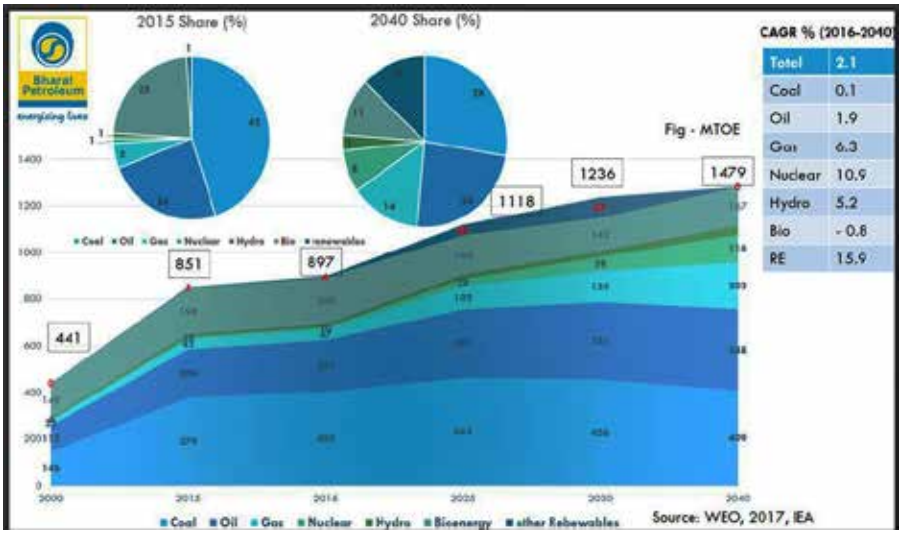
of "transition" to explain the exponential growth of solar energy in the upcoming years.

Tony Seba in one of his presentations has used the term "disruption" instead of "transition" to explain the exponential growth of solar energy in the upcoming years.

From now to the next few decades

The complex interconnectivity between Supply and Demand of Conventional Energy Resources vis a vis economic development was never so alarming if we see the projections which were available a couple of decades back and now adding the distortion caused by fast unbalanced growth has made the situation much worse due to Carbon imprints' imbalance.





The entire perspective on Input of Energy Resources in all dimensions of Human life and related needs for its very existence has drastically changed. This draws highest priority towards creating a NEW OUTLOOK on SUPPLY AND DEMAND SIDE Management.

This aspect can be dealt in three separate converging dimensions as we proceed further: -

a) Energy conservation
b) Energy efficiency
c) Switch over from singular system to hybrid systems.

Our eventual focus shall be to create stand alone micro power plants for individual unitized systems.

Way forward

In order to make the dream of sustainable development faster the United Nations has mandated as under: -

"At its essence, sustainability means ensuring prosperity and environmental protection without compromising the ability of future generations to meet their needs.

A sustainable world is one where people can escape poverty and enjoy decent work without harming the earth's essential ecosystems and resources; where people can stay healthy and get the food and water they need; where everyone can access clean energy that doesn't contribute to climate change; where women and girls are afforded equal rights and equal opportunities."
— United Nations

The individual governments particularly the fast growing ones will have to make their own roadmaps for achieving their individual objectives.

In Indian context, multiplicity of actions on the part of government, private parties, academia and actual players in the arena must start the action right away, irrespective whether they are new single person army, startups, small or medium scale organizationor industry mega houses in stock market.

More than that, the switchover needs a long term commitment to replace the energy input in use by conservation, replacement by new technology and whatever means are available.

The team work by different ministries, universities and polytechnics, EPC-companies, suppliers of upstream part of supply chain, manufacturers, transporters and last but not the least "consumer GOD", and have already started.

This needs to be synchronised by a central agency. Lines should be drawn to clearly demarcate the autonomy and sourcing of resources. The regulators should be more of watchdogs rather than shackle holders (once known as inspector raj model).

With this zeal, enactment may be considered by the judiciary, corporates, parliamentor whatever agencies are concerned for making all systems from "FIELD TO FORK, KNOWLEDGE TO APPLICATION".

From the point of view of Business models in Indian scenario, we may divide this aspect in multiple parts: -

- Small size organizations comprising of creative thought leaders who can make business sense to companies and their products in niche areas. These people (say 6 to 10 should be drawn out of existing talented and reputed scientists, engineers and cost accountants by professions). This group should have a reach to Nitiudyog, concerned ministries and academia/CSIR and the likes.
- Small and medium size companies which can be either specialized in single product manufacturing/building/designing/constructing modules relevant to RE sector. These modules should find market in larger conglomerates of relatively higher cost and societal value. Only as an example these could be dealing with structures and multifaceted integrated parts of bigger industrial use. Examples can be portable gensets mounted on wheels, portable integrated service type workshops stand alone powered by Hybrid RE stations.
- Larger business houses including some MINIRatnas, Maharatnas and highly reputed and branded market players (AT SOME LEVEL WE MUST THINK OF BUSINESS RE-ENGINEERING SOLUTIONS, AND B2B integration of like to like collaborative segments).

THE THREE DIMENSIONS OF THE ENERGY TRILEMMA

- Identify those businesses which are relevant and exclusive support to sectors like Banking, Defense, Research in Food products, Health Care etc. where PPP approach is feasible/ desirable.

In each of these segments ministerial control and regulatory requirements must include mandates for use of non-conventional Sources of Energy to maximum extent.

Fund mobilization mechanism should become easier for all kinds of entrepreneurship, and the change must be enabled on war footings.

In the last 5 years, many major businesses have switched to solar already to enhance their business model by saving on their utility costs and contributing to the environment as much as they can. Several players have grown many folds in short span of time and have graduated to higher echelons. One of the latest policy idea from the government is to change the equity part of very large oil companies into renewable sector.

The above narration is a vision probably of conservative and stereotype thinkers who wish the society to take off on the runway of ZOOMING TURNAROUND ON THINKING PROCESS AND WISH that the actual doers hold the steering and joysticks firmly.

The GPSs and technology is ON, kids are playing gamesrelevant to their times—let the middle and active generation collaborate with elders and make an army against all evils.

Unlocking the Potentials of Renewable and Unconventional Sources of Energy in India

By Sudhir Mathur

Today, India is the fastest growing economy in the world with the growth rate for 2019 pegged at a healthy 7.3% by the World Bank. This growth is driven by rapid urbanization, infrastructure development and industrial growth in primary and secondary sectors of the economy. Energy forms the basis of all this growth and helps us accelerate development in all sections of industry and society.

With growing development, India's energy demand has also gone up through the years, which is currently met predominantly through fossil fuels. In 2017, 92% of India's primary energy requirements were met through coal, oil and gas. The trend is expected to continue and projections for 2040 show that the economy will still remain largely dependent on fossil fuels to meet its demands. This will happen despite the share of non-fossil fuel based sources in the energy mix, expected to increase from 8% to 18%. 83% of India's oil &over 45% of gas consumptionis met through imports. This puts our energy security at a serious risk and leaves our economy vulnerable to oil shocks. In addition, geopolitical changes resulting in increase of fossil fuel prices put a huge burden on the exchequer with valuable foreign exchange paid to meet our energy demand. India's dependence on oil imports is also projected to cross 90% by the year 2040.

This grim reality makes it imperative for us, as a nation, to devise ways and methods to reduce our dependence on fossil fuels and turn to renewable sources of energy, to fuel our industries and economy. India has already taken the lead with the launch of an ambitious target of 175 GW of installed renewable energy capacity, by 2022. The government is giving this initiative the necessary impetus by offering generation-based incentives (GBIs), capital and interest subsidies, viability gap funding, concessional finance and other fiscal incentives.

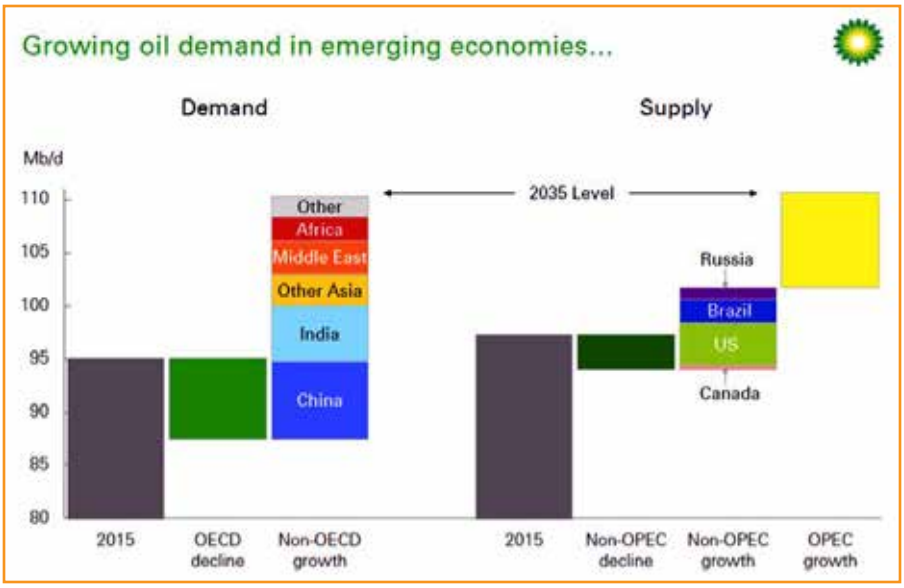
While these measures will go a long way in reducing our dependence on fossil fuels, they will not be enough for the rate at which our economy is growing. Renewables can help us pivot towards clean energy and power some of our industries but cannot replace fossil fuels entirely. It is therefore pertinent to optimize the utilization all available sources of energy, in particular India's unconventional

Sudhir Mathur
CEO
Cairn Oil & Gas

Mr Sudhir Mathur is Chief Executive Officer of Cairn Oil & Gas – Vedanta Limited, Hehas more than 32 years of rich expertise and experience in finance and strategic planning, supply chain management, as well as regulatory affairs. He has a proven track record in deploying large capital to enable value creation for companies, and is leading the effort to increase Cairn's contribution to India's domestic oil and gas production to 50 percent.SudhirMathur has been instrumental in defining the organisation's strategy and its growth story.

Prior to joining Cairn as CFO in September 2012, Mr Sudhir was CFO and Head of the Netco Business for Aircel Cellular Limited. He has formerly held leadership positions of increasing responsibility at Delhi International Airport Limited, Idea Cellular, Ballarpur Industries Limited and Price Waterhouse Coopers, India.

Sudhir is an Economics graduate from SRCC, Delhi University, and has earned his Master's degree in Business Administration from Cornell University, New York. He lives in Delhi with his family and enjoys cricket and reading books. He is also an avid basketball enthusiast and a former player.



energy resources such as shale, tight oil &gas, coal gasification amongst others. These sources offer significant growth opportunities and address two immediate issues:

1. Stem India's production decline
2. Realise the hydrocarbon potential to its fullest

There is a tremendous opportunity to develop these unconventional sources which have remained unexploited so far in our on-shore and off-shore basins. We have been focusing on exploration and production of conventional oil and gas while little attention has gone to harvest other associated resources that require additional effort and investment. We have untouched resources of shale and tight oil & gas, the extraction of which could greatly reduce our dependence on imports.

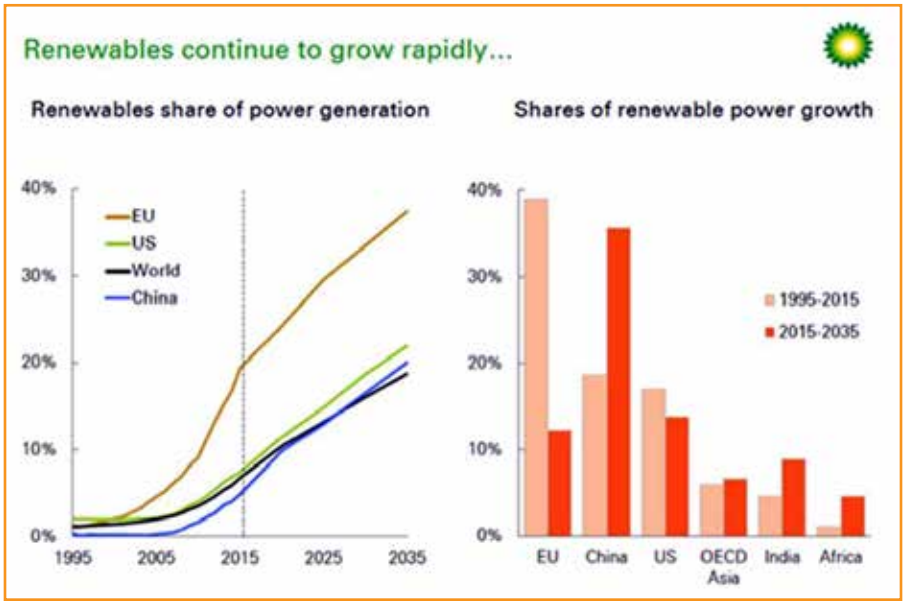
India can learn useful lessons from the U.S., which witnessed a revival of their oil & gas story with the discovery and extraction of shale and tight oil & gas. Today, tight oil remains the leading source of future US crude oil production. Around 50% of total crude oil production in the U.S. in 2017 came from tight oil resources. Given the increasing domestic production of energy, total net energy imports to the U.S. were at the lowest level since 1982. Powered by the shale gas revolution, for the first time since 1957 the U.S. has been a net natural gas exporter.

Estimates suggest that India also possesses large reserves of shale oil and gas which require large scale investments and technological disruptions to make it an economically viable source of energy.

Indian policymakers are mindful ofthe role that these sources of energy can play and have taken several steps to realise their potential. Policies such as HELP (Hydrocarbon Exploration and Licensing Policy) allow for a uniform licensing regime for all hydrocarbons including Shale Gas / Oil, Tight Gas, Gas Hydrates& CBM. This is a welcome change from the earlier NELP and pre-NELP policies which restricted access to include only conventional energy sources. Other public sector institutions such as Coal India Limited are also actively initiating action plans to set up coal gasification plants to promote cleaner alternative fuels.

These important steps will go a long way in creating a framework to explore unconventional sources of energy. As the next steps forward, the government should also put in place policies to allow private players to explore shale oil and gas under the NELP and pre-NELP PSCs. This will bring in much-needed foreign investment in the sector and speed up the process of exploration by leaps and bounds. To realise the government's aim of becoming a gas-based economy, there should be a dedicated focus on creating infrastructure on a common carrier principle to allow transparent access to pipelines.

Prime Minister Narendra Modi has explicitly stated his vision of reducing the import burden of oil and gas on the economy. This vision is achievable if pragmatic and forward-looking measures are taken to realize the vast potential of India's natural resources. We are hopeful that the government and policy-makers will expeditiously provide necessary framework for public and private players to reach its stated goal and put the country on the fast track to development and prosperity.



Gulf of Cambay Potential to Supply Gigawatts of Energy

By Ashok Varma

While we keep deliberating on ways to harness the Wind, Solar and other renewable sources of power, an ambitious project of the Government of Gujarat conceived a couple of decades ago, is still waiting for serious actions. As per initial studies, the project, besides benefitting Gujarat and its neighboring states in many ways, had the potential to produce about 2500 MW of wind and solar power and about 5850 MW tidal power. The project was named Kalpasar project by the Government and was being monitored at the highest levels, but for reasons unknown, has been lying in a state of neglect for quite some time.

The Gulf of Cambay (or Khambhat) extends from north to south about 200 km and the width varies from 25 km at the inner end to 150 km at the outer mouth, covering an area of about 17000 sq. km.

Narmada, Dhadhar, Mahi, Sabarmati and some rivers from Saurashtra region flow into the Gulf of Cambay, pouring several million cubic meters of sweet water into the sea.

Gujarat is a water deficient State. It occupies 6.4 % of land area of the country and has 5% of the country's human population, but its surface water resource is only 2% of the country. The idea of constructing a dam across the Gulf of Cambay, and thus restricting the sea water out side and saving and storing sweet water from these rivers into a huge manmade reservoir was mooted long ago. Renowned public dignitaries such as late Shri Bhoghilal Shah (former Member, Rajya Sabha), Shri Pratapbhai Shah (Ex-minister, Ports) and experts such as late Dr. Viththubhai Patel (international earthen dam expert), Dr. Anilbhai Kane(former Vice Chancellor, MS University) and others made suggestions from time to time for construction of a dam across the Gulf of Khambhat.

About twenty years ago, a pre-feasibility study was carried out followed by a technical feasibility study. "Kalpasar" project was launched and an Expert Advisory Group and a Steering Council of Ministers under the chairmanship of Hon'ble Chief Minister as the apex decisionmaking body were formed to deliberate and approve all major aspects of the project.Further, due to the complex nature of work, a Committee of Secretaries headed by Principal Secretary was also constituted with a view to resolve issues related to technical sanction, rates for all types of works and agreements, environmental, social, economical and Public-Private Partnership related policy issues, etc.

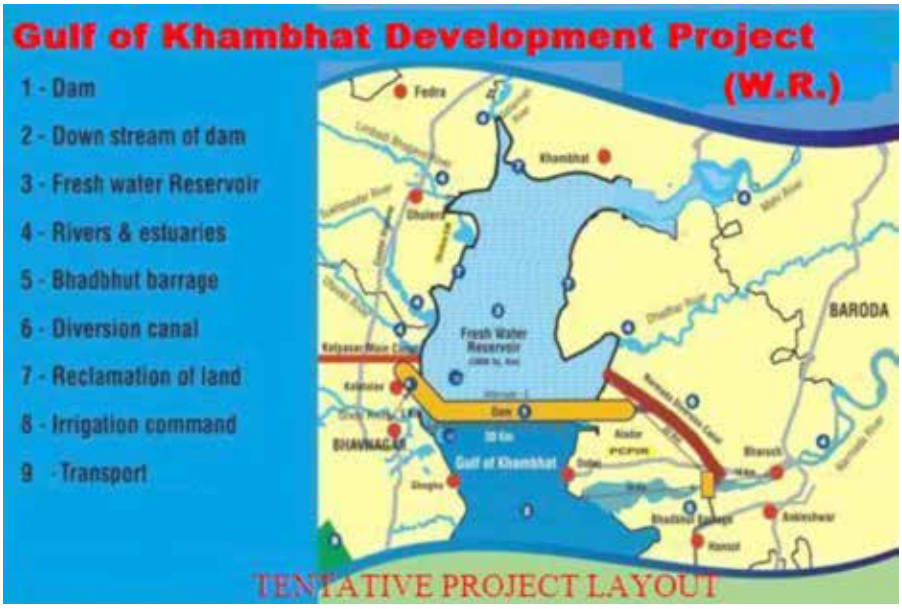
Ashok Varma
Former Director (onshore), ONGC

Mr. Ashok Varma has been associated with the petroleum industry for about four decades. He graduated as a Petroleum Engineer from Indian School of Mines, Dhanbad, (now IIT-ISMDhanbad), in 1977 and worked for Oil and Natural Gas Corporation Ltd, the national oil company of India, till his retirement in 2015 as Director (onshore).

He has wide ranging experience in all aspects of the oil industry, He was involved in thedesign and engineering of all offshore oil production platforms and pipelineswhich were under various stages of development in Mumbai High in the eighties. He was a key person involved in the first major acquisition of an oil and gas property by India abroad - 20% stake in Sakhalin-1 Project by ONGC Videsh. He was the first CEO of Imperial Energy, acquired by OVL, in Siberia, Russia. He headed Assam Asset and Eastern Offshore Asset of ONGC. First oil production from deep seas off the East coast of India came during his tenure as head of that Asset.

Besides being a full time Director on the Board of ONGC, he was also on the Board of ONGC Teri Biotech, ONGC Mangalore Petrochemicals Ltd. and ONGC Tripura Power Company Ltd., He was a member of the Governing Council of Jawahar Lal Nehru Technical University, Kakinada, and is Adjunct Professor at IIT-ISM Dhanbad.

He has extensively worked in the oilfields of India spread over Assam, Gujarat, Andhra Pradesh and Tamil Nadu. He also had exposure to the oilfields of United States (Texas), United Kingdom (North Sea), Russia, Kazakhstan, Kyrgyzstan, Uzbekistan, Trinidad and Tobago, Colombia, Qatar etc..

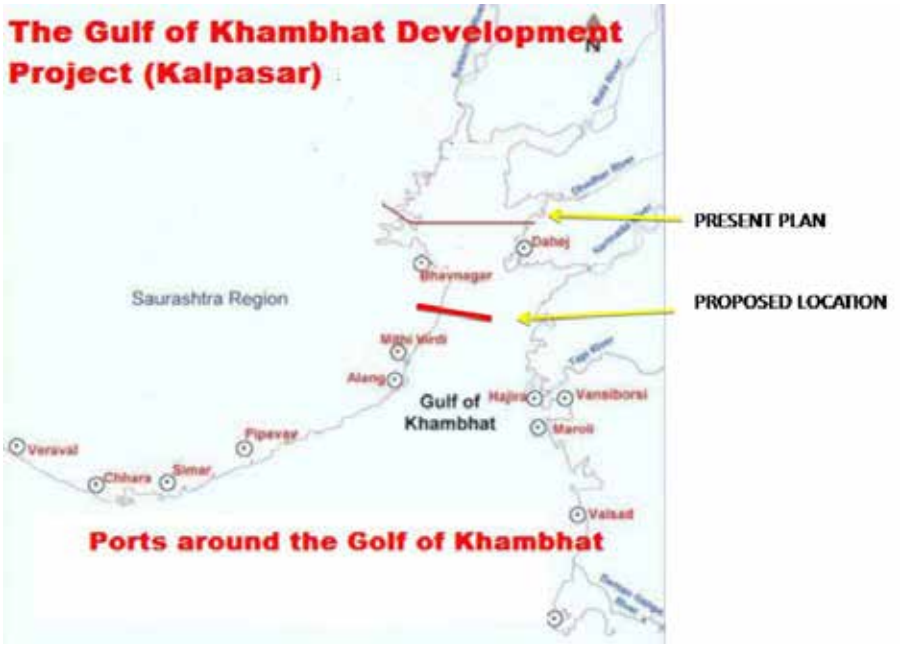


It was envisaged that the project would create world's largest man made fresh water reservoir in the sea and make available about 6500 million cubic meters of fresh water forirrigation to over 10.5 lakh hectare land in 39 talukas of 6 districts of Saurashtra region, besides making available drinking water for Saurashtra and Central Gujarat regions. Besides making available water, the project would also generate 1470 megawatt power through Wind and additional 1000 megawatt through solar energy.

A 10 lane road and a railway track over the dam would connect Dahej and Bhavnagar, reducing the distance between the two important cities by over 200 kilometers and triggering exponential industrial growth in the entire belt.

Numerous other indirect benefits have also been envisaged such as about 1.5 to 2 lakh hectares additional land becoming available through reclamation due to end of high tides, generation of high level fresh water table in Saurashtra and Central Gujarat, reduction in soil salinity, development of tourism, improvements in the ports, boost to fisheries etc.

As per one estimate, the project was to cost about Rs. 60,000 crore and the media report in January 2017 stated that as per the estimates of revenue generation, the project would give 12% return.



The project had been moving at average pace initially. Several resolutions were passed between 2006 and 2011. The Expert Advisory Committee met atleast a dozen times, several technical studies were carried out and technical experts of international repute were hired. In none of the meetings any indication of the project not being technically or commercially viable, or a decision to stall or going slow has been given.

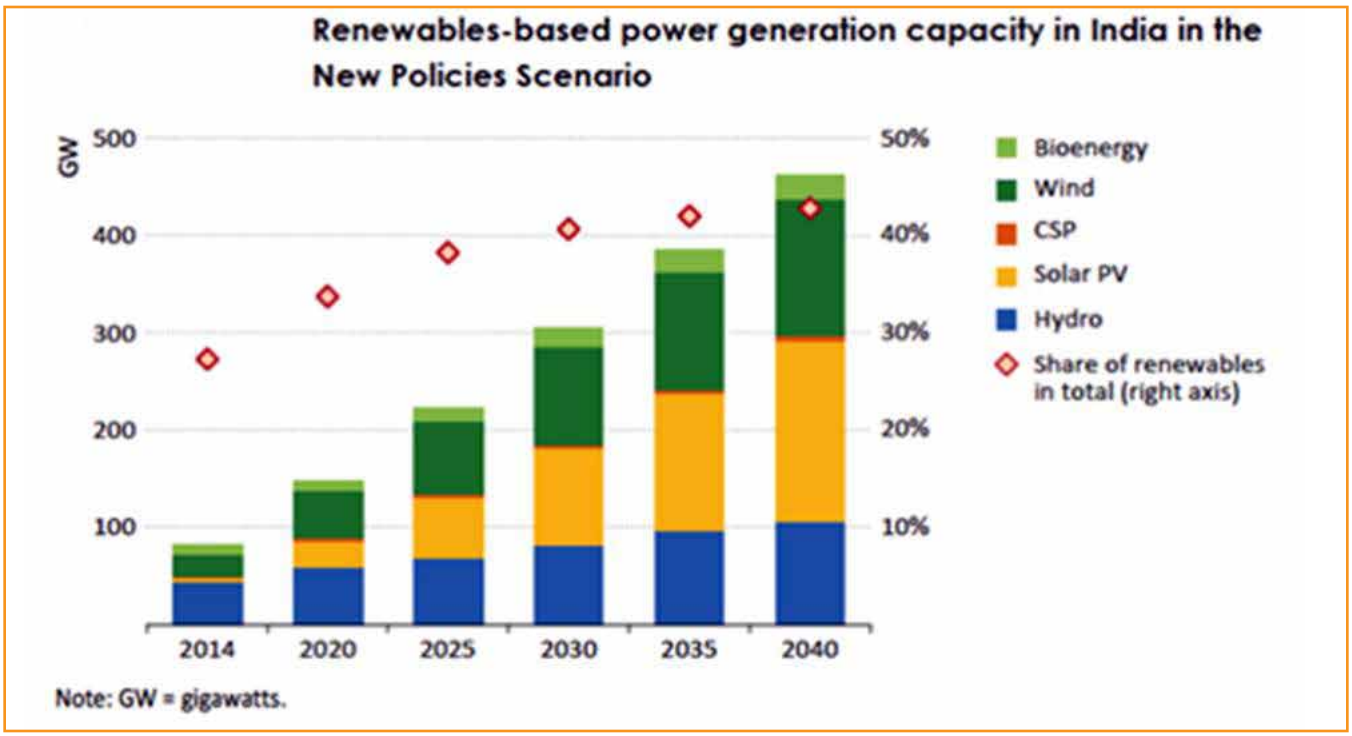
The website does not contain any fresh updates since 2012, including minutes of meetings or outcomes of the studies that had been in progress. Mails to the office go unanswered. The newspapers carried a report in early 2017 that the project might take 20 years to complete, but the way things appear now, it has been shelved altogether. Letters to the PMO also have been dismissed without any response or explanation.

In fact the project could have been much better planned and moved at a much better pace and lesser cost, had the various committees and groups adopted a visionary approach or used same level of ingenuity as had been used for creating the concept. The Project has far more potential than envisioned till now, and can certainly be completed much faster and at a much

lesser cost than being projected now. Some of the possibilities are:

- Instead of a conventional dam, it could be a much wider rock and clay dam, constructed by dredging the sea and developing the entire area as a unique reclaimed land with holiday resorts, forests and public entertainment parks. Aswan dam in Egypt was constructed in a similar manner.
- The site of the dam should be further south of where it has been envisioned now, taking Dahej and Bhavnagar ports also in the sweet water part.
- There could be a navigation lock system connecting the two sides of the dam through a pair of gates allowing movement of ships from one side to the other at different levels, which would be a further tourist attraction, and luxury cruises could be deployed.
- An island resort could be developed for tourism purposes.
- Water sports could be encouraged.
- An international airport could be developed on an artificial island like the Kansai airport (Osaka) to share the load of traffic from Mumbai, Delhi and Ahmedabad airports. This could be developed as the best airport of India, comparable to Dubai and Changi.
- The difference in level on both sides could be further utilized to generate hydro-electric power.
- The entire sea front would now be more similar to a lake front due to calm and static water level and could be developed along with a rail track/ road for even better connectivity with remote small areas, triggering growth in these areas also.
- All these projects would be commercially very attractive and many private players would come forward to invest in these, thus saving the Government significant investment. In fact if planned with a good strategy, after the initial technical studies, the Government may not have to invest any more, but would earn by giving licenses to private operators for all such activities.

It is surprising that such a wonderful project should be at a standstill for so long. It is hoped that a fresh look at the project be given, whatever obstacles have appeared, be removed, and a dynamic leader like Sridharan be entrusted to steer the project forward.



Natural Gas Hydrates –New frontiers for Energy Security of India and Technological Developments for Commercialization

By Dr Pushpendra Kumar

India requires huge energy in coming years due to increased demand from industrial and domestic sectors. This becomes critical as required growth in domestic supply from conventional energy resources is not achievable due to resource limitations. Recent activities and results show that gas hydrates have enough potential to meet the future growth in demand of energy in the country.

India needs a game changer like what shale gas has done for the USA. Gas hydrates may play a similar role in India due to huge resource potential. The energy resource potential of gas hydrates is much more than the combined energy resources of coal, oil & gas, peat, moss etc. As per the global estimates, about 20000 TCM (742000 tcf) of natural gas is considered to be entrapped in the natural gas hydrates. Based on the studies, it is understood that Gas Hydrate prognosticated resources in India are approximately 1894 TCM (66886 tcf). The global resource potential of gas hydrates distributed in sand hosted reservoirs has been estimated recently(Art Johnson, 2011)which is about 43000 tcf globally and 933 tcf in Indian offshore. Even if 10% of this 933 tcf gas in place in hydrate bearing sands is produced, it would fulfill the energy requirement of the country for many decades from gas hydrates alone.

Due to the vast energy resource potential of gas hydrates, many countries such as USA, Canada, Japan, India, Korea, China, Taiwan, Norway etc have undertaken National Gas Hydrate Programs.

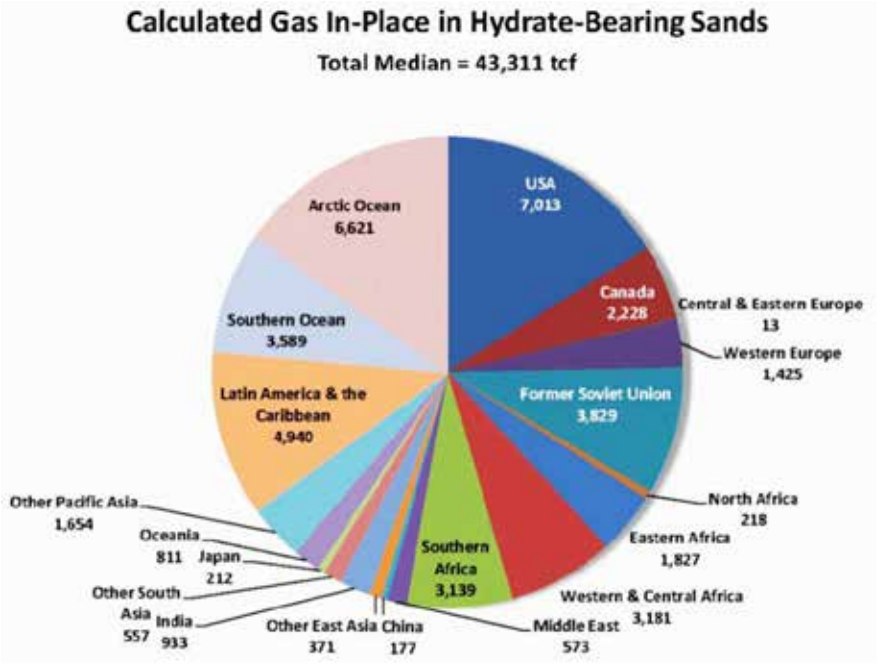
Dr Pushpendra Kumar
Former Group GM & Head – GHRTC, ONGC

Dr. Pushpendra Kumar is Ph D in Chemistry from University of Allahabad and carried out the studies and research on natural gas hydrates at Colorado School of Mines, USA. He joined ONGC in 1984 as Chemist and superannuated from ONGC on 31st March 2018 as Group General Manager & Head-Gas Hydrate Research & Technology Centre, ONGC.

Dr. Kumar had been involved in Indian National Gas Hydrate Program (NGHP) since its inception in 1997 and has taken several initiatives on gas hydrate exploratory research in Indian Offshore. His major initiatives include the planning, execution and monitoring of gas hydrate coring/drilling/logging in Indian Offshore under NGHP Expedition 01 in 2006 & NGHP Expedition 02 in 2015. Dr. Kumar was the Project manager for National Gas Hydrate Program Expedition 02 (NGHP-02) wherein two world class gas hydrate reservoirs have been discovered in KG deep offshore area.

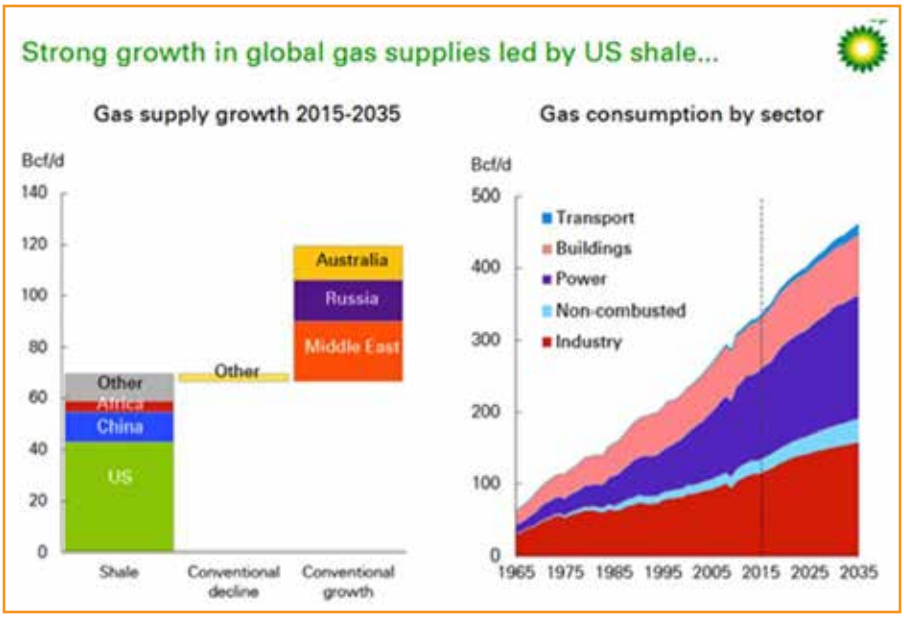
Dr. Kumar has been instrumental for major international cooperation under Indo-US and Indo-Japan cooperation programs in the area of gas hydrate with United States Department of Energy (USDOE), US Geological Survey (USGS), US Bureau of Ocean Energy Management (USBOEM), Texas A & M University, USA and AIST, Japan.

Dr. Kumar was the spotlight scientist in the Winter 2007 issue of Fire-in-the-ice news magazine published by US Department of Energy. Dr. Kumar was invited to Co-chair the Gas Hydrate Session during American Geophysical Union Congress in December 2007 in San Francisco, USA. Dr. Kumar was invited by Noble Laureate Dr. Carlo Rubia, Director-Institute for Advanced Sustainability Studies, Potsdam, Germany to participate in “Hearing on Gas Hydrates” during 8-9th Nov 2011. Dr. Kumar was invited for a talk on India’s Gas Hydrate Program during OTC -2016 in Houston, USA Dr. Kumar has received 23 Awards/Merit certificates including the OCEANTEX-2010 Award of Excellence for Outstanding Achievements in the R&D in the area of Gas Hydrates Dr. Kumar has one patent on gas hydrates and is coauthor on two books published by Elsevier, USA. He has published/presented 78 papers on gas hydrates and other topics in international/national journals/conferences and workshops in India and abroad. His papers have 526 citations as per the Research Gate Citation Index.



drate Programs for dedicated research on gas hydrates for exploration and potential exploitation.Globally, so far eight dedicated gas hydrate pilot production tests have been conducted in the field in order to test the technologies in arctic & offshore areas (3 tests in Canada, 2 tests in USA, 2 tests in Japan and more recently 1 test in China in 2017). Although these pilot scale field tests were for short period of time ranging from a week to maximum two months, the tests have successfully demonstrated the potential technologies for gas production from gas hydrate reservoirs. However, long term tests for extended period of time are required for establishing the sustained production and commerciality of gas hydrate exploitation. One such long term pilot production test extending beyond one year is planned in North Slope of Alaska jointly by USA and Japan to assess the long term production sustainability and economic viability for commercialization.

Gas hydrate exploratory research in India is being steered by the Ministry of Petroleum & Natural Gas (MoP&NG) under National Gas Hydrate Program (NGHP) with participation from Directorate General of Hydrocarbons (DGH), National E&P companies (ONGC, GAIL, OIL & IOC) and National Research Institutions (National Institute of Oceanography, National Geophysical Research Institute and National Institute of Ocean Technology & Geological Survey of India). ONGC being a leading National E&P Company is carrying out research on gas hydrates since early 90's prior to inception of NGHP in 1995 and has contributed significantly in the planning and execution of NGHP Expedition 01 in 2006 and NGHP R&D Expedition 02 in 2015.



The two gas hydrate expeditions conducted in India in 2006 (NGHP-01) and 2015 (NGHP-02) have led to the discovery of world class producible gas hydrate fields in KG deep waters. The established resources of gas hydrates need to be commercialized on a Mission Mode. Before the Commercialization of Gas Hydrates, a dedicated Expedition is planned for carrying out Pilot Production testing for understanding the reservoir behavior to address the field specific challenges for cost effective production of gas from gas hydrates in Indian Offshore. The technological challenges that need to be understood before the commercialization of gas hydrates are cost effective conversion of solid gas hydrates into fluid phase in the reservoir, low productivity of gas per well, sand control measures, geo-mechanics and fluid dynamics of the reservoir. Some of these issues have already been addressed in the pilot production tests conducted through international cooperation by USA, Canada, Japan and China. However, further research/ technological development is required before commercialization of gas hydrates becomes a reality.

This paper presents the gas hydrate resource potential globally as well as in India and the technological developments for gas hydrate commercialization in the near future. The paper will also present techno-economics of gas production from hydrate reservoirs.

Unlocking Renewable Energy Potential for India

By Dr Suresh Chandra Sharma

Renewable Energy status for India

The Indian renewable energy sector is the second most attractive renewable energy market in the world. The country ranks fourth in the world in terms of total installed wind power capacity. Installed renewable power generation capacity has increased steadily over the years, posting a CAGR of 9.29 per cent over FY08–18. India added record 11,788 MW of renewable energy capacity in 2017-18. The focus of Government of India has shifted to clean energy after it ratified the Paris Agreement. With the increased support of government and improved economics, the sector has become attractive from investors perspective. As India looks to reduce its energy import dependence, the renewable energy is set to play an important role. India has already launched a program to deploy renewable energy capacity of 175 GW by 2022 in order to reduce dependence on imported energy sources..

Some major investments in Indian renewable energy sector are as follows:

- With 28 deals, clean energy made up 27 per cent of US$ 4.4 billion merger and acquisition (M&A) deals in India's power sector in 2017.
- In March 2018, ReNew Power finalised a deal estimated at US$ 1.55 billion to acquire Ostro Energy and make it the largest renewable energy company in India.
- World's largest solar park named 'Shakti Sthala' was launched in Karnataka in March 2018 with an investment of Rs 16,500 crore (US$ 2.55 billion).
- Solar sector in India received investments of over US$ 10 billion in CY 2017.
- Private Equity (PE) investments in India's wind and solar power have increased by 47 per cent in 2017 (January 1 to Sept.) to US$ 920 million, across nine deals, as compared to US$ 630 million coming from 10 deals during the corresponding period in 2016

Initiatives taken byGovernment of India to boost Indian renewable energy sector:

- The Ministry of New and Renewable Energy (MNRE) has decided to provide custom & excise duty benefits to solar rooftop sector, which in turn will lower the cost.
- Around 4.96 million household size biogas plants were installed in the country under the National Biogas and Manure Management Programme (NBMMP) by end of 2016-17.
- The Indian Railways is taking increased efforts to use clean energy to cut down emission level by 33 per cent by 2030.

Renewable energy has a great potential to usher in universal energy access

In a decentralized or standalone mode, renewable energy is an appropriate, scalable and viable solution for providing power to un-electrified or power deficient villages and hamlets. Currently, over 1.2 million households are using solar energy to meet their lighting needs and to meet their cooking energy needs from biogas plants. Solar Photovoltaic (PV) power systems are being used for a variety of applications such as rural electrification, railway signaling, microwave repeaters, mobile towers, TV transmission and reception and providing power to border outposts.

Dr Suresh C Sharma
Former OSD (Energy & Climate Change) to GoI & Former Group GM, ONGC

Dr S C Sharma is former OSD (Climate Change & Energy), Planning Commission and former Group General Manager, ONGC. Advised Government of India on energy sector policy formulations investment decisions for projects and enterprise development from E&P to natural gas, LNG, refining & marketing, power, nuclear, renewable energy, fertilizer, petrochemicals, transport, shipping, Inland waterways, social infrastructure. Member of bilateral & multilateral dialogues with major OECD nations.

Resource Potential for Wind, Solar, Hydel and Biomass

India has an estimated renewable energy potential of about 900 GW of commercially exploitable sources viz. Wind – 102 GW (at 80 metre mast height); Small Hydro – 20 GW; Bioenergy – 25 GW; and 750 GW solar power, assuming 3% wasteland is made available. The Ministry had taken up a new initiative in 2014 for implementation of wind resource assessment in uncovered / new areas to assess the realistic potential at 100 m level in 500 new stations across the country. National Institute of Wind Energy has used advanced modeling

techniques and revised the estimate the wind power potential at 100-metre hub height at 302 GW.

Preliminary estimates of offshore wind energy potential indicate potential in Tamil Nadu and Gujarat. Under off-grid applications, there exists significant potential for meeting hot water requirement for residential, commercial and industrial sector through solar energy and also for meeting cooking energy needs in the rural areas through biogas. The total estimated resource potential of renewable energy including for some of the major states is given below in table 1 for major states.

The National Institute of Wind Energy (NIWE) has developed the Wind Atlas of India. NIWE also collects data from Solar irradiation resource assessment stations to assess and quantify solar potentialfor development of Solar Atlas of the country. National Institute of Solar Energy has assessed the State wise solar potential by taking 3% of the waste land area to be covered by Solar PV modules. The Indian Institute of Science, Bengaluru has developed Biomass Atlas of India, and the Alternate Hydro Energy Centre, Indian Institute of Technology, Roorkee has assessed small hydro potential of country.

India's Current RE Deployment & Future Plan Ahead

Total installed renewable energy capacity (including large hydro projects) in India touched 114.43 GW as of May 2018, which is around 33 per cent of total power capacity of the country. According to data released by the Department of Industrial Policy and Promotion (DIPP), FDI inflows in the Indian non-conventional energy sector between April 2000 and December 2017 stood at US$ 6.26 billion. More than US$ 42 billion has been invested in India's renewable energy sector since 2014. The installed capacity (MW) can be seen from Table 2.

The Government of India is committed to increased use of clean energy sources and is already undertaking various large-scale sustainable power projects and promoting green energy heavily. In addition, renewable energy has the potential to create many employment opportunities at all levels, especially in rural areas.

Plan for 175 GW RE Deployment by 2022

The MNRE has set an ambitious target to set up renewable energy capacities of 175 GW by 2022 of which about 100 GW is planned for solar, 60 GW for wind & other for hydro, biomass & others. India will need investments of around US$ 125 billion to reach this target. It is expected that by the year 2040, around 49 per cent of the total electricity will be generated by the renewable energy, as more efficient batteries will be used to store electricity which will further cut the solar energy cost by 66 per cent as compared to the current cost. Use of renewables in place of coal will save India Rs 54,000 crore (US$ 8.43 billion) annually. Table 3 gives a snapshot of targets for 2022.

Offshore Wind Potential

To give confidence to the country's wind industry, the MNRE has now announced the medium and long-term target for offshore wind power capacity additions in India, which are 5 GW by 2022 and 30 GW by 2030. This announcement comes on heels of high interest shown by stakeholders in the first ever expression of interest (EoI) for an offshore wind project. In April 2018, the National Institute of Wind Energy (NIWE)had invited Expression of Interest (EoI) for the development of country's first offshore wind energy project, which was further extended in May 2018.

Offshore wind power would add a new element to the already existing basket of renewable energy mix for the country. MNRE had notified National Offshore Wind Policy in October 2015 to realize the offshore wind power potential of the country. Preliminary studies have indicated good wind potential for offshore wind power both in southern tip of the Indian peninsula and along the country's western coast. Two regions where preliminary studies have been conducted are the off coasts of Gujarat and Tamil Nadu. For precise wind quality measurements, one LiDAR has been installed near Gujarat coast, which is generating data about the quality of offshore wind since November 2017. Encouraged by the quality of offshore wind, a

Table-1.Renewable Energy Resources in India (MW)

S. No	States	Wind@100m	SHP	Bagasse Cogen	WTE	Biomass	Solar	Total
1	Gujarat	84431	202	350	112	1221	35770	122086
2	J&K		1431			43	111050	112523
3	Karnataka	55857	4141	450		1131	24700	86279
4	Rajasthan	18770	57		62	1039	142310	162238
5	Tamil Nadu	33800	660	450	151	1070	17670	53800
6	Other States	109393	13258	3750	2231	13034	417490	559156
Total		**302251**	**19749**	**5000**	**2554**	**17536**	**748990**	**1096081**

Table-2 - India's Renewable Energy Capacity (MW)

Sector	FY- 2018-19		Cumulative Capacity
	Target	Achievement	(as on 31.05.2018)
I. GRID-CONNECTED (MW)			
Wind Power	4000	48.2	34193.2
Solar Power-Ground Mounted	10000	530.81	21118.64
Solar Power-Roof Top	1000	147.12	1210.75
Small Hydro Power	250	7.4	4493.2
Biomass (Bagasse Cogeneration)	250	0	8700.8
Biomass (non-bagasse)	100	12	674.81
Waste to Power	2	0	138.3
Total	**15602**	**745.53**	**70529.7**
II. OFF-GRID CAPACITY (MW)			
Waste to Energy	18	0	172.15
Biomass Gasifiers	1	0	163.37
SPV Systems	200	51.57	722.98
Total Off-grid (MW)	**219**	**51.57**	**1058.5**

private sector player has also installed LiDAR in Gulf of Kutch in Gujarat for offshore wind resource measurements. Plans are afoot to install more of such equipment in Tamil Nadu and Gujarat. Surveys to understand the oceanographic and seabed condition within identified zones off the coast of Gujarat and Tamil Nadu have also been planned. Globally, there have been installations approximating 17-18 GW of offshore wind power led by countries such as UK, Germany, Denmark, Netherlands, and China. Recent years have witnessed fall in offshore wind tariff in some of these markets.

Offshore wind Policies and Economics

MNRE has come up with offshore wind energy policy with following salient features:

- Preliminary Resource Assessment and demarcation of blocks
- Oceanographic studies - to determine construction costs for special foundations, special ships for both operation and maintenance requirements
- Sea Bed Lease Arrangement
- Single Window Procedure for Statutory Approvals (NOWA)
- Grid Connectivity and Evacuation of Power
- Technology
- Fiscal and Monetary Incentives
- Security & Confidentiality of data collected during studies and surveys

Other features of Offshore Wind Policy as stated below:

- Incentives available to onshore wind projects viz. tax holidays; concessional customs/excise duty etc. may be available to offshore wind projects.
- Government may call for proposals for development of offshore wind energy demonstration project(s) in specified block(s).
- Existing leaseholders of seabed for other purposes such as oil & gas exploration and exploitation, seabed mining etc. who are interested in installation of offshore wind farm on their existing lease to route proposal through NOWA.

MNRE to act as a nodal ministry for development of offshore wind energy on following:

- Overall monitoring of the offshore wind development in the country.
- Co-ordination with other Ministries/ Departments.
- Issuing guidelines/directives for development of offshore wind energy.
- Oversee working and to provide necessary support to National Offshore Wind Energy Authority (NOWA) for smooth functioning.
- Promoting indigenous research for technology development.

National Offshore Wind Energy Authority (NOWA) to be established under MNRE - to be responsible for the following:

- Carry out Resource Assessment and Surveys in the EEZ of the country.
- Enter into contract with the project developers for development of offshore wind energy project in the territorial water (12 nm).
- Single Window Agency to facilitate clearances.

Role of other agencies/Bodies:

- Offshore Wind Energy Steering Committee, under the Chairmanship of Secretary, MNRE to oversee overall development of Offshore Wind Energy.
- Ministry of Shipping (for major ports), State Maritime Board/state designated agency to provide port related logistical support.
- State Electricity Board/state designated agency to undertake power evacuation.
- CERC & SERCs to finalize guide-

Table-3 - Renewable Energy Capacity by 2022

Source of Energy	Targets for 2022 (MW)
Solar PV- Ground Mounted	60,000
Solar PV- Rooftop	40,000
Wind Onshore	60,000
SHP	5,000
Biomass	10,000
Total	175,000

Table-4 - Cost of Renewable Energy Technologies

Technology	Useful Life	PLF/CUF	Capital Cost	O&M Expense	Fuel Availability	Auxiliary Consumption
Wind	25	22%-35% depending on height hub	Rs 500 Lacs –Rs 750 Lacs	Project Specific & market Competitive	Depends on wind density	Not Applicable
Solar	25	19%	Vary by market and the size of the system	Project Specific &market Competitive	Abundantly available	For Solar thermal-10% and for Solar PV- None
SHP	35	30-45% depending on region	Rs 593 Lacs- Rs 830 Lacs	Rs 18.9 Lacs-33.2 Lacs	Major potential exists in hilly areas	In the range of 10%-13%
Bio-power Cogen	20	60%-80%	Rs 559 Lacs-Rs 652 Lacs	40 Lacs	Surplus bio-mass availability	1st year-11% and 2nd yr onwards 10%

lines for transmission, distribution and purchase of power from Offshore Wind Energy Projects

Cost of Offshore Wind Deployment

At present, the cost associated with setting up of offshore wind farm is on the higher side with respect to the mature technology of onshore. The cost is around 10-15 Cr for setting up 1 MW offshore wind farm in India. Besides, there is no word yet on how the power from offshore farms will be priced. Offshore windmills are more expensive than onshore ones. Power generated could cost around Rs 9-12 per unit, compared to around Rs 2.43/ kwh for onshore wind power. But, there are other cost reduction potentials like:

- **Cheap labour, material and production cost:** A report published by Global Wind Energy Council (GWEC) and the Indian Wind Turbine Manufacturers Association (IWTMA) on the wind energy industry in India reveals that turbine prices have always been lower than the global average due to lower labour and production cost in the country.
- **Economies of scale:** Another factor favoring the cost reduction is the mass production of turbines. The current annual production capacity of onshore wind turbines manufactured in India is about 3000-3500 MW, including turbines for the domestic as well as for the export market. With the new market entrants, it is expected that the annual production capacity will rise to 5000-6000 MW per year by 2015.

Learning-by-doing: The process of gaining experience from a project and applying it in an improvised manner to other projects count for learning-by-doing. At Horns Rev and Nysted wind farms (Denmark), the world's two largest offshore wind farms built until the end of 2003, for the first time purpose-design ships were used for turbine erection, both by the same contractor. Horns Rev was build in 2002 and 80 turbines were installed in the farm. ¬The average installation time was reduced from over 3 days per turbine for the first few turbines to a final average of 1.4 turbines per day.

Cost of Renewable Energy Deployment

Table below gives benchmark costs associated with different renewable energy technologies present in India as per CERC.

Policies for Promoting Renewable Energy in India

The Government of India has undertaken a number of policy measures for increasing share of renewable energy in India's energy mix. These, inter-alia, include:

- Provision of Renewable Purchase Obligation (RPO) under the National Tariff Policy
- Notification of the long-term growth trajectory of RPO for solar and non-solar energy for next 3 years from 2016-17, 2017-18 and 2018-19
- Development of Solar Parks and Ultra Mega Solar Power Projects
- Development of power transmission network through Green Energy Corridor project
- Making roof top solar as a part of housing loan provided by banks
- Waiver of Inter-State Transmission Charges and losses
- Repowering of Wind Power Projects for optimal utilization of wind resources
- Offshore wind energy policy for development of offshore wind energy for Indian Exclusive Economic Zone.
- Supporting research and development on various aspects of renewable energy including with industry participation
- Financial incentives for off-grid and decentralized renewable energy systems and devices for meeting energy needs for cooking, lighting and productive purposes; and
- Permitting 100 percent Foreign Direct Investment in sector through automatic route.

Advantages of Renewable Energy for India

- Multiple Forms: Multiple renewable energy sources can now be used. These energy sources are now virtually limitless unlike fossil fuels, which are a finite resource.
- Green Energy:Unlike fossil fuels, renewable energy sources have a very low impact on the environment.
- Energy Independence:Renewable energy allows India to become more energy independent, therefore al-

lowing them to control their pricing and availability.

- Less Maintenance:The facilities used for renewable energy need less maintenance. Due to the production process, it means there is less likelihood of wastage product.

Conclusion

India has huge potential for producing power from Renewable Energy Sources (RES). Over the last few decades, in particular, Government of India has endeavored to lay the foundation for a broad-based renewable energy program and designed it specially to meet the growing energy needs, and to fulfill energy shortage and security concerns of the country. Considerable experience and capabilities exist in the country on renewable technologies. Although at present the contribution of renewable energy is small, but future developments might make RES technology more competitive to displace conventional energy sources. Prospects for RES are steadily improving in India towards a great future. As conventional energy sources start to run out and promote speculative prices, the world is now starting to seeimpact of fossil fuels-burning on the environment& climate change. Therefore it's imperative we gradually change from fossil fuels to more renewable resources to benefit our future generations. Renewable energy is excellent for country's energy independence. This also applies when to households if you are to use solar rooftop panels in your home with storage technology, which is gradually becoming competitive.

As the storage technology becomes more cost affordable, unlocking renewable energy potential in next 20 year could possibly facilitate the share of renewables reaching to 30% to 40% in total share of energy to save the climate and environment.

Conventional and non-conventional Energy Prospects in India

By S K Pandey

India, though, being the third largest consumer of energy after USA and China, its per capita energy consumption is only one third of the average of world. More than 80% of oil and 44% of gas from the present consumption is being imported making a huge impact on fiscal. In such situation it has become very necessary to look for a sustainable and affordable source of energy which can make us free from dependability to the possible extent. The author has look for various sources of energy in the Indian context, its availability, sustainability and affordability with minimum impact on environment, and made an efforts to suggest a focus area, where we can intensify our activities to move a step ahead towards energy security. Though the Government has made a lot of efforts in this direction in terms of modification in policy for better participation, oversea investment and indigenous production, but the situation demands more to ensure the basic need of their citizen. The author has made an effort to look into the direction of energy security.

Energy plays vital role starting from the generation to the destruction of any civilization. The nature and the type of energy or say fuel that human kind have been using since the start-up of civilization is a measure of its growth and advancement. There has been the time, before the fire was invented, the source of energy have been the same, what we have been looking for today ie renewables. Sun used to warm them and the wind used to cool them to keep the human civilization alive and moving ahead. Stepping up the fuel from wood to coal to oil to gas and now to renewables indicates that ultimately we have to surrender before Mother Nature who has abundance for her children. She has enormous and unlimited energy for human civilization to sustain and grow, the question is how we take it out from her replenishable and uncountable reserve.

The author Tom Bower in his famous book " The Squeeze" had once commented that the disaster happened when the oil was invented. Had it not been, perhaps the human society, by now, would have explored other source of energy and the global warming, ecological imbalance, global polarization, gulf war and many others unwanted related to oil and gas would not have been talked about.

The energy is the prime need for the development of the society. The progress and prosperity of the society is measured by how much energy they consume per capita. Though India is the third largest consumer of energy , after USA and China, but the per capita consumption is much less and falls much below the average of the world. India's per capita electric energy consumption is 957 kwh per year, which is one third of world average and around fourteen times less than USA and four times less than China. The primary energy consumption per capita in India has been reported to be 560 kg of oil equivalent, which is 13 times less than USA and one third of China's.

In such scenario, where India is much starved of energy it has become imperative and essential to look for a dependable and secured source of energy. The present dependability of 82.1% of oil and 44.4% of gas on import, makes us think for an alternative, which can be indigenous and sustainable source. Non-conventional and Renewable, are the areas where India can venture out safely with a calculated risk.

S K Pandey
Former Executive Director, ONGC

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Total 26 sedimentary basins, consisting of more than 31.3 lacs sq kms, have been explored in India. Out of these,seven consisting of about 5.3 lacs sq km, falling in category I,are under exploitation and production. The next categoryII, consisting of threebasins of total about 1.82 lacs sq km, though reported to be promising are yet to be exploited. Remaining sixteenbasins where a lot of uncertainties prevail. These are only indicative and therefore cannot be considered for the energy security of the nation. The Basin in deep water consisting of about 13 lacs sq km are distant probabilities. Though, a multi organizational team (MOT) constituted by MOPNG, consisting of ONGC, OIL and DGH,

have indicated in their report in 2017, that the total estimated hydrocarbon reserve consisting of both oil and gas have moved upward by about 49%, but still, even it is true, this alone cannot ensure the energy security to a third largest consumer of world. It is therefore not prudent to depend upon conventional source and therefore we must look for non-conventional.

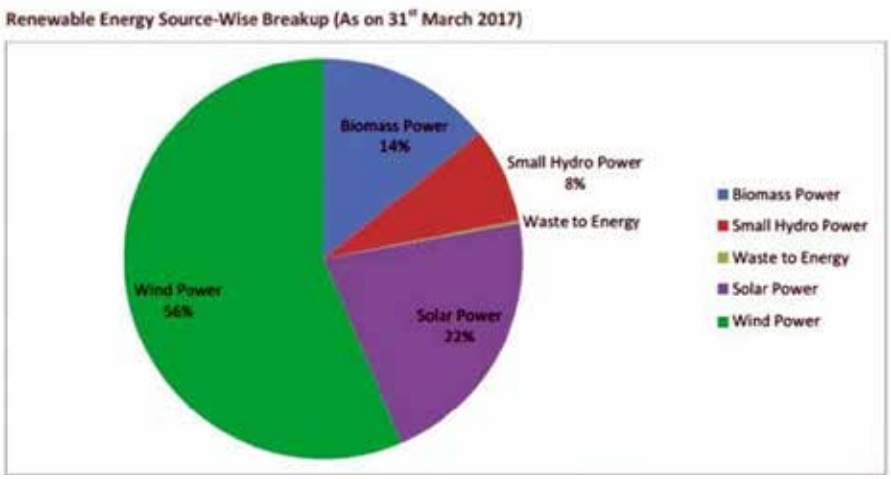
Non-conventional source can be divided in following five categories, which can be look in Indian prospective. Government of India accounts small hydroelectric under the category of renewables, but the same has not been focused here.

1. Shale oil & gas
2. Coal Bed Methane (CBM)
3. Gas Hydrates
4. Renewables, and
5. Nuclear

Shale Oil gas Gas –It is estimated that a number of sedimentary basins situated mostly in coastal area like Gujarat, Rajasthan, Andhra Pradesh have vast reserve of shale, along with hydrocarbon bearing zone like Cambay, Assam, Arakan and Damodar. Various agencies have estimated the reserve of shale gas in India, which are as under.

1. M/s Schlumgerger reported a figure of 300 to 2100 cft (Cubic Feet)
2. EIA (Energy Information Administration), USA in his report issued for the year 2011 estimated the shale gas reserve to be 290 cft, which was further modified to be 584 in its 2013 report.
3. ONGC has estimated this figure to be 187.5 in its survey in Cambay onland, KG onland, Cauvery onland, Ganges Valley, Assam and Arakan.
4. CMPDI (Central Mines Planning & Design Institute), Ranchi estimated in six sub basins covering mostly in coal bearing zone like Jharia, Bokaro, North Karanpura, South Karanpura, Raniganj and Sohagpur and reported a figure of to be 45 tcf.
5. United States Geological Survey has reported 6.1 tcf recoverable from Cambay, KG and Cauvery.

If we take our own conservative estimate by ONGC, in Cambay, KG, Cauvery and others where conventional E&P activities are already in place and therefore logistic support, we can look into, examine and to venture out , subjected to technological and environmental constraints.



Shale gas exploitation needs fracking which is water intensive. It has been estimated that on an average around 25 to 30 thousand cubic meter of water is needed for a single well fracking. It requires space for the effluent treatment and fear of waterbody getting contaminated due to leakages always exists. In a country like ours, where space and potable water have always been always issues, one has to think over. TERI in its report has very categorically ruled out this venture in Indian context due to being a water scare nation and space constraint. There needs to be a technological advancement in fracking of shale to make it techno economically viable for India. It has been reported that though China has the shale gas reserve twice more than USA, but could not venture out because of the field being located in difficult terrain, much higher depth and want of suitable technology in that context.

As per policy guidelines ONGC and OIL have to carry out shale gas and oil exploration in 50 and 5 wells respectively. ONGC so far drilled 22 wells in 18 blocks in four basins. OIL has drilled two wells in upper Assam and Jaisalmer. The studies are under way.

Coal Bed Methane (CBM) – The gas found out in coal bed seam is mostly methane and hence called CBM.It is adsorbed on the surface of coal unlike the conventional reservoir where the gas is pocketed in the pores and therefore need to be permeable to flow. The estimate reserve of CBM, as per the report issued in April 2017 by DGH, is 91.8 tcf (2.6 tcm). It is spread over in eleven states , and mostly located in Jharkhand state.

GOI has awarded 30 CBM blocks so far under four rounds of bidding to national, private and joint venture companies. In addition, two CBM block awarded on nomination basis and one through FIPB (Foreign Investment Promotion Board). CBM in place reserve of 9.9 tcf has been established by different operators. The recoverable is estimated to be around 28%.

E&P of CBM has become a full proven technology and many countries like Russia, China, Australia, Canada are exploiting it to commercial production. In India M/s GEECL and M/s Essar Oil are commercially producing CBM @ 5.5 and 8.8 Lacs m^3 per day from Raniganj South and Raniganj East field, respectively. RIL from its allocated field of Sohagpur in MP, is commercially producing @ 8.4 lacs per day. ONGC in its nominated Jharia field is producing, though at low rate of 10000 m^3/d.

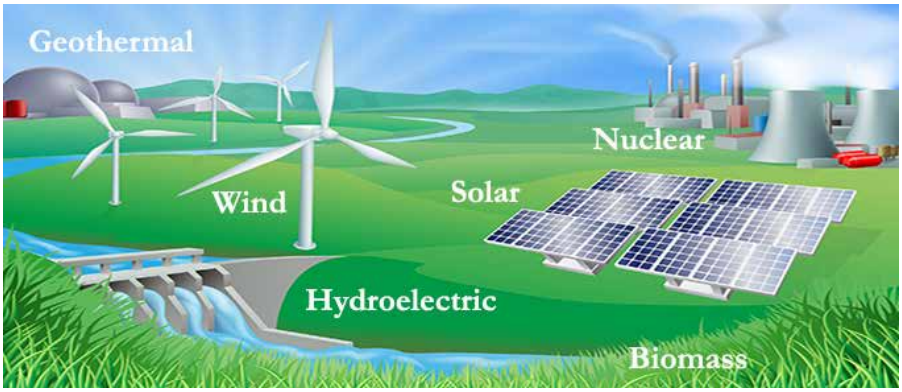
The exploitation of CBM from coal mines has got very large safety benefit . The evacuation and purging out of methane from coal mines is essential from the safety point of view and therefore mandatory, before entry to make it operational. At present, CBM from the mines are purged out and released in

atmosphere to facilitate the coal mining operation. This does not only create a fire hazard, but destroys the ozone layer of the planet which has 23 times more Ozone Depleting Potential than CO_2. Montreal Protocol which talks about ozone layer protection, very strictly prohibits the release of hydrocarbon in atmosphere.The exploitation of CBM from coal mines can avoid the release of methane to atmosphere to a great extent which is presently being carried out in the pretext that the capturing the methane is commercially non-viable.

Coal quality in India ranges from high volatile to low volatile bituminous with high ash content (10-40%) and its gas content is between 3-16 m^3/t of coal, depending upon the rank of the coal, depth of burial and geo tectonic settings of the basin , as estimated by CMPDI, Ranchi. Jharia coal field, which is considered to be the most prospective area, the gas content is estimated to be 7.8 to 28 m^3/t of coal with a depth of 150 to 1200 meter. Analysis indicates that every 100 meter increase in depth is associated with an increase of 1.3 m3/t of methane. This indicates the high exploitable potential of CBM from coal mines.

Gas Hydrates – Gas hydrate is an ice like compound, formed under very high pressure and temperature under deep earth inside sea. It has very high potential to meet the energy demand of the world. Estimate in order of 1800 tcm. At 30 % recovery, this quantity is equivalent to meet the energy requirement of the country more than 2000 years, with present rate of consumption. But, so far, no breakthrough in exploitation has been reported . No country in the world have exploited the gas hydrate so far for commercial production. Japan had announced a time line to get breakthrough in gas hydrate exploitation , but so far nothing substantial has been heard.

GOI has has established National Gas Hydrate policy in 1997, under which NGHP-2 (National Gas Hydrate Project 2) drilled 42 wells in March-June 2015 in 25 different sites in KG Basin and discovered significant hydrate bearing sand reservoir. Studies are underway.



In such scenario it is not prudent to take the gas hydrate under the premises of energy security, until some significant technological breakthrough, to make it techno economically viable, is established.

Renewables – This is a great and abundant source of energy in Indian context. The production growth of renewable energy, particularly solar and wind has left much behind other sources both fossil and non-fossil.It leaves no carbon foot print and replenishableand least maintenance cost.

India has the large coastal perimeter (around two third of total) and receives excellent solar irradiance making it highly suitable for wind and solar power production. This has made, India as 4th largest wind power producer and 7th solar power producer in the world. As per E&Y, Renewable Energy Index, which takes into account various factors governing renewable energy growth in a country, India is ranked 3rd in the world. Out of total grid connected installed capacity of 343 GW as on May 2018, renewable (consisting of wind, solar, biomass and small hydro) contributes around 20%. The capacity growth has been 22% CAGR over last decade. More than 75% renewable energy production in India, comes from wind and solar. India's current installed capacity of wind power is reported to be 8.7 GW, which is approximately 10% of world installed capacity.

Government of India has set a target of 175 GW from all renewables by 2022 from present level of 69 GW, and providing a lot of incentive to promote the energy production from renewables.

Nuclear Power –Though many countries in the world, like Japan, France produce most of their required power from nuclear, but there is inherent risk of radiation involved in it. At the same time the reserve of the fuel, uranium, in India is dwindling and India has to depend on the import, mostly from Russia. Geo political condition and nuclear fuel transfer treaty makes it more cumbersome. India has been making advances in thorium based nuclear fuel. Also working on the design and development of proto type reactor based on thorium and low uranium. The installed capacity of nuclear power in India is 5.7 GW which is 1.8% of total installed capacity.

In such circumstances and geo-political condition with scarcity of fuel and very high consequential risk, it shall not be prudent to take it under the premises of energy security in India. The efforts to add this energy into Indian basket mix, must continue with advancement in technology and safety consideration.

Conclusion – Looking into the various aspects in different sources of energy, as mentioned above, for both conventional and non-conventional, their necessity and dependability, availability and affordability, technicality and sustainability, environmental impact and other determining factors, it is opined that India must focus on exploitation and production of energy from CBM and renewables mostly from wind and solar additionally. The present source from fossil must continue with still bigger thrust on E&P activities to feed the nation.

Renewable and Unconventional Sources of Energy in India - An Overview & Outlook

By Kanchan Kumar

Today, Renewables accounted for 19% of India's installed power capacity. India's renewable energy generation capacity has reached 62 GW, while the total installed power capacity in the country stood at 333 GW. The total renewables capacity includes 33 GW of wind, 10% of the country's overall power capacity. Next in renewable comes solar with more than 17 GW, 5% share of the total mix. Though, Coal remains the leading power source in the power capacity mix, while renewables ranked second.

However, as against the global wind energy of 540 GW, India's total wind energy capacity stands at 0.34 GW, almost negligible fraction. India has an untapped wind power potential both in onshore and offshore.

The Government has kept an on-shore wind energy target of 60 GW by 2022 and more than half of this has already been achieved. In a recent bidding, onshore wind power has emerged today one of the cheapest source of renewable energy in India at around Rs2.50 per unit.

As per estimate, India has an untapped offshore wind power potential of 125 GW, especially off the coasts of Tamil Nadu, Gujarat, and Maharashtra. India has a target of achieving 5 GW offshore wind power capacity additions by 2022 and 30 GW by 2030. India's first large-scale offshore wind project has attracted 35 Expressions of Interest (EoI) from the leading offshore wind developers, global and domestic. In April 2018, the Government had invited the EoI for the first 1 GW commercial offshore wind farm in India, off the coast of Gujarat.

Though the offshore wind energy project carries a set of challenges, like high costs and transmission issues besides operations and maintenance. But it is economically feasible for India. With its electricity generation cost even if matching to LNG, it can be an alternative /supplementary source. Secondly, initially, we may outsource O&M to global firms with a suitable provision for technology transfer/ training of our manpower.

Both solar power and wind power have emerged today as the cheap sources of renewable energy in India at around Rs. 2.44 and Rs 2.51 per unit respectively. More investment needs to be channelized to this sector and reduce ever-increasing oil import bill. Solar and Wind Power is

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He is a rank holder in MBA (Finance) and Gold Medallist in MSc (Statistics). He has passion for research and started his career as Lecturer with teaching to MSc classes at a University. He has attended advanced training programs at IIMs, Canadian Petroleum Institute and RBI.

He writes on oil & gas, global economy, investments, macro-economic and market analysis. He has written over 200 articles for different business papers and websites.

Mr Kanchan is now Chairman, Trustworthy Advisors Pvt Limited, and provides financial, technical and management advisory and consultancy services.

an environment friendly alternative. The concern for Environment also demands more emphasis on wind and solar energy, especially when out of most polluted 15 cities globally, 14 are in India.

Now, let us have a look onsome unconventional sources of energy. India has a coal reserve of 285 billion tonnes, the world's fourth-largest coal reserves and holds significant prospects for exploration and exploitation of CBM. CBM, a natural gas which contains 90-95% methane, is stored or absorbed in coal seams.

The progress in CBM so far has, however, remained slow. Though, 33 CBM blocks were awarded to different public sector and private companies through four rounds of bidding between 2001 and 2008, only four blocks have gone into commercial production. 9 Blocks are in Exploration or Development phase. The remaining allotted blocks have either been relinquished or likely to be relinquished. In last 10 years, no bidding round took place.

CBM is currently produced from only four blocks viz. Jharia block in Jharkhand by ONGC, Raniganj East in West Bengal by Essar Oil Ltd, Raniganj South in West Bengal by Great Eastern Energy Corporation and Sohagpur West in Madhya Pradesh by RIL. Last year, they together produced around 735 million standard cubic metres (MMSCM) of CBM.

"BP projections show that
1. India's energy consumption would grow by 4.2% p.a., the fastest among all major economies by 2040 with coal contributing most to meeting this demand followed by renewables.
2. Renewables become the second largest source of domestic energy production overtaking gas and then oil by 2020."

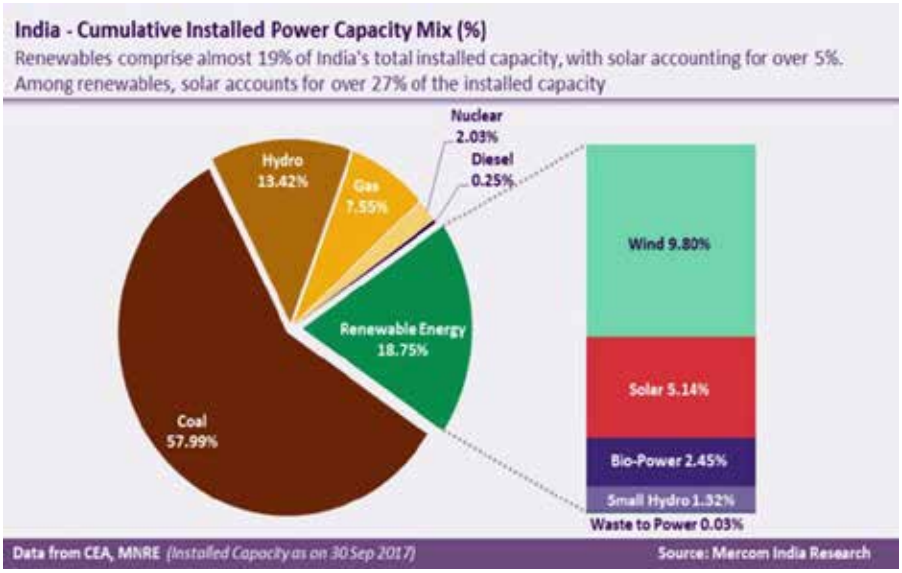
BP Energy Outlook 2018

"On the supply side in the India's power generation mix, renewables will give big competition to the coal sector. By 2040 coal's share drops to half from 76% today, solar PV rises by 100-fold and wind by nine-fold."

World Energy Outlook Nov' 2017 by International Energy Agency (IEA)

Some of the reasons for slow growth has been coal bed methane areas overlapping with coal blocks, delay in land acquisition and statutory clearances, water handling problems and lack of gas infrastructure in CBM blocks.

The liberalized regulations and policies relating to CBM are expected to make investment in CBM attractive.



First, in March 2017, the government's new policy provided marketing and pricing freedom at arm's length price in the domestic market to contractors of CBM blocks. As a result, CBM fetches higher price than the government- formula based natural gas price.

Second, under new Hydrocarbon Exploration License Policy (HELP), the contractors get full right under a single license for the entire contract duration to explore and produce both conventional and unconventional oil and gas resources, including coal bed methane, shale gas and oil and gas hydrates. No separate license is needed for exploration and production of CBM.

Third, similarly, Coal India and its subsidiaries holding Coal Mining Lease will not have to make fresh application to the Petroleum Ministry under the P&NG Rules 1959 for grant of Mining Lease (ML) for CBM. This removes a major retarding force in development of CBM in India.

In short, the liberal terms make the investing in CBM more attractive. The Industry leaders believe the share of CBM gas in India's natural gas basket may go up from the present 3% to 10% in next five years.

COAL TO GAS

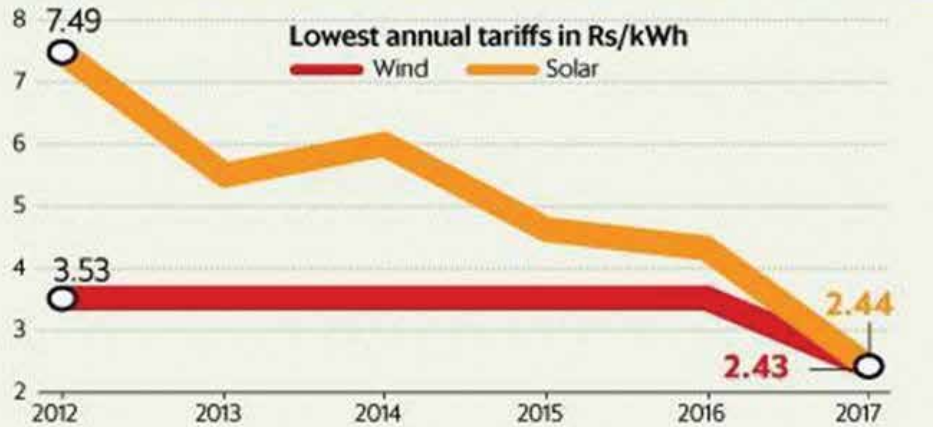
Another potential way of exploiting India's huge coal reserve is to convert coal to gas at the underground location.

Coal resources that are not suitable for conventional mining, such as too deep, low grade, or that have thin layer resources, can be converted to gas at the underground location by the process of underground coal gasification (UCG). Air, oxygen, water or steam is injected into the coal bed through a well drilled. The chemical reaction produces a mixture of fuel gas that is extracted from a production well. The gas mixture which primarily consists of methane, carbon monoxide, hydrogen, carbon dioxide and water vapour are separated on the surface and used.

But the high costs of extraction held back the growth of In-situ Coal Gasi-

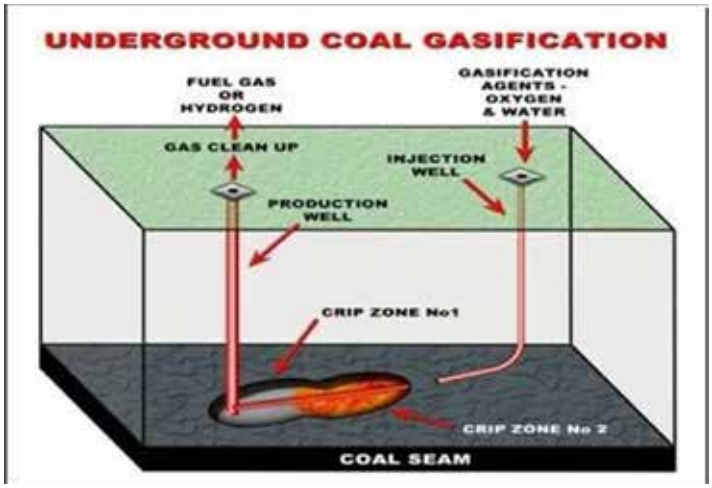
LOWER PRICES

Wind power tariffs had plummeted to a record low Rs2.43 per kWh at an auction conducted by Gujarat Urja Vikas Nigam Ltd in December, beating the record low solar tariff of Rs2.44 per unit registered in May.



fication in the 20th century. However with the advent of the hi-tech such as seismic technology, horizontal drilling, and hydro-fracking, the UCG has become both technically and economically feasible and exhibits many potential advantages over the conventional mining methods. UCG projects are being explored in some countries such as China, Australia, New Zealand, Europe, and the U.S.

As 80% of India's huge coal reserves are not suitable for conventional mining, Underground Coal Gasification offers good opportunities. Today, there is only one commercial Coal Gasification Plant in Odisha, owned by Jindal Steel and Power, besides some pilot projects of ONGC and others. India has initiated the process of identifying blocks suitable for undertaking Underground Coal Gasification (UCG) projects. The Central Mine Planning and Design Institute Ltd (CMPDI), the technical and advisory arm of Coal India, is the nodal agency for Underground Coal Gasification. After their technical evaluation, the identified blocks will be put on bidding and awarded for development and production on revenue sharing basis on lines similar to the existing policy for Coal Bed Methane (CBM).



CBM in India: at a glance

- 33 CBM blocks awarded: Area 16613 Sq. Km;
- Prognosticated Resource: 1.7 TCM (62.4 TCF);
- Established GIP: 280 BCM (9.9 TCF);
- Commercial Production since July 2007;
- CBM Wells drilled: 926;
- Blocks in Development/Exploration Phase: 9;
- Many allotted blocks are under relinquishment or relinquished;
- Current Production: 1.7 MMSCMD from 4 CBM blocks.

Both CBM and UCG need to extensively explored and exploited to enhance gas contribution to India's Energy Basket, importing latest technology.

Energy consumption is an indicator of the level of economic development of a nation. In India, we are far behind with per capita energy consumption of less than a third of the global average. The faster growth of the nation requires more energy pushing the demand increasing at the rate exceeding 5% per year. The country, which is heavily dependent on import of energy, especially oil and gas ha to look for alternative sources to supplement the conventional sources. Renewable and Unconventional Sources can gradually reduce the demand - supply gap of energy and reduce import dependency.

Unlocking the Vital Energy Within

By Dr Jauhari Lal

"It is all pervasive energy which is responsible for all the movement and activities in the universe. It is there in each and every particle and creature. Scientists, over the years, had been exploring various sources of energy. The Search still continues.

Similarly, energy in human body controls to a great extent the quality of our life i.e. physically, mentally, emotionally and spiritually. Though there is a great fountain of energy within each one of us, the majority is not aware of this power within.

This write up is an attempt to take through this great journey and explore dormant sources of energy within each one of us and experience the same for fulfillment of larger mission of life."

"We are a circle within a circle… With no beginning and never ending."

"FROM THE GREAT SPIRAL GALAXIES, thousand of light years across, to the trillion of atoms swirling in a grain of sand, the universe is composed of spinning wheels of energy. Flowers, tree trunks, planets, and people, each is made of tiny wheels turning inside, riding upon the great wheel of the Earth, spinning in its orbit through space. A fundamental building block of nature, the wheel is the circle of life flowing through all aspects of existence."

Wheel is the Symbol of energy

At the inner core of each one of us, spin seven wheel-like energy centers called Chakras. Swirling intersections of vital life forces, each chakra reflects an aspect of consciousness essential to our lives. Together the seven chakras form a profound formula for wholeness, that integrates mind, body, and spirit. As a complete system, the chakras provide a powerful tool for both personal and planetary growth.

Chakras are organizing centers for the reception, assimilation, and transmission of life energies. Our chakras, as core centers, form the coordinating network of our complicated mind/body system. From instinctual behavior to consciously planned strategies, from emotions to artistic creations, the chakras are the master programs that govern our life, loves, learning illumination and so on.

The body is a vehicle of consciousness. Chakras are the wheels of life that carry this vehicle about, through its trials, tribulations, and transformations. To run our vehicle smoothly, we need an owner's manual as well as a map that tells us how to navigate the territory which our vehicle can explore.

Muladhara- First Chakra

Our journey up the spinal column begins at the base of the spine, home of the first chakra. This is the foundation of our entire system- the building block on which all the other chakras must rest – so this chakra is of crucial importance. It relates to the element earth, and all solid, earthly things, such as our bodies, our health, our survival, our material and monetary existence, and our ability to focus and manifest our needs. It is the

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As President of MLDC, he has organizsed 215 training programs for various companies including ONGC, RIL, SBI, GAIL, BHEL, NTPC etc. and his book "Ageless Ageing" was released by Hon. President of India. His planning for superannuation is very popular Training programme.

As president of Bal Aarogya, more than 80,000 school children were medically examined and given treatment, Also exposed them towards, Yoga, moral values, discipline and safeguarding from exploitation, mentally, physically and emotionally.

He had been practicing and propagates yoga and meditation for peaceful and blissful life.

manifestation of consciousness in its final form- solid and tangible. It is our need to stay alive and be healthy, and the acceptance of limitation and discipline so crucial to manifestation. In this system, earth represents form and solidity, our most condensed state of matter and the "lowest" end of our chakra spectrum. It is visualized as a deep, vibrant red, the color of beginning, and the color with the longest wavelength and slowest vibration in the visible spectrum.

The Sanskrit name of this chakra is Muladhara, which means "root support". The sciatic nerve, traveling from the sacral plexus down through the legs, is the largest peripheral nerve in the body (about as thick as your thumb) and functions much like a root for the nervous system The feet and legs, which provide locomotion, enable us to perform tasks necessary to obtain life sustenance from the earth and its environment. Our legs touch the ground below us and connect our nervous system with the earth, our first chakra element. We respond then, kinesthetically, to gravity- the basic underlying force of the earth-constantly pulling us downward. This force keeps us connected to our planet, rooted in material existence.

In the body, the first chakra is located at the base of the spine, or more accurately, the perineum, midway between the anus and the genitals. It corresponds to the section of the spine called the coccys, as well as the coccygeal spinal ganglion and the lower lumbar vertebrae from which this ganglion sprouts. In keeping with the correlation to solid matter this chakra relates to the solid part of the body, especially the bones, the large intestine (which passes solid substances), and the fleshy body as a whole.

First chakra consciousness is oriented towards survival. This is the maintenance program that protects the health of our bodies and our day-to-day mundane needs. Here we function from an instinctual level, concerned with hunger, fear, the need for rest, warmth, and shelter.

In order to consolidate our energy in the first chakra, we must first see that our survival needs are met in a healthy and direct way, so that our consciousness is not dominated by them. To ignore these demands is to be constantly pulled back into survival consciousness, making us unable to "get off the ground."

Chakra one Symbols and Correspondences

Sanskrit Name : Muladhara
Meaning : Root Support
Location : Perineum, base of spine, coccygeal plexus
Element : Earth
Function : Survival, grounding
Inner State : Stillness, security, stability
Outer Manifestation : Solid
Malfunction : Weight problems, hemorrhoids, constipation, sciatica, degenerative arthritis, knee troubles
Color : Red
Seed Sound : Lam
Metal : Lead
Foods : Proteins, meats
Chief Operating Force : Gravity

Swadhisthana- The Second Chakra

The second chakra is located in the lower abdomen centered between the navel and the genitals, although it encompasses the whole section of the body between these two points. It corresponds to the nerve ganglion called the sacral plexus. This plexus hooks into the sciatic nerve and is a center of motion for the body. Because of this, it is often called the "seal of life."

The concepts of yin and yang also apply to the chakras themselves. Chakra one is yang, as it is our beginning, our foundation, and an odd number. Chakra two is yin, thus encompassing more of the "feminine" qualities associated with receptivity, emotions, and nurturance. The bearing of new life, centered in the area of Svadhisthana (the womb) is distinctly feminine. Water is receptive, adopting the shapes of that which it encounters, following the path of least resistance, yet gaining power and momentum as it flows.

The second chakra is related to the moon. Like the moon's pull on the tides, our desires and passions can move great oceans of energy. The moon rules the unconscious, the mysterious, the unseen the dark and the feminine. This gives the center a very distinct power of its own as we move from our depths outward to create change in the world. The element of this chakra is water, therefore, the chakra corresponds to bodily functions having to do with liquid : circulation of blood, urinary elimination, sexuality, and reproduction, as well as all the qualities of water, such as flow, formlessness, fluidity and surrender.

Chakra two Symbols and Correspondences

Sanskrit Name : Svadhisthana
Meaning : Sweetness
Location : Lower abdomen, genitals,

womb
Element : Water
Function : Desire, pleasure, sexuality, procreation
Inner State : Feelings
Outer State : Liquid
Glands : Ovaries, testicles
Malfunction: Impotence, frigidity, uterine, bladder or kidney trouble, stiff lower back degenerative arthritis, knee troubles
Color : Organge
Sense : Taste
Seed Sound : Vam
Metal : Tin
Food : Liquids
Chief Operating Force :Attraction of opposites

Manipura : The Third Chakra

Manipura is the third chakra. Its purpose is transformation. Just as fire transforms matter to heat and light, the third chakra transforms the passive elements of earth and water into dynamic energy and power. Earth and water are passive. They flow downward, subject to gravity and follow the path of least resistance. Fire, by contrast, moves upward, destroying form, and takes the raw energy of matter to a new dimension – to heat and light.

If we are to rise upward through all seven chakras, it is the fire of our WILL that propels that movement. It is through our WILL that we liberate ourselves from fixed patterns and create new behavior. It is our WILL that steers us away from that path of least resistance, that addictive habit, or the expectations of others. It is through our WILL that we take actions that are difficult or challenging, moving toward something new. As we take these actions, we begin to transform, but the first step is breaking old patterns.

Thus, the initial task of the third chakra is to overcome inertia. In physics, inertia refers to the tendency of an object to remain in the state it is in – either in motion or at rest – unless acted upon by some other force. In the third chakra, the WILL combines the forces of stillness and movement, earth and water, each shaping the other.

At Manipura, force and form combine and evolve each other to higher and more efficient levels. Once the third chakra flame has been lit, the fire is less difficult to maintain. Once the light of understanding has dawned, the path to further understanding is illuminated. When Kundalini rises to this Chakra, she makes herself apparent. Here she kindles the fire to destroy ignorance, karmic traps, and physical impurities. It is at this chakra that Kundalini begins to burn.

The hardest part is getting started. Once we get a fire going, it burns more easily, only needing to be stirred and fed. Once we get a business started, we then use its returns as fuel to keep it productive. Once we overcome inertia to the point where energy is produced easily, the third chakra "kicks in" and begins producing power with less effort and will. Doing something with ease and grace is the mark of true power.

Chakra three Symbols and Co-respondences

Sanskrit Name : Manipura
Meaning : Lustrous gem
Location : Navel to solar plexus
Element : Fire
Function : Will, Power, Assertiveness
Inner State : Laughter, joy, anger
Glands : Pancreas, adrenals
Other Body Parts : Digestive system, muscles
Malfunction : Ulcers, diabetes, hypoglycemia, digestive disorders
Color : Yellow
Seed Sound : Ram
Chief operating quality

Anahata – The Fourth Cha kra

The Sanskrit name for this chakra is Anahata, meaning "sound that is made without any two things striking", as well as "unstruck," "unhurt", "fresh", and "clean". When the chakra is free of grief from old hurts, its opening is innocent, fresh, and radiant. The fight of the third chakra is replaced by acceptance in the fourth. If the third chakra has done its job, our circumstances are easier to accept.

The element of the fourth chakra is air. Air represent breath, the vital process through which our cells are kept alive. The Hindus call it prana (from pora, "first," and na, "unit"), In yoga philosophy, prana is referred to as a vital energy in and of itself, a basic unit from which all life is made.

A normal human being inhales between 18,000 and 20,000 breaths per day totaling an average of 5,000 gallons of air. In weight alone, this is thirty five times as much as we take in from food or drink. Aside from maintaining basic life functions, the breath is one of our most powerful tools for transforming ourselves: for burning up toxins, releasing stored emotions, changing body structure and changing consciousness. The brain, too, relies critically on a constant source of oxygen. In the resting body, one-fourth of the oxygen consumed is used by the brain.

We now reach the central point of the Chakra System. Even in our language, the heart refers to the center of things, the essence, the kernel of truth, as in "to go to the heart of the matter." This is our spiritual center, our core, the place that unites forces from above and below, within and without. The task of chakra four is to integrate and balance the various aspects of our being. In so doing, it brings a radiant sense of wholeness to the entire organism, an acceptance of the exquisite interpenetration of both spirit and matter. Within this sense of wholeness lie the seeds of inner peace.

It is very important to keep a balance in life- physically, mentally emotionally and spiritually. The most significant factor for keeping balance is love, compassion, kindness i.e. the qualities of a good human-being. Its chief operating quality is 'equilibrium' symbolizes the equanimity of mind i.e. 'sambhav' keeping a balance in 'Sukh' and 'Dukh', 'Labh-Hani', 'Jai-Parajay', 'Yash-Upyash'.

As we perceive patterns in this way, we see that all lasting patterns are a product of a dynamic equilibrium among its parts. In our interpersonal relation-

ship, the same rule of balance applies. Relationship endure when an overall balance is maintained. Balance within ourselves gives us the best shot at maintaining balance in our relationship with others. If we are not in balance with ourselves, our chakras fall out of alignment. Imbalances within the heart (the central core) can throw the entire system off balance.

The love we experience at the level of the heart chakra is distinctly different from the more sexual and passionate love of the second chakra. Sexual love is object oriented- the passion is stimulated by the presence of a particular person. In the fourth chakra, love is not dependent on outside stimulation, but experienced within as a state of being. In this way it radiates outward, bringing love and compassion to whatever comes into our field. It is a divine presence of empathetic connection, rather than an extension of our need or desire. Hopefully, through the force of the will, our needs have been fulfilled or transcended. Love can emerge with the deep sense of peace that comes from lack of need, with a joyous acceptance of our place among all things, and the radiance that comes from inner harmony. Unlike the changing nature of the second chakra with it s transitory passions, love from the heart is of an enduring quality, eternal and constant.

In the body, this chakra relates to the cardiac plexus and rules over the heart, lungs, and thymus gland. Just as each chakra can be seen as a disk of swirling energy, so, too, can the entire body/mind be seen as a chakra. If we follow a path from the crown chakra, spiraling through each center, we find that the heart is the end point of the spiral – the center, the destination. Here we find the eye of the storm, where calm prevails in the midst of fury. The heart is indeed a center of peace.

Chakra Four Symbols and co-respondences

Sanskrit Name : Anahata
Meaning : Unstruck
Location : Heart
Element : Air
Function : Love
Inner State : Compassion, love
Color : Green
Seed Sound : Lam
Petals : Twelve
Celestial Bodies : Venus
Metal : Copper
Chief Operating Quality : Equilibrium

Vishudha- The Fifth Chakra

Chakra five is the center related to communication through sound, vibration, self-expression, and creativity. It is the realm of consciousness that controls, creates, transmits, and receive communication, both within ourselves and between each other. It is the center of dynamic creativity, of synthesizing old ideas into something new. Its attributes include listening, speaking, writing, chanting, telepathy, and any of the arts- especially those related to sound and language.

Communication is the process of transmitting and receiving information through symbols. As written or spoken words, as musical patterns, omens, or electrical impulses to the brain, the fifth chakra is the center that translates these symbols into information. Communication, due to its symbolic nature, is an essential key to accessing the inner planes. With symbols, we have the means to represent the world in a more efficient way- one that gives us infinite storage capacity in the brain. We can discuss things before we do them; we can absorb and store information in a concise form' we can synthesize thoughts into concrete images and store the images again as thoughts- all through the symbolic representation of perceived patterns.

The chakra of communication, commonly called the throat chakra, is located in the region of the neck and shoulders. Its color is blue- a bright, cerulean blue, as opposed to the indigo blue of chakra six. It is a lotus with sixteen petals, which contains all the vowels of the Sanskrit language. In Sanskrit, vowels are typically thought to represent spirit, while consonants represent the harder stuff of matter.

Chakra Five Symbols and co-respondences

Sanskrit Name : Visuddha
Meaning : Purification
Location : Throat
Element : Sound
Function : Communication, creativity
Inner State: Synthesis of ideas into symbols
Outer Manifestation : Vibration
Other Body parts : Neck, Shoulders, arms, hands
Malfunction : Sore throat, stiff neck, colds, thyroid problems, hearing problems.
Color : Bright blue
Sense : Hearing
Seed Sound : Ham
Petals : Sixteen, all the Sanskrit vowels
Metal : Mercury
Chief Operating Quality : Resonance

'Ajna'- The Sixth Chakra

The Sanskrit name of this chakra is 'Ajna', which originally meant "to perceive" and later "to command". This speaks to the two fold nature of this chakra- to take in images through perception, but also to form inner images from which we command our reality, commonly known as creative visualization.

"If therefore thine eye be single, thy whole body shall be filled with light."

At the fifth chakra level of awareness, we experienced vibration as an underlying manifestation of form. At chakra six we encounter a higher, faster vibration than that of sound, though of a fundamentally different character. Here, we embrace the part of the electromagnetic spectrum that we perceive as visible light. Ultraviolet radiation, radio waves, x-rays, and microwaves are just a few of the many wave forms within this spectrum that are not visible to the eye. Light is the form within this spectrum that are not visible to the eye. Light is the form directly perceivable by consciousness. Whereas sound is expressed through a wavelike oscillation of air molecules, light is a far finer vibrational energy, produced by radiative emission from atomic and molecular systems as they undergo energy-level transitions. In a

very real sense, light is the voice of atoms and molecules, whereas sound is the voice of larger structures.

'Ajna' is the gift of seeing- both inner and outer- that is the essence and function of chakra six. Through seeing, we have both a means of internalizing the outer world, and a symbolic language for externalizing the inner world. Through our perception of spatial relationships, we have building blocks for both memory of the past and imagination of the future. Thus, this chakra transcends time.

The "brow chakra," as it is often called, is located in the center of the head behind the forehead- either at eye level or slightly above, varying from person to person. It is associated with the third eye, an etheric organ of psychic perception floating between our two physical eyes. The third eye can be seen as the psychic organ of the sixth chakra, just as our physical eyes are tools of perception for the brain. The chakra itself includes the inner screen and vast storehouse of images that comprise our visual thinking process. The third eye sees beyond the physical world, bringing us added insight, just as reading between the lines of written material brings us deeper understanding.

Chakra Six Symbols and co-respondences

Sanskrit Name : Ajna
Meaning : To perceive, to command
Location : Center of the head slightly above eye level
Element : Light
Function : Seeing, intuition
Other Body parts : Eyes
Malfunction : Blindness, headaches, nightmares, eyestrain blurred vision
Color : Indigo
Seed Sound : Om
Metal : Silver

Sahasrara- The Seventh Chakra

The seventh chakra relates to what we experience as the mind, especially the awareness that makes use of the mind. The mind is a stage for the play of consciousness, and can bring us comedy or tragedy, excitement or boredom. We are the privileged audience that gets to watch the play, although sometimes we identify so completely with the characters on stage (with our thoughts) that we forget it is only a play. Sahasrara is the seat of the soul, an eternal and dimensionless witness that stays with us throughout lifetimes.

This chakra connects us to divine intelligence and the source of all manifestation. It is the pervading consciousness that thinks, reasons, and gives form and focus to our activities. It is the true essence of being as the awareness that dwells within. In Sanskrit, the crown chakra is called Sahasrara, meaning thousand fold, referring to the infinite unfolding petals of the lotus. Glimpse of this chakra reveal a pattern of such magnitude, complexity, and beauty, that it is almost overwhelming. Its petals bloom in fractal like patterns upon patterns, infinitely embedded in each other, drooping down like a sunflower to drop the nectar of understanding into the awareness of being. Each perfect petal is a symbol of intelligence, which together form the galaxy of an overarching divine intelligence – sensitive, aware, responsive, and infinite. Its field is delicate, the slightest thought will ripple through the petals like wind in a field of grass. The shining jewels deep in the lotus shine forth only in a state of ultimate stillness. To witness this miracle is profound.

When we reach this level, the seed of our soul has sprouted from its roots in the earth, and grown upward through the elements of water, fire, air, sound, and light and now to the source of all- consciousness itself, experienced through the element of thought. Each level brings us new degree of freedom and awareness. Now the crown chakra blossoms forth with infinite awareness, its thousand petals like antennae reaching to higher dimensions. It is this chakra that yoga philosophy has deemed to be the seat of enlightenment. Its ultimate state of consciousness is beyond reason, beyond the senses, and beyond the limits of the world around us.

Chakra Seven Symbols and co-respondences

Sanskrit Name : Sahasrara
Meaning : Thousandfold
Location : Top of head

Element : Thought
Manifestation : Information
Psychological State : Bliss
Malfunction : Depression, alienation, confusion, boredom, apathy, inability to learn
Color : Violet or White
Metal : Gold

The purpose of this write-up is to give a brief introduction of vital energy lying dormant within us. How to energies, is a matter of great practice under an experienced master. In higher dimension this is also known as 'awakening' of kundalini, the 'power of serpentine'. It requires 'focusing' on each and every centre of energy with its seed mantra. The elementary invocation to begin with is to reaching out from Muladhara to Sahasrara by way of sound "A……A……A…..0……0……0…..M……M….M" i.e sound pervading from bottom to top through 'sushamna' just doing 21 times both morning and 21 times evening on a proper 'Asana'. In the course of time, it will unfold itself and guide for further progress if practice with great reverence.

Chakra Self Test

Directions : Answer each question to the best of your abilities.

N = Never	P = Poor
S = Seldom	F = Fair
O = Often	G = Good
A = Always	E = Excellent

Score one point for the first column (N Or P), two points for the second column (S or F), three points for the third column (O or G), and four points for the forth column (A or E). Add up the points for each chakra and compare.

Chakra One : Earth, Survival, Grounding	Answer	Score
1. How often do you go for a walk in the woods, Park, or otherwise make contract with Nature?	N S O A	
2. How often do you exercise consciously? (work out, do yoga, etc.)	N S O A	
3. How would you rate your physical health?	P F G E	
4. How is your relationship to money and work?	P F G E	
5. Do you consider yourself well grounded?	N S O A	
6. Do you love your body?	N S O A	
7. Do you feel you have a right to be here?	N S O A	
	Total:	
CHAKRA TWO : Water, Emotions, Sexuality		
8. How would you rate your ability to feel and express emotions?	P F G E	
9. How would you rate your sex life?	P F G E	
10. How much time do you create for simple pleasure in your life?	N S O A	
11. How would you rate your physical flexibility?	P F G E	
12. How would you rate your emotional flexibility?	P F G E	
13. Are you able to nurture and be nurtured by others in balance?	N S O A	
14. Do you struggle with guilt about your feelings or sexuality?	A O S N	
	Total:	
Chakra Three : Fire, Power, Will		
15. How would you rate general energy level?	P F G E	
16. How would you rate your metabolism/digestion?	P F G E	
17. Do you accomplish what you set out to do?	N S O A	
18. Do you feel confident?	N S O A	
19. Do you feel comfortable being different (if need be) from those around you?	N S O A	
20. Are you intimidated by others?	A O S N	
21. Are you reliable?	N S O A	
	Total:	
CHAKRA FOUR : AIR, LOVE RELATIONSHIP		
22. Do you love yourself?	N S O A	
23. Do you have successful long-term relationships?	N S O A	
24. Are you able to accept others the way they are?	N S O A	
25. Do you feel connected with the world around you?	N S O A	
26. Do you carry a lot of grief in your heart?	A O S N	
27. Do you feel compassion for those with faults and troubles?	N S O A	
28. Are you able to forgive past hurts from others?	N S O A	
	Total:	

Chakra Five: Sound, Communications, Creativity

29.	Are you a good listener?	N	S	O	A
30.	Are you able to express your ideas to others so that they are able to understand them?	N	S	O	A
31.	Do you speak the truth faithfully, speaking up when you need do?	N	S	O	A
32.	Are you creative in your life? (This is not limited to doing an art form, it could be creative with anything-setting the table, writing letters to friends, etc.)	N	S	O	A
33.	Do you engage in an art form? (painting, dancing, singing, etc.)	N	S	O	A
34.	Do you have a resonant voice?	N	S	O	A
35.	Do you feel "in synch" (harmony) with life?	N	S	O	A
		Total:			

Chakra Six: Light, Intution, Seeing

36.	Do you notice subtle visual details in your surroundings?	N	S	O	A
37.	Do you have vivid dreams (and remember them)?	N	S	O	A
38.	Do you have psychic experience? (intuitive accuracy, seeing auras, sensing future events, etc.)	N	S	O	A
39.	Are you able to imagine new possibilities as solutions to problems?	N	S	O	A
40.	How would you rate your ability to visualize?	P	F	G	E
41.	Are you able to see the mythic (imaginary/fictitious) (bigger pictures) of your life.	N	S	O	A
42.	Do you have a personal vision that guides you in life?	N	S	O	A
		Total:			

CHAKRA SEVEN: THOUGHT, AWARNESS, WISDOM, INTELLIGENCE

43.	Do you meditate?	N	S	O	A
44.	Do you feel a strong connection with some kind of higher or greater power, God, Goddess, sprit, etc.?	N	S	O	A
45.	Are you able to work through and release attachments easily?	N	S	O	A
46.	Do you enjoy reading and taking in new information?	N	S	O	A
47.	Do you learn quickly and easily?	N	S	O	A
48.	Does your life have significant meaning beyond personal gratification?	N	S	O	A
49.	Are you open-minded in regard to other ways of thinking or being?	N	S	O	A
		Total:			

Score of 22-28 indicate a very strong chakra; scores of 6-12 indicate a weak chakra. Scores between 13 and 21 are in the average range, but could use improvement. However, it is the distribution that is important. Compare your scores between different parts. Aside from the strongest and weakest chakras, is there a distribution pattern, such as higher scores in the lower chakras, or higher scores in the upper or middle chakras? Does this pattern coincide with your own views about yourself?

Some Policy Initiatives by the GoI

India launched the first round of bidding under Open Acreage Licensing (OAL)

Last year, India had invited EOI under Open Acreage Licensing (OAL) and Hydrocarbon Exploration License Policy (HELP). In OAL, the investors were allowed to carve out their own areas and submit the EOIs for the same. In all, 55 valid expressions of interest were received from six companies.

- Blocks on offer: 55
- Vedanta bids for all 55
- ONGC bids for 37 on own or in consortium
- OIL India bids in 22
- Overall nine companies have put in 110 bids
- Results by next month

These blocks were subsequently put on bidding. Nine Companies placed 110 bids for 55 oil and gas blocks. Vedanta Cairn India put in bids for all the 55 blocks on offer. ONGC bid for all 9 offshore and 28 onshore blocks, total 37 bids. The evaluation and award of the blocks is in progress.

The blocks will be awarded under new Hydrocarbon Exploration License Policy (HELP), more liberal than the old policy, NELP. The contractors get full right under a single license for the entire contract duration to explore and produce both conventional and unconventional oil and gas resources, including coal bed methane, shale gas and oil and gas hydrates with the pricing and marketing freedom. The new license marks a shift to a simple revenue-sharing model from the complex and controversial cost-recovery model.

Licencing for CBM exploration in CIL blocks liberalized

The state-run miners, the Coal India and its Subsidiaries, can now explore and produce Coal Bed Methane (CBM) from areas under Coal Mining Lease allotted to them. No separate license/lease is required for extraction of Coal Bed Methane (CBM) under their Coal Bearing Areas. The Government of India granted relaxation to Coal India and its subsidiaries from applying for grant of license under the PNG Rules, 1959 for extraction of Coal Bed Methane (CBM) under their coal bearing areas.This exemption has been given by amending provisions of its earlier notification. This is likely to expedite development of CBM in India.

India's Natural Gas Production: A Turnaround — Billion Cubic Meter (BCM)

Financial Year	Total Gas Production	Change (%)	Offshore Production	Onshore Production
2011-12	47.55	(8.92)	38.47	9
2012-13	40.67	(14.46)	31.80	8.87
2013-14	35.40	(13)	26.39	9.01
2014-15	33.65	(5)	24.86	8.79
2015-16	32.24	(4.19)	23.01	9.23
2016-17	31.89	(1.08)	22.03	9.85
2017-18	32.64	2.35	22.01	10.63

India Launched Discovered Small Fields Bidding Round- II

With the success of the first bidding round of Discovered Small Oil and Gas Fields last year, the second round of auction of discovered fields are being now launched. In Round II, 60 oilfields are on offer: 23 onland and 37 offshore. The sixty fields are clubbed in 26 contract areas: 15 onland and 11 offshore (shallow water). The fields have Initial In-place volumes of over 195 MMT oil and oil equivalent gas (1400 million barrels), more than double resource base offered in the Round-I. As the oil and gas are already discovered in these fields, there is less exploration or production risk. This gives a good entry point for the entrepreneurs, new to the oil industry. The eligibility criteria do not require any prior experience in oil and gas industry.

Success Story of DSF Round I

- Contract awarded & signed on fast track, within 10 months in March 2017.
- 20 companies successful won contracts for 30 areas, of which 15 were new entrants.
- Petroleum Mining Lease (PML) already granted to 23 contract areas.
- Field Development Plan (FDP) of a third of the contracts prepared/ approved.
- Some contract winners found reserves much higher (two to five times) than earlier estimated.
- Some Fields to go into production within a year, others in next two- three years.
- Oil production of 15,000 barrel per day and gas production of 2 mmscm per day at the peak expected from 30 awarded fields.

ओएनजीसी विदेश
ONGC VIDESH

राष्ट्र की परिकल्पना को इसकी सीमाओं तक नहीं बांधा जा सकता है।

चार महाद्वीपों में बीस देशों की इकतालीस परियोजनायें ओएनजीसी विदेश के अंतर्राष्ट्रीय समाकलन और सहयोग को दर्शाती हैं।

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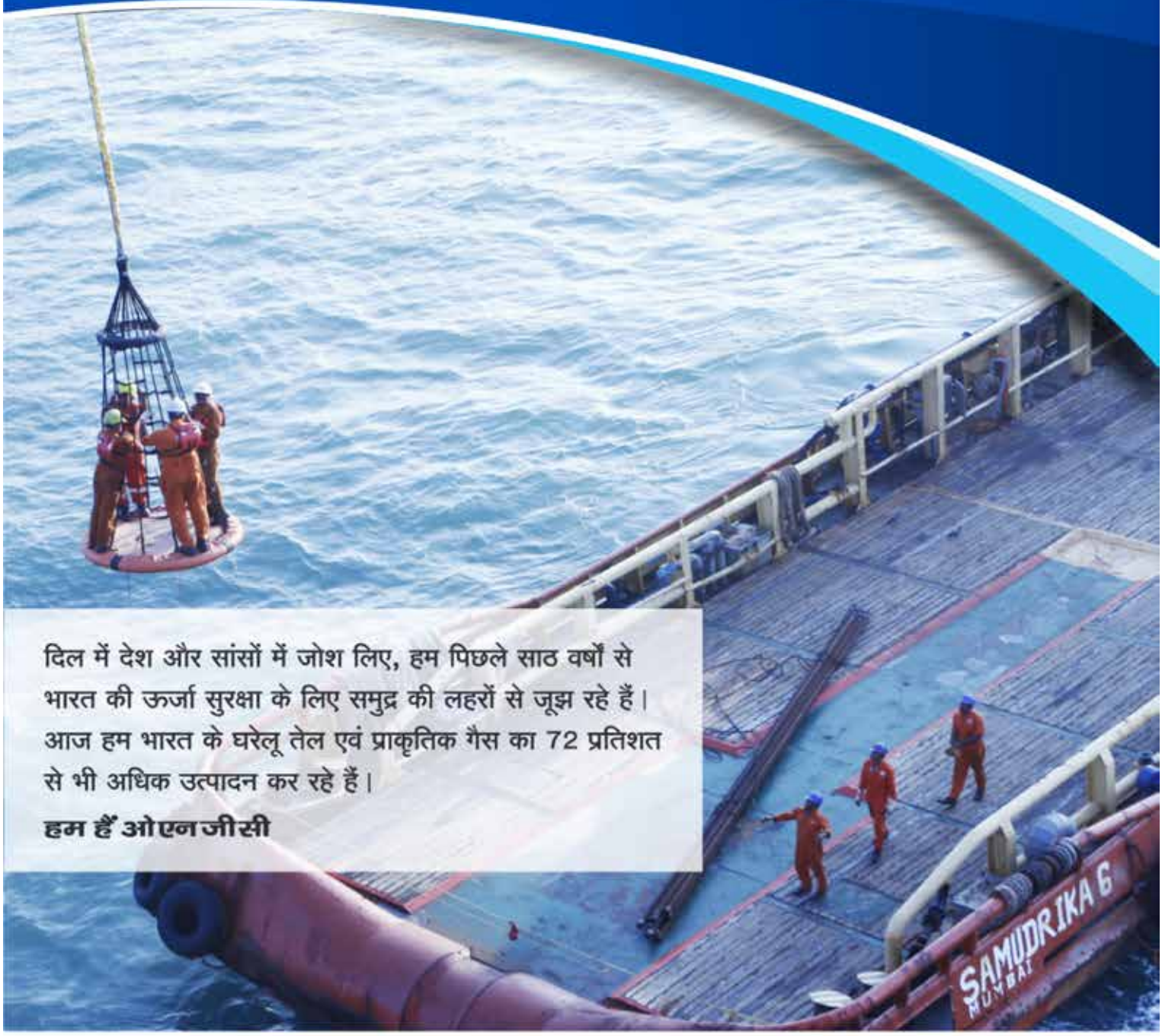
ONGC

समुद्र की लहरों से, देश के दिल तक...
ऊर्जा के संचालक



दिल में देश और सांसों में जोश लिए, हम पिछले साठ वर्षों से भारत की ऊर्जा सुरक्षा के लिए समुद्र की लहरों से जूझ रहे हैं। आज हम भारत के घरेलू तेल एवं प्राकृतिक गैस का 72 प्रतिशत से भी अधिक उत्पादन कर रहे हैं।

हम हैं ओएनजीसी

नई दिशाएं, नई खोज, नई ऊँचाई एवं नई सोच के साथ आगे बढ़ते हुए – ओएनजीसी

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