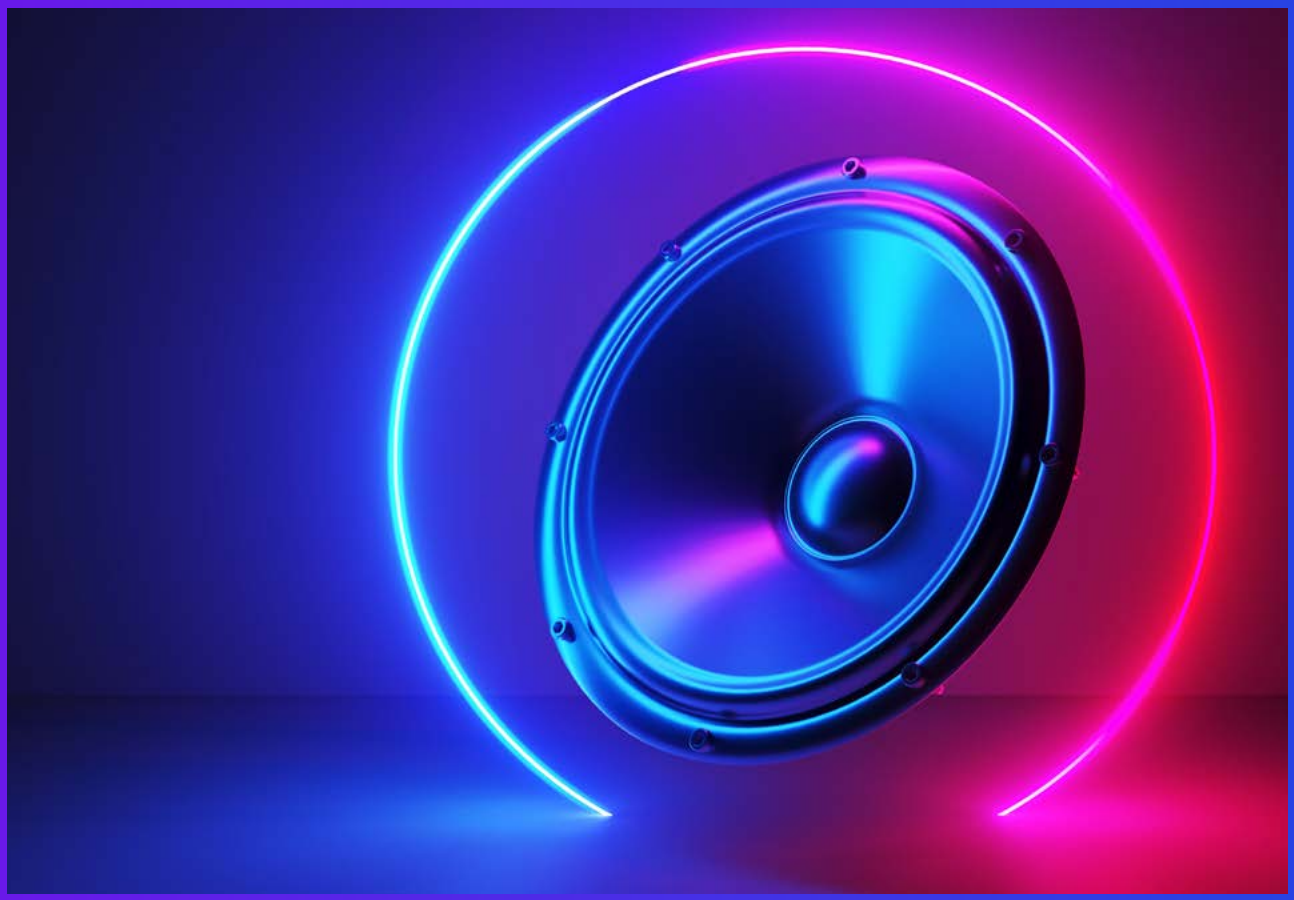
KPMG

Voices 2023

Policy, industry, academia: Collaborating for accelerating energy transition



October 2023

A message from

Shri Dharmendra Pradhan

Hon'ble Minister of Education and Minister of Skill Development and Entrepreneurship

India is currently taking bold strides towards becoming a developed nation, and the pivotal role of equitable and sustainable education cannot be understated in this journey. Under the visionary leadership of our Hon'ble Prime Minister Shri Narendra Modi, India is undergoing a massive transition towards renewable energy sources. We have firmly committed ourselves to the Paris Agreement on climate change and have emerged as one of the world's fastest-growing renewable energy sectors. Our ambitious goals to achieve net-zero emissions by 2070 and source 50 per cent of our electricity from renewables by 2030 are significant steps in the global fight against climate change, setting an example for sustainable development worldwide.

PM Narendra Modi launched National Education Policy 2020 with renewed focus on holistic and multidisciplinary education for students, including sustainable development. Initiatives like Mission LIFE are becoming mass movements with high participation across the school, higher, and skill ecosystem. India's approach of 'growing with less' can also be seen in its successful space programmes to Mars and recently with the success of Chandrayaan 3 and Aditya L-1 Mission.

To achieve the vision of becoming a developed country, however, a robust innovation ecosystem, education, and skill enhancement is required. Considering the need of the hour, immediate and collective action is needed to energise collaboration between industry, academia, and policymakers to drive implementable and scalable innovations and skill enhancement.

The synergy between industry, academia, and policymakers will not only accelerate innovation in the energy sector but also prepare our nation and the world for impending transitions in this field. Each stakeholder plays a distinct role: policymakers create conducive business environments, academia invests in research and innovation, and industry collaborates with academia to implement these solutions. This vibrant collaborative ecosystem will bridge the gap between current and desired skill sets needed for India's bold energy transition journey.

At the recent New Delhi G20 summit, the leaders' declaration acknowledged the vital role of collaboration in the education sector. A significant milestone in this direction is the signing of Memorandums of Understanding (MoUs) between Higher Education Institutes (HEIs), represented by the Council of Indian Institutes of Technology (IIT Council), and the Association of American Universities (AAU). This initiative establishes the **India-U.S. Global Challenges Institute**, aimed at advancing new frontiers in science and technology, **encompassing sustainable energy**, agriculture, health, pandemic preparedness, semiconductors, technology, manufacturing, advanced materials, telecommunications, artificial intelligence, and quantum science.

In addition to collaboration, one of the major focus areas of leaders' declaration is **skilling, reskilling, and upskilling** which includes identifying skill gaps and prioritising policies aimed at addressing those gaps. This involves strengthening national statistical data and expanding the International Labor Organization (ILO) and OECD Skills for Jobs Databases to encompass G20 nations. These will assist in monitoring and measuring current skill gaps and in identifying intervention areas in skill enhancement, especially for making our nation future ready for new energies.

In line with India's human-centric approach and to ensure 'One Earth, One Family and One Future', policymakers, industry and academia need to work together to boost innovation and skilling. India's unique blend of attributes, including its vast market size, dynamic and rapidly evolving education ecosystem, robust democracy, diverse demography, and inclusive culture, positions it as an ideal environment for all stakeholders to collaborate and thrive. By nurturing this collaboration, sharing knowledge, and fostering innovation, I am confident that we will create a sustainable landscape that makes the world greener, healthier, and more prosperous for our future generations.

From

Yezdi Nagporewalla

Chief Executive Officer, KPMG in India

Doing more with less – Enrich

In last 100 years, all indices of growth have shown an upsurge underpinned by economic growth. Availability of modern energy sources has underpinned this rapid growth. Advancement in sciences, vigorous economic growth and sustained productivity increase has led to reduction in poverty, malnutrition and illiteracy. Vaccines that help cure diseases like Polio, Smallpox, Measles and recently even COVID-19 has helped deal with difficult and often seemingly intractable challenges.

Rapid economic and social development has also had its costs. For years, the world has managed to maximize the flow of natural resources to keep up with rising demands for energy. Excessive exploitation of natural resources is fast causing the fabric of our planet on which all species on earth depends to unravel. The economic growth we desire and require for driving down poverty threatens the future of humanity. We are currently going through an unprecedented time with escalating environmental and social concerns. Extreme weather events have become more frequent and intense. The Intergovernmental Panel on Climate Change (IPCC) and other agencies have warned that unless the change in atmospheric temperature is less than 1.5°C, we are well on our way to climate disaster. Making a note of it, the G20 nation communique in Delhi in September this year reiterated their intention to work towards keeping the increase to less than 1.5 degrees. Most nations have declared their 'Net Zero' ambitions and between year 2050-2070 expect to be carbon neutral and in complete harmony with the nature.

In order to be carbon neutral and achieve the net-zero ambitions "Doing more with less" has assumed significance. Beyond resource optimization, it has found profound synergy with the intricate principles of ESG and revolves around precision, innovation, and the systemic optimization of resource usage. In effect, energy transition should focus on redistribution and diversification of energy technology, sourcing, financing to continue to support growth for the underdeveloped and developing countries. This would require stability and seamless interplay of energy, technologies, skills, resources and financing. It would also require part of globe to continue to invest and develop fossil fuel driven energy sources to prevent energy shortages, till clean energy becomes dominant.

That said, rapid transformation to a clean and resource-efficient energy system must take centre-stage and become a global imperative. This will require a combination of electrification, clean energy investment and deployment, energy efficiency, and other critical decarbonisation levers to work in tandem. Global investment in green hydrogen, increasing energy storage, clean coal, increasing efficiencies, and energy services innovation will be critical. In addition emerging technologies like Artificial Intelligence (AI) and Web 3.0 will play a crucial role in optimizing future supply chains and ensuring circular economy principles.

Collaborative global action driven by concerted policy actions underpinned by sound global compact to drive the Sustainable Development Goals (SDG) is essential. The compact in turn will have to be actioned by industry and society. The research and innovation ecosystem will have to be co-opted into this process. This requires society to come together and think on a wide canvas. This is the platform that ENRich seeks to provide. I look forward to reading the contributions in Voices received from our esteemed colleagues in industry, academia, and policy makers as well as fellow KPMG colleagues on this critical topic of 'Doing more with less'

Contributors

All 'Voices' are arranged in an alphabetical order (as per first names). The views and opinions expressed herein are those of the persons quoted and do not necessarily represent the views and opinions of KPMG in India.

Contributors

Anish De Global Head for Energy Natural Resources & Chemicals (ENRC)
KPMG International

What G20 achieved for the climate

The effects of climate change are now becoming apparent almost on an everyday basis. From unforeseen wildfires in Canada to floods in Libya, it is wreaking havoc for life at the margins. Expert agencies including the Intergovernmental Panel on Climate Change (IPCC) have warned of the world falling behind the required greenhouse gas reduction trajectory and the need for urgent, near-term actions. Making a note of it, the G20 reiterated its intention to work towards keeping the increase to less than 1.5°C. This however will require rapid and sustained reductions in global GHG emissions of 43 per cent by 2030 relative to the 2019 levels.

Renewables will be a critical near-term action theatre and the G20 converged on the need to treble global renewable capacity. This, if achieved, will be significant. Another crucial step forward was agreement on the "High Level Voluntary Principles on Hydrogen". While nascent, green hydrogen offers great promise. Indian industry is establishing centres for research and inking MOUs with organisations for development and supply of green hydrogen. The next logical steps will be formalisation and agreement around standards for transportation, safe storage, maintenance, and trading of hydrogen. That is what the declaration focused on. With a planned outlay of more than USD2 billion, India is betting big on successfully setting up and executing green hydrogen production. Globally from across the world, including the US, Europe and Australia, significant incentives are being rolled out.

Two other alliances that were declared at the G20 summit dealt with circular economy (Resource Efficiency and Circular Economy Industry Coalition (RECEIC)) and Global Biofuels Alliance. All very welcome steps and very timely indeed.

This rapid change of track will require many enablers. I foresee financing of the transition as a critical enabler. According to the UNFCCC report, public climate finance has been flowing from developed to developing countries since the adoption of the Paris Agreement from USD 30 billion in 2015 to USD 40.1 billion per year on average in 2019–2020, while multilateral development banks provided USD 45.9 billion per year on average in 2019–2020. This is much less than the USD5.8 trillion that is required for implementing Nationally Determined Contributions to carbon reduction before 2030 and around 4USD trillion in technologies to get to net zero. The flow of funds to where it is needed needs acceleration. Unless developed economies and the global financial institutions set up mechanisms for clear/transparent and trackable disbursement of funds, another ask by the G20 via New Collective Quantified Goal (NCQG), providing for just transition may prove to be hard.

When it comes to coal, progress has been made from COP 26 where scaling down of coal consumption was first mentioned. However, multiple geopolitical events in the recent past have raised energy security concerns. There was reiteration of the need to phase down coal power in line with national circumstances, is a progress in my view.

Five years ago, I wrote about the need for a policy vision that would enable the transition of India to a manufacturing leader in renewable components so needed for the transition. I believe that the various policy initiatives since taken by the government such as Make in India and PLI schemes are well-placed to provide the support needed for the manufacturing ecosystem to take off. For example, a solar linked PLI with an estimated outlay of INR 24,000 crore is estimated to add 48 GW of solar manufacturing capability taking India's production capability to 100 GW and making us a net exporter soon.

I believe the manufacturing ecosystem will provide the much-needed job creation that will enable the movement of jobs from high-carbon industries to those that support the energy transition. This will be good for India and the world.

Debabrata Ghosh Partner,
KPMG in India

Policy–industry–academia collaboration for accelerating energy transition

In the last few years, the Indian government has formulated several policies to encourage the production and usage of renewable energy. These include Panchamrit Goals, the National Action Plan for Climate Change (NAPCC) which consists of eight National Missions on different forms of renewable energy, National Green Hydrogen Mission (NGHM), National Electricity Plan, as well as the recent amendments to the Energy Conservation Act, amongst several others. All of these policies have been formulated to achieve the goal of making India a global leader of just energy transitions and turning India into a clean and green energy economy. These policies can only be effectively put into force through the means of an able and skilled workforce for the future – both for India and for the world.

For accelerating energy transition, India's education and skilling requirements need to include both fresh skilling – for new forms of green energy such as biofuel, ethanol blending, and green hydrogen as well as reskilling or upskilling – for transition into greener production of existing energy sources such as coal and petroleum. The collaboration of industry and academia with the policymaking bodies is the key to fulfilling these skilling requirements.

Energy companies and academia, especially higher education institutes, play an instrumental role in investing/providing funding for education and skill development in the domain of accelerated energy transition. Stakeholder involvement in each step of the educational value chain is the key to leverage education and skilling to enable green transition.

The first step in this direction is to identify the demand-supply talent gap for enabling energy transitions. Once the demand-supply gap and associated job roles are identified, there is a need to develop industry relevant courses and accordingly aligning them to National Credit Framework (NCrF). Standard setting bodies such as All India Council for Technical Education (AICTE) and National Council for Vocational Education and Training (NCVET) along with Sector Skill Councils (especially in the areas of hydrocarbon, power sector and green job) need to work in coordination with industry leaders to make this happen. Additionally, to enhance industry relevant curriculum and pedagogy, there is a need for designing the curriculum by involving industry experts, sector skill councils and energy transitions experts across areas of power sector, hydrocarbon sector and green energy.

Further, synergy needs to be created between industries and educational institutes to enable institutes' research and development cells to provide research and consultancy services to companies in areas of green energy. This synergy can be further leveraged to offer internship-embedded degree programmes in collaboration with green energy companies enabling students to get access to hands-on experiential learning.

Additionally, innovation quotient of youth needs to be harnessed. The Ministry of Education (MoE) through the MoE's Innovation Cell (MIC) is encouraging innovation and entrepreneurship amongst the youth of the country by helping institutes to set up their own institutes innovation councils (IIC). These IICs are showing immense potential in developing ideas and prototypes for products and start-ups involved in the green energy and sustainability domain. Greater industrial involvement and availability of angel investors for seed funding would lead to a boom in sustainable start-up companies. The innovation may further be supported by involving agencies like National Institute for Entrepreneurship and Small Business Development (NIESBUD) for building green energy focused MSME ecosystem in the country.

The number of industry-sponsored programmes in green skilling, available through skill sector councils, needs to increase. Joint certification courses designed or certified by the skill sector councils should be introduced in universities, colleges, and industrial training institutes (ITIs).

Further, to enhance access and equity in achieving energy transitions, greater emphasis needs to be placed on digital means of education and skilling, which makes them more accessible to a larger audience. Open access platforms such as SWAYAM can be strengthened so that fruitful collaborations can be forged between private players and government, which can enable private players to contribute in capacity building trainings, content development as well as delivery for the successful implementation and expansion of ongoing programmes and schemes.

By creating a synergy between policy, industry and academia, India will be able to create a talent pool not only to achieve the goals that were set during COP26, but also supply trained human resources for the requirement of other countries and thus become a 'Vishwa guru' in accelerating energy transition.

Dr. Deepak Dwivedi

Assistant Professor,
Department of Chemical Engineering & Biochemical Engineering, Rajiv Gandhi Institute of Petroleum Technology

Hydrogen supply using existing natural gas pipelines: Challenges and opportunities

It has been forecasted that around 15% of the global energy demand will be met using hydrogen-driven technologies by 2050. However, building the new infrastructure and assessing the suitability of the existing natural gas pipelines for hydrogen transportation have been identified as some of the critical challenges.

It is worth mentioning that building new infrastructures (pipelines) for hydrogen transportation would be a costly affair; hence it is of paramount importance to assess the suitability of existing natural gas pipelines for hydrogen transportation. Therefore, it is important for Indian companies working in the energy domain and in the areas of green hydrogen production, storage, and transportation to work on the development of guidelines for hydrogen transportation through natural gas pipelines, which are not yet fully developed.

In addition to this, companies must identify the potential risks in terms of failure of materials to mitigate future accidents and to ensure the safety of operators and the public. There are different guidelines that exist for the existing pipeline infrastructure; however, it is noteworthy that these guidelines are designed for natural gas transportation. As a developing country, India must consider utilising the existing natural gas pipelines to bring down the cost of supply pipeline construction. Therefore, it is necessary for Indian energy companies to design guidelines for safe hydrogen transportation.

Although some studies are available that provide the guidelines for hydrogen transportation using existing natural gas pipelines, these guidelines cover only limited aspects such as the design aspects of pipelines. ASME B31.12 (mostly used for boiler and pressure vessel systems) standard is the most common guideline on which industries are relying[1]. This ASME B31.12 standard is not solely designed for hydrogen transportation; however, it provides the guidelines under sour (H_2S) conditions which is completely different in the case of pure hydrogen supply. In addition to this, the ASME B31.12 standard does not cover much about the weldment strength, and the same industries use NACE MR0175/ ISO 15156[2]. It is worth mentioning that stress corrosion cracking of weldments could be a potential challenge. The present standard deals with sulfide-induced stress corrosion cracking (S-SCC), however, it does not cover the stress corrosion cracking in pure hydrogen conditions for weldment failure. It is not necessary for natural gas pipelines to follow the NACE MR0175/ ISO 15156 and ASME B31.12 standard.

The area that needs immediate attention is designing the standard for hydrogen transportation as per Indian climatic and industrial conditions. Pipeline transportation of hydrogen involves multiple challenges viz. hydrogen induced embrittlement, pipelines defects, weldment defects, fatigue driven failures and appropriate NDT utilisation.

From the point of view of R&D and technical operations, there must be two separate standards for pipelines used in hydrogen gas supply. One must illustrate (including the service life estimation) the safety aspects associated with existing natural gas pipelines and the other must discuss the new pipeline development (using modern alloys such as. Ni 718, Duplex steel etc.).

The major challenges or factors which must be considered in designing the standards for existing hydrogen transportation pipelines are: (a) characteristics of hydrogen gas such as pressure, temperature, purity (blending %) etc. (b) mechanical forming process like residual stresses in pipeline material, stresses in weldments, mechanical forming operations used in manufacturing pipelines, heat treatment of alloys followed while manufacturing etc. (c) details related to pipeline materials e.g. metallurgy of steel (such as steel/alloy grades like API X70, API X65, ASTM A106), the microstructure of pipeline (crystallographic texture), mechanical properties like fracture toughness, fatigue properties, etc.), composition etc. and (d) pipeline design with weldment details like defects, etc. On the other hand, for the inspection teams working in the industry, there must be a clear guideline for selecting appropriate non-destructive testing technologies under different conditions.

In the Indian context, it is high time for energy domain industries to set up different centre of excellence in collaboration with R&D and academic institutions to perform focused R&D activities on (a) new commercial grade alloy development for hydrogen transportation (b) new and efficient NDT methods development for pipeline inspection and (c) standards development for hydrogen transport in Indian climatic and different industrial operating conditions.

[1] Hydrogen Piping and Pipelines, B31.12, The American Society of Mechanical Engineers, 5th September 2023

[2] NACE MR0175/ ISO 15156, NACE, 5th September 2023

Gangadhar Krishnamurthy

Associate Partner,
KPMG in India

Industry 4.0's ability to transform energy grids

The global energy system is currently undergoing a massive transformation, and in the decades ahead, it will continue to become more decentralised, digitalised, and decarbonised. To reach the commitments made under the 2015 Paris Agreement – limiting the global temperature rise to well below 2°C – this transition must accelerate. In recent years, the energy sector has become increasingly digital and further digitalisation will be a key feature of the energy transition and an essential driver of the sector's progress towards ambitious climate goals. Meeting climate goals of 100 per cent clean energy and achieving net-zero emissions economy will involve a massive build-out of clean energy technologies and an accompanying scale-up in its supply chains, especially in several technologies poised for exponential growth, including manufacturing of components for solar, wind, nuclear, grid and battery storage, batteries, and hydrogen.

Industry 4.0, which refers to the new era of digitally enabled supply chain and includes smart factories and smart manufacturing techniques, provides a solution. On one hand, Industry 4.0 includes 'smart factories', which create a world wherein physical and virtual production systems work together flexibly worldwide. As a result, industrial production will be digitalised and networked, known as cyber-physical systems (CPS). These production systems can exchange information, initiate actions, and control machines autonomously. On the other hand, Industry 4.0 integrates various renewable energy technologies – hydropower, wind, solar, geothermal, and biomass energy, which increases production efficiency. By concentrating on the effectiveness, consistency, and security of the power generating systems, IoT technology can possibly overcome supply shortages. By regularly monitoring demand and supply, real-time monitoring can improve efficiency. In addition, Industry 4.0 can contribute to improved transmission system management. Thus, Industry 4.0 technologies can improve the electricity distribution system in numerous ways by managing power loss and fault detection in transmission lines. Furthermore, decentralised microgrids for energy storage can serve as supplements to the primary supply or as independent plants. Notably, the trading of renewable energy has significantly improved because of emerging technologies such as the energy internet and blockchain.

Our interaction with various infrastructure ministries shows us that there is awareness of the need to implement and adapt our policy and standards ecosystem based on the flexibility that Industry 4.0 can bring to our economy. Ministries are focusing on upskilling of personnel on Industry 4.0 to influence policy making across manufacturing, steel, mines, and heavy industries.

Given the impact IoT can have on efficiency and productivity improvements, it is critical to examine the models for stability and reliability. Grid stability will be critical while managing seamless transition across various sources of energy, managing peaks and troughs of demand. There is a need for research and development investment to support policy making and establish practices around flexibility while ensuring stability and reliability of grids. Power and utility bodies should engage with research institutions to run continuous analysis of the impact of implementation of Industry 4.0 practices.

Guilherme Mendonca Head-Energy, Siemens Limited

India's bold moves in energy transition paying off

India has made several bold moves toward energy transition in recent years. The goals are both ambitious and achievable – Net Zero by 2070, renewable energy capacity of 500 GW by 2030 (50 per cent of total energy sources), for instance – and these are supported by the requisite policy measures. Integration of the increased renewable energy would also need reliable transmission network, the bedrock of energy transition, to back it up. The USD30 billion investment announced by the government earlier this year to expand the transmission network is a very important policy measure. A modernised and resilient grid is of vital importance for a sustainable energy transition – the faster the expansion, the earlier the energy transition will take place.

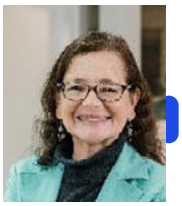
To take India to the next level of energy transition, it would need a balanced approach toward generation and transmission, as well as introduction of technological innovations in areas such as grid stabilisation, energy storage, and carbon capture utilisation and storage (CCUs). India has indeed been a leading example of developing and implementing policy measures to kick-start industry adoption of sustainable energy transition and decarbonisation technologies. There are clear policies and incentives for technology innovation, and we will soon see demand specially in refineries, cement, steel and fertiliser, which are considered hard to abate. Other hard to abate sectors in industry, transport and agriculture will also come on the radar.

Given that India is one of the most dynamic energy markets of the world, partnerships for innovation, manufacturing and project development hold the key for successful energy transition journey. Industry contributes to 33 per cent of energy consumption and 20 per cent of carbon emissions. Cross-industry, multilateral collaboration help address concerns such as trust and security related to industry-wide data, which needs to be shared across digital ecosystems. Through digitalisation, the entire industry can work towards finding common solutions to address the energy transition, giving companies access to emissions-related data and improvement areas.

And partnerships with academia, industry experts, scientists and citizens do provide a long-term advantage. Through insights from over 2,000 energy experts around the world for the Global Energy Transition Readiness Report, it was found that every region needs to do much more and much faster. The real impact of energy transition can be felt only with the positive contribution of the community, and every individual stands to gain – more green jobs, better access to energy and enhanced living conditions.

There is no doubt that energy transition is being, and will continue to be, driven by technology. It needs to start now, and for that collaboration is key. With new technologies being introduced every day, it is difficult to manage energy transition by one company or one industry alone. While government policies can boost the scaling of innovation, it is the industry that needs to set top priorities and take action following a systematic approach to achieve energy transition goals.

I will repeat what I said earlier – everyone, every company, every country needs to make the switch today, and drive energy transition continuously, step by step!



Jennifer Holmgren

CEO,
LanzaTech

Accelerating the energy transition through collaboration

At the G20 this year, Hon'ble Prime Minister Shri Modi announced the launch of the 'Global Biofuels Alliance' (GBA), a coalition of governments, international organisations, and industry to facilitate the adoption of biofuels as an essential pillar of energy transition. Only through this vision for global, private-public collaboration is the energy transition possible.

Our way of life is built on carbon, from our fuel sources to the materials in our consumer products, but we need a more sustainable way to source carbon to protect the future of our planet and to ensure the sustainable development and growth of all economies, including the developing countries and marginalised communities around the world. To achieve our climate goals, a large-scale, robust, rapid, and sustained effort must be made to re-design our carbon economy in a way that benefits everyone, including the most vulnerable. India has been a leader in highlighting the urgency with which scalable, impact-driven technologies must be embraced to address the climate crisis. At LanzaTech, we believe we have enough carbon available above ground to meet many of our needs. With carbon recycling technology, both energy-intensive industries and consumer supply chains can reduce their carbon footprints, while still meeting increasing global demand for fuel, including sustainable aviation fuel and everyday products.

Using a technology process, we call biorecycling, LanzaTech captures and processes multiple forms of waste carbon before they can enter the atmosphere and cause harm. Emissions sources like steel mills can attach LanzaTech's bioreactors to their facilities, which then act like a brewery. Instead of using yeast to convert sugar into beer, proprietary microbes convert carbon-rich gases into essential raw materials like ethanol, a primary raw material for the production of sustainable aviation fuel and a range of everyday consumer goods. This biology-based approach gives waste carbon a new life by recycling it into more sustainable versions of the critical chemical building blocks necessary for everyday products, which are typically sourced from virgin fossil carbon.

In effect, carbon recycling enables a circular carbon economy that connects disparate stakeholders: one industry's emissions become the feedstock for another. As the third largest global energy consumer, India is diversifying its basket of energy solutions by bridging sectors across its economy through technology and policy, including by leading the Global Biofuels Alliance. Carbon utilisation technologies like LanzaTech's can be applied at the local level and link together agriculture, energy-intensive industries, and waste management to establish local supply chains, including in rural areas. Unquestionably India has made great strides in blending first generation ethanol into gasoline. Going forward, waste based advanced biofuels will boost India's progress toward road and air decarbonisation and green job creation.

In India, LanzaTech is working with IndianOil Corporation to build the world's first plant to convert refinery off-gas into sustainable ethanol. Expected to come online this year, the resulting ethanol can be used as a feedstock for sustainable aviation fuel and as a raw material for consumer goods. Additional carbon recycling projects underway in India include Ankur Scientific, MRPL and Spray Engineering Devices Ltd all focused on recycling agricultural residues into ethanol for use in the production of fuels and materials. LanzaTech is also working with India Glycols Limited to convert ethanol made from recycled carbon into ethylene oxide and monoethylene glycol, key ingredients for consumer goods and packaging.

By turning waste into a resource, we are generating cleaner burning fuels and low-carbon materials stamped with 'Make in India' while also creating regional economic prosperity and new jobs to support and operate this technology.

A circular carbon economy is the path forward. As business leaders, we must rethink how we source, use and dispose of carbon and consider the benefits of a new carbon system; as consumers, we can choose where our carbon comes from. Thanks to India's leadership and the creation of the Global Biofuels Alliance, anew circular carbon model based on waste carbon will support a more sustainable, equitable, and resilient economy.

Koyel Kumar Mandal Chief of Programs,
Shakti Sustainable Energy Foundation

Freight electrification: Role of philanthropy in India's e-FAST initiative

India's freight transport ecosystem has a critical role to play in achieving our twin objectives of developed nation status by 2047 and net zero economy by 2070. Decarbonising freight transport offers important opportunities to reduce transportation costs, improve air quality, and promote domestic manufacturing and export of clean technology. Reducing freight emissions, however, demands a multifaceted approach that includes manufacturing and adoption of zero-emission trucks, public awareness of the benefits of the transition, and establishment of green infrastructure. All these need to be supported by enabling policy measures.

NITI Aayog, Government of India's e-FAST (Electric Freight Accelerator for Sustainable Transport – India) initiative is strategically designed to expedite the transition toward electrification of freight vehicles, with a specific focus on medium and heavy-duty commercial vehicles. e-FAST India is the country's first platform to facilitate collaboration between government stakeholders and private sector partners — original equipment manufacturers, logistic service providers, financiers, and charge point operators — to shape strategies and actions that support freight electrification at scale. The collaboration engenders an environment of shared learning, fostering collective efforts toward cultivating a cleaner freight industry in India. It has three focus areas - technology & innovation, market acceleration, and public policy support.

By cultivating an environment conducive to grassroots transformation within the decentralised freight industry, the e-FAST platform orchestrates a range of activities. These include employing peer-tested planning and evaluation tools and hosting capacity-building workshops. The programme spurs partnerships that pave the way for pilot deployments.

Philanthropy, in the context described, serves as a vital catalyst that drives the realisation of e-FAST's goals and objectives. Through strategic guidance and knowledge-sharing, philanthropic organisations provide essential support by bridging the gap between abstract theoretical concepts and practical, actionable initiatives. This involvement is crucial as it helps convert visionary ideas into tangible projects that can be implemented effectively. By actively engaging different parties, philanthropic organisations promote dialogue, understanding, and alignment of interests. This collaborative environment fosters an atmosphere of trust and shared purpose, creating a conducive setting for generating meaningful change.

As the government of India moves forward with its feet electrification targets, philanthropic organisations can work with the grassroots driving behaviour change, culture change as well as orchestrate capacity building in the semi-organised logistics sector, which is hyper critical for change to embed.

Within the e-FAST ecosystem, philanthropy becomes a lynchpin, channelling its influence and resources to amplify the programme's objectives. By facilitating technical acumen, philanthropic initiatives enhance the programme's capacity to bring together stakeholders. This orchestration of unity not only accelerates the transition toward sustainable freight transportation but also sets a precedent for harmonious collaboration among seemingly divergent interests.

While policy action rightly targets large scale transformation, investing in grassroots capacity building, and behavioural transformation can be very effectively driven by philanthropic bodies, which are embedded within the freight ecosystem.

K. Shanti Swaroop

Professor, Electrical Engineering, Member of The Energy Consortium, IIT Madras

NetZero decarbonisation for energy sustainability

Decarbonisation and moving towards NetZero are the key drivers for energy sustainability. If humankind is to have a future, we need to make continued progress in our journey to decarbonise our industries, reduce and remove carbon from the atmosphere and make energy generation and energy consumption as low carbon as they can be. Effective and efficient use of different types of renewable energies for reduction in carbon footprint is a challenge that needs to be overcome. New advancement in technologies have transformed the conventional energy scenario to a digital energy transition network which integrates energy injection at different levels. Examples are virtual power plants, transactive energy, energy trading, etc. Research at IIT Madras is focusing on these areas to achieve a NetZero decarbonisation for energy sustainability. Given the collaborations that our research facilities have with industry, we are proud to have tested and partnered on designing a lot of these solutions prior to implementation.

Achieving complete decarbonisation may not be possible. Theoretically it may sound feasible, but practically it may be difficult to achieve. It has to be done gradually in stages. A case in point, the starting of large power generating units usually requires thermal power plants as they are the best option – for provision of the burst of energy needed to kickstart. These are called black start units and are the reliable solution for the large amounts of energy needed to start the process. Hydro power plants cannot replace thermal power plants in these situations, due to seasonal availability of water resources. Hence processes such as hydro-thermal scheduling, an age-old practice need to be revisited, and new strategies introduced.

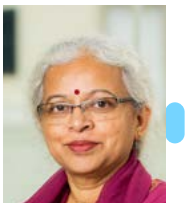
Seamless renewable energy integration for decarbonisation is the key challenge. For hard to abate industry, this situation is more acute as significant amounts of energy are required to run manufacturing units, refineries, and even energy generation plants. Hence, complete reliance on renewal energy (RE) is not advisable, as reliability of power availability is an important issue. It has been reported that many utilities are facing problems with the dependence on RE only. They have to depend on expensive gas fired units to start (black start) either after a blackout or brownout. This is both expensive as well as infeasible. Gas fired plants are of low capacity fast starting units.

Large scale energy storage is the only solution for decarbonisation. New technologies need to be identified, explored and feasibility studies run to realise this. Redox flow batteries (VRFB) are one such solution, which are capable of storing large amounts of power and energy. They are designed for large duration energy storage.

At this point, it is evident that significant policy and government support will be needed to operationalise these technologies, do detailed consultations with the various stakeholders and come to agreement on standards, usage guidelines and drive the regulatory changes needed to implement such large-scale initiatives. Besides the above, innovative financing mechanisms, funding channels will also be required to support the extensive R&D investment needed to bring the technologies to scale. PPP is an established mode but it now needs to be brought in for R&D as well.

The reliability of the energy system is an issue, which needs to be considered. Decarbonisation, Reliability and Sustainability (DSR) are three conflicting aspects, which need to be addressed by the technical people from both academia and industry alike. Achieving perfect balance is a task which, between them, is the challenge of the future.

Many industries are driving towards achieving energy sustainability through NetZero and de-carbonisation. New ideas are required in this aspect on how to utilise various theoretical concepts for realising this goal.



Leena Srivastava Director and Head,
Ashoka Center for a People-centric Energy Transition (ACPET)

Knowledge aggregation for effective, ambitious energy transitions

Energy transitions, leading to transforming energy systems towards no-carbon, sustainable and equitable systems, have become an urgent call. Starting with major concerns over air pollution followed by recognising the huge contribution of fossil energy consumption to climate change, energy transitions are needed at an ever-increasing speed and ambition. The tight timelines for moving to net-zero energy systems and the catastrophic implications of overshooting climate goals even by small percentage points, make it imperative to fail-proof transition paths and ensure that the efforts to achieve other global goals, such as the SDGs and biodiversity goals, are strengthened in the process. Not an easy challenge.

Adopting multi-stakeholder approaches to overcome knowledge gaps in each domain becomes critically important in ensuring the greatest possibility of success and minimising trade-offs. Three of the key stakeholder groups essential for charting successful energy transition pathways are policy makers, industry and the scientific establishment.

Science has played an exceptional role, supported by advances in digital and computing technologies, in unravelling the complexities of, and the contributors to, the climate system. However, it has an even more challenging role in helping decision-makers decipher the impact of interventions chosen for achieving systemic energy transitions on the overall socio-economic system. To be a material player in this, science has to step out of its comfort zone and partner with real-world stakeholders to bridge its own knowledge gaps, particularly on socio-political and business drivers. Only then would it be able to impactfully facilitate crystal-gazing into the future of alternative energy transition pathways. Needless to say, science has to break the disciplinary barriers within itself too to provide such systemic analyses.

By the same token, industry, a key stakeholder in the energy transition pathways defined by governments - as suppliers, consumers or financiers, needs to recognise its dependence on the scientific community to provide non-partisan advice to policy-makers, thereby minimising potentially huge costs arising from policy uncertainty and incoherence. Undoubtedly, the chasm between the academic community and practitioners is huge in terms of objectives and even lexicon. However, an investment in empowering and supporting science – both in terms of practical knowledge sharing as well as financial support – to come out of its ivory tower and better appreciate the inclusive drivers of policy making would make this investment self-serving. Industry, in turn, could learn from the multi-stakeholder consultations to better present their case to policy makers.

The policy making community, on the other hand, is much more comfortable in dealing with both industry and academia. An aligned view on energy transitions between the above two communities – with academia also internalising civil society views in their multi-stakeholder approach – would greatly strengthen their hand in collaboratively designing and implementing an enabling framework for sustainable energy transitions. A robust and practical knowledge-driven underpinning to policy making could significantly reduce any contradictions arising from pure political considerations.

In short, an energy transition approach based on collaboration and mutual trust between scientific, practical and political knowledge bases will maximise the probability of achieving desired outcomes in an equitable manner.

Manas Majumdar Partner, National Leader, Oil & Gas and Chemicals, KPMG in India

Trimurti of policy reform, innovation and investments for sustainable growth in oil & petrochemicals

Evolving story of oil and petrochemicals

The post-Covid growth story for the oil industry has been driven by the resurgence of global demand as well as supply changes from geopolitical crises. Within this, the petrochemicals segment remains a bright spot and is expected to drive 50 per cent of the oil sector growth by 2050[3]. In India, this has been playing out well, with Indian oil refinery majors reporting strong profit performance and increased exports of petrochemical products. Going forward, the Indian petrochemical industry is expected to grow by 9-10 per cent over the next 20 years[4] to meet India's rising demand potential.

Sustaining growth through the climate change era

In this context, the challenge that the global energy transition raises is immense and has the capacity to derail the growth story if not addressed. Globally, solar energy is being produced and transmitted much cheaper than traditional sources of energy and it is a matter of time before renewable energy-based locomotion and travel impinges on key demand sources for oil. In this situation, it is essential that oil refinery majors implement methods to decarbonise and diversify their portfolios and focus on establishing and increasing revenue streams toward cleaner chemicals, and greener derivatives like green hydrogen.

Trimurti of industry-academia-government to come to the fore

To drive further growth in the petrochemicals market, the Trimurti of industry–academia–government needs to come together and collaborate to achieve multiple objectives: effective new product development, speed to commercialisation, production efficiencies and promoting trade & exports.

The government can play a key role in this endeavour by introducing collaborative platforms and e-marketplaces that will drive innovation and speed to market for the petrochemical industry. Further policy initiatives such as the National Petrochemical Policy, Hydrocarbon Vision 2030, Productivity linked Incentive (PLI) schemes, and 100 per cent FDI in petrochemicals, have provided an impetus to Indian downstream majors to expand into plastics, synthetic fibres, and rubber.

Industry, at its end, needs to look at investing in an end-to-end manufacturing value chain to both reduce import in key petrochemical chemistry and build downstream linkages with MSME for end-use products. Further focus can be on leveraging Make-in-India programmes to transform into Make-for-World initiative and build India into a chemicals hub.

Equally, it is important to leverage our strong academia pool and their startup ecosystem and integrate into the chemicals industry to bring in innovation on green chemistry, new technologies, and business models. There is a need for structured collaboration among academic labs and government and industry R&D centres to come together to make production value chains efficient and sustainable and explore circular solutions. Many oil companies have invested in startups focused on PE/PET recycling which has gone into durables and even clothing. The need of the hour is for a connected R&D network and investments in this area to ensure a sustainable innovation pipeline.

Final word

Indian oil majors have a game-changing opportunity on their hands to become exporters of petrochemicals and low-carbon products. For this, there is a need to go about it in a coordinated manner with investments in domestic manufacturing and R&D, focused collaboration with academia and startups for innovation, and working closely with the government on requisite policy initiatives that incentivise energy-efficient production and better technology.

[3] International Energy Agency
[4] Mordor analyst report

Dr. Milan Kumar

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Grey areas of green hydrogen production from water electrolysis

India is constantly keeping an eagle eye on targets of becoming energy independent by 2047 and achieving Net-Zero emission by 2070. It has been significantly expanding renewable energy horizons, and required infrastructure, to meet the growing demand for electricity. Even though, its current share is partial (12.3 per cent of the total energy mix) but it is considerably alleviating the dependency on fossil fuels and their environmental impacts. The share is expected to increase to 50 per cent by 2030[5]. Through the National Green Hydrogen Mission, India aims to channel the harvested energy from renewable energy sources to produce Green Hydrogen, not just to meet domestic demands but also for the world[6].

Usage of hydrogen can be bifurcated as: (i) feedstock for petroleum refining, fertiliser, steel manufacturing industries, and treatment and production of metals; and (ii) as green fuel and energy carrier in city gas distribution systems, and for varied sectors such as vehicle, aviation, and shipping. For remote places where electricity and fuel cannot be transported economically, distributed hydrogen generation systems operated on renewable energy sources will prove a boon for denizens in meeting their requirements, as energy carriers and fuel.

The annual domestic demand for hydrogen in India is estimated around 5 million metric tonnes (MMT), which is met by hydrogen produced from different processes using fossil fuels. The global demand is about 100 MMT. At policy upfront, India is aggressively moving ahead and finalising strategies to gain the leadership position. Some of the key points are the promotion of research and development through the Hydrogen Valley Platform, incentivising supply chain, ease of doing business, and skill development.

Hydrogen is the smallest molecule and can exist in gaseous form, which is highly flammable. As a pure gas, it's a rarity in nature and mostly exists in a combined form. Of all hydrogen compounds, water is most abundant in nature, which is also the source of life for all beings. Hydrogen production by electrolysis of water, generating a highly explosive mixture of hydrogen and oxygen gases, has been known for more than two centuries, since the time of Volta, Davy and Faraday. Huge scientific efforts have been put together in various laboratories to examine and evaluate electrode and gas separating materials/membranes, theories and mathematical equations are developed, and engineering tools are employed to design and develop a device; thus, came existence of electrolysers, working in acidic and alkaline environments. Feed requirement is water and electricity. If green electrical energy harvested from renewable sources is used, hydrogen is green – no emissions en-route to its generation or after its use as a fuel. However, the high price of electricity and electrolyser systems makes this route costlier than the conventional process: ~USD6 versus ~USD2 per kg H2.

Current efforts for the development of materials, devices and processes are mostly non-synergistic. The gaps are wide and evident which need to be addressed to make green hydrogen an economically viable, future fuel:

1. **Electrode materials:** The best materials, which require low potential for electrolysis, are platinum group metals and rare earth elements. These materials are highly costly and are not easily available. Countries like Indonesia, Australia and Canada can produce them, but are further processed in China to make them suitable for usage. Serious efforts are needed to develop cost-effective, indigenous materials for electrodes.
2. **Gas-separation materials/membranes:** To avoid generated gases from mixing and forming an explosive blend, a separating material or membrane is required. Its conductivity, pore size, and thickness control potential requirements, gas purity, and durability. The vulnerability of this costly separator in high TDS water needs serious attention from the research perspective. Its complete elimination, leading to a membrane-less electrolyser, has enormous potential. Further, its scaling up for commercial applications needs unified efforts from academic and technology developers.
3. **Domestic manufacturing:** Currently devices and complete-electrolyser systems are mostly imported by industries to fulfil their obligation for green hydrogen. Domestic manufacturing lacks infrastructure and skilled manpower for the development of component materials at a commercial scale.

Apart from the above, there is a need to work towards the development of a complete process keeping in mind safety concerns arising from hydrogen. Industries are very efficient in dealing with it.

Bringing policies to fruition, a three-way collaboration – industry, academia, and technology developer – is the need of the hour to make the mission successful. Most of the time, collaboration exists only between two of these entities. The government is already helping at policy levels to create a conducive ecosystem, the onus is on us to fathom our capabilities and believe in others to use this opportune time to mitigate these spotted, grey areas in the pathway of green hydrogen.

[5] National Statement by Prime Minister Shri Narendra Modi at COP26 Summit in Glasgow, Press India Bureau, November 2021

[6] National Green Hydrogen Mission, Ministry of New and Renewable Energy, January 2023

Nikhil Moghe
Partner,
KPMG in India

Harvesting hope – biofuels: The next green wave in energy

In the quest for a sustainable and eco-friendly future, renewable energy sources have emerged as the shining beacon of hope. Solar, wind and EVs have taken centrestage, leading the charge towards a cleaner planet. However, there's another contender that's quietly gaining momentum and could play a pivotal role in our transition to a greener world, and that is biofuels.

Biofuels, derived from organic materials such as plants, agricultural residues, municipal organic waste and algae, offer a fresh perspective on clean energy. Unlike fossil fuels, biofuels emit significantly fewer greenhouse gases when burned. This makes them a vital component in reducing carbon emissions and mitigating the impacts of climate change.

Biofuels present an opportunity to transition away from conventional gasoline and diesel, providing cleaner alternatives like biogas, ethanol, biodiesel, and sustainable aviation fuels. Their compatibility with existing infrastructure and combustion engines makes them a practical choice for immediate adoption.

One of the most striking aspects of biofuels is their resource efficiency. The cultivation of biofuel feedstocks can be remarkably efficient compared to traditional agriculture. Crops like napier grass, switchgrass and algae can thrive in marginal lands with minimal inputs, reducing the strain on fertile soils and freshwater resources. This not only conserves valuable resources but also aids in land restoration and ecosystem preservation in addition to address the food vs. fuel debate.

The biofuels industry has the potential to be a catalyst for social upliftment and women's empowerment. In many parts of the world, biofuel feedstock cultivation is a labour-intensive activity. Small-scale farming operations, often run by women, can benefit from the increased demand for biofuel crops. This can lead to enhanced income opportunities, better education, and improved healthcare for rural communities, particularly in developing countries.

Similarly, farmers stand to gain significantly from the biofuels boom. Growing biofuel crops or harvesting agriculture waste can diversify their income sources in addition to help reduce environmental impact by reduction of agriculture residue. Moreover, the biofuels sector can stimulate rural economies by creating jobs in cultivation, harvesting, and processing of feedstocks. This has the potential to revitalize farming communities and improve the livelihoods of countless individuals.

Biofuels offer not just social and environmental benefits but also opportunities for sustainable economic growth. This includes advancements in crop genetics, biofuel production processes, and infrastructure development. By investing in biofuels, nations can position themselves as leaders in this emerging sector, fostering economic growth and job creation. The biofuels industry has the potential to create a thriving ecosystem of research, development, and innovation. The Global Biofuel Alliance is one such step towards creation of one community for sharing of knowledge for the growth of biofuels sector.

As the demand for biofuels continues to grow, so does the need for a skilled workforce. This sector offers a wide range of job opportunities, from agricultural experts specialising in biofuel feedstock cultivation to engineers developing cutting-edge biofuel production technologies. Furthermore, biofuel production facilities require operators, technicians, and maintenance personnel to ensure smooth and efficient operations. Research institutions and universities are also actively engaged in biofuel-related research, offering positions for scientists and researchers dedicated to advancing biofuel technologies.

The biofuels sector isn't limited to traditional roles alone. It encourages innovation and entrepreneurship, paving the way for startups and small businesses to thrive. From biofuel distribution and marketing to bioplastic production using biofuel byproducts such as bio manure, there are numerous entrepreneurial avenues waiting to be explored.

The biofuels industry isn't just about reducing our carbon footprint and promoting sustainability; it's also a significant driver of job opportunities. As the world recognises the importance of transitioning to cleaner energy sources, the biofuels sector stands as a beacon of hope for those seeking meaningful and rewarding careers in the pursuit of a greener future. Biofuels are not just the next sunrise industry, they are a vital part of our sustainable energy future and a catalyst for job creation and economic growth.

Pankaj Kumar

Director (Production),
Oil and Natural Gas Corporation Limited

Energy security in the era of energy transition

Being in the business of conventional energy feels uncalming these days. Everyone seems to be blaming coal, oil and gas for all the woes assailing the climate. Shutting coal, oil and gas down seems the easiest and the quickest way out if you suspend all reason and logic. What seems to be missing from the dialogues is the benefit that stable energy has brought to the world and mankind. When stability is brought into the picture, suddenly, the discussion is more nuanced.

Globally, approximately 161[7] million barrels of oil are being consumed every day. When a transition is discussed, it seems a fine print that for every barrel of oil or natural gas produced, there is a need to find a new replacement to maintain the level of supply and, at the same time, make the investments to transition. This makes the transition process quite challenging, as it must happen while keeping the energy flow consistent, stable, and reliable.

As much as transitioning is necessary, energy security has never been more important for India. As the recent geopolitical developments have shown, no country can relax its vigil to secure stable and reliable energy sources. In the face of unforeseen challenges, Indian oil and gas companies, supported by mature policymaking, have shown the capability to transform, be resilient, and continue to provide stable energy to support India's transition into a major world power.

For oil and gas and traditional energy providers, the need of the hour is to invest in and deploy technology that reduces the amount of carbon released per barrel of oil produced and get to a point where consumption-driven carbon is offset by processes such as carbon credits and carbon capture technologies. ONGC entered a MOU with IndianOil for CO_2 based Enhanced Oil Recovery (EOR)[8] initiative. Under this collaboration, the CO_2 captured from the IOCL's Koyali refinery will be injected in the depleting oil fields of ONGC in Gandhar field, near Vadodara. The project has the potential for sequestrating 5 to 6 million TCO_2 by the year 2040.

Recognising the importance of environmental aspects, ONGC has achieved substantial progress in reducing its emission (Scope - 1 and Scope – 2) by 17%[9] in last five years. ONGC has also set an ambitious goal to achieve Net Zero emissions for Scope – 1 and Scope – 2 by 2038.

Investing in Green Hydrogen, CO_2 capture technologies, diversifying production-related energy requirements to renewables, investing in forestry etc. are some of the ways traditional oil and gas can speed up their transformation into energy-efficient organisations and invest in the nation's energy transition targets. ONGC has chalked out a roadmap for investing into renewables energy and plans to scale its renewable portfolio to 10 GW[10] by 2030. We also have plans to invest over 1 trillion Indian rupees in low carbon businesses including green hydrogen and its derivatives. We are actively looking at partnerships with leading clean energy players to drive our green energy business agenda.

Managing the cost of energy transition will be critical to the success of the 'transition with security' initiative. To that end, firms have the opportunity, indeed the imperative to invest in material research, testing, and experimentation along with universities and academia via sponsorships and MOUs. ONGC, over the years, has been collaborating with institution and academia to promote R&D and innovation in the energy sector. ONGC and its subsidiaries viz. MRPL and OEC, have formed R&D collaborations[11] with Centre of High Technology (CHT), CSIR – NCL, CIPET, CSIR-IICT, IITG, NITK, NMAMIT, etc. Some of these technologies have far reaching impact beyond energy and help improve air and water quality. For example, the Advanced Effluent Water Treatment Plant (AEWTP) developed by ONGC Energy Centre (OEC) in collaboration with BARC treats water for agricultural use, reducing TOC and TDS levels.

The third vertex is government action. India has already taken significant steps towards sustainable development, particularly in the realm of green energy. The "Panchamrit" pledge, made by Prime Minister at the historic COP26 summit, demonstrates India's commitment to promoting sustainable growth while addressing climate change. Alongside its decarbonisation agenda, Government of India has also set a goal of self-reliance in energy. ONGC has re-aligned its strategy to our national priorities by pursuing exploration in frontier areas, enhancing production and reducing carbon intensity of its operations.

I am hopeful that ONGC will be at the forefront of the energy revolution in India enabling the country to achieve the panchamrit goal to deal with climate change.

[7] 2023 Statistical Review of World Energy, Energy Institute, 2023
[8] ONGC Annual Report FY 2022-23
[9] ONGC Annual Report FY 2022-23
[10] ONGC Annual Report FY 2022-23
[11] ONGC Annual Report FY 2022-23

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Ten principles for energy transition

The world is at an interesting stage in its history where on one hand, globalisation is the order of the day and digitalisation is shrinking the world, on the other hand, the inequity between nations is growing. The least developed nations are struggling to build their economy in this complex technology-led global growth bypassing many sequential pathways, and the mid income nations like India, who are aspiring to be a leading economy globally (already number five!) in next few decades, are trying to do the balancing act of hybridising the existing economic models with the emerging new models.

And the new disruptors are energy transition and Artificial Intelligence/Machine Learning (AI/ML).

Energy transition and AI/ML will embrace all pillars of the society and has complex ramifications. When India focusses its energy transition based on four principles viz. energy independence, energy for economic development, energy access to all sections of the society (energy equity), and clean energy for local and global environment, it becomes at once obvious the nature of the problem that 1/6th of the global population (with 1/6th land availability) will be subjected to. Hence what India does now and in next three decades will largely define the global future of economics (political economy) and climate change challenges.

This needs a very elevated level of thinking from thought leaders and policy makers from India and abroad. One-size-fits-all proposed by many pundits won't simply do. What we must understand is that the problem of climate change is global but the solutions unfortunately not so. Very often, this is missing in many bilateral and multilateral dialogues.

India, if it has to become a global beacon of energy transition under the above-mentioned four sovereign principles, it has to follow multiple strategies which have to interface with emerging technologies. These are enumerated below as ten principles:

1. India will have to build a strong base of renewable energy generation using solar wind with an equally strong storage capacity.
2. Even with strong base of renewable energy stated above in point no.1, by 2050, India's renewable energy will still form just about 27 per cent of the total energy demand (and this is due to the challenge of only 20 million Ha being available which can support maximum 3500 GWe of renewable energy installed capacity. This means India will have to depend on its only available fossil viz coal, nuclear, biomass and hydro for 73 per cent of energy demand by 2050.)
3. A new pathway – clean coal technologies rooted in coal gasification technologies away from the current coal combustion is the best option for India.
4. CO_2 capture, utilisation, and storage – CCUS – is going to be an inevitable part of technology development for India to deliver net zero pathway (2070) while meeting its energy needs. This calls for an entirely new set of strategic and policy initiatives.
5. CCUS will also need to be integrated in many CO_2 guzzling industries like cement, steel, aluminium, fertilisers, etc. which are in the mid-life of their lifecycle. New capacity additions for these will be based on new technologies for making steel, cement, aluminium, fertilisers etc.
6. Hydrogen will be a key non-carbon energy carrier based on RE. We have to build a complete value chain involved around storage, transportation, trading, and exchange
7. The hydrogen or its carriers like ammonia or LOHC will become embedded in all the end-use applications from electricity, transport, agriculture, industrial heating and buildings and residential energy needs. Hydrogen will become a main source of fossil substitute for major industries as input raw materials
8. Renewable electricity also will find similar applications from EV to E-boilers
9. Nuclear energy needs a clear push for both large scale 700 MW + and also small scale (SMRs) which can generate hydrogen to meet the local needs
10. Biomass as a key resource for energy and material is another important resource for India and new technologies at distributed scale are needed to make biomass as a tool for farmer's prosperity while not coming in conflict with food or fodder.

The above ten principles will define the energy transition for India. Technology, policy initiatives, funding the transition, public acceptance of the changes and robust regulatory framework will need to realise the same. This is once-in-a-lifetime trillions of dollar opportunity for the industrial sector while a big challenge to the academic and research community to speed up the technology development.

Supporting academia and industry will be the third vertex of policy where the Government will have to create a policy environment that sets up SOPs and operating standards keeping pace with the new technologies as well as strengthening the regulatory ecosystem to ensure safety of people plus sustained reduction in GHGs all the while keeping eyes firmly on the overall transition of the economy.

Sandeep Kohli

Senior Energy Specialist,
The World Bank

David in the world of Goliath: Widget financing for climate change

Sustainable Development Goal 7 (SDG7) calls for ensuring 'affordable, reliable, sustainable and modern energy for all' by 2030. The Energy Progress Report for 2023, that tracks SDG7 indicators, shows that the world is not on track of meeting these targets. If no additional efforts and measures are put in place, then in 2030, some 660 million people will be without electricity access (per IEA 2022a), and 1.9 billion will be without access to clean cooking solutions.

At the same time, climate change is increasing the frequency and intensity of extreme weather events such as heat waves, droughts, floods and tropical cyclones, aggravating water management problems, reducing agricultural production and food security, increasing health risks, damaging critical infrastructure, and interrupting the provision of basic services such as water and sanitation, education, energy, and transport. SDG13 calls for taking urgent action to combat climate change and its impacts.

The challenge of decarbonisation, therefore, is to redouble efforts to meet SDG7 targets, while also combating climate change and its impacts. In 2020, the share of renewable energy in the Total Final Energy Consumption (TFEC) stood at just 19.1 per cent, while to limit temperature rise to less than 1.5°C, this share must reach 30-33 per cent by 2030. Similarly, to make up for lost ground in the area of energy efficiency, improvements in energy intensity must now occur at twice the rate achieved in the last decade.

The New Delhi G20 declaration acknowledged that developing countries will need USD5.9 trillion till 2030 to meet Nationally Determined Contributions, and an additional USD4 trillion each year for clean energy technologies, to meet zero emission goals. To put this in perspective, at its peak in 2017, international public flows supporting clean energy in developing countries stood at USD26.4 billion.

The key to going from billions to trillions may lie in innovations in the area of clean energy 'widget' financing. These 'widgets' – heat-pumps, building renovations, roof-top solar, fuel cells, distributed batteries, clean cooking solutions, efficient lighting and home appliances, and even geothermal developments – have costs that are way below the threshold of project financing. Hence, while our focus has been on de-risking large scale project financing, the greatest lag in SDG7 targets is in energy efficiency, clean cooking, and distributed renewables, where project finance is not an appropriate financing mechanism. Why not apply well established models of home, consumer, and white goods lending to clean energy widget financing?

Our financial institutions are very familiar with credit principles and lending due diligence. In fact, home and white goods financing are likely a much larger part of most banking portfolios than project finance – especially in developing countries. Moreover, tapping into local financial institutions for financing such widgets circumvents issues of foreign exchange mismatches, and gaps in energy sector regulations. What they need is to deepen the learnings of banks on the technical and commercial aspects of clean energy widgets. Let us apply principles of big-data and Artificial Intelligence (AI), to clean energy widgets financing, and root for the David in this battle!

Sanjiv Rangrass

Ex Group Head - R&D, Climate & Sustainability, Projects and EHS, ITC Limited

India's energy transition - Role of the three critical pillars - policies, industry and academia

Balancing climate change and economic development and becoming global leaders in low carbon capacities.

Energy demand in India is projected to continue increasing over the coming decades. The increase in Indian energy consumption is expected to account for almost a quarter of the total increase in global energy consumption over the period to 2040 (IEA database).

As the world grapples with the pressing issue of climate change, India stands at the forefront of the global energy transition. However, for this, India's energy landscape will have to undergo a profound transformation. At COP27, India pledged to further reduce the emissions intensity of its GDP by 45 percent by 2030, from 2005 level. If all the pieces are set in place to create the right demand signals within this decade, then not only can India add low-carbon capacities in the next two decades but become a world leader in this area.

The single-minded objective should be to make India the leader in low carbon technology. This requires an ecosystem where research informs policy, policy incentivises industry action, and industry advancements drive further innovation and economic growth. Effective coordination among policies, industry, and academia is critical for India's successful energy transition, as it addresses energy security, environmental sustainability and economic development simultaneously.

Much like the NHAI, it is suggested that the government could constitute a central body under the aegis of the PMO, which is charged with the objective of achieving leadership in this space and coordinating across the three pillars and with respective ministries.

Policy

India needs to focus on policy stability and consistency, ensuring that investors have confidence in the long-term viability of their clean energy projects. A comprehensive, long-term energy policy that outlines clear targets for renewable energy capacity, emissions reduction, and energy efficiency improvements is essential. This would provide the private sector with a predictable roadmap, encouraging industry investments in clean energy technologies and infrastructure.

Furthermore, the government can incentivise carbon pricing mechanisms such as carbon taxes or cap-and-trade systems. By internalising the environmental costs of emissions, these policies can stimulate industries to reduce their carbon footprint and invest in cleaner alternatives.

International collaboration is another critical aspect of India's energy transition policies. Engaging with global organisations and countries can provide access to climate finance, technology transfer, and best practices. India can tap into the vast pool of global expertise.

Industry: Driving innovation and implementation

India's industrial sector must lead the way in investing in and implementing clean energy solutions. Major companies in clean energy sector have already made significant strides in renewable energy generation and electric vehicle manufacturing. These industry leaders are not only contributing to emissions reduction but also creating jobs and driving economic growth.

The manufacturing and deployment of electric vehicles (EVs) is a prime example of industry-driven innovation. Global automobile manufacturers have introduced electric cars and electric two-wheelers, while companies like Ather Energy are investing in EV charging infrastructure. This industry focus on EVs not only reduces emissions in the transportation sector but also positions India as a global player in sustainable mobility.

Industry-academia partnerships can lead to joint research projects, technology transfer, and a skilled workforce. Research and development in clean energy technologies, energy storage solutions, and grid management are areas where academia and industry can collaborate to drive innovation.

Academia: Nurturing knowledge and talent

Academic institutions can provide valuable insights and evidence-based recommendations for appropriate energy policies. Universities must update their curricula to include courses and degrees in renewable energy, sustainable engineering, and green finance, preparing graduates for careers in the clean energy sector.

Research on battery technology, energy storage, and grid integration is vital for overcoming the challenges of intermittent renewable energy sources.

India's energy transition is a multifaceted challenge that requires a delicate balance between addressing climate change and fostering economic development.

Saurabh Gupta Partner, KPMG in India

Ankit Anurag Associate Director, KPMG in India

Customer-centric transformation of charging infrastructure is key to mass adoption of EVs in India

India's e-mobility sector witnessed an important landmark in 2022 with 5 per cent EV penetration in terms of new sales. This is globally considered as a tipping point, signifying the start of mass adoption. This has been a collective achievement with all stakeholders taking proactive initiatives and supported by timely policy and regulatory interventions.

As India gears up for the next wave of growth, it will be critical to strengthen other verticals of the e-mobility sector, specifically EV charging infrastructure. At present, a majority of the charging demand is being met through home charging. However, sustaining an increasing number of EVs will require publicly accessible charging infrastructure.

Proliferation of public chargers and advancements in battery performance have helped address the range anxiety to a certain extent. Instead, a new apprehension has taken its place, i.e., charge anxiety. This is the feeling of uncertainty whether an EV user will be able to charge at a public charging station. As EV use expands beyond early adopters, these problems are expected to become more prominent. Hence, keeping customers at the core and proactively addressing their concerns is key to accelerating the e-mobility growth.

Ideally, customers should receive the same level of convenience with public EV charging as offered by fuel refilling stations of ICE vehicles. People making the switch to EV must have the confidence that the public charging network they need is available and reliable. Achieving such level of service will require concerted efforts and adherence to five basic tenets of consumer engagement –

1. **Availability –** Public charge-points should be easy to locate
2. **Reliability –** There should be consistency in service each time, every time
3. **Transparency –** Fostering trust through transparent pricing and easy payments
4. **Accessibility –** Charging stations should be inclusive and accessible for all
5. **Innovation –** Creating customer delight through constant innovation.

A basic expectation of EV owners is to find and access public charge-points wherever they live. This will necessitate systematic planning to ramp up charger density. Keeping pace with the global trend, India needs to adopt a more granular approach with metrics like number of EVs per charge-point or public charging power capacity per EV. Further, open data standards need to be brought in to make available charger information like location and availability to all users.

Review of customer feedback on EV charging applications has highlighted a number of pain points. It will be crucial to put in place a strong reliability and service standards along with a framework for reporting and monitoring the same. Pricing and payments at public charging stations also define the consumer experience – pricing should be transparent, easy to comprehend, and comparable while the payment should be hassle free. This will instill trust and confidence towards the e-mobility ecosystem and help accelerate the EV transition.

An inclusive design with the right mobility and communication features will bring greater number of people in the ambit of EVs, including drivers with disabilities. Finally, innovations targeted at addressing customer needs like shorter charging time, smart charging, peer-to-peer charging, etc. will provide added value to users, and consequently enhance EV adoption. A dedicated centre-of-excellence or R&D hub for EV charging can be envisaged to facilitate such innovations. Further, academia can also play an important role in skilling and sensitising the workforce towards more accessible design and services.

As India positions itself at the forefront of global efforts to mitigate climate change, the customer-centric transformation of the public charging landscape emerges as a critical enabler. By placing the customer experience at the forefront and addressing challenges such as range and charge anxiety, accessibility, and ease-of-use, India can embark on a journey that not only facilitates a seamless transition to EVs but also cultivates a positive perception of sustainable mobility among its citizens.

Saurabh Kumar Vice President,
The Global Energy Alliance for People and Planet (GEAPP) in India

Unlocking energy transition potential: The power of collaboration for 'growing with less'

In an era marked by climate change concerns, the energy transition has become a global imperative. The transition from traditional fuels to cleaner, more sustainable energy sources is necessary to mitigate the effects of climate change and ensure a sustainable future for our planet. However, this transition is not without its challenges. To successfully navigate this complex journey, collaboration is key. We also need to be mindful of the ideas of 'Our Common Future' and 'Limits to Growth' and come up with innovative solutions to grow with less.

Rationale for growing with less

We need to adopt the philosophy of growing with less, being mindful of the fact that there is only one earth. Providing dignity of life to eight billion people in the world requires thinking and a change in mindset to deal with the challenges of environmental concerns, dwindling resources, and increasing populations. The international obligations to reduce GHGs and the Government of India's commitment towards addressing climate change are clearly evident through their various efforts. Last year, Prime Minister Shri Narendra Modi launched the scheme Mission LiFE (Lifestyle for Environment) to encourage people to consciously adopt environmentally friendly lifestyles.

The power of collaboration

The energy transition cannot be a solitary endeavour happening in a vacuum but a collective journey that requires collaboration at all levels. Collaboration brings synergy, goals alignment and the adoption of new technologies, and most importantly, it leads to a strong partnership and ownership among all stakeholders. It helps in facilitating research, development, demonstration, and deployment of innovative products in the real market. Successful partnerships between academia, industry, and government stakeholders working in this space will create pathways for scaling innovative solutions as per their feasibility and consumers' requirements.

Successful case study on policy, industry and academic collaboration

Mahatma Phule Renewable Energy & Infrastructure Technology Limited (MAHAPREIT) and the Global Energy Alliance for People and Planet (GEAPP) have partnered to enable the implementation of 500 MW worth of decentralised solar projects in the state of Maharashtra for the PM KUSUM Scheme. Through this partnership, INR2,500 crore will be invested in solar energy projects, resulting in a 400,000 tonnes yearly CO_2 emissions reduction, and helping about 100,000 farmers.

The establishment of the International Solar Alliance is another example where collaboration has led to the successful deployment of innovative solar technologies in emerging economies.

What more can be done to synergise policy, industry and academia collaboration?

Though the Government of India has created an ecosystem through various initiatives such as the Atal Innovation Mission, the National Innovation Fund, Start-Up India, and Digital India to facilitate partnerships among the academia, industry and regulatory stakeholders, more needs to be done. The government can create better linkages between industry and academia by setting up innovation and incubation centres on university premises and supporting small and medium-scale enterprises through funding and technological support by leveraging international capabilities.

Dr. Shalivahan

Director, Professor,
Department of Petroleum Engineering & Earth Sciences,
Indian Institute of Petroleum and Energy

Carbon markets in India: A path to sustainability

Carbon markets have emerged as a critical tool in the global fight against climate change. These markets provide financial incentives for countries and businesses to reduce their carbon emissions, promote sustainable practices, and transition towards a low-carbon economy. Carbon markets are critical enablers for India's decarbonisation journey and there is a need to focus on its effective implementation.

Why India needs carbon markets?

Climate change mitigation: India is one of the world's largest emitters of greenhouse gases (GHGs), primarily due to its growing population and industrialisation. Implementing carbon markets can help India reduce its carbon footprint and contribute significantly to global climate change mitigation efforts.

Economic opportunities: Carbon markets create opportunities for economic growth and sustainable development. They incentivise businesses to adopt cleaner technologies and invest in renewable energy, which can create jobs, stimulate innovation, and drive economic growth.

Compliance with international agreement: India is a signatory to international agreements like the Paris Agreement, which commits countries to limit global warming to well below 2 degrees Celsius. Carbon markets can help India meet its commitments by incentivising emissions reductions.

Attracting foreign investment: As the world shifts towards sustainability, countries with robust carbon market mechanisms can attract foreign investment from environmentally conscious investors and organisations. India can tap into this potential by establishing an efficient carbon market.

How to implement carbon markets in India?

Setting emission reduction targets: The first step in establishing a carbon market is setting clear, ambitious emission reduction targets. India should establish sector-specific targets and timelines to ensure emissions are reduced across industries.

Monitoring and reporting: Implement a robust monitoring and reporting system to track emissions accurately. This requires cooperation between the government and businesses to ensure transparency and accountability.

Carbon pricing mechanisms: Introduce carbon pricing mechanisms such as carbon taxes or cap-and-trade systems. These mechanisms put a price on carbon emissions, creating a financial incentive for businesses to reduce their emissions.

Support for clean technologies: Encourage the adoption of clean technologies by providing incentives, subsidies, and research and development funding. This will help businesses transition to low-carbon practices.

Market development: Develop a carbon trading market where companies can buy and sell carbon credits. This market should be transparent, regulated, and accessible to a wide range of participants.

Public awareness and education: Increase public awareness about the importance of carbon markets and sustainable practices. Engaging the public can generate support for these initiatives and encourage individuals to reduce their carbon footprint.

International collaboration: Collaborate with international organisations and other countries to share best practices and ensure the compatibility of carbon markets on a global scale. This can help India access international carbon markets and attract foreign investment.

Challenges and solutions

Data accuracy and transparency: Ensuring accurate reporting of emissions data can be challenging. India can address this issue by implementing strict monitoring and verification protocols and investing in data infrastructure.

Equity and social impact: Carbon markets must consider the social and economic impacts on vulnerable communities. Implement policies to protect these communities and ensure that the benefits of carbon markets are equitably distributed.

Regulatory framework: India needs to establish a robust regulatory framework to govern carbon markets effectively. This includes defining emission limits, penalties for non-compliance, and mechanisms to address market manipulation.

Price volatility: Carbon markets can experience price fluctuations, which may deter businesses from participating. India can mitigate this by introducing price stability mechanisms, such as price floors and ceilings.

Carbon markets are a crucial tool in addressing climate change and promoting sustainable development in India. By implementing effective carbon pricing mechanisms, setting emission reduction targets, and fostering international cooperation, India can reduce its carbon emissions, attract investment, and contribute to global efforts to combat climate change. The government plans to develop the Indian Carbon Market (ICM) where a national framework will be established with an objective to decarbonise the Indian economy by pricing the Green House Gas (GHG) emission through trading of the Carbon Credit Certificates. While the plan seems to be in right direction, India needs to expedite the implementation of Indian Carbon Market (ICM) for the benefit of its environment and economy.

Dr. Steve Moore

Deputy CEO,
Cairn Oil & Gas, Vedanta

Energy security crucial for Aatmanirbhar Bharat

The successful G20 Summit under India's Presidency has underscored the country's growing global influence and capability to muster consensus on divergent global issues such as climate change. The biggest takeaway for us has been the focus on energy security that will continue to be at the heart of India's impressive economic growth – now powering its way to be a USD5 trillion economy making its way to the top three global economies by the turn of the decade. This projected growth will be closely linked to India's status as an emerging global energy economy.

India needs an increased reliable energy supply to drive industrial growth and digitalisation, making agricultural processes more efficient, bolstering supply chains, and enhancing overall quality of life.

Currently, nearly 85 per cent of the country's energy requirements are met by coal, oil, and solid biomass. As the nation focuses on transitioning to Net Zero by 2070, securing reliable energy to meet domestic household consumption and power business sectors cannot be compromised. The importance of achieving energy self-sufficiency has been further accentuated by the recent geopolitical developments and resulting oil price volatility. Duly, the idea of Aatmanirbhar Bharat has never been more alive in the context of energy requirements.

The oil and gas sector has a critical role to play in guiding India towards its stated twin goals of becoming aatmanirbhar while also achieving net-zero by 2070. Currently, oil is the second-largest contributor to India's energy mix with a 24 per cent share in powering the economy. At the same time, India is a net importer with ~85 per cent of crude being imported, and with the rising Brent prices, its import bill continues to go up. Therefore, it will be prudent to empower domestic oil and gas producers by incentivising investment in the sector, to achieve self-reliance.

The Indian government has taken several laudable measures to promote clean energy production while deftly balancing the demand-supply gap. Further, realising the crucial need to increase domestic production of oil and gas, it is pertinent to look at the high levels of taxes and levies and ensure continuity in operations through lifecycle contracts for oil and gas fields. This will further help in optimising costs while deriving more value from the assets, allowing operators to pace energy security with enough investible surplus for establishing long-term sustainability.

Various countries, including the United States, Canada, China, Thailand, Norway, and the United Kingdom, have implemented policies to augment domestic production while maintaining a commitment to clean energy. Their policies and incentives are designed to ensure that energy security is not sacrificed in the pursuit of economic growth, as the two are closely intertwined. They have also rightly recognised the role of oil and gas in not just allowing economic growth but also accommodating energy transition.

For India, this balance of energy security with energy transition is especially relevant, given the population size and economic ambition. To achieve energy security that is sustainable, it is important to maximise energy production while minimising emissions by deploying technology to decarbonise the entire value chain.

Cairn Oil & Gas today contributes 25 per cent to India's domestic crude basket and has set a firm goal to double capacity to 50 per cent while also aiming to achieve net-zero within the next five years. The goals are ambitious but pertinent in ensuring that India remains powered round-the-clock without degrading its natural ecosystems.

As India strengthens its position as a leader of the Global South, and indeed the world, energy security through sustainable and responsible ways will fuel and give wings to its ambitions. Therefore, today more than ever, we must recognise the role of the oil and gas sector in driving energy security while benefiting the triple bottom line – people, planet and purpose.

Varinder Dhawan Executive Director,
Steel Authority of India Limited

Decarbonisation in steel making

While the world is charting pathways for decarbonisation of energy, transport, and industrial sectors, we have a long distance to cover when it comes to hard-to-abate sectors. India is a key contributor to the global action against climate change, and has set a goal to achieve its net zero emissions by 2070. India is rapidly scaling up deployment of renewable energy and focusing on clean energy technologies. Greening the end-use of energy is equally critical as the industrial emission in overall emissions currently contributes to about 28 per cent[12].

The steel industry is one of the most hard-to-abate and energy-intensive sectors, contributing to 7-8 per cent of total anthropogenic CO_2 emissions. The Indian steel industry has higher carbon footprint than the world average due to its inherent limitations of main raw materials (viz. iron ore and coal) and low availability of scrap and clean fuels such as natural gas.

SAIL, the largest PSU steel producer in India, is striving hard in this endeavour by improving its processes, efficiencies and upgrading the technologies to be at the forefront of this mammoth transformation. Key sustenance parameters are complementary to each other and improvements in any of these parameters lead to improvement in other parameters as well. Various efforts are being undertaken in the following areas:

- **Reducing the specific energy consumption (SEC)**
  Measures being taken to reduce the SEC are through the application of advanced energy-efficient technology, the use of dry quenching technologies in coke ovens, installing larger volume blast furnaces (BFs), BFs with top recovery turbines (TRTs), reducing coke rate in BFs by increasing coal dust injection and increasing pellet usage, phasing out old energy-intensive units, shifting to VVVF drives, thyristorisation and use of LED lights across the steel plants.
- **Availability of green energy and scaling up its usage in the steel industry**
  SAIL is increasing its share of solar power to meet the power demand at its steel plants
- **Capturing energy through recovery and recycling of heat energy escaping our processes, wherever possible**
  Currently, 18 per cent of the power requirement is met through co-generation and is achieved through the installation of facilities such as TRTs in the BFs, back pressure turbo generators in the coke ovens, hot charging in the mills, waste heat recovery systems, etc. The component of all these new age state-of-the-art technologies is being increased in successive modex plans.
- **Resource efficiency**
  Beneficiation shall enable the usage of leaner ores and the upcoming stamp-charged batteries shall enhance usage of indigenous coking coal. The focus is on reducing carbon footprint by developing corrosion and earthquake-resistant products with higher life and higher strength-to-weight ratio steels promoting lesser usage.
- **Use of green hydrogen in our processes**
  Although green hydrogen is still in a very nascent stage of R&D and is not yet a cost-effective solution, it has a huge potential for decarbonisation in the steel industry.

SAIL has reduced its carbon footprint by 19 per cent since 2005 and has also earned huge Energy Saving Certificates (ESCerts) under different cycles of the PAT Scheme of Government of India (GoI). In addition, we at SAIL have adopted 4R's policy (Reduce, Recover, Recycle, and Reuse) across all our processes and have adopted various initiatives to enhance the utilisation of various by-products and waste being generated at our plants and mines. SAIL is also collaborating with various technology suppliers, academic institutes, and research organisations to develop energy-efficient and low-emission technologies suitable to steelmaking in the Indian context.

I am fully confident that India will achieve the target of Net Zero by 2070 and its strong, vibrant, and efficient steel industry will be a proactive contributor in this journey.

[12] Decarbonising India's Hard-to-Abate Manufacturing Sectors with Green Hydrogen, Shakti Sustainable Energy Foundation, 2021

Vijay Mittal Joint Secretary,
Ministry of Heavy Industries

Decarbonisation of hard-to-abate industries

> *Sustainable energy financing is critical for nations to achieve its energy security and decarbonisation goals.*

Despite low per-capita emissions (1.8 tons CO_2), India is the third-largest emitter globally, emitting a net 2.9 gigatons of carbon dioxide equivalent ($GtCO_2e$) every year as of 2019. The bulk of these emissions (about 70 per cent) are driven by six sectors: power, steel, automotive, aviation, cement, and agriculture. These industries are the driving force behind India's infrastructural change. Thus, the need for decarbonisation has prompted the search of innovative, clean and sustainable technologies. Government of India (GoI) has taken significant steps in this direction at a crucial time. *This is a decisive decade where accelerating decarbonisation will create more opportunities and enhance economic growth.*

It is a multipronged war, fought on multiple fronts and all the stakeholder ministries are taking steps for the decarbonisation of hard-to-abate industries. Ministry of New & Renewable Energy (MNRE) has taken up multiple initiatives towards increasing the RE capacity, and the promoting the use of alternative fuels like hydrogen through the National Green Hydrogen Mission.

India has 300 billion tonnes of coal reserves. It continues to remain one of its main sources of energy and is expected to play a critical role in the energy mix for a long time. Keeping this in mind, Ministry of Coal (MoC) has launched the National Coal Gasification Mission with plans to convert 1 million ton of coal/year to produce SynGas which is a cleaner form for utilisation of coal energy.

The Ministry of Heavy Industries (MHI) is an active stakeholder in achieving India's decarbonisation goals. MHI, through its Maharatna PSU Bharat Heavy Electricals Limited (BHEL), has developed technologies to utilise coal in an eco-friendly way. BHEL has developed 'Advanced Ultra- Supercritical Technology' (AUSC) with support from MHI to increase the efficiency of thermal power plants (TPP). The implementation of this technology increases the efficiency of the TPP by 11 per cent – 15 per cent i.e. more power from less coal. An 800 MW TPP with the implementation of AUSC technology shall save 2.6 lakh tons of coal/year which means less CO_2 emissions of 3.6 lakh tons/year. BHEL has also developed Coal Gasification Technology for high-ash content Indian Coal and has entered into an MOU with Coal India Limited to commercialise the same.

The use of coal without CO_2 emissions is an important step for India in its efforts of decarbonisation. Hence, Carbon Capture and Utilisation Technology (CCUT) is also being experimented with at MHI, which aims to capture CO_2 from the source itself and utilise it to produce value-added products, which will also help in curtailing imports.

BHEL has devised an innovative way to implement the Coal Gasification project with CCUT. Amine-based absorption process is being used to capture CO2 which is converted into methanol, an important import substitute for the nation. BHEL has established a pilot plant of 0.25 TPD in Hyderabad, successfully running for the last two years for the same. This technology will help the country move towards the adoption of clean technology and promote the use of methanol as a transportation fuel (blending with gasoline), utilisation of DME in LPG blending, as a hydrogen carrier and production of other chemicals from coal. A 2000 TPD plant design for ammonium nitrate is also at advanced stages of R&D.

With an aim of significantly contributing towards future technologies, BHEL has taken the lead to create a centre of excellence in Varanasi for the development of hydrogen electrolysers, Type IV cylinder design and manufacturing and national testing facilities to support MNRE's vision of developing a hydrogen ecosystem in the country. This is a first-of-its-kind facility in India.

Thus, GoI has a detailed medium-term decarbonisation plan with sector-specific priorities and policy frameworks that account for interdependencies across sectors and provide demand signals to guide corporates to invest. The government is targeting all components of decarbonisation in a 'Whole of the Government' approach to fulfill its commitment to achieving the Panchamrit Goals.

Vikas Gaba Partner and National Head, Power & Utilities, KPMG in India

India needs triple helix++ model of innovation to accelerate energy transition

India needs triple helix++ model of innovation to accelerate its journey towards energy transition. By 2047, the renewable energy capacity is likely to grow to 13 times from the current, energy storage by 65 times, nuclear power by 8 times, power generation output by 4 times and an annual production capacity of 25 MMT of green hydrogen. These will require corresponding investments in electric and hydrogen grid infrastructure expansion. The challenge is not only implementation of these targets, but also to do it in the most efficient and affordable manner. Innovation will need to be the cornerstone of this transition and will be required in new materials, technology, supply chains, manufacturing, skills, recycling, etc.

In simple terms, triple helix[13] means interactions between 'universities/academia' – that engages in providing knowledge and research; 'industry' – that focuses on producing commercial goods and deployment; and government/policy – that creates a regulating market environment to foster economic and social development.

India has umpteen number of bilateral collaboration examples where 'government-industry' or 'government-academia' or 'academia-industry' have come together to create transformation. For instance, the Production Linked Incentive (PLI) scheme for manufacturing of advanced solar cells or advanced chemistry cell (ACC) for battery storage, solar bidding, biofuels under Sustainable Alternative Towards Affordable Transportation (SATAT) Programme, procurement of energy storage under facilitative mechanism etc. are all examples of 'government-industry' collaboration. Likewise, India's start-up ecosystem is a case in point for 'government-academia' collaboration, where collaboration between academic institutes and government institutions has led to creation of 400+ incubators (including in tier 2/ tier 3 cities) supporting entrepreneurs, startups and students with promising ideas.

While all of the above initiatives have achieved results and scale, instances of all the three ecosystems coming together have been limited or not pursued consistently. In addition, most of the initiatives are either focused on deployment or innovation exclusively.

Triple helix++ model enables government-industry-academia collaboration to deliver innovation at scale hence encouraging innovation-led deployment. The most common example is the Silicon Valley, U.S. where government provided concessional land, tax benefits, favourable financing, aligning the requirement of IT companies and encouraging innovations. The space flourished with some of the best-known global IT companies. The openness and transparency encouraged university accelerators to collaborate, so much so that they took part in commercial activities through patenting and licensing, extending much beyond their original realm. In certain cases, it led to creation of hybridised entities like the Technology Transfer Offices within academic universities to foster the transformation of applied research into commercial value and goods. The Fraunhofer Institute in Germany is another example that has been doing this consistently. Hence, a well-structured triple helix led innovation model creates a strong win-win.

In the emerging context of energy transition where sector boundaries are blurring, there will be multiple hybridised versions of triple helix that need to be considered. These include a 'quadruple helix' that adds a fourth dimension i.e. public, civil society and media at large; and 'quintuple helix (5-helix)' that adds a fifth dimension i.e. natural environment to the framework.

A classic case for application of such hybridised approach is Mission Life launched by PM Modi during COP26 that focusses on nudging individual and collective action towards 'Lifestyle for Environment'. The Mission defines seven life themes: reduce waste, reduce e-waste, adopt healthy lifestyles, adopt sustainable food systems, say no to single use plastics, save water and save energy. All these themes are amenable to a 5-helix approach working together, for instance:

- Policy action e.g. policy for waste segregation and management; energy use guidelines; appliance labelling schemes and so on.
- Academic innovations and workforce skill building; e.g. new innovations in waste management and recycling, prototyping low carbon materials and products; providing skilled and semi-skilled workforce; specialised trainings, etc.
- Industry action, by co-opting such innovation for mass scale production; e.g. superefficient ACs and fans, large scale recycling of aluminium cans, glass bottles, metals, etc.
- People participation on awareness creation and adoption of measure instituted – voluntary or mandatory – e.g. adoption of EVs, buying choices for low carbon products and services
- Natural environment – lowering the damage to natural habitats; avoid shift and improve policies.

Energy transition is an all-encompassing economic transformation that will require collective action to alter changes in demand patterns, supply systems, and policies. As the life mission defines it, प्रकृति: रक्षति: रक्षिता, - nature we must protect, and nature will protect us. Collective action involving all the five actors – policymakers-academia-industry-people-natural environment – have to be at the core of this transformation.

[13] The framework of Triple Helix was developed by Henry Etzkowitz and Loet Leydesdorff who published their paper "The Triple Helix---University-Industry-Government Relations: A Laboratory for Knowledge Based Economic Development," in 1995.

Vinod Tahliani

VP, Integrated Gas & Power – India Growth
bp India Private Limited

Collaboration is the need of the hour!

As the world sees a growing impetus towards cleaner forms of energy to help reduce the impact of climate change, we at bp believe that there is a need to do both – commit investments to grow cleaner forms of energy **and** continue investments to deliver hydrocarbons to meet the growing energy demand of the customers and ensure as smooth a transition as possible.

As an integrated energy company, we see ourselves playing a key role in helping the world make this transition.

Globally, we are pursuing several alternate forms of energy (renewables, hydrogen and biofuels) as part of this transition. At the same time, we feel that a smooth transition will require continued investment in hydrocarbons especially in growing energy markets like India – with gas playing a key role to support this transition.

The need of the hour is for increased collaboration between policy makers, industry and academia to encourage the transition.

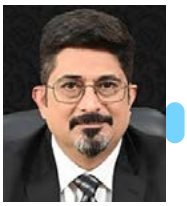
As an example, bp sees low carbon hydrogen as an essential complement to electrification of global energy systems, with a key role in hard to abate transport and industrial sectors. India is creating a robust green hydrogen economy through the National Hydrogen Mission, Green Hydrogen policy and demand mandates coupled with production linked incentive scheme for electrolysers with the aim to make India a global hub for Green Hydrogen production and export. With these policies in place, and active and significant government support to keep pushing the technology forward, industry is committing significant capital to help develop solutions at scale.

Digital technology is another focus area to transform and optimise the energy system – increasing recovery of resources, reducing costs of supply and reducing demand. It has potential to reduce current demand by ~18 per cent to 2050. For instance:

- a combination of autonomous vehicles, ride-sharing and intelligent traffic management systems could reduce demand by up to 40 per cent in the light-duty vehicle sub-sector;
- adoption of smart homes, smart meters, connected infrastructure and energy management systems could reduce up to 20 per cent demand in residential and commercial buildings.

Indian manufacturing industry has robot density (# of robots per 10,000 workers) of 1 versus world average of 77. Academia needs to drive automation across Indian industry via Industry 4.0 with the increased productivity leading to increased economic activity. In addition, we need to capitalise on our increased ability to capture and analyse data in real time to make sense as the data is acquired and help drive optimised business decisions.

In summary, I believe India is uniquely positioned to make the transition to cleaner energy while continuing to provide affordable energy for upliftment and development. bp is proud to partner India on this journey with its experience, technology and global scale.



Vishal Kapoor CEO, Energy Efficiency Services Limited

Catalysing energy efficiency through aggregation

The urgent reality of climate change looms large demanding a swift and unwavering response. In this backdrop, it is important to increase visibility of the pivotal role of energy efficiency interventions. While it is established that energy efficiency has a potential to contribute to almost 40 per cent of the GHG reductions, unfortunately it doesn't get the attention it deserves. While large renewable energy projects like wind and solar often take the spotlight, energy efficiency projects operate quietly and, in the background, and sometimes fail to demonstrate their direct economic impact. These projects, often fragmented and involving diverse clients and scopes, add complexity to assessment.

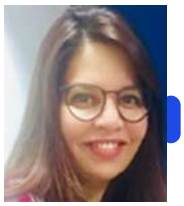
To truly have a substantial impact, we must double our annual progress in energy efficiency. This means increasing investments in this sector from the current USD600 billion to a staggering USD1.8 trillion by 2030. Our focus must encompass both domestic and industrial sectors to maximise the reduction in greenhouse gas emissions per unit of investment.

To overcome these challenges, it is imperative that we establish a binding framework for aggregating energy efficiency projects, regardless of their size or scope. Integrating research and academia into the framework building process ensures scientific rigour and will be crucial for converting sceptics to the cause of energy efficiency. Aggregation holds the key to reshaping the energy efficiency landscape in several ways. Firstly, it provides much-needed visibility in the market, attracting investments and stimulating innovation. Secondly, by consolidating projects and enhancing their collective value, we can reduce costs for scalable, replicable, and repeatable projects and products. Thirdly, aggregation improves the allocative efficiency of finance to Energy Service Companies (ESCOs) or off-takers, simplifying the process. Furthermore, it diminishes information asymmetry, lowers costs, and bolsters delivery efficiency through standardised contracts.

With the tremendous potential that the aggregation model offers, there arises a pressing need for an energy efficiency marketplace. Such a marketplace could serve as a one-stop destination for all energy-efficient products and services. Aggregation can also be leveraged to provide services, uniting ESCO companies and project pipelines. This, in turn, makes the adoption of comprehensive energy-efficient solutions and sustainable practices more accessible to consumers.

Beyond the realm of energy efficiency, the transportation sector stands as a significant contributor to annual emissions due to fossil fuel consumption. Shifting towards electric mobility becomes imperative for curtailing these emissions, especially as our energy grid becomes increasingly green through heightened renewable energy integration. Electric mobility, specifically the adoption of electric buses, has received a substantial boost through the aggregation model. This approach has revolutionised the conventional bus ownership model into a bus-as-a-service concept, drawing in financiers, bus manufacturers, and operators alike. This transition marks a groundbreaking shift in the public transportation sector.

The aggregation model is exceptionally well-suited to electric mobility, encompassing both electric four-wheelers (e4Vs) and electric vehicle charging infrastructure (EVCI). By harnessing the power of demand aggregation and facilitating delivery through the energy efficiency marketplace, electric mobility solutions can be efficiently scaled up. With concerted efforts, government collaboration, and strategic implementation, we can harness the power of aggregation to pave the way for a sustainable future for generations to come. Together, we possess the power to make a tangible difference, and it is incumbent upon us to seize this moment and usher in a more sustainable and prosperous future.



Dr. Vishalli Dongrie Partner and Head – People Consulting, KPMG in India

Just transition for energy transition

With a 2.4 degree rise in global temperatures predicted, and the extreme weather events unfolding across the globe, the attention on the 'Environment' part of ESG is merited. The need for urgent energy transition is only balanced by the need for an orderly transition to protect the gains made by our country in becoming energy secure.

Energy transition is a culture transformation

We believe that transforming our learning and skilling models is critical for embedding energy transition. While interacting with our clients, a key question we are getting asked often is – how to institutionalise ESG behaviour and how to implement long-term change in a culture which is immediacy driven?

In our opinion, organisations need to go deep into their cultural psyche and identify root causes for employee behaviours that may be disrupting ESG-related transformations and then establish programmes and processes to identify opportunities for change and embed the same in workplaces and communities. We cannot become energy efficient and energy positive without transforming the way we live and work.

Focus on Social 'S' of ESG for a just transition

Imagine the plight of millions of coal workers and fossil fuel workers if energy transition was done overnight. To make such transitions work, alternative models of livelihood, of skills, of housing, of education must be established. At the forefront, India will need programmes and processes that empower our women and our rural population. Any policy that impacts industrial employment has tremendous potential to damage rural economies. In most of such cases, the brunt is borne by the women. From focusing on establishing and sustaining women self-help groups to focusing on credit programmes that enable health and education through women could be powerful ways to improve social outcomes.

Industry and academia need to work together on incubating new models that can then be implemented via policy. Academia especially has a very strong role to play in terms of testing out efficacies of possible alternative income and learning models, change management models that can embed the deep-rooted changes required to make the energy transition successful.

Improving diversity, equity, and inclusion (DEI) outcomes will be critical for transition and inclusion

Enough research is available on the benefits of diverse workplaces yet women participation in our employed population is steadily declining. While the social roots of the same need a review, analysis and policy level support, organisations can do a lot in this space. Critically examining your policies for hurdles to running diverse workplaces is a start. Examining your talent management practices for unconscious biases is another. It is said that when women are educated and employed, societies grow richer. We would like to push that point by saying, when any minority group is more involved, the society is enriched. And an enriched society is a more profitable society. Adding to that, diverse workgroups have the capacity to create innovative ideas that could help organisations by improving energy efficiency, reducing energy intensity, improving organisational governance – all of which are critical to energy transition and SDGs.

In summary

Embedding transformation takes time, energy, commitment, and deep detailed planning. Focused interventions by industry, academia and government can help provide an orderly transition.

Vivek Rahi Partner,
KPMG in India

Collaborating for innovation: Advancing Carbon Capture, Utilisation and Storage (CCUS) deployment in India

Limiting global warming to 1.5° C requires a deep and sustained reduction in global GHG emissions of 43 per cent by 2030 relative to 2019 levels. Despite significant efforts to deploy renewable energy at rapid pace and scale, the ambition of 1.5° C reduction in global warming seems unattainable unless carbon capture technologies are put into action for cleaning up the hard-to-abate end-use sectors. The earliest instances of CO_2 capture and utilisation began in the early-to-mid 20th century within the oil and gas industry. Enhanced Oil Recovery (EOR) techniques were developed that involved injecting CO_2 into oil reservoirs to increase oil production. In the contemporary context, (Carbon Capture and Utilisation Systems) CCUS has garnered recognition and significant expansion (growth of 44 per cent in the number of CCS facilities since 2021) as a crucial technology to curtail carbon emissions and achieving the net zero emissions future. This is a result of government action across the world creating a supportive system for CCUS through a combination of policy measures, public-private partnerships and investments in technology and innovation. Similar developments have been observed in India at a national level as well. India has created a national task force to develop the 2030 roadmap for CCUS. In addition, the government is setting up National Centre of Excellence for Carbon Capture and Utilisation (NCoE-CCU) at Indian Institute of Technology (IIT), Bombay and National Centre in Carbon Capture and Utilisation (NCCCU) at Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru. The government is also considering providing tax breaks and other financial incentives for businesses that deploy CCUS technologies. The Indian government has established a national programme on CO_2 storage research which supports carbon capture research and develops pilots and projects. Another major step includes Accelerating CCS Technologies (ACT) and Mission Innovation (MI) programme. The MI carbon capture innovation challenge aims to enable near-zero CO_2 emissions from power plants and carbon-intensive industries. Additionally, Council of Scientific and Industrial Research (CSIR) is working with industry partners to develop CCUS technologies for a variety of applications including power generation, cement production, and steel making.

Currently, there are many pilot CCUS projects being implemented across sectors. For example, ONGC and Indian Oil are working on India's first industrial scale carbon capture project wherein CO_2 captured from Koyali refinery will be transported through pipeline to Gandhar field for injection into the wells to enhance oil production. CCS is a proven technology with an operating global capacity of ~45 MT[14] and about 149 MT under advanced stages of development, expected to be ready by 2030. India needs to significantly catch up when it comes to development of commercial capture facilities. Global experience reveals that a conducive policy framework that appropriately incentivises and de-risks investments in developing CCUS value chain is a critical enabler. NITI Aayog in its policy paper contemplated key elements of the policy framework viz. finance, incentive structure, business model and risk mitigation. The key, therefore, is to swiftly implement a comprehensive policy framework that enables creation of economically viable CCUS projects. In addition, there is need to pace up the R&D efforts and enabling industry-academia collaboration. Learning from global leading practices, the academic institutions in India may set up CCUS research centres and programmes and offer a variety of courses and degrees in CCUS-related fields to attract the talent and build skills.

CCUS also aligns with five of the seventeen SDGs, namely, climate action; clean energy, industry, innovation, and infrastructure; responsible consumption and production; and partnerships to achieve the goals. With concerted efforts, CCUS can be a game-changer in the global effort to combat climate change and build a cleaner, more sustainable world for future generations.

[14] Tracking Carbon Capture, Utilisation and Storage, IEA, July 2023;

Other sources- Global Status CCS 2022: CCS experiencing record growth, Carbon capture journal, October 2022; Press Information Bureau; Carbon Capture, Utilization, and Storage (CCUS) – India's leap towards Green Energy, Invest India, May 2022; Carbon Capture, Utilisation and Storage (CCUS), Department of Science and Technology, March 2021; Tata Steel and Council of Scientific & Industrial Research (CSIR) sign MoU to collaborate in the area of Carbon Capture, Utilisation & Storage (CCUS), CSIR News, 2022,

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