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PDEU JOURNAL OF ENERGY AND MANAGEMENT

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CONTENT

EDITORIAL

We are pleased to present the VIIIth edition of the PDEU Journal of Energy and Management. The following are the highlights of the papers presented in this edition.

The first paper on Mg-Al layered double hydroxide catalyst for green hydrogen production by Lokesh Sankhula and Rohit Srivastava describes the facile synthesis of Mg-Al Layered Double Hydroxide electro-catalyst through the hydrothermal method for green H2 generation. The synthesized electrocatalyst possess a cathodic current density of 10 mA/cm2 at 1.987 V and anodic current density of 10 mA/cm2 which indicates good electrochemical stability of Mg-Al LDH in basic medium.

The second paper by Surendra Singh Kachhwaha and Pravin Kodgire studies novel experimental studies for biodiesel production. The authors commented that globally fast depleting fossilized fuel reserves and increasing environmental pollution problems are the key motivating factors to pursue research on alternative fuels derived from biomass, which can fulfill the increasing future energy demand for sustainable development. In this regard, biodiesel as a sustainable alternative helps to protect the environment due to its non-toxic, renewable, and biodegradable nature and produces less sulphur emissions and greenhouse gases.

The third paper highlights human rights oversight in ensuring energy security. Ms Lesley Amol Simeon, the researcher found that the Narmada Bacho Andolan in September 1989 and the two major power blackouts in India in 2012 are the two examples that put forth the two-fold impact that energy insecurity can have on human lives and their inherent rights. The paper discusses the above-mentioned facets of energy security and poverty through a trio of interrelated parameters - the global quest for energy security, the Human Rights implications of energy security and the Indian response and policy framework, governing energy security.

The fourth paper by Vivek Pathak deliberates on improving the mental health of the workforce under new norms through spirituality. The author sensitises the reader about the new changes at the workplace related to work in isolation and social distancing in the context of the new normal and argues that the new norms create a lot of mental stress in the workforce. The authors explore various mechanisms for developing the individual spiritual strength thereby contributing toward better job performance and organisational growth under ethical leadership. Various solutions are being explored to facilitate individuals' protection from the inherent stress created by this pandemic. The research analysis identifies the application of meditation and related techniques to help workers to handle the mental stress related to the new normal of various organisations.

Finally, the paper titled 'Smallest Element Hydrogen Offering Biggest Opportunities for Energy Transition: The Global Trends for Green Energy' by Dr P.S. Pradeep and the Team provides a comprehensive perspective of the current scenario and potential of Green Hydrogen in India. The paper also focuses on the global demand and supply of hydrogen. A comparative understanding has been done between blue and green hydrogen to understand its scalability along with opportunities and challenges. This paper also narrates the key attributes of the Green Hydrogen policy in India along with future scope on production through less explored resources.

Dr. S. Sundar Manoharan, Director General
Chief Editor

1

MG-AL LAYERED DOUBLE HYDROXIDE CATALYST FOR GREEN HYDROGEN PRODUCTION

Lokesh Sankhula and Rohit Srivastava

ABSTRACT: Hydrogen production from water electrolysis has become a potential technology for replacing non-renewable exhaustible energy resources. The utilization of low cost, bifunctional catalysts and renewable energy sources for the electrolysis of water help to reduce the energy consumption and produce a high yield of green hydrogen (H2). This research paper describes the facile synthesis of Mg-Al Layered Double Hydroxide (LDH) electro-catalyst through the hydrothermal method for green H2 generation. The phase identification of crystalline material has been analyzed by using the X-ray diffraction (XRD) technique, whereas the surface area of synthesized LDH electrocatalyst was determined by using BET experimental data. The surface morphological structure of LDH catalyst was observed by using SEM images. From the electrochemical measurement data it was found that the synthesized electrocatalyst possess a cathodic current density of 10 mA/cm2 at 1.987 V and anodic current density of 10 mA/cm2 at 1.378 V and low Tafel slope which indicates the good electrochemical stability of Mg-Al LDH in basic medium. The synthesized electro-catalyst can be further use for the development of alkaline electrolyzer in order to produce the green hydrogen at larger scale.

KEYWORDS

Layered double hydroxide, Green hydrogen, Hydrothermal method, Corrosion

1. Introduction

The global energy demand has been increasing due to the scarcity of fossil fuels and environmental pollution concerns, so an alternative energy source has to be found to tackle the modern issues (Kuchkaev et al., 2021). The prominent and effective technology to replace the existing technology is electrolysis of water for producing hydrogen and oxygen fuels. Hydrogen has many advantageous features like highest gravimetric energy density, most efficient, clean and flexible source for almost zero carbon emissions (Srivastava, n.d.). This fuel doesn't liberate any harmful gases while combusting, so it is considered as a green fuel (Bhavanari et al., 2021). However, the hydrogen generation from water electrolysis is mainly governed by the hydrogen evolution (HER) and oxygen evolution reaction (OER) reaction steps. The efficiency of electrolysis is limited by certain factors like slow kinetics of HER and OER, long term stability, large energy consumption (Pandey et al., 2019).

An efficient electrocatalysts are necessary to enhance the reaction kinetics, stability of the electrolyzer system and also reduce the energy requirements by many folds (Bouali et al., 2020). There are some noble metal based catalysts which have better performance for HER and OER, such as Platinum based catalysts for only HER and iridium and ruthenium based oxides are considered as benchmark for OER activity enhancement(Kumar, Srivastava, & Chattopadhyay, 2021; Nouseen et al., 2021). Recent developments for efficient electrocatalysts include metal hydroxides/oxides, metal phosphates for OER activity in acidic medium, whereas metal alloys, metal chalcogenides, metal carbides/nitrides towards HER activity in acidic medium(Kumar, Srivastava, Pak, et al., 2021; Srivastava et al., 2021). There are some limitations for noble metal based catalysts for industrial adaptability like high cost, less availability, so developing a catalyst that can improve both the HER and OER activity and acts as bifunctional electrocatalysts(Chattopadhyay et al., 2020; Srivastava et al., 2020).

Recently Layered double hydroxides has gained major attention of researchers for their development and applications in various domains such as adsorption, electrochemistry, biomedical sciences, photocatalysis(Shanker et al., 2021). LDH are a class of layered anionic clays with a structural formula of $[M^{2+}_{1-x}M^{3+}_{x}\ (OH)^{A?}_{2}]\ A^{x}+\ [A_{n}^{-}]_{x/n}{\cdot}mH_2O$, where M^{2+} (e.g., Mg^{2+}, Cu^{2+}, Ni^{2+}, Zn^{2+} etc.) and M^{3+} (e.g., Al^{3+}, Fe^{3+}, Ga^{3+} etc.) represents the divalent and trivalent cations, respectively. A^{n-} indicates the interlayer gallery ions such as CO_3^{2-}, NO_3^{2-}, Cl^-, etc. along with water molecules (Feng et al., 2021; Shanker et al., 2021; Srinivasa et al., 2021; Yan et al., 2017). These LDH catalysts can be synthesized by using hydrothermal, co-precipitation, ion-exchange, sol-gel methods. The main objective of this paper to develop economically favorable LDH based bi-functional electro-catalyst for the development of alkaline electrolyzer.
In this manuscript, we have reported the synthesis of Mg-Al LDH electro-catalyst with nitrate ion present at interlayer gallery of metal oxide layers. This LDH can have better activity in different electrolytes and also helps to suppress the corrosion activity by trapping the corrosion responsible ions. The perimammary investigation of this research work suggest that the synthesized electro-catalyst can be used as bi-functional catalyst for the development of prototype alkaline electrolyzer to generate the green hydrogen from sea/tap water.

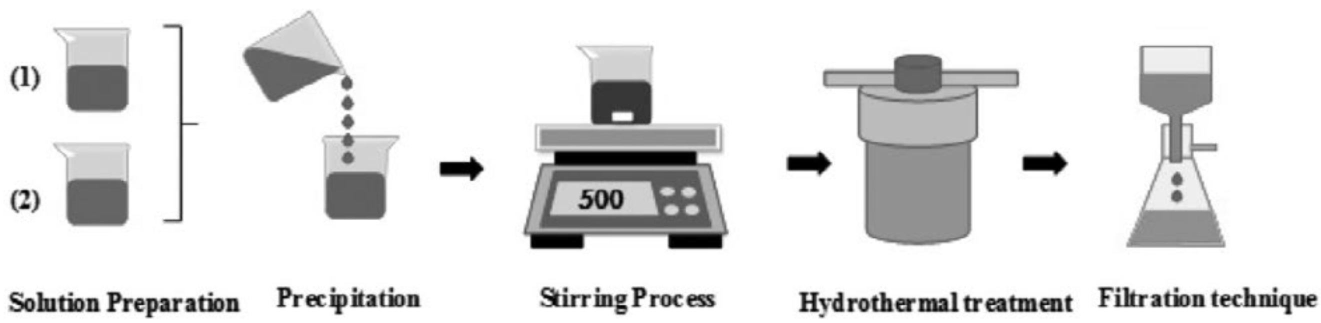
2. Experimental Procedure

2.1. Materials:

The essential chemical reagents such as Magnesium nitrate hexa hydrate (Mg $(NO_3)_2$. $6H_2O$), Aluminum nitrate nonahydrate (Al $(NO_3)_3$. $9H_2O$), Sodium nitrate ($NaNO_3$) and Sodium hydroxide (NaOH) were purchased from Merck, India Private limited.

2.2. Synthesis Procedure:

The synthesis procedure of Mg-Al–Nitrate 2D LDH electro-catalyst was prepared by hydrothermal method with slight modification (Zhang et al., 2021). Mg $(NO_3)_2$. $6H_2O$ (0.50M) and Al $(NO_3)_3$. $9H_2O$ (0.25M) was slowly added to 100 ml of $NaNO_3$ solution under vigorous stirring at room temperature. The pH of the solution was kept constant at 10-10.5 by simultaneous addition of NaOH solution (2.0M). The obtained slurry was introduced in to stainless steel autoclave for hydrothermal treatment at 65ºC for 24 hours. The obtained mixture was centrifuged (4800 rpm) and washed several times with distilled water.
The final product was dried at 50ºC temperature under atmospheric conditions for 12 hours. The entire step by step procedure for the synthesis of Mg-Al LDH electro catalyst is shown in Fig. 1.



(1) $Mg(NO_3)2.6H_2O$ and $Al(NO_3)_3.9H_2O$ (2) NaOH and $NaNO_3$

FIGURE 1: Schematic of Mg-Al –NO_3 LDH synthesis

2.3. Materials Characterization:

The physical characterizations and surface morphology of synthesized LDH electrocatalyst can be interpreted by using Scanning electron microscopy measurements (Model: Sigma 300, Zeiss). The crystallinity and lattice spacing of atoms in catalyst can be determined by performing X-ray diffraction experiments (Model No: D8 Advance, Bruker, Netherlands) in the 2θ range of 0º to 90º, whereas the intensity of diffracted x-rays was detected and analyzed by using standard intensity pattern of different compounds. The adsorption and desorption mechanism of nitrogen gas on synthesized LDH catalyst can be obtained by performing BET surface area analysis (micromeritics Tristar II 3020 3.02 instrument). The inert gas diffuses into the pores of the catalyst and adsorbed on the active sites, thus surface area and pore volume can be obtained according to BET theory assumptions.

2.4. Electrochemical Characterization:

The electrochemical techniques such as cyclic voltammetry, linear sweep voltammetry, tafel plot, electrochemical impedance spectroscopy describes the performance of catalyst in different electrolyte mediums. The voltammetry curves such as cyclic voltammetry and linear sweep voltammetry are obtained by varying potential at a particular scan rate in the definite potential range. The tafel plot suggests that amount of overpotential required for increasing the rate of electrochemical reaction, whereas the lower tafel slope indicates the better catalytic performance in an electrolyte medium. The electrochemical impedance spectroscopy measurements indicate the resistances for ion transfer towards electrode surface such as solution resistance, pore resistance, corrosion resistance, etc. All the electrochemical measurements were performed by using Gamry electrochemical work station (Model: Interface 1010). The electrochemical analysis of synthesized LDH electrocatalyst was performed in 3-electrode standard electrochemical cell as shown in Fig. 2.

3. Results and Discussion

3.1. X-ray Diffraction:

The Fig. 3 describes the X-ray incident diffraction pattern of synthesized Mg-Al LDH electrocatalyst. The constructive interface of monochromatic X-rays and sample is observed and the intensity is recorded with angle of incidence. The following miller indices of (012), (104), (110), (202), (119) matches with the standard data of magnesium oxide. The XRD pattern also indicates that synthesized LDH is crystalline in nature (Olfs et al., 2009).

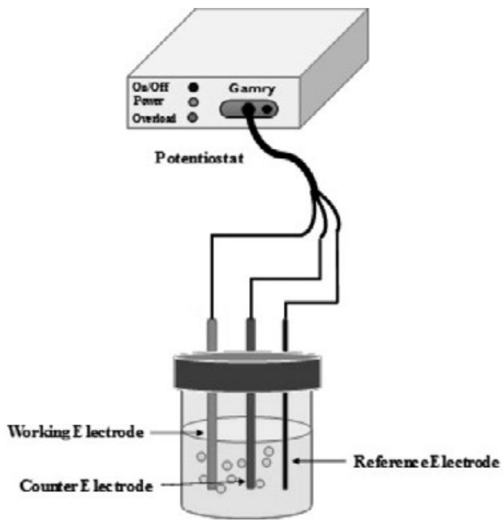


FIGURE 2: Schematic of electrochemical experimental set up

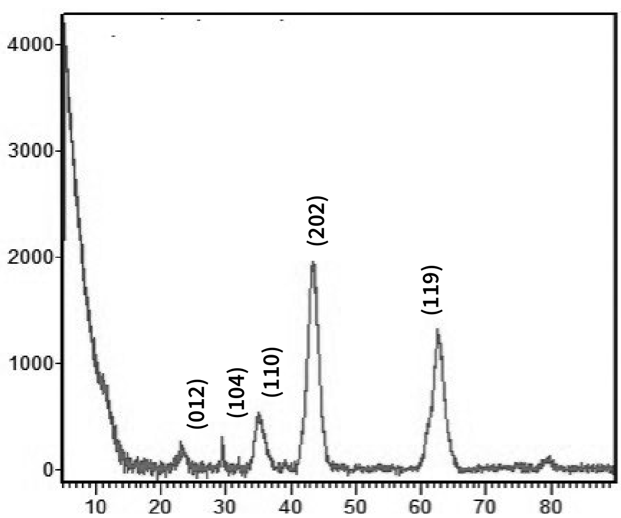


FIGURE 3: X-ray diffraction pattern of synthesized LDH particle

3.2. BET Surface area Analysis:

Fig. 4 gives information about adsorption and desorption pattern of N_2 gas on synthesized catalyst by the use of Brunauer-Emmett- Teller (BET) theory. This theory gives that synthesized electrocatalyst has surface area of 59.0055 m^2/gm. Barrett Joyner Halenda (BJH) desorption cumulative surface area of pores is 45.4229 m^2/g and single pore volume of 0.6854 cm^3/g respectively. The adsorption molecules are effectively desorbed by reduction in pressure, indicates that the reversibility of adsorbed molecules, thus Mg-Al-LDH catalyst can be used for hydrogen storage applications.

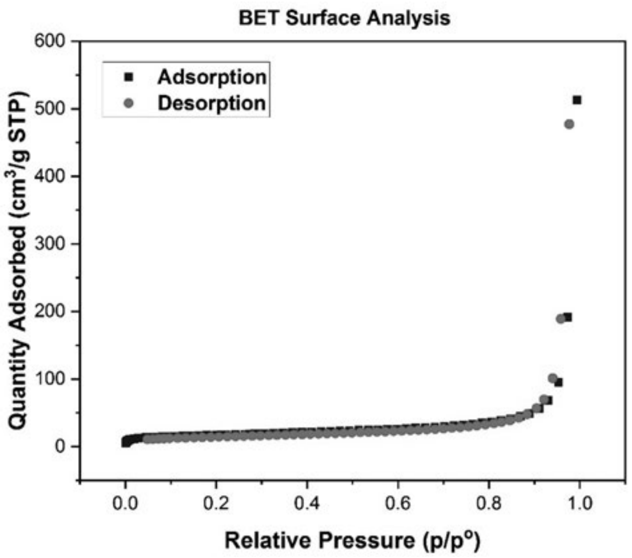


FIGURE 4: Adsorption and Desorption pattern of Mg-Al LDH

3.3. SEM Images:

The SEM images of Mg-Al-LDH electroctaalyst is shown in Fig 4. The scanning electron microscopy (SEM) analysis was performed for better understanding of surface morphology of LDH particles at 1μm resolution and different magnification. These SEM images (Figure 5 (a) and (b)) revealed that LDH particles looks like two dimensional flakes like structure. Each LDH particle may have different number of layers with ions present between the layers.

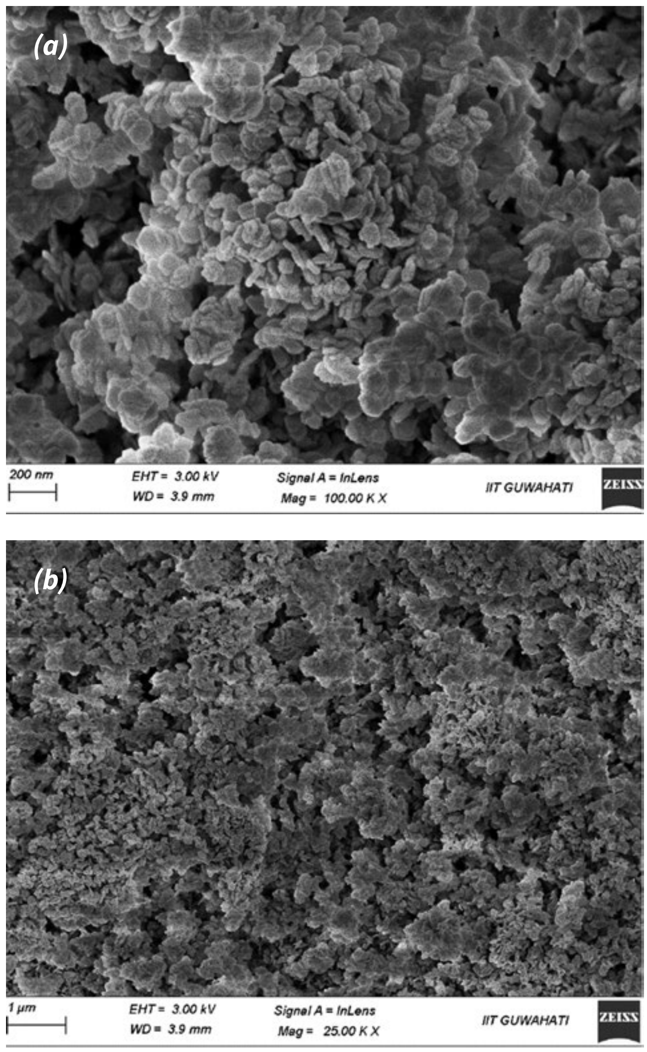
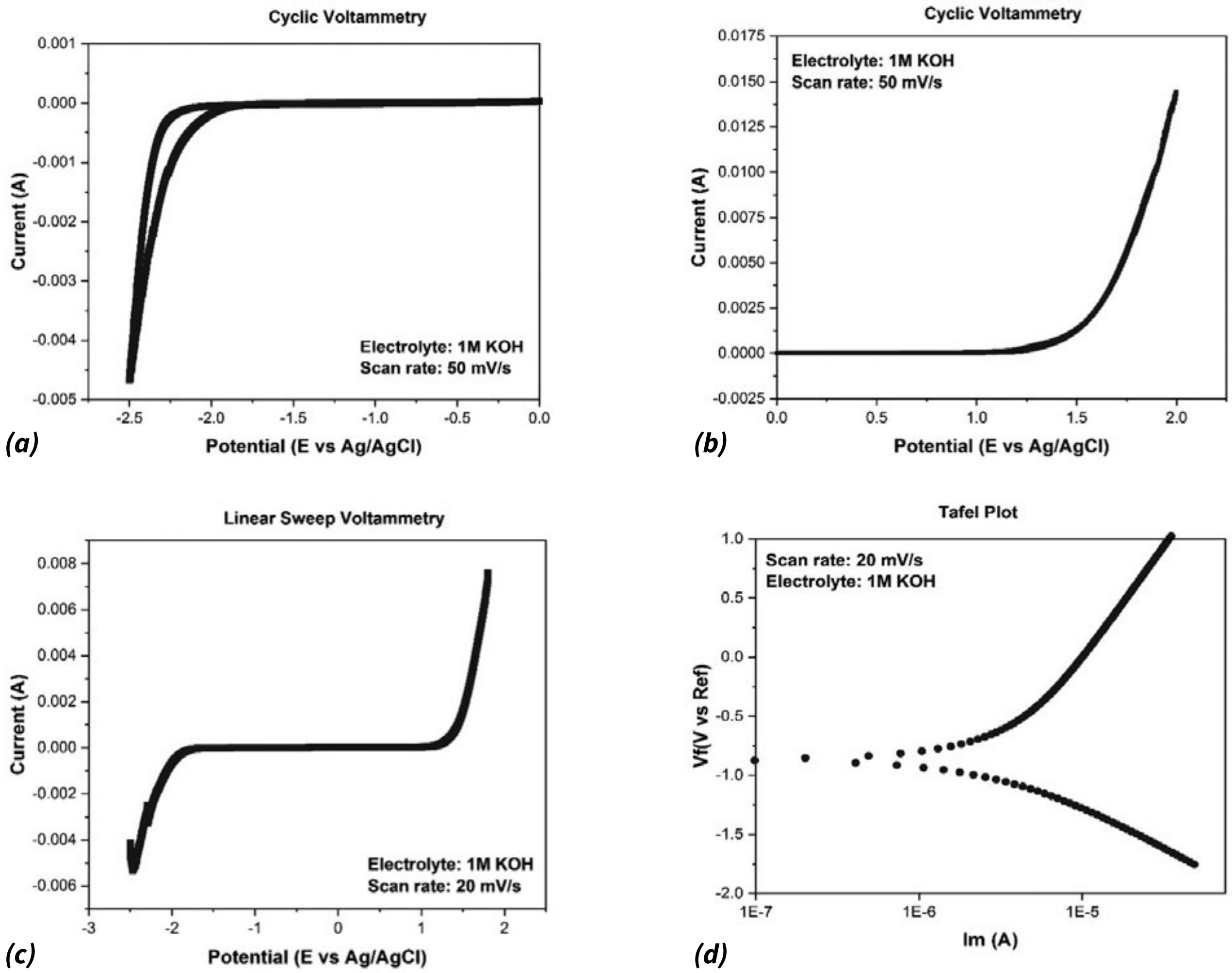


FIGURE 5: SEM images of Mg-Al LDH

3.4. Electrochemical performance of LDH:

The Fig. 5 represents the electrochemical performance of Mg-Al LDH electrocatalyst in basic medium (1M KOH). The figure 6 (a), (b), (c) of voltammetry curves illustrates that the catalyst possesses a cathodic current density of 10 mA/cm^2 at 1.987 V and anodic current density of 10mA/cm^2 at potential of 1.376 V. The figure 6 (d), (e) are tafel plot and impedance spectroscopy shows that the catalyst has better stability in basic medium. The lower tafel slope and high solution resistance implies that good electrochemical performance.



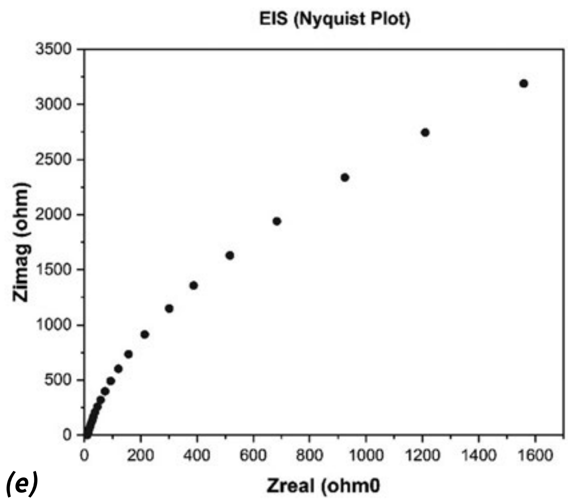


FIGURE 5: Electrochemical performance of Mg-Al-NO_3- catalyst in basic medium (a) Cyclic Voltammetry for HER, (b) Cyclic Voltammetry for OER, (c) Linear sweep Voltammetry, (d) Tafel plot, (e) Electro-chemcial impedance spectroscopy.

4. Summary

Mg-Al LDH electrocatalyst has been synthesized successfully with nitrate ion present at interlayer geometry of LDH and it is responsible for electrochemical and corrosion resistance applications. This synthesized LDH electrocatalyst has many advantages such as easy synthesis, good electrochemical performance, better stability and easy scale-up. The synthesized Mg-Al LDH electrocatalyst has been characterized with the help of various analytical instruments such as XRD, BET, SEM. The XRD data revealed that the synthesized catalyst has well defined crystal lattice structure. The BET surface area analysis shows high surface area around 59.0055 cm^2/gm , which can also reflects the hydrogen storage applications. The electrochemical performance analysis shows the synthesized electro-catalyst exhibits a cathodic current density of 10mA/cm^2 at 1.987 V potential and an anodic current density of 10mA/cm^2 at a potential of 1.376 V, which implies that LDH acts as bifunctional catalyst. The preliminary obtained data suggests that the synthesized electroctaalyst can be scale up to develop the efficient electrolyzer.

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R.S. and L.S. would like to thank PDPU, India, for providing the required infrastructure and start-up research grant. I would like to thank Chemical Engineering Department, IIT Guwahati for performing XRD, BET experiments, Central instrument facility, IIT Guwahati for conducting SEM analysis and Central research facility, IIT Delhi for performing HR-TEM analysis. This research work was funded by Shell Energy India Private Limited and SERB- DST, New Delhi, under the scheme “ASEAN-India Research & Development” (Grant No.: IMRC/AISTDF/CRD/2018/000048).

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2

NOVEL EXPERIMENTAL STUDIES FOR BIODIESEL PRODUCTION USING PROCESS INTENSIFICATION TECHNIQUES DEVELOPED AT A HIGHER EDUCATION INSTITUTE OF INDIA

Surendra Singh Kachhwahaa and Pravin Kodgire

ABSTRACT: Globally fast depleting fossilized fuel reserves and increasing environmental pollution problems are the key motivating factors to pursue research on alternative fuels derived from biomass, which can fulfil the increasing future energy demand for sustainable development. In this regard, biodiesel as a sustainable alternative helps to protect the environment due to its non-toxic, renewable, and biodegradable nature and produces less sulphur emissions and greenhouse gases. It is easy to use as well as clean and safe to handle as compared to gasoline diesel. Biodiesel research has remained in the high priority areas for researchers around the globe for the last two decades due to the number of challenges such as to make it an economic and industrially viable product.

Introduction

Globally fast depleting fossilized fuel reserves and increasing environmental pollution problems are the key motivating factors to pursue research on alternative fuels derived from biomass, which can fulfill the increasing future energy demand for sustainable development. In this regard, biodiesel as a sustainable alternative helps to protect the environment due to its non-toxic, renewable, and biodegradable nature and produces less sulphur emissions and greenhouse gases. It is easy to use as well as clean and safe to handle as compared to gasoline diesel. Biodiesel research has remained in the high priority areas for researchers around the globe for the last two decades due to the number of challenges such as to make it an economic and industrially viable product.

The use of process intensification techniques along with in-situ concept in biodiesel production has the potential to reduce both energy requirement and cost involved at different stages of biodiesel production process. Moreover, there is a lot of research scope for optimizing the properties of the biodiesel and its blends (binary as well as ternary) so that the desired compression ignition engine performance and combustion characteristics can be achieved with a focus on the emission reduction.

The prime objectives of present experimental research work is on design and development of an environment-friendly, energy-effective and industrially viable process intensification (PI)- techniques {Ultrasound, Microwave, and Conjoint (microwave + ultrasound) technique} using both homogeneous (potassium hydroxide, KOH) and heterogeneous (calcium oxide, CaO) catalysts to synthesize biodiesel from various combinations of waste cooking oil (WCO), blended oils and seeds (normal and irradiated) as a feedstock.

In Microwave irradiation, microwave energy acts as a non-ionizing radiation energy source caused due to molecular motions of ions and rotation of the dipoles. It does not disturb the molecular structure but not able to remove the limitation of mass transfer. Whereas, ultrasound has a significant formation of microbubbles that affect the rate of various processes but is not enough to cause an overall escalation in temperature of the reaction mixture. The ultrasound and microwave techniques, independently have definite limitations like weakening effect and low diffusion depth respectively. This necessitates to develop and embrace a suitable conjoint microwave and ultrasound effect. Thus, the combination of both irradiations (refer Fig. 1) acting perpendicular to each other, creates the physical effect which includes the formation and breakdown of microbubbles that causes the formation of high pressure and heat release cycles at micro-scale resulting in improved mass and heat transfer. Thus, the high energy level of bubble cavitation under ultrasound can prompt particle fragmentation and molecule excitation, whereas microwave polarization can encourage dielectric volumetric heating and selective heating of molecules. The summary of the various experimental studies performed at CBBS (Centre for Biofuel and Bioenergy Studies), PDEU are given below:

The experimental results of the study performed on ultrasound process [1,2] showed the enhanced biodiesel yield (98% for KOH and 96.45% for CaO catalyzed conditions) from WCO and significant reduction in the reaction period (10 min), making the process energy-efficient in comparison to the conventional mechanical stirring (MS) technique which is commonly used by the biodiesel industry. The optimization study of process parameters was performed using a Box-Behnken design of experiments method.

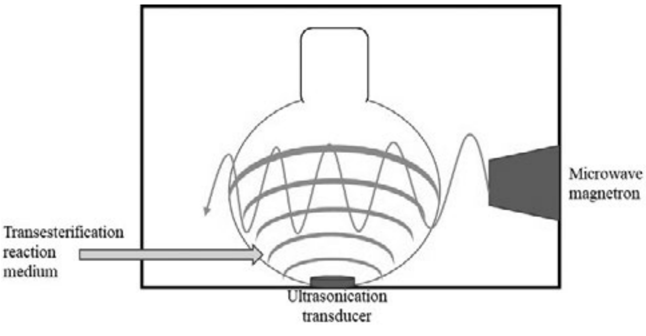

FIGURE 1: Conceptual diagram of wave propagation of microwave and ultrasound

Similarly, experimental study on microwave-assisted biodiesel production technique [1,3] from WCO has shown significant results in terms of lower reaction time (9.7 min), with higher yield (96.77% for KOH and 90.5% for CaO catalyzed conditions) and achieved high energy efficiency. In this process, the optimization of process parameters was done using the full factorial design of experiments.

The scarcity of feedstock is the major concern for biodiesel production, and this can be resolved by blending the available non-edible feedstock. This approach will provide option to prepare a low-cost feedstock with large availability and uniform properties. Further it has been observed that blending of feedstock improves the biodiesel properties. The conjoint microwave + ultrasound technique was used for biodiesel production using the blends of WCO and raw castor oil (RCO). For the first time, blending ratio as a unique process parameter for combination of oils was considered for biodiesel production process. The optimization of process parameters was performed via the Box-Behnken design of experiments. The study showed that the conjoint effect of the microwave + ultrasound technique produces biodiesel with improved fuel properties. Also, higher biodiesel yield (93.38% for KOH and 92.19% for CaO catalyzed conditions), lower reaction time (10 min), and energy requirements makes it a superior energy-efficient process in comparison to that of individual microwave and ultrasound subsystem as well as the MS technique [4,5]. First time the "blend ratio" as a unique parameter is optimized for blended oil transesterification and 60RCO40WCO fraction was found to be the optimum one to produce biodiesel yield of 93.38% for KOH catalyzed condition and 92.19% biodiesel yield for CaO catalyzed conditions.

The reaction kinetic analysis was performed for all three PI reactor systems assuming pseudo-first-order kinetic. The activation energies for PI techniques were observed to be reduced significantly (ultrasound reduces the activation energy by 1.7 and 1.5 times in comparison to MS for KOH and CaO conditions respectively, reduction in activation energy using the microwave reduces the activation energy by 2.6 and 1.7 times in comparison to MS for KOH and CaO conditions respectively, and for conjoint technique the activation energy was reduced by 2.5 and 1.8 times for KOH and CaO catalyzed conditions respectively) in comparison to MS technique. Further, energy analyses were performed for all the above-mentioned processes. Parameters like dissipated power, delivered power, and percentage efficiency were estimated and analyzed. These analyses effectively demonstrated that the PI techniques are energy-efficient (11 times for ultrasound, 21 times for microwave and 3 times for conjoint technique) in comparison to MS technique. Based on the batch size process optimization results, commercialization potentiality of all the three techniques was examined by performing a scale-up study. A ten-fold scale up of 50 mL batch size was taken to perform the experiments based on the optimized parameters and it showed that about 90% biodiesel yield was obtained within a short span of 15 - 20 min. Using recently developed large scale ultrasound and microwave equipment available in the market, the successful commercialization of PI techniques can be achieved. All the processes have shown bright prospects for commercialization for small scale applications with certain modifications (based on type of equipment) in process equipment and design parameters. The physicochemical properties of produced biodiesel were correlated with ASTM petrodiesel standard and biodiesel fuel standards. All the fuel properties found to comply within ASTM biodiesel standard limits and at par with the petrodiesel.

Biodiesel is produced through transesterification reaction that is conventionally carried out using mechanical stirring post oil extraction that makes it a two-step process. In continuation to the above mentioned experimental research, the present study demonstrates innovative single step in-situ biodiesel production process eliminating oil extraction stage using coordinated ultrasound-microwave reactor. Castor is a non-edible oil crop due to presence of toxic element ricien in its chemical structure. Castor oil has unsaturated ricinoleic acid in higher proportion (85-90%) which has hydroxyl bond in its chemical structure causing high viscosity. The radiation chemistry is known to cause the changes in the chemical structure of the oil and can help to control its properties. The effect of gamma rays irradiation on castor seeds and optimum conditions of insitu transesterification reaction parameters for biodiesel production are investigated thoroughly. Normal as well as gamma irradiated castor oil seeds have been used for the in-situ biodiesel production using simultaneous intensification by ultrasound and microwave (hybrid intensification, refer Fig. 2). Gamma irradiation found to affect the fatty acid profile of the oil obtained from the castor seeds. The proportion of ricinoleic fatty acid is found to be decreased in fatty acid profile of gamma irradiated castor seeds compared to normal castor seeds. Formation of squalene was detected and its proportion was found to be increased up to 2.07% in castor seeds irradiated with dosage value of 9 kGy. The viscosity of castor oil obtained through gamma irradiated castor seeds was decreased to 195 cst (for 9 kGy) as compared to 210 cst of castor oil obtained through normal castor seeds.

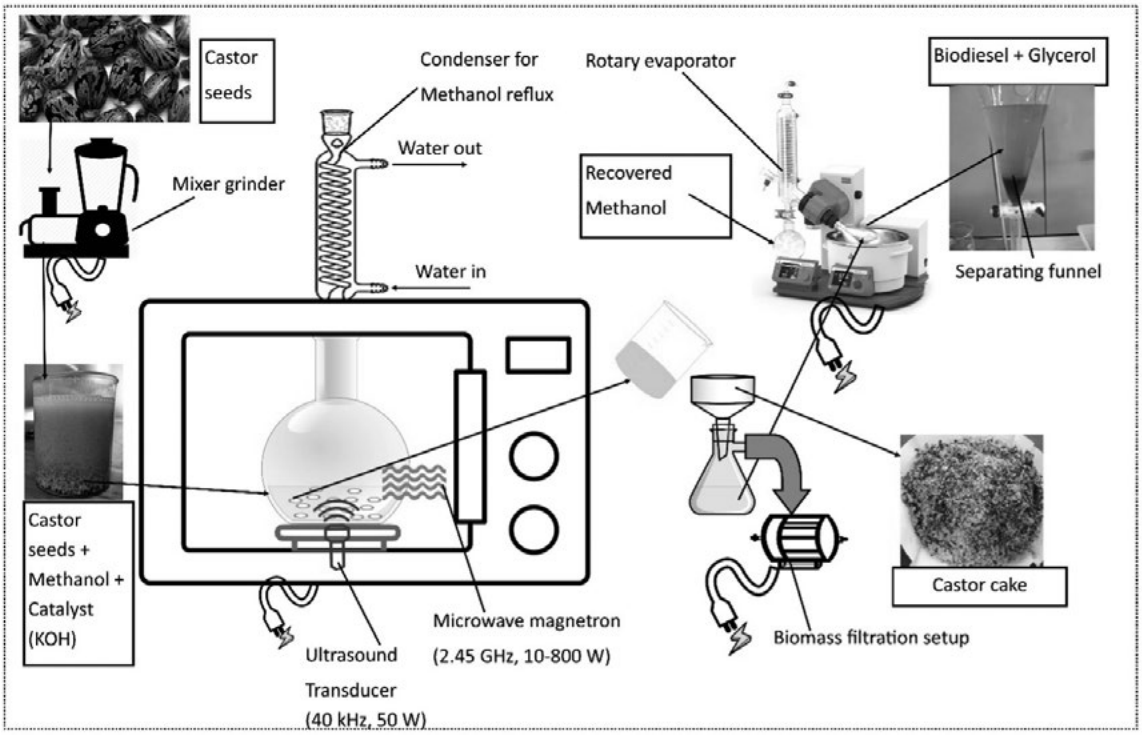

FIGURE 2: Schematic of lab scale in-situ transesterification of castor seeds using hybrid reactor

For normal seeds the maximum biodiesel yield of 93.5 ± 0.76 percent is achieved for optimum reaction conditions of 350:1 methanol to oil molar ratio, 1.71% catalyst amount, 44 °C reaction temperature, and 30 min of reaction time using response surface methodology (RSM) coupled with central composite design (CCD) [6]. The optimum reaction conditions for gamma irradiated castor seeds are obtained using RSM coupled with Box-Behnken Design (BBD) which includes: gamma radiation dosage 9 kGy, methanol to oil molar ratio of 288:1 (6.5 ml of methanol per gram of castor seeds; v/w), catalyst amount 1.33%, 52.5°C reaction temperature and 30 min reaction time. The biodiesel yield obtained from gamma radiated castor seeds by applying these optimized reaction conditions is 96.04 ± 0.53 % which is 2.5% higher as compared to the biodiesel yield obtained from non-irradiated castor seeds. The methanol to oil molar ratio is found to be reduced by 17.71% while catalyst loading requirement is reduced by 22.22% which makes the process environmentally as well as economically viable. It is found that reaction rate of the transesterification has been improved by 30-40% and activation energy has been decreased by 50% (14 kJ/mol) when compared to transesterification reaction of non-irradiated castor seeds (28.27 kJ/mol). The gamma irradiation causes formation of squalene (0.40 to 2.07%) which is not observed in the original oil compositions of non-irradiated castor seeds. Physico-chemical properties of biodiesel were compared with biodiesel standards (ASTM D6751 and EN 14214) and found satisfactory for both the cases. The calorific value of the biodiesel obtained through gamma radiated castor seeds (39.05 ± 0.2 MJ/kg) is improved by 2.7% compared to biodiesel obtained through normal castor seeds (38.01 ± 0.2 MJ/kg). The pour point is comparable and is found to be as low as -35°C. The oxidation stability of the biodiesel produced from the gamma radiated castor seeds is higher and has been found to be unaffected upon irradiation.

In the above mentioned experimental research, first time conjoint microwave + ultrasound reactor has been applied for biodiesel production from transesterification of blended RCO and WCO oil mixture as well as insitu combination. It can be concluded that the blending of inexpensive non-edible oil/ waste cooking oil has been proven to be a promising solution for the production of biodiesel. This is because (a) the final product cost will reduce, (b) dependency of edible oil will be less and (c) different types of non-edible/ waste oils can be blended in different proportions based on the availability. The conjoint effect of process intensification techniques (microwave + ultrasound) results in a synergistic effect of mass transfer and heat transfer that enhances the biodiesel yield within a short reaction time. It also tends to improve the physicochemical properties of biodiesel. Thus, the present work demonstrated a successful comprehensive experimental study to assess the overall performance of PI techniques in reference to the MS process.

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THE HUMAN RIGHTS OVERSIGHT IN ENSURING ENERGY SECURITY

Lesley Amol Simeon

ABSTRACT: The Narmada Bacho Andolan in September 1989 and the two major power blackouts in India in 2012 are the two examples that put forth the two-fold impact that energy insecurity can have on human lives and their inherent rights. Often it is observed that in their bid to ensure energy security for their populations, Governments around the world have more than often ignored the human rights implications of their energy projects. This is reflected in several energy security interventions such as the Narmada Bachao Andolan in India (1980s), the land acquisition policies of the Coal India Limited – the world's largest coal miner, the Baram Dam project in Sarawak, Malaysia etc. Secondly, access to energy in itself is a means as it is an end. Nobel-winning economist Amartya Sen notes that "economic development can be achieved only if the poor come to enjoy a set of freedoms including political participation, safety, and economic opportunity." Access to energy, thus, is a crucial foundation for the safety and security aspects of this very freedom. The paper aims at discussing the above-mentioned facets of energy security and poverty through a trio of interrelated parameters - the global quest for energy security, the Human Rights implications of energy security and the Indian response and policy framework, governing energy security.

KEYWORDS

Energy poverty, energy security, human rights

Introduction

In September 1989, renowned social activist Baba Amte led a rally of 60,000 people in Harsud, a modest town boasting of 20,000 people in the central Indian state of Madhya Pradesh. The rally, was one of the many held as part of the umbrella Narmada Bacho Andolan that collectively protested against the then Government of India's ambitious plan to construct a series of dams over the Narmada river, which flows through the states of Gujarat, Madhya Pradesh and Maharashtra. The multi-crore Narmada Valley Development project was to ensure 1450 MW of electricity and pure drinking water to close to 40 million people. The project, though focussed on the 'collective good' rather conveniently ignored and environmental and human costs it would have to bear - the displacement of tens of thousands of people. Though the displaced people were supposed to be given 'land for land' (on paper at least), a considerable section of the displaced population were simply unable to furnish documents to prove their legal ownership over their land, house, property which fell in areas to be submerged by the flooding, as a result of the dam projects.

In 2012, two major power blackouts in India in the month of July drew global attention towards what is often referred to in retrospect, as the worst power-crisis in the history of mankind. According to statistics, the first of the two blackouts on July 30 impacted 350 million people, the second blackout the very next day affected close to 670 million people. However, certain opinions also take note that the blackouts were not as devastating as was made out to be - what with power cuts - both planned and unplanned - being a common phenomenon in India, so much so as for the private power system - which manifests itself through coal-burning captive power plants, diesel generators and inverters, among others - firing up almost immediately to save the day.

Similarly, close to one third of the Indian households do not have access to electricity - according to the 2011 Indian Census data. Most of these households fall in the rural areas of the country.

The International Energy Agency defines energy security as "the uninterrupted availability of energy sources at an affordable price." The oldest definition of energy security comes from Mason Willrich, who defines energy security as 'Assurance of sufficient energy supplies to permit the national economy to function in a politically acceptable manner.' 1

Energy security, more comprehensively, is defined as thE feature (measure, situation, or a status) in which a related system functions optimally and sustainably in all its dimensions, freely from any threats. 2

The above two examples put forth the two-fold impact energy insecurity can have on human lives and their inherent human rights. Firstly, in their bid to ensure energy security for its populations, Governments around the world have more than often ignored the human rights implications of their energy projects. This is reflected in the Narmada Bachao Andolan in India (1980s), the Baram Dam project in Sarawak, Malaysia that threatened to rights of the indigenous people in the region and the human rights allegations against Coal India Limited – the world's largest coal miner, over their land acquisition policies. Secondly, access to energy in itself is a means as it is an end. Nobel-winning economist Amartya Sen notes that, "economic development can be achieved only if the poor come to enjoy a set of freedoms including political participation, safety, and economic opportunity." Access to energy, thus, is a crucial foundation for the safety and security aspects of this very freedom.

The paper aims at discussing the above mentioned facets of energy security and poverty through a trio of interrelated parameters - the global quest for energy security, the Human Rights implications of energy security and the Indian response and policy framework, governing energy security.

Why is Energy Security as Human Right?

In their book, *Human Security in South Asia*, authors P.R. Chari and Sonika Gupta note that human security is beyond mere materialistic fulfillment, but is also 'freedom from anxiety and fear' - a concept that is also related to the freedom from want. An all encompassing definition of human security includes economic security, food security, health security, environmental security, personal security, community security and political security. In an argument that is narrated in the research article, realisation of basic needs are linked to an individual or household's day to day activities and how efficiently he or she can realise them. If one does not have the basic energy needs vis a vis electricity or biogas in some cases, how are these daily activities ever lead to fulfillment of needs? Author Youngho Chang, in the essay *The Economics of Energy Security* has defined energy security as an adequate and reliable supply of energy at a reasonable price. However, with the increasingly imperative and more dominant realm of sustainability finding more and more relevance in today's times, contemporary security challenges include those of population growth, energy demand and supply and water and food security - all of which are interlinked. As reiterated in the essay *Urbanisation, Sustainable Cities and the Arab Gulf State* by author ohsen Aboulnaga, an observation which can be held common to communities worldwide, inhabitants of urban areas need water, food and energy to survive - the failure to secure which poses strategic challenges for governments that must carefully manage supply and demand to create a balance. Energy security, for the providers as well as the beneficiaries, increasingly is a matter of human rights. As noted by Thorsen, Sune Skadegaard snd Børrild, Troels, 'the human rights situation in a country can upset the level of energy security considerably. In addition, it relies on how corporations in the extractive industry deal with the challenges posed by doing business in environments marked by widespread human rights violations.'

India's energy policy framework

Questions about India's population growth rate usually end with a statement that claims India's growth rate to be steady enough to overtake China's population in the coming few decades - around 2045. With the current population being close to 1.3 billion people, the Indian population accounts for more than 17.5 per cent of the global population. Out of this, 32 per cent is reportedly urban, while the rest is rural. With respect to the energy security of the above mentioned numbers, India's energy use has increased 16 times in the last decades and the installed electricity capacity by 84 times. In the year 2008 itself, India's energy use was the fifth highest in the world. Given this background and if the predictions pertaining to India's economic and population growth are anything to go by, India is soon headed to an energy security crisis - if it has not witnessed glimpses of it already. The primary energy demand in India has grown from about 450 million tons of oil equivalent (toe) in 2000 to about 770 million to in 2012 - with the said figure only set to increase by 1250 (estimated by the International Energy Agency) to 1500 (estimated in the Integrated Energy Policy Report) million toe in 2030. The Indian economy is also projected to grow at a rate of 8 to 9 per cent per annum along with and increase in urbanisation and increased needs to improve standards of living for millions of Indians at the household level.

At the policy level, the Government of India as per its own statement on the official website of the Ministry of Power, claims the adoption of a 'two-pronged' approach - on the one hand it caters to the increasing energy demands of its citizens, while on the other hand it attempts to sustainably tend to increasing global demands from countries to ensure minimum growth in C02 emissions vis a vis promoting greater use of renewable in the energy mix mainly through solar and wind and at the same time shifting towards supercritical technologies for coal based power plants. On the other side, efforts are being made to efficiently use the energy in the demand side through various innovative policy measures under the overall ambit of Energy Conservation Act 2001. 3

The Energy Conservation Act, 2001 aims at reducing the energy intensity of the Indian economy. The Bureau of Energy Efficiency, was set up as a statutory body in the year 2002, to facilitate the implementation of the Energy Conservation Act, which amongst other things mandates the setting of standards and labelling of equipment and appliances, energy conservation building codes for commercial buildings; and energy consumption norms for energy intensive industries. The Act also directs states to designate agencies for the implementation of the Act and promotion of energy efficiency in the state. Similarly the Act provides for the setting up and occasional revision of the National Electricity Policy aims at laying own structured guideless for development of the power sector, providing supply of electricity to all areas and protecting the interests of consumers and other stakeholders keeping in view availability of energy resources, technology available to exploit these resources, economics of generation using different resources, and energy security issues. 4

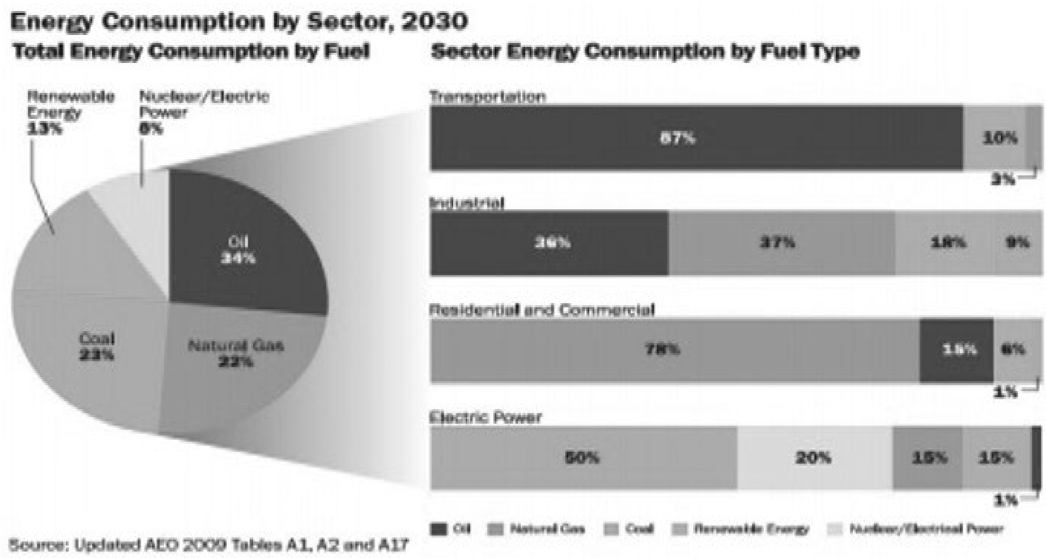


Table 6 Share of Different Renewable Sources in India

Resource	Potential (MW)	9th Plan	10th lan	11th Plan Target	11th lan Upto 9/10	11th Plan Achivemt	12th Plan Project	13th Plan Projection
Wind	48500	1667	5427	9000	4714	12809	27300	38500
Hydro	15000	1438	538	1400	759	2823	5000	6600
Bio*	23700	390	795	1780	1079	2505	5100	7300
Solar		2	1	50	8	18	4000	20000
Total		3497	6761	12230	6560	18155	41400	72400

(Source: Ministry of New and Renewable Energy, Government of India)

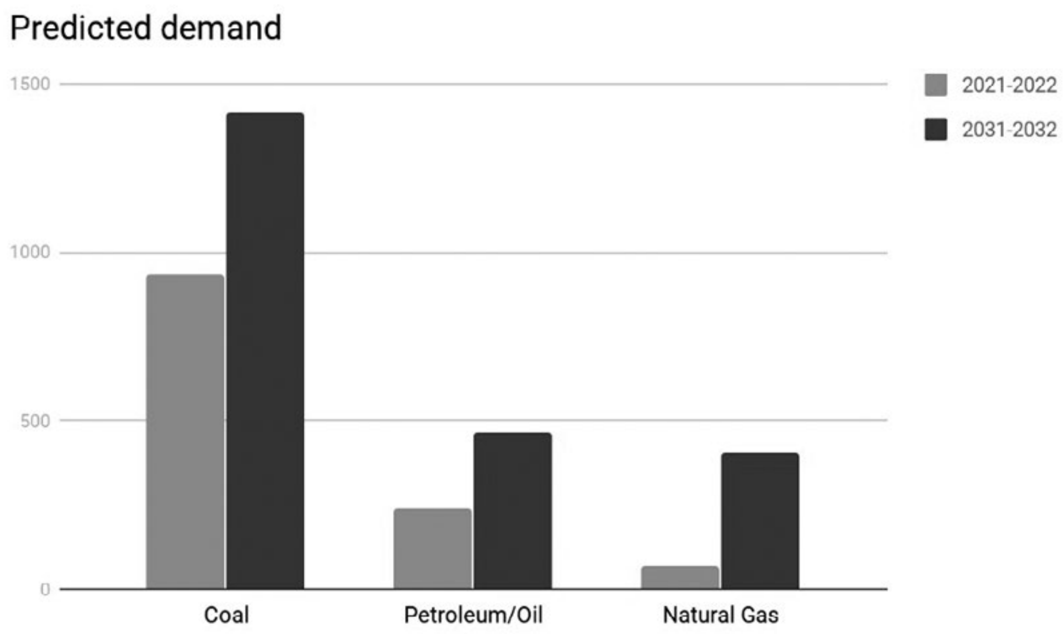
* Includes biomass, bagasse cogeneration, urban and industrial waste to energy

SOURCE: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.695.7988&rep=rep1&type=pdf

The Indian energy policy also provides tools and mechanisms for comprehensive energy analysis that entails the evaluation of alternative configurations of the energy system that will balance energy supply and demand. These include Energy and Power Evaluation Program, Market Allocation Program, Long-Range Energy Alternative Planning System, Model for Analysis of Energy Demand among others.5

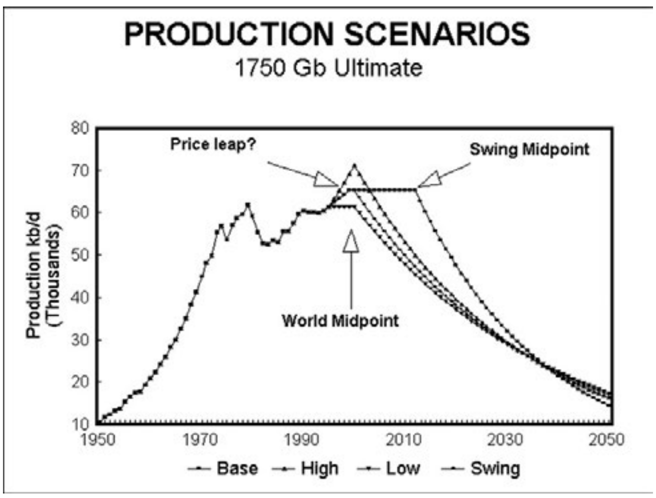
The National Mission for Enhanced Energy Efficiency (NMEEE) is one of the eight missions under the National Action Plan on Climate Change (NAPCC). The NMEEE aims to strengthen the market for energy efficiency through conducive regulatory and policy regime.

This makes the question of eradication energy poverty all the more fundamental. The broad vision of India's energy policies are said to be designed to reliably meet the energy demands of all of the sectors involved - households and industry, among others, at the least cost.



SOURCE: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.695.7988&rep=rep1&type=pdf

Coal - in million tonnes, Petroleum/Oil - in million metric tonnes, Natural Gas - in billion cubic metres



SOURCE: http://www.oilcrisis.com/campbell/camfutur.htm

Global quest for Energy Security

According to a number of geopolitical strategists, investment bankers, geologists and physicists, most of humankind will radically alter their way of existence in the coming three decades - owing primarily to the exhaustion of cheap energy resources. This event will however be predated by a number of conflicts and confrontations over the control of the last remaining sources of natural energy resources. These events, leading to the eventual development, are now being discussed and described as the 'last Great Game'- especially with respect to oil production. The reduction of oil production, increasingly volatile oil prices and the increase in world consumption are some of the factors that are together leading towards the inevitable economic and energy crisis.

The oil industry is predominantly in State hands - almost 90 per cent of the world's oil supplies, for example - though the private sector has attempted to get access to these resources and control them. This however, has been more or less been trumped by 'energy nationalism', the result of which is that oil and natural gas has remained government territory as is seen, for example in the case of Russia, which has defiantly rejected foreign engagement in the national energy market. What is interesting to note, is the fact that the boost in demand coupled with diminishing resources is shifting the balance of power from consumers to producers. This shift becomes all the more poignant given the fact that resource supply is subject to, not private companies but to the state-producers - adding fuel to the already burning furnace of energy-centric geopolitics. This has led to, as noted by academician Dr. Velichka Milina, the increasing importance of 'transit-states'. These states, such as entities in the Caspian region and Central Asia, intervene between consumer and producer states by means of exerting control over oil and gas pipelines. These 'transit-states' become subjects of benevolence by both, the producer and consumer states. The oil and energy resources of the Central Asian States are an important component of the new-age Great Game being played between Russia on the one hand, and the United States of America on the other. (This can be traced back to as early as the 1998 policy statement issued by the USA and the European Union on the 'Caspian Energy') 6

Close to 60 per cent of the world's oil reserves, however, continue to remain concentrated in the West Asia region. This coupled with lowest-cost oil production facilities are in this politically unstable region. All of these factors together will eventually lead to an intricate struggle for ownership of energy resources amongst the great powers of the contemporary world. In the attempts to avoid economic, political, natural and social crisis, severe in nature, prominent consumer states as well as producer states will try and mark active participation on the global energy market - the aim being energy security. In today's times, the notion of energy security has undergone a drastic change. It is no longer restricted to exports, but also translates to security in the political sphere, in critical infrastructure and environmental protection. 7

Energy security concerns are not limited strictly to oil. Power blackout in the USA, Europe, Russia, China and India as well (as mentioned at the start of the paper), have questioned the reliability of electricity grids and the supply system at large. As far as natural gas is concerned, the general demand and supply trends have rendered North America no longer self-reliant. At the same time, the threat of global terrorism and non-state activity looms large, what with these non-state outfits occasionally and for a prolonged period of time, pccupying regions which in turn command control over energy resources. This again, brings us back to the point earlier made in this same passage, about newer pathways of energy supply being continuously sought such as the oil and natural gas fields in offshore of West Africa, Central Asia and the Caspian Sea. If the future energy security scenarios were to be panned out for some of the globe's major powers, Russia might now aim to reassert state control over strategic resources and gain primacy over the 'main pipelines and market channels through which it ships

its hydrocarbons to international markets'. As for the developing countries, the concern is now to focus on their balance of payments which are increasingly vulnerable to the change in energy prices. China and India on the other hand, will have to draw attention on how they channel their ability to rapidly adjust to their relatively new-found independence in the global market which they use, either to link with energy producer-states or forward their former commitments to self sufficiency. For Europe, the debate revolves around questions regarding dependence on imported natural gas, nuclear capacities and the possible return to clean coal. As for the USA, their goal of energy independence, is now increasingly contradictory to the current state of affairs. 8

Human Rights implications of energy security

The primemost argument while laying the framework for highlighting the human rights aspect of energy security, is the link the latter shares with human development. Human Development is considered a better indicator of the development, than Gross Domestic Product. The Human Development Index (HDI) takes into account parameters such as life expectancy, education, per capita GDP and other standard of living indicators at the national level. Human development in the broad sense has meant 'the expansion of people's freedoms and capabilities to lead lives that value and have reason to value'. A holistic discussion on development would include debates on, not just to meet these needs but also improving the above-mentioned capabilities. Noted economist Dr. Amartya Sen, who developed the capability framework, had defined energy carriers as 'commodities or input factors that expand an individual's set of capabilities as it provides lighting, motive power and access to mass media and telecommunication'. This gives us the needed context to understand energy access.

The link between poverty and the lack of access to modern energy access has somewhat been recognised in the recent past - simply because, without energy access, 'people are destined to live in poverty'. Decades ago, developed countries saw the provision of such services to elevate the standard of development and as a key ingredient to provide a sustainable way of living for the population. However, close to two billion people or one third of the global population lack access to electricity supplies. The lack of energy security also translates to limit the ability of developing countries to benefit from the opportunities for economic development and increased living standards. In today's times, the international community accepts this well-found claim that access to energy services is integral to overcome poverty. Lack of energy access is not just a sign of poverty, but also contributes to it. Women and children, especially in developing countries, form the larger portion of the affected population. For example, when households are taken into consideration, women are traditionally responsible for food preparation and cooking, Without proper energy services, women are thus forced to spend a significant amount of time searching for firewood to fuel their cooking and other needs (a study commissioned by the United Nations Development Fund for Women (UNIFEM) relates how women in Sierra Leone spend days in the forest without tools, breaking firewood off with their bare hands and carrying it home on their backs). Energy access is thus the starting point for an individual to realise the many other human rights he or she is entitled to. For example, according to the 1948 United Nation Declaration of Human Rights lists a total of 30 human rights, right from Right to Equality, Education and Social Security, to Freedom from Discrimination and Slavery - the fundamental grounding of which is an individual's self-realisation. Without energy access, achieving most of these human rights (explicitly) and the rest (implicitly) becomes a challenge. Energy allows for the pumping of clean, potable groundwater and avoids the need to use contaminated surface water for drinking and household uses. Similarly, energy is vital in boiling, purifying, disinfecting and storing water, as well as for irrigating lands - to increase the latter's productivity, in turn increasing the availability of food supplies and employment opportunities. Energy is also integral to the necessary implements of healthcare delivery, such as sterilization; lighting; water pumping for clinics, fans, and other cooling devices; and the refrigeration of vaccines and drugs. The lack of access to modern energy services is particularly detrimental to women and children in developing countries. For example, traditionally, women are responsible for food preparation and cooking.

Consequently, without such services, they are forced to spend a significant amount of time searching for firewood for cooking and other needs. Though there is no document of with the sanction of international law per se, that makes it mandatory for access to energy to be considered as a fundamental human right. However, this does not take away from the fact that energy security is irreplaceable in an individual's effort to gain any of the rights mentioned in such documents of international standing. For example, the socio-political rights listed in the 1966 International Covenant on Economic, Social and Cultural Rights (ICESCR). The right to the highest attainable standard of physical and mental health elaborated upon in Article 12 of the ICESCR is impossible without access to sustainable energy services. Similarly, the Convention on the Elimination of Discrimination against Women requires states to eliminate discrimination against women, particularly in rural areas, and to ensure that they "enjoy adequate living conditions, particularly in relation to housing, sanitation, electricity and water supply, transport and communication." Rights such as these are found, implicitly, on the very assumption that the targeted section of society are subject to a certain level of energy access. 9 Energy security again is no longer about securing sustainable supply of energy or power - in today's times it also entails public heat=lth and environmental issues. Amidst political instability in oil producing regions and the increasingly worrying phenomena of global warming, it is no longer sustainable to overly depend on high-carbon fossil fuels. To circumvent supply volatility and reduce carbon-emissions, more countries now explore alternative energy. But again, the shift to such alternative resources bring about their own human security issues. Though nuclear energy is seen as an attractive source of energy, especially in the developing Asia-Pacific economies, nuclear energy does bring forth issues of developing a safety culture and nuclear waste management. The global community also faces a challenge in addressing the disposal of large amounts of spent fuel accumulated from the world's NPPs because of possible transboundary contamination. Shale gas has in this scenario, emerged as a cheaper alternative.

However, shale gas reserves are deep and located beneath water-stressed regions, which makes extraction difficult, expensive, and environmentally risky. The extraction process of hydrofracking releases methane and poses inherent risks to public health, air quality, water quantity and quality, and wildlife. Similarly, the entire procedure, known as 'hydrofracking' is said to add to cumulative global carbon emissions. While renewable energy has been highlighted to bring to the table to the kind of relief from the current energy crisis, production of renewable energy by economies in the world today in the manner that it is, is a grave contributor to human rights violations. For example, hydropower dams in East and South Asia have displaced communities, undermined the quality and quantity of water supply, and continued to disrupt the livelihoods of people across borders and downstream throughout Asia from the Mekong to the Ganges-Brahmaputra-Meghna (GBM) basin. 10

Similarly, numerous treaties and documents in the realm of International Law make a compelling case for energy access to be counted amongst the most fundamental human rights. These include

Another aspect of the human rights oversight while ensuring energy security is the blatant ignorance of the rights of indigenous people who are more than often left to fend for themselves in the face of energy projects. The paper discusses two such instances wherein the rights of indigenous people were not just blatantly violated, but these instances continue to form contemporary reality of such peoples in the face of energy projects and matters concerning their basic human rights. The issue of energy poverty have a gender issue ingrained in it as well - owing to the gendered societal role that result in men and women lacking access to modern energy sources differently.

The Narmada Sardar Sarovar Project

The Narmada Valley Development plan is arguably one of the most ambitious and challenging plans to have been proposed by any Indian regime, in terms of scale and calculated impact. The project, which is basically a multi-crore project that involved building a series of dams -30 large dams, 135 medium dams and 3,000 small dams to be precise - over the river Narmada, was estimated to generate 1450 MW of electricity, produce pure drinking water to close to 40 million people, irrigation for over six million hectares of land and hydroelectric power for the millions of people living in the Narmada river valley. The very nature of this project, which also received considerable financial aid from the World Bank, was underlined to overlook the many human and environmental costs in the face of the reported high economic benefits or the 'collective good'. The river flows across three Indian states - Gujarat, Madhya Pradesh and Maharashtra.

The Sardar Sarovar Project in Gujarat however, proved to be the most controversial large dam amongst all of the 30 large dams. The then-Government of India reportedly stated that this dam alone would end up irrigating nearly 1.8 million hectares of land in the state of Gujarat and close to 73,000 hectares of land in the neighbouring state of Rajasthan - apart from the other benefits of potable water availability.

What was not given due importance in the discussion and implementation of the project was the widespread displacement, of around tens of thousands of individuals and considerable environmental damage. Right from the late 1980s, rural activists, social and political action groups lawyers, students, journalists and the like have been protesting against the construction of the dams, the largest of which was the Sardar Sarovar Project. The project was widely protested and one such poignant manifestations of protest was the 2002 documentary film, Drowned Out, that followed the life of a tribal family that decide to stay at home and drown rather than make way for the Narmada Dam. The submergence created by the dam has a number of direct and adverse impacts. However, there is no greater impact than the ousting of hundreds of thousands of people. 11

An estimated 248 towns and villages were at the danger of being submerged, and at least 90,000 people relocated by the Sardar Sarovar dam alone. However, the authorities were allegedly involved in a number of human rights exesses such as arbitrary arrests and beatings in riverbank villages, violence against women (oncluding sexual violence), use of force and intimidation during surveys and roadbuilding and suppression of peaceful protest. Reportedly, in a span of months in the middle of 1993, an overwhelming number of individuals complained of abusive or prejudicial treatment at the hands of law -enforcing authorities. These include people from the Narmada Bachao Andolan (NBA), representatives of organizations representing tribal villagers, unions, peasants, journalists, and prominent opposition politicians. Some of these reported incidents include ones of alleged harassment, short-term detention and abuse in custody by police.

Similarly, the indigenous communities were not consulted about the project in the entirety of the project - right from its inception. After the project was conceptualised and initial work had commenced, the height of the said damn was raised to 122 metres, which resulted in the inevitable inundation of many villages and hamlets which were near and relatively near to the river banks, forcing the permanent displacement for several villages. Reportedly, most of these population was not even considered 'displaced' - thus completely excluding them from the framework of compensation or rehabilitation benefits, that officially recognised displaced people are subject to. This population includes tribals, fisher folk and landless poor amongst others. These sections were not even given alternative land neither were they given alternative livelihood sources, in many cases - some of them, who were fortunate to be even considered to be subject to land-based rehabilitation, had to make do with barren, conflict-ridden land or paltry monetary compensation. Additionally, the Sardar Sarovar Narmada Nigam Limited and Narmada Valley Development Authority failed in ensuring fair and just means to secure environmental clearance for the 13,385 odd hectare of forest land at the threat of being submerged by the project.12

For the matter, there developed friction between the ground realities and the growing voices of protest against the project on one hand and the policies of the World Bank governing the human rights-aligned stance of the Bank, on the other. The World Bank's operational policies and directives were developed as a response to external and internal pressures over time to develop and establish a robust framework of environmental and human rights guidelines for its lending practices. On a side note, even the state response to the widespread protests against the project came under the scanner for numerous excesses of human rights violations. These include warrantless arrests, custodial torutre, harassment of women, rape of women and use of force and intimidation during surveys and roadbuilding.13

Numerous fact-finding missions and reports aimed to look into the on-ground impact the various redressal channels had, namely - the Narmada Water Disputes Tribunal Award, the direction of the Supreme Court of India in October 2001, in the Sardar Sarovar Project case, the rehabilitation and resettlement policies of the states of Gujarat, Madhya Pradesh and Maharashtra, the Involuntary Resettlement and Indigenous Peoples policies of the World Bank applicable to the Sardar Sarovar Project and India's obligation to protect housing rights under international human rights law. 14

The fact finding missions found numerous individual cases of human suffering of the affected communities. 'The floodwaters during the height of the monsoons in late August and early September, 2002, submerged the crops and houses and washed away the personal property and livestock in some of the affected villages in Maharashtra and Madhya Pradesh'. In Jalsindhi, Jhabua district, Madhya Pradesh, and Domkhedi, Nandurbar district, Maharashtra, first-hand evidence of destruction of homes and standing crops was noted. All along the river, homes and fields had been scoured bare by the monsoon waters, which had receded by considerable levels. The river also contained many trees that were still submerged as explained by the villagers. 15

The treatment meted out to the numerous indigenous communities affected by the project falls short from fulfilling the number of human rights guaranteed in the framework enshrined by numerous documents on the subject matter. For example, Article 11(1) of the ICESCR states, "The States Parties to the present Covenant recognize the right of everyone to an adequate standard of living for himself and his family, including adequate food, clothing and housing, and to the continuous improvement of living conditions. The States Parties will take appropriate steps to ensure the realization of this right." As per the United Nation, "Adequate shelter means adequate privacy, adequate space, adequate security, adequate lighting, adequate ventilation, adequate basic infrastructure and adequate location with regard to work and basic facilities, all at reasonable cost." 16

Similarly, the UN Committee on Economic, Social and Cultural Rights has said that evictions should not result in rendering people homeless or vulnerable. 17

The more damaging aspect of the displaced peoples is that almost all of the tribals in these areas are incapable to prove their ownership over their land vis a vis legally recognised documents. For example, the affected people in Alirajpur Tehsil, Jhabua District in Madhya Pradesh, who are predominantly tribal, told one of the fact-finding teams that, though they have been cultivating the land for generations, their names do not figure in land records and now their lands are going to be submerged with entitlement to any compensation. 18

Human rights excesses of Coal India Limited

Earlier in 2017, international non-profit organisation Amnesty International released reports on the issue of human rights violations in coal mines run by Coal India Limited - the Indian state-controlled, West Bengal-headquartered coal mining company. The entity is the largest coal producer in the world and contributes to nearly 82 per cent of India's coal production. In the said report, Amnesty International pointed out to the phenomena that Coal India Limited seldom takes into account the impact of its activities or even the consent rather of the adivasi community in India that bear the brunt of its development-induced displacement, by the virtue of being on or in close proximity to the land acquired by the coal producer for its mining activities. Though indigenous people like the adivasis are protected by a set of laws meant to protect their interests, it has not stopped entities like Coal India from taking away their lands, destroying their livelihoods all in the name of business activities meant to fuel 'development' for the larger good. Such communities have not even been made beneficiaries of effective land acquisition, rehabilitation and resettlement policies. The adivasis, who constitute about 8% of India's population, rely on their lands and forests for their livelihoods. They have been frequently displaced from their lands by laws such as the Coal Bearing Areas (Acquisition and Development) Act, which does not require authorities to consult affected communities or seek the free, prior and informed consent of indigenous peoples, as stipulated under international law and standards. Under this Act, there is also no compulsion on the authorities to pay compensation before taking possession of land. The Act does not even provide for the protection of the human rights of the displaced populace nor does it provide for human rights impact assessments to be conducted prior to land acquisition proceedings. Similarly, there are no requirements to consult with non-landowners who may be affected by land acquisition, such as landless labourers. This phenomena of complete apathy towards persecuted communities is all the more important to take note of given the fact that 70 per cent of India's coal is located in the central and eastern states of Chhattisgarh, Jharkhand and Odisha. These states form the homes of over 26 million members of Adivasi communities. Coal India and its subsidiaries are estimated to have displaced at least 14,000 Adivasis from 1973 to 2014. In 2016-17 itself, Coal India subsidiaries acquired or took possession of over 21,000 hectares of land using the CBA Act.

Other laws, such as the Scheduled Castes and Scheduled Tribes (Prevention of Atrocities) Act, which in fact criminalise the dispossession of land belonging to the Adivasis or inhabited by them, without fairly sought consent, are hardly enforced. 19

The Coal Bearing Areas (Acquisition and Development) Act (CBA Act) governs land acquisition for coal mining by the Indian Government. The Ministry of Cola is the body responsible to ensure effective implementation of the Act. According to the Act, when the government is satisfied that coal can be obtained from a certain area, it declares its "intention to acquire" the land in the official government gazette. However, the Act does not make any provision for the authorities to consult with the affected communities to seek their free, prior and informed consent. Inspite of a parliamentary committee pointing out in 2007 that "coal reserves in the country are mostly in the far-flung areas inhabited by the tribal communities" who "hardly have any access to the Official Gazette wherein they could see that their lands are to be acquired for public purposes", there have been no changes made to the process of informing communities that their land will be acquired. 20

For example, amongst the numerous examples listed in the Amnesty International report on the excesses of Coal India limited, one elaborates upon the reality in Tetariakhiar, Jharkhand. The communities surrounding the Tetariakhiar mine are concerned about the fate of common lands called gair mazrua lands. Accordingly, 'Under a state law which applies to the district, a senior-level official in the district administration has to approve any acquisition of gair mazrua land for mining by the central government. However the central government does not follow this process, and instead uses the CBA Act to acquire common land without any consultation with communities'. 21

On the other hand, the phenomena of open-cast mining has environmental effects as well. In the 1970s, India's coal production shifted from underground mining to open cast mining. Only about two in five of Coal India Limited's 430 mines are open cast mines. But these very mines account for nearly 93 per cent of its total production. 22

hough the mineral deposits are easy to remove in open cast mines, it also involves removing of trees and vegetation on the surface of the land, blasting and clearing the layer of soil between the surface and the coal deposits to expose the coal seams, and then drilling into and extracting the coal in strips. 23

Conclusion

Energy is vital - not just for the development of a country, but also of an individual. For the former, the power scenario in India as of today is made ineffective by persistent shortages, unreliability, high prices for industrial customers as well as an acute problem of energy poverty. Energy is central to the interrelated framework of economic, social and environmental objectives of sustainable human development. The situation is all the more grave given the fact that for a population of 1.37 billion people, the country uses just 6 percent of the world's energy. The country's growing dependence on fossil fuel imports, which reportedly account for nearly half of its energy consumption, adds negatively to the debates around energy security. India is also on an ambitious plan to triple renewable power - primarily from solar and wind, but also including bioenergy and small hydropower. However, to really land an impact on the domestic energy scenario, India's renewable will have to account for more than 40 per cent of the overall power generation capacity. Thus to bring about the change in its energy production, consumption and sustainability patterns, India will have to focus on its energy policies, and work towards their effective implementation - of long term policies, targeted to reach fruition by 2050, and policies with short term goals to be met in the next couple of years. As suggested by many reports, the fundamental aim behind such policies should be to meet energy demands reliably and delivering clean and affordable energy using different fuels and forms of energy. However, as proposed by journalist Sam Tranum in his book *Powerless - India's Energy Shortage and its Impact*, India needs to ask itself a series of questions - will it continue to suppress energy costs for end users for the good of the power or will the power have to make adjustments themselves to tend to the benefits of the power utilities, oil marketing companies, etc? Will it continue to harp on the 'cheap energy' slogan at the cost of the environment, or keep higher environment-friendly benchmarks for itself and instead raise energy prices for its citizens? Finally, will India continue to turn a blind eye to the rampant displacement and abuse of its rural citizens - especially the Adivasis and other indigenous communities - to make way for mines to be dug and dams to be build? 11 There will be future shocks to the energy market and that is a given. The foreseeable developments include coordinated terrorist attacks in the West Asian and African region and turmoil in other oil-rich parts of the globe, including Latin America and Central Asia. In such conditions, it is imperative for economies and countries at large to focus on diversification of the energy mix. It is pressing for contemporary times to develop nuclear power capabilities and 'clean coal' technologies and encourage usage of renewable sources of energy. This, as an extension, which requires investment in new technologies as well, across the energy spectrum.

The problem of energy poverty is alarming in the developing countries of South Asia and Sub-Saharan Africa — the latter posing the greatest challenge, with only 13 percent of the population having access to electricity. 24 However, a quote by one of the impacted individuals in Amnesty International's report on the Human Rights excesses by Coal India Limited, enshrines the thought that ought to govern energy policies and decisions henceforth - "I understand that some people must make sacrifices for the nation, but why must it always be us?" (- Nirupabai, forcibly evicted in February 2014 from Barkuta village, Chhattisgarh.) 25

Human security with respect to energy security plays out on two levels. Firstly, an increasing section of the population is without an effective or sustainable access to energy. This then lead into a vicious cycle of disadvantage and poverty. Secondly, certain sections of their population and their fundamental human rights cannot be blatantly sacrificed to make way for projects to ensure energy security for the rest. More so, the question of energy security becomes all the more crucial - a question of life and death in fact - during times of conflict. For example, so-called left wing extremism and the insurgency scenario in India till date presents such dire situations to the impacted vulnerable populations. Energy needs to be placed at the centre of the larger framework of empowerment and equitable and inclusive growth - as a fundamental human right that is in fact the starting point of an individual's efforts to realise her or his other human rights. Growth of a country must be judged through the parameters of the growth of its individuals and its impact on the lives and freedoms of the people.

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4

IMPROVING MENTAL HEALTH OF WORKFORCE UNDER NEW NORMS THROUGH SPIRITUALITY

Vivek Pathak

ABSTRACT: In the new normal lot of changes are enforced at the workplace especially related to work in isolation and social distancing. These have become accepted norms. These norms are not only difficult to practice but they are also creating a lot of mental stress on the workforce. The paper aims at exploring various mechanisms for developing the individual spiritual strength thereby contributing toward better job performance and organisational growth under ethical leadership. Various solutions are being explored to facilitate individuals' protection from the inherent stress created by this pandemic. Organizations striving under ethical leadership and spiritual culture can have a better success rate in the new business norms. This analysis identifies the application of meditation and related techniques to help workers handle the mental stress of the new normal of various organisations. What are the new practices under the new norm? How they are being coped? How does psychological stress create a despondent workforce? How this despondency can be removed by virtue of spiritual practices? This all emerges out under ethical leadership and workplace spirituality.

KEYWORDS

New Norms, Transformation, Workplace Spirituality, Ethical Leadership, Spiritual practices, Meditation, Organization.

Introduction

The world changes continuously. When the change is referred it is tantamount to a transformation. In other words, change is a transformation. Transformation is a disturbance. The only thing which remains constant in this world is Change. Water flowing in the river or stream is fresh and new because it changes continuously. This water can be used for multiple activities and also can generate power. Whereas, water confined to a pond remains stuck without a change. This water is stinking and stale. Mosquitoes and diseases breed in such a stagnated water. Organisations which continuously churn themselves remain ongoing, fresh and powerful. New norms are being accepted amidst a transformation happening post pandemic. Transformation is very important to take forward any organisation through any changed perspectives. *"Social interaction, forming and shaping work relationships, is an important mechanism to understand how employees deal with contemporary large-scale organizational challenges on a day-to-day micro level".[1]*

Transformation

In the tough times of Pandemic, new norms have emerged which are quite sensitive for any organisation because of scare of death remains. Employees participation in protecting themselves from the effects of pandemic is being considered very important under the new norms. An employee who falls sick due to effect of mysterious virus will be a carrier leading to sickness at work place. Usage of mask (Personal protective equipment) is being promoted aggressively. Along with are arising the new norms like maintaining social distance (Safe act), restricted travel (safe act), closed offices (safe conditions), work from home (safe act), provision of soaps and sanitizers at workplace(safe conditions), Usage of Artificial Intelligence (Safe condition), promoting Video conference (safe action), issuance of written circulars/notifications/orders (Administrative control), avoidance of gatherings/ get together (Administrative control) and continuous sanitization of workplace (Administrative control). These disrupting changes are happening due to the pandemic which can be considered under New norms. Transformation is happening involuntarily. Organizations are incorporating such transformation through the employees' participation. Historically it is observed that organisations that endure and come out powerfully from such troubled times do emerge more powerful. Organisations that cannot endure such changes get wiped away. History has ample proof of the same.

"Digitalization and technological disruption, both of which are considered truly game-changing developments for entire industries, and by providing insights into the way in which employees factually cope with such environments."[1] Shifting of norm from Brick and mortar companies to click culture has brought tremendous societal change among employees within organizations. It is unfortunate that such a change is not being catered to by the old leadership and conservative management groups within any organization. This may be hidden slow disruptions or neglected uninvestigated near misses. Established practices do face organizational inertia and psychological resistance. "*Whether the translation of emerging practices such as digitization and global standards between the East and West experience lower translational hurdle"[2] is an area of introspection and research. Organisations exist in different cultures and contexts that provide specific perspectives for research and analysis. "Differences in various institutional forms and arrangements, and in philosophical and cultural orientations provide much explanatory power for understanding variation in how firms and other forms of organization behave and how they are understood by the various audiences they confront."[2]*

Organizations shifting towards Artificial Intelligence (AI), Internet of Things(IOT) and Machine Learning (ML). A disruption model is emerging which is directly or indirectly effecting the motivation and morale of the employees in any organisation. Digital Transformation is evident but it requires better understanding by *"disentangling DT and ITOT based on how value propositions and organizational identity interrelate in these processes."[3]* This is important because organizations need to define *"what they want to be and the interplay between digital technology and their value proposition".[3]* In the changed times, all organizations understand that digital transformation is very important in order to stay competitive. This transformation leads to a change in the way they do business or meet customer expectations. *"Based on literature and empirical findings, it is evident that there is a strong connection between digital transformation and corporate culture".[4]* It is true that organizations will change in order to remain surviving in the changed times. They have started investing in developing the managers, investing in digitization and transforming leadership capabilities. *"Organizations can enhance their chances of successful digital transformation, by using the frameworks presented to change the corporate culture. Organizations will thereby be able to develop their desired culture, suitable for the digital economy".[4]* Framework referred herein are Cultural change framework and Leadership development framework.

Although automation and digital transformation are the new realities organizations face resistance from employees who remain engaged with old practices. Learning organizations do take effective steps to engage employee engagement in such transformations. *"The dynamic marketplace requires employees to adjust successfully to changing policies and structures and operate effectively in the arduous environment, which in turn exert pressure on employees."[5]* In the changed norms organizations are getting the pressure to adapt to the changing perspectives. Organizations in these times must plan the development of the employees' development and engagement. The development needs to be from external and internal areas. Organizations feel the heat to transform themselves as per the marketplace to remain competitive. Leadership must strive diligently *"to invest in building learning organization to develop employee resilience, in general, to keep their employees engaged".[5]*

Leadership

Leadership has a major role in the contemporary organization undergoing transformation. Changes in the marketplace dynamics and workplace environment compels an organisation to inherently transform itself to stay competitive in the changed times. Changes within any organization becomes possible under Transformational leadership rather than under Transactional leadership. Transformational leadership is more dynamic and creative compared to Transactional leadership which is static and rigid. Transactional leadership is control oriented whereas transformational leadership is effectively engagement oriented. *"Leaders and employees in organizations need to be built up to participate in the process of change in their organizations. Organizations and employees also have the same interests that must be achieved so that followers will voluntarily engage in change. The best way is to focus on human resources as the capital asset for successful organizational change."[6]*

In every organization there are few individuals who influences the culture. Though they think differently, yet they make an impact on group behaviours. These leaders contribute to development of organizational culture in their own ways. *"Their commitment, dedication, and passion has had a powerful ripple effect and in turn, they role model, inspire, and lead their teams to excellence".[7]* Though Tranformational leaders initiate change through the employees engagement by promoting innovation and keep them motivated, yet it is the collective responsibility of employees. When it becomes a collective responsibility then the employee engagement is very essential in the transformed organization rather than the dictates of an individualistic leader. *"Organizational change leadership re-imagined is concerned with broader interests of ethics and what is in the interest of the wider society and organizations within it, rather than narrow sectional and individual interests of leaders."[8]* When ethics is involved then the role of Value system takes over. Organizational transformation by attuned value system takes supremacy then. For changing an organization an individual change must happen. *"Successful organisational change in this era of rapidly changing technology, globalisation, uncertainty, unpredictability, volatility, surprise, turbulence, and discontinuity begins with, and depends on, changing the individual consciousness of those who are employees of the organization".[9]* Individual employee consciousness can be impacted directly or indirectly by spirituality. Workplace spirituality leads to change of ethics and values in an organization. Aligning of Values cannot become the nodal cause to change the organization but it becomes the bedrock foundation to trigger such a change. *"It is through the implementation of a comprehensive values alignment process that it is possible for organisations to properly prepare the individual consciousness of its employees, and the organisational culture as a whole, to be able to constructively cope with the changes needed to ensure the organisation's long-term success and viability".[9]*

New Normal

Transformation brings with it resistance to change, disruption in existing systems, disorderliness in practices, change in human behaviour, structural re-alignments and systematic amendments of processes. Psychological impact on employees' morale and mental state also happens during any disorder created by transformation happening due to outside or inside environment. Present pandemic is such an event which has disrupted business cycles. Organizations are feeling the heat to survive in this changed environment and keep their employees safe. Death is ruling the roost as the spread of virus cannot be curtailed. Owing to the pandemic it loss of human lives, increase stress at workplace and permeating fearful environment can be evidenced. This can surely be a reason for an adverse effect on mental health in the workforce. Employees' engagement at the workplace under stressed times keep them reminded when insistence is upon wearing masks and maintaining social distances. These are the changed norms. Handshakes are avoided, Meetings are not promoted, Video conferencing is encouraged for interaction and Gatherings are stopped. Besides, most employees are encouraged to work from home or on alternate days from the office in isolation. This changed norm though precautionary creates a psychological stress on employees at workplace. Transformation has taken place in the Organisational behaviour. This pandemic has also resulted in unemployment and social isolation as a changed norm in the human civilization. Unemployment can lead to social and psychological problems. *"While the critically urgent issues of virus containment, treating of patients and vaccine development are being addressed, it is also mandatory to start addressing as soon as possible the long-term effects of destabilized mental health of global societies. Due to public health and outlined economic reasons, it is well recognized that COVID-19 presents a serious threat for mental health around the globe".[10]*

A new norm in society has brought tremendous changes in workplace and in organizational culture. Covertly it has developed shock, disappointment, anxiety and job loss threats. The pandemic definitely has created hidden risks impacting mental health of employees over long term. Uncertainty in markets, Poor plight of workers, continuous threat of job losses, work in isolation, maintaining social distance and Inability to get associated have created stress induced harmful psychological effects to the human brain. Pandemic has lead to bankruptcy of businesses, enterprise closures, workers' layoffs, depleting resources, collapsing of supply chain and lock down of existing systems. *"Since work has functions directly related to individuals' psychological health and self-esteem, job insecurity inevitably has implications to one's identity, self-efficacy beliefs, confidence and social support system. The threat is thus not only financial but rather multidimensional".[11]* In times to come the effects of Pandemic can effect Mental health of workers leading to Trauma due to job loss or Post Traumatic Stress Disorder.

Spirituality & Mental Health

"The potential fallout of an economic downturn on mental health is likely to be profound on those directly affected and their caregivers."[12] Social distancing and loneliness are two different things. Human beings are social animals. With social belongingness any person can avoid the potential to inflict harm on self, protect oneself from suicide and retain emotional balance by sharing. Prolonged loneliness can create a typical psychological disorder in the human mind. *It is not confirmed yet hypothetically assumed that "in the longer term, it is possible that SARS-CoV-2 will have persistent direct neurotoxic effects and immune mediated neurotoxic effects on the brain."[12]* Problem is the new norm which has the inherent potential to create an atmosphere which can lead to probable feelings of psychological disorder. Though this remains to be established from the present pandemic however it was proved from historical perspectives from research post various pandemics. Organizations need to work on developing employees engagement for a fruitful business environment but that is possible through promoting a culture based on spirituality under the ethical leadership. *"Strengthening the constructs of ethical leadership and workplace spirituality would prompt and cultivate the concept of work engagement among employees based on the trust they will have in the leadership and organizational environment."[13]* Such initiatives do make a change in any organization as employees follow leaders. Spiritual and Ethical practices on part of leadership set an example of trust and positivity among employees. Such an amended culture then gets visible through the motivated behavior of employees, positive thought process in various stakeholders and value based customer relationship leading to enhanced response towards products and services. Organizations planning such cultural competitive advantage must engage employees and management practices based on spirituality and ethics. Self Determination Theory(SDT) which encircles around human motivation, inner growth and psychological requirements can be promoted further through workplace spirituality and moral leadership. Such organizations then transform themselves towards inner strength to handle inner and outer instabilities and to develop effective work culture. This transformation can then drive an organization towards effective reduction of costs thereby contributing to business profits.

"Focused attention, emotional balance, improved concentration levels, self-awareness, better relationships and enhanced well-being are benefits of mindfulness practices that are all important attributes needed to aid employee functionality in the workplace". [14] Mindfulness leads to reduction of stress, anxiety and depression. It also leads to increase of focus, attention and compassion. Such effects the enhancement of company's turnover due to enhanced job performance by engaged employees. Organizations can start with mindfulness related training sessions to send the message across the employees. *"In particular, mindfulness training played an important role in reducing employees' anxiety, burnout, distress, stress and increasing their awareness, motivation, positive emotion, resilience and well-being".[14]* Mindful meditation can be used to enhance cultural settings within the organization thereby leading to improvement in well being of employees. Studies have confirmed about *"the presence of a positive relationship between inner life and Work to Family Enrichment, which is believed to be the result of the self-understanding of inner intrinsic spiritual needs such as helping society, or the influence of religious perspective".[15]*

Organizations can improve harmonious relationships under new norms in the workplace by helping their psychological well being. Psychological well being can be enhanced by motivating employees to practice spiritual practices as deemed in every religion and belief. *"Organizations (leaders) who invest in an employee's spirituality will help employees to achieve a positive well-being, which leads to positive organizational outcomes". [16]* Since these are the practices and leadership must set an example. So it has to be messaged across along with various facilitated training programs and dissemination of messages dealing in with the practical application of spiritual exercises. Every person must be motivated to practice meditation at home. Just to begin with the first activity and the last activity of any day should be meditation. Sitting in silence after a brief prayer need to be persuaded in meetings and workplace. Such practices when get recorded in Minutes of meeting will spread the message across the workplace. Ethical practices can be imitated if practised by setting an example. Pedantic pedagogy doesn't help in such situations. Motivational spiritual messages can be displayed across the workplace. When people realise their true potentials, then get themselves engaged, thereby leading to the progress of any organisation. *"An awareness of the capabilities of oneself will help in creating an attachment towards his/her own work and workplace. Promoting workplace spirituality is a win–win situation for both, the organization and the employees. Knowledge is the primary source of competitive advantage for the organizations. Stimulating a sense of knowledge sharing among the employees is absolutely essential to thrive in this era of competition. Knowledge sharing among organizational members stimulates innovation and growth and also enables faster decision making". [17]*

Conclusion

Workplace spirituality can facilitate positive deliverable if individual belief and practices become stronger through knowledge sharing. Self aggrandizement, spiritual practices and information sharing intent are inter-connected with each other. The only solution during present times, wherein new norms are becoming common, it is always best to resort to developing of mental strength. Developing mental strength will lead to enhancement of individual capabilities leading to better engagement at work and better job performance. Resorting to meditation on daily basis at home and workplace will lead to inner resilience and mental strength. Meditation doesn't mean closing eyes and sitting at a place. A person can meditate while walking, sitting and working. Making work as worship also helps to gain strength in character and ethical power. Workplace spirituality is a covert derivative of this new workplace norm. This is the best prevention against the cure for depression, anxiety and stress. As the economy tries to stabilize itself, the businesses continue to thrive. In the world undergoing pandemic, the acceptable activities have become the new norm. This new norm may be a bit different but not difficult to adopt. Organizations with uplifted workplace with inherent spiritual and ethical practices will be able to develop the best habits to practice. In the end, the show must go on.

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5

SMALLEST ELEMENT HYDROGEN OFFERING BIGGEST OPPORTUNITIES FOR ENERGY TRANSITION: THE GLOBAL TRENDS FOR GREEN ENERGY

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ABSTRACT: As world is moving towards green and sustainable energy, there are several alternative sources which needs to be explored further. One such source of energy is Hydrogen which requires special attention in order to utilize it up to its full potential. On the basis of its origin Hydrogen can be categorised as Grey Hydrogen, Blue Hydrogen and Green Hydrogen. This paper comprehends all the aspects of Green Hydrogen. The objective of this study is to understand the current scenario and potential of Green Hydrogen in India and how to use it up to its greatest extent. This paper also focuses on global demand and supply of hydrogen. A comparative understanding has been done between blue and green hydrogen to understand its scalability along with opportunity and challenges. This paper also narrates the key attributes of Green Hydrogen policy in India along with future scope on production through less explored resources.

KEYWORDS

Green Hydrogen, Blue Hydrogen, Geothermal Energy, Sustainability, Fuel Cell.

Introduction

Hydrogen plays a pivotal role in global energy transition by its production from various renewable sources that have zero carbon emissions (Capurso et al., 2022). This green energy fuel makes them a successful alternative to petroleum-based products especially in the automobile industry. Moreover, the turbines at the thermoelectric plants could be powered by hydrogen by replacing coal and could be used in the secondary energy production including wind, solar and hydroelectric plants (Welder et al., 2019).

When we talk about the potential of Hydrogen fuel, the utilization of hydrogen fuel offers measurable advantages over conventional modalities in the energy and transportation sectors.

- Hydrogel fuel cell replaces the needs of ordinary batteries which operates on metals (lithium/ cobalt) that possess huge environmental and biological concern.
- Electric vehicles driven through hydrogen fuels signify a dual advantage on minimizing carbon emission and adequate restoration on depleting fossil fuels.
- Hydrogen offers a large volumetric energy storage density, thereby frequent discharge of cells shall be greatly minimized.
- Quick recharge and sustainable discharge make hydrogen fluid dynamics more interesting in the mobility industry.

Despite the energy and environmental credentials, countries around the globe still face certain limitations in acquiring the proper action plan that channelizes the mass production and supply of hydrogen fuel, some of the crucial limitations were listed below.

1. Storage and transportation network on large-scale production is still in primitive stage and needs high-level execution to widen the distribution cycle.
2. Lack of infrastructure and technologies substantially inflates the cost of hydrogen production.
3. The absence of international regulations concerning production, storage, and supply across the territories is still not well established, this scenario has a negative impact on formulating the global trade market.
4. Hydrogen is known for its flammability nature, hence requiring an expensive infrastructure for the cause of safe production and efficacious supply.

Steady-state collaboration among policymakers, academicians, and industries becomes inevitable in framing the guidelines that advocate the hassle-free production and supply of hydrogen through reliable sources. Novel technologies are required to explore the maximum potential of the biomass waste that tends to curtail the need for diminishing fossil fuels. Vibrant low-cost infrastructures which ensure a high level of safety could even synergize the investors to replenish their thoughts on next-generation renewable energies like hydrogen. Interdisciplinary research approaches enable well-organized logistics and supply chain of hydrogen fuel concerning geological mapping, mass production, safe storage, and channelized supply (Figure 1). In conclusion preparedness of future technology in securing a clean environment will surely make hydrogen an icon of international trade.

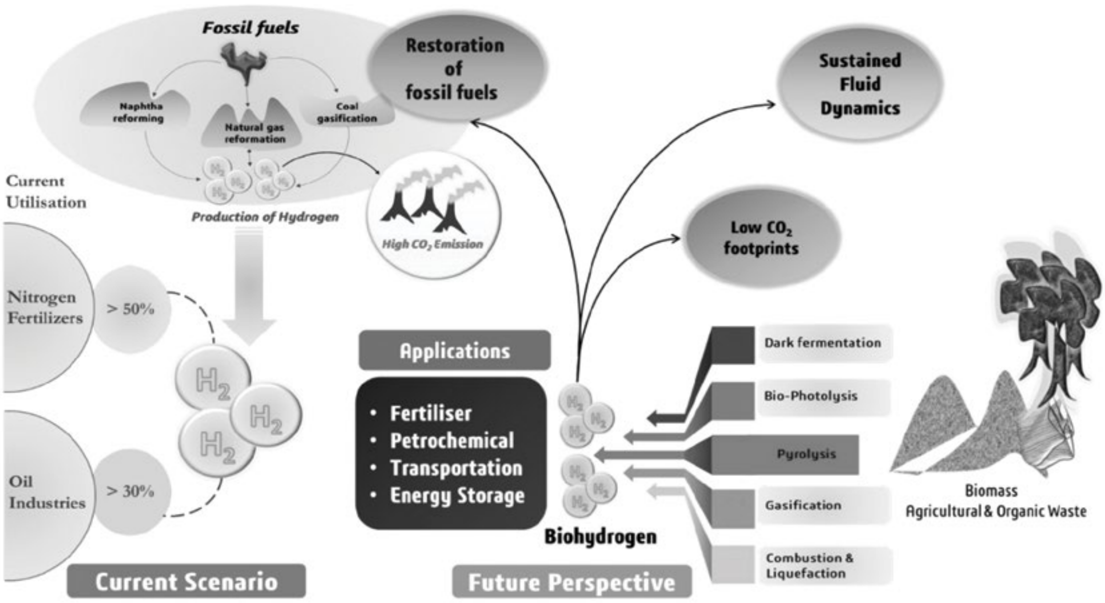

FIGURE 1: Current scenario and future perspective of hydrogen production

Depleting resources of fossil fuels gear the shift towards alternate sustained resources that adequately compensates for the energy demand in both developed and developing countries. The high conversion value and eco-friendly nature of hydrogen attract the researcher to explore diversified ways of synthesizing, storage, and utilization of hydrogen as a next-generation renewable fuel. By considering its potential there is a constant increase in annual demand (5-10%) for hydrogen and it may be expected to reach an exponential hike by the year 2050 (Agyekum et al., 2022).

On average, nearly 6 percent of natural gas along with 2% of coal consumption imparted for hydrogen production to accomplish the industrial requirement. Perhaps this process negatively impacts the environment by revoking 830 million tonnes of carbon dioxide annually (IEA, 2019).

Industrial demand for hydrogen attains newer hikes since the year 1975 and as per the estimate justified in the year 2018, it was hypothesized that a major quantum of hydrogen has been utilized by the industries for the production of fertilizers (ammonia based), petrochemicals, solvent, polymers, resins, etc. (Brandon and Kurban, 2017) Global industrial necessity for hydrogen has been significantly increased since 2013, it was estimated that about 324.8 billion cubic meters of hydrogen demand exist in the year 2020 (Wang et al., 2019).

By year 2020, emissions of carbon dioxide fell by 5.8%, or about 2 Gt CO2, the greatest record drop and nearly five times bigger than that of the drop following the international economic meltdown in 2009. Since the epidemic reduced demand for oil and coal faster than that of other forms of energy, Emissions of carbon dioxide decreased far beyond energy requirements in 2020, whereas renewables climbed. Causing a drop in 2020 (IEA, 2021), worldwide energy-related Emissions of CO2 continued at 31.5 Gt, contributing to CO2 hitting its maximum record average yearly atmospheric concentrations of 412.5 ppm in 2020 – over 50% greater than if the industrial revolution started (Figure 2). As coal consumption, petroleum, and gas recovers with the market, worldwide energy-related Emissions of CO2 are expected to rise and increase by 4.8 percent in 2021 (IEA, 2021).

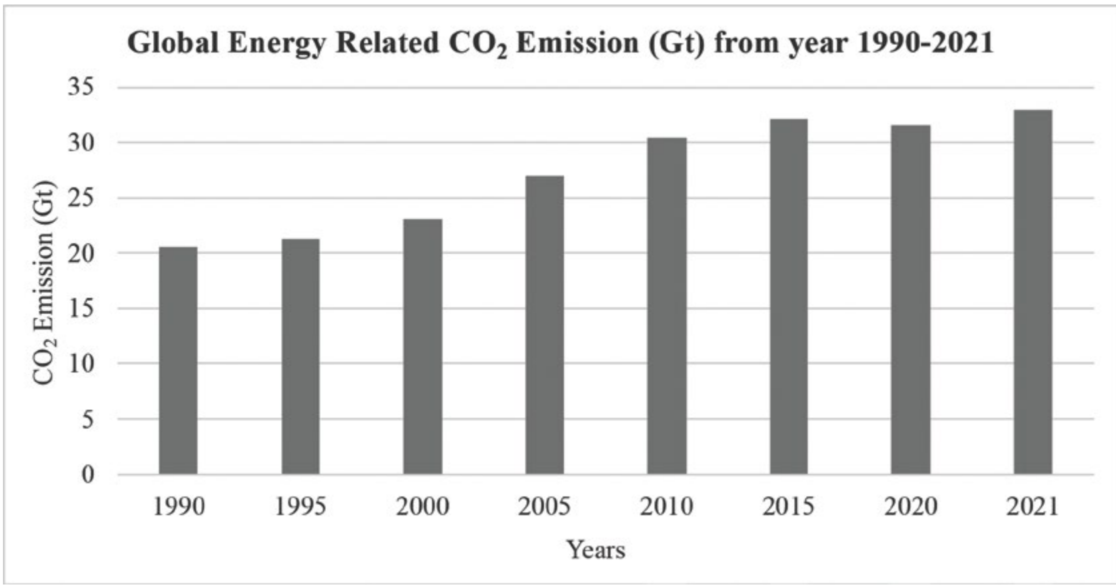

FIGURE 2: Global Energy Related CO2 Emission (Gt) from year 1990-2021 (IEA, 2021)

Nuclear power could speed the process that currently offers the majority of the globe's hydrogen. Using nuclear energy to aid natural gas vapor converting (methane). In order to generate Hydrogen and Carbon Monoxide by mixing methane with vapour the temperature of Stream Reformation of Methane (SRM) need to be set above 700oC (Nikolaidis and Poullikkas, 2017). By using Nuclear as production source for hydrogen one can cut down around 30% of the natural gas intake (El-Shafie et al., 2019). Beginning with electrolysis process the overall performance of the system increases by around 25% by using recent reactors to 36% with much more effective reactors, to 45 percent for high-temperature electrolyser of vapor, and to roughly 50% or over with continuous thermo - chemical synthesis. Table 1 represent the types of methods for hydrogen production using nuclear energy.

	Temp (°C)	Pressure (atm)	Efficiency (%)	Heat (MJ)	Water (kg)	Natural Gas (kg)
Alkaline Electrolysis	60	1	30	26	11.5	0
PEM Electrolysis	60	1	27	26	11.5	0
Solid Oxide Electrolysis	800	1.57	36	30	83	0
Steam Methane Reforming	870	4.1	79	0	10.3	2.9
Thermochemical	910	3.85	25	375	9	0

TABLE 1: Types of Hydrogen generator using Nuclear Energy (Pinksy et al., 2020)

Hydrogen Fuel Cell Vehicles (FCVs) are nearly identical to electric vehicles (EVs) in which power their wheels with an electric engine rather than a combustion engine. FCVs, on the other hand, create their own electricity rather than relying on cells which must be recharged. In a battery pack, hydrogen (H2) fuel from car's fuel system reacts with oxygen (O2) from atmosphere to make electricity, leaving only heat and water as residual materials. Fuel cell automobiles are propelled by pressurized hydrogen gas, which is fed into an inbuilt fuel cell "stacking" that converts the chemical energy of the fuel into electrical energy rather than burning it. The electric engines in the car are then powered by this electricity. There are no combustion pollutants, and the only residue generated is clean water. The fuel cell is constructed similarly to a power supply. Hydrogen reaches the anode and gets into touch with catalysts, which aids in the dissociation of hydrogen into electrons and protons.

The high calorific value of hydrogen (119.9 MJ/kg) than the methane (50.02 MJ/kg), propane (45.6 MJ/kg), gasoline (44.5 MJ/kg), diesel (42.5 MJ/kg), ethanol (27.0 MJ/kg), and methanol (18.5 MJ/kg) makes them a promising fuel by generating high amount of energy during combustion. The safety of hydrogen as fuel depends on several physical parameters such as Lower Detonability Limit (LDL) in Air, Upper Detonability Limit (UDL) in Air, Lower Flammable Limit (LFL) in Air, Upper Flammable Limit (UFL) in Air, Maximum Laminar Burning Velocity, Maximum Concentration, Stoichiometric Laminar Burning Velocity, Stoichiometric Concentration, Density, Ignition Limit in Air, Ignition Temperature, Minimum Ignition Energy in Air, Maximum Combustion Rate in Air, Detonation Limits in Air and Stoichiometric Rate in Air.

The explosion and fire hazards of several flammable substances can be determined by their detonation limits, LDL and UDL. The LDL for hydrogen ranges between 11 to 18% which is much higher than methane (6.3%), propane (3.1%), and gasoline (1.1%). Similarly, the UDL of hydrogen is much higher (39%) than the other gases respectively. Although, methane has a slightly higher LFL at 5.3%, hydrogen when compared to gasoline (1.4%) and propane (2.1%) has high LFL value. In contrast, the UFL of hydrogen is 75% which is 5, 8 and 10 times higher than methane, propane and gasoline. The relativity, diffusivity, and exothermicity information are required for designing, modelling and validation of turbulent combustion and kinetic mechanism of the engine. Laminar burning velocity parameter measures these information for hydrogen with a value of 3.46 m/s at its maximum and the peaking flame speed or stoichiometric laminar burning velocity if 2.37 m/s. This represents the efficient thermodynamic conditions of hydrogen upon ignition. The conversion of mass and energy of resources to produce hydrogen is denoted by its stoichiometric concentration. Hydrogen holds a high stoichiometric value of 29.5% than methane (9.5%), propane (4.1%), and gasoline (1.8%). Also, the maximum combustion rate of hydrogen in air is 3.46 m/s which is several fold increase in range compared to methane (0.43 m/s) and propane (0.47 m/s) (Farias et at., 2022).

Blue and Green Hydrogen

Steam methane reforming (SMR) process reforms natural gas to form hydrogen and carbon monoxide from methane and steam (Andrews et al., 2020). The production of hydrogen through SMR with CO2 capture and storage (CCS) is referred as “blue hydrogen”. Globally, till date, blue hydrogen is produced by Shell in Alberta, Canada and Air-products in Texas, USA (Howarth et al., 2021). Although blue hydrogen claims to have zero greenhouse gas emissions, there is no substantial evidences to prove the amount of hydrogen emitted during the production of blue hydrogen. Methane, being a powerful warming agent, is a strong greenhouse gas than CO2 that constitute approximately 25% of the total global warming share (Sun et al., 2021).

The assessment of methane based severity depends on the greenhouse gas emission metric. Global warming potential (GWP) metric analyses the future threats of global warming by greenhouse gases (Neubauer et al., 2021). Furthermore, the higher and lower calorific value of natural gas extracted with crude oil are directly related to the methane emission. In context with the blue hydrogen, further research and relevant data collection are highly required to frame the impact of global natural gas system.

On the other hand, green hydrogen uses renewable energy to generate hydrogen through electrolysis technology (Zhou et al., 2022). Although this process is slightly expensive than other established model, electrolysis based hydrogen generation uses green technology with total decarbonisation.

As recently predicted by Rystad Energy, an independent energy resource and business Intelligence Company at Oslo, Norway, the economic impacts after Russia’s invasion to Ukraine has spiked the grey and blue hydrogen production as the green version (PV magazine global, 2022).

Presently, Europe has set a target to produce 3 million tons of green hydrogen annually from 2030. India, on March 21, 2022, has started its first huge project on green hydrogen based energy storage at National Thermal Power Corporation Limited (NTPC)-Simhadri plant, Visakhapatnam, Andhra Pradesh. This facility aims to initiate green hydrogen production using advanced 240kW solid oxide electrolyser and storing them in a 50kW micro grid based standalone fuel cell. Multinational companies like Goldman Sachs, USA have predicted the hydrogen fuel market could reach up to $1 trillion by 2050 and have bought 3 stocks analysing the India's focus on green hydrogen production. The green hydrogen International (GHI) has recently announced setting up the world's largest green hydrogen hub at Texas, USA to be commenced on 2026 aiming for the benefit of sustainable energy fuel and green ammonia production. Table 2 represents the characteristics and advantages of blue hydrogen and green hydrogen.

	BLUE HYDROGEN	GREEN HYDROGEN
Source	Natural gas	Renewable energy
GHG emission	CO_2 capture and reused	Zero emission
Technology readiness level (TRL)	8-9	9
Technology	SMR with CCS	Water electrolysis
Scalability	Industrial	Commercial
Process	Well established technology	Sustainable technology
Strength	Economically competitive	Clean fuel with zero GHG emissions
Weakness	Usage of methane from natural gas	Remains in small sector; Limited specialized workforce
Opportunity	Fossil fuel industries will account an significant improvement Environmental, Social, and Corporate Governance (ESG) metrics	Real investment accounting 24% of world's energy by 2050
Challenges	Optimization of integrated systems to produce blue hydrogen	Production of green hydrogen with low energy losses

TABLE 2: Comparison of Blue and Green Hydrogen

Green Hydrogen Policy in India

The green hydrogen policy for any nation should be based on four major foundations. These four foundations are (1) Strategies for National Hydrogen: The strategy stage should be based on the research and development programs in order to have better understanding of the green hydrogen technology (IRENA, 2020); (2) Priorities for setting policy: As green hydrogen has broad range of applications, the priorities for its applications must be defined properly(IRENA, 2020); (3) Guarantees of Origin: As the molecules of green hydrogen are quite similar to the characteristics of grey hydrogen it is important that the origin of produced green hydrogen is renewable source (IRENA, 2020); (4) Governance system and enabling policies (IRENA, 2020): The production of green hydrogen should not only be beneficial with its application but should also contribute value to the economy and environment.

There is a growing global understanding that coordinated action is required to keep global warming below 2 degrees Celsius, and if achievable, to 1.5 degrees Celsius above pre-industrial conditions. Therefore to achieve energy transformation and mitigate emissions, several nations have pledged their Nationally Determined Contributions. The majority of major economies, including India, have pledged to net-zero goals. One of the most important criteria for reducing emissions, particularly in hard-to-reduce industries, is the switch to green hydrogen (Hydrogen Energy, 2022). The Indian government is considering a range of legislative initiatives to smooth the transition beyond fossil fuel-based sources to green hydrogen as a fuel transmitter and chemical raw material for various industries. Following are some key highlights of Green Hydrogen policy in India:

- Green hydrogen is characterized as hydrogen produced through the water electrolysis process utilising clean source of energy (Ministry of Power, 2022).
- A remission of transmission rates for inter-state will be provided to Green Hydrogen producers for a term of 25 years for work executed until June 30, 2025. Renewables sources used to make Green Hydrogen will be allowed to be banked for a duration of 30 days. The price gap between both the mean tariff of sustainable energy bought by supply authority during

prior year and the market clearing price (MCP) in the Day Ahead Market (DAM) during month wherein the green sources has indeed been saved up shall be determined by the State Commission as well as shall not exceed (Ministry of Power, 2022).

- Green hydrogen generation by a producer utilising green energy from one co-located sustainable energy plant, or acquired from a distant clean energy plant, either built by the same builder or a foreign entity, or obtained through a power exchange method. After 15 days of receiving a request that is comprehensive in all aspects, Green Hydrogen facilities will be given Freely Accessible for acquiring green resources. The prices for public access must be in compliance with the established rules (Ministry of Power, 2022).
- Under Power Regulations 2021, connection to the ISTS for renewable power generation built up with the intention of producing Green Hydrogen will be permitted on a priority basis (Ministry of Power, 2022).
- Green Hydrogen manufacturing land might be given in sustainable energy zones.
- Green sources used in the manufacturing of Green Hydrogen counts toward consumption institution's RPO compliance. The green energy consumption in excess of the producer's requirement will be counted to towards the DISCOM's Disciplined in the region where the property is situated.
- Green Hydrogen producers in respective states may purchase and distribute green energy from transmission licensees. In these kind of circumstances, the transmission licensee is just allowed to charge the price of acquisition, wheeling fees, and a tiny margin imposed by the state government (Ministry of Power, 2022).
- The Ministry of New and Renewable Energy (MNRE) will create a separate platform for all regulatory permits and licenses needed for Green Hydrogen manufacturing, transmission, storage, and sales. The involved authorities would be asked to do is provide permits and licenses as quickly as possible, ideally within thirty days of the filing date.
- To improve the competitive costs, MNRE might pool request from other industries and execute combined tenders for Green Hydrogen acquisition through any of authorized public entities.

Future scope on production through less explored resources

The manufacturing of nitrogen-based fertilizers grabs more than 50% of the total hydrogen production followed by oil industries (>30%). In the current scenario, fossil fuels remain the primary source of hydrogen synthesis, these resources were classified into three major categories which include 1. Naphtha reforming (30%) 2. Natural gas reformation (48%) and 3. Coal gasification (18%) (Agyekum et al., 2022). Limited resources and high carbon footprints are the major limiting factors of fossil fuels, hence exploration of the alternative source becomes the need of the hour.

India is a land of rich agricultural diversity intron uplift the scope of hydrogen production from biomass feedstock. Tons of agricultural/ organic waste generated from the crop field each year synergize the research on exploring the possibility of hydrogen production from this robust source. Conversion of biomass into bio-hydrogen is an ideal strategy to minimize greenhouse emissions (Adessi and De Philipps, 2012). Through dark fermentation technology and with the aid of viable anaerobic bacteria pyruvates derived from pre-treated biomass (waste) are successfully converted to format that yields hydrogen.

Bio-Photolysis is another unique mechanistic pathway of synthesizing hydrogen through microalgae (chlamydomonas reinhardtii) that are capable of releasing hydrogen-producing enzymes. Pyrolysis and gasification become a promising thermochemical model of generating hydrogen from biomass at a higher temperature. Avoidance of oxygen and water in these techniques greatly controls the emission of CO2 (Aydin et al., 2021).

Conclusion

With increasing demand of clean, green, sustainable and affordable energy sources hydrogen will play very important and competitive role. In this paper an aim is targeted to understand about the hydrogen its types of sources along with its marketing and policy strategies. In this paper it has been narrated that how the collaborative approach of policymakers, academicians, and industries becomes inevitable in framing the guidelines that advocate the hassle-free production and supply of hydrogen through reliable sources. This paper also talk about the techniques like Hydrogen Fuel Cell Vehicles (FCVs) which uses the waste heat from the combustion engine and convert it into hydrogen which can be used to power the vehicle. It also narrates about how the green hydrogen is better than the blue hydrogen. It talks that how the green hydrogen is more sustainable technology then blue hydrogen and how it can be generated by simple water electrolysis technique with zero emission. The four foundations of Indian Green Hydrogen Policy is describe which are (1) Strategies for National Hydrogen; (2) Priorities for setting policy; (3) Guarantees of Origin; (4) Governance system and enabling policies. With all this analysis future scope on green hydrogen production with less explored resources is concluded.

Nomenclature

SRM- Stream Reformation of Methane

FCV- Fuel Cell Vehicles

EV- Electric Vehicles

UFL- Upper Flammable Limit

LDL- Lower Detonability Limit

UDL-Upper Detonability Limit

LFL-Lower Flammable Limit

CCS- CO2 Capture and Storage

GWP- Global Warming Potential

NTPC- National Thermal Power Corporation Limited

MCP- Market Clearing Price

DISCOM- Distribution Company

MNRE- Ministry of New and Renewable Energy

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