for implementing the initiative of EVs as well. To continue on this path, EVs require few amendments and improvements in various sectors, such as stringent emission regulations, lowering the expenditure on battery, better and well distributed infrastructure of charging stations, increasing consumer awareness, and acceptance and better package in terms of ownership shall help in strengthening the EV position in Indian markets.

This initiative of NEVI and e-Gle is known as smart mobility that is based on the Alternative Development Model (ADM) which is guided by the principles of energy efficiency, environmental responsibility and sustainability (EES). This coincides with the efforts of NITI Aayog, which is working on an Electric Vehicle Policy that is targeted towards accelerating the adoption of personal as well as commercial electric vehicles. It is a part of the government's plans to switch to 100% EVs by 2030.

Recently, in the second week of November, NITI Aayog released a proposal for a short pilot project to develop EV infrastructure in collaboration with Finland-based clean energy solutions provider AC2SG. This pilot project will help in rapid construction of charging infrastructure that is essential for efficient working of the electric vehicles in the Gurgaon–IGI–South Delhi–Noida corridor. Continuing with the government's plans to switch to 100% EVs by 2030, the policy think tank announced that it is working with the Government of India to offer incentives on electric vehicles under FAME-1 (Faster Adoption and Manufacturing of Electric Vehicle) till March 2018. It is expressed that this planning will make the process faster and save costs related to the deployment. The five- step planning process includes project kickoff, formation of 'long list' of locations, streamlining and timing, documentation' and wrap-up. At present, the cost of setting up a rapid-charging outlet is around $38,245 (₹25 lakh), while that of a slow charging station will be around $1,529 (₹1 lakh). Functional setup and usage of EV shall require nearly 300 charging stations with four to five charging slots each in a stretch of 3 km. Calculating this price, building an extensive network of charging stations across Delhi would require an investment of more than $504.7 million (₹3,300 cr) over the course of five years. This proposal for developing the pilot includes 55 locations with 135 charging stations of which 46 are DC quick charging stations and 89 are slower AC charging stations. This deployment would require co-operation with state governments, selected government authorities and companies as well as some private enterprises (for instance, DIAL at IGI, DLF Mall). The plan includes a deployment timeline with first installations in November 2017. Based on the experience from this 'quick

pilot', further expansion of this in Delhi NCR and other cities in India will be considered. All the information provided in this paragraph is from Press Release of Information Bureau Government of India of NITI Aayog dated November 10, 2017.

EVs Now

December 2017 has witnessed EV Expo 2017, one of India's biggest EV technology exhibition that was held at Pragati Maidan in New Delhi from December 22, 2017. It was inaugurated by Mr Nitin Gadkari, Minister of Road Transport and Highways. This event is expected to be attended by over 100 Indian and international EV companies. All kinds of electric vehicles including e-rickshaws, e-carts, e-bikes, e-scooters, e-bicycles, e-loaders as well as e-buses will be showcased along with components, batteries and other environment-friendly transportation solutions. The International Centre is also organizing a full day '2nd Catalyst Conference on Innovations in E-vehicle Industry' for Automotive Technology (ICAT) on December 21, 2017. The conference will be addressed by specialists from M&M, Siemens, Bosch, Volvo, JBM, and Tata Motors, among others.

Once EVs will become an active participant in the transportation sector, it will help in reducing air pollution and limit the various ailments related to vehicular emissions. More EVs on road will increase demand on the energy sector. As battery charging is an essential component of EVs, this shall provide a window for renewable energy deployment and utilization. However, energy demands shall increase in peak hours of traffic movement, thereby the energy sector needs to be well prepared for this new endeavours. Thus, EVs are clearly going to impact the electrical usage and as a result, the electrical distribution system will become more stressed and worked. According to William Torre from the Center for Energy Research at the University of California, another way to reduce the impact on electrical usage is by looking at automated demand response wherein the utility grid and the control systems can be strengthened to optimize the charging so it minimizes the cost to the customer, and also minimizes the impact of the grid. This will help in achieving and the charging as required by the customer.

Although greater usage of EVs presents an exciting and thrilling road ahead, there are some issues related to convenience and infrastructure. However, it is a promising venture for individuals as well as the market economy. EVs can bring about a revolution in the transportation sector by improving the environment and enhancing self sustainability. Due to its negligible tail pipe emission and the fact that EVs are not driven by fossil fuels,

EVs shall enhance self sustainability of nations, unlike fossil fuels, the supply of which on earth is limited and is getting depleted at a rapid pace. Currently, global estimates are reflecting that electric vehicles are less than 1% of the total vehicles that run on the road. The international and national EV future requires more EV charging infrastructure facilities and this availability of charging stations will also help make EV a positive business venture. EF

Suggested Reading

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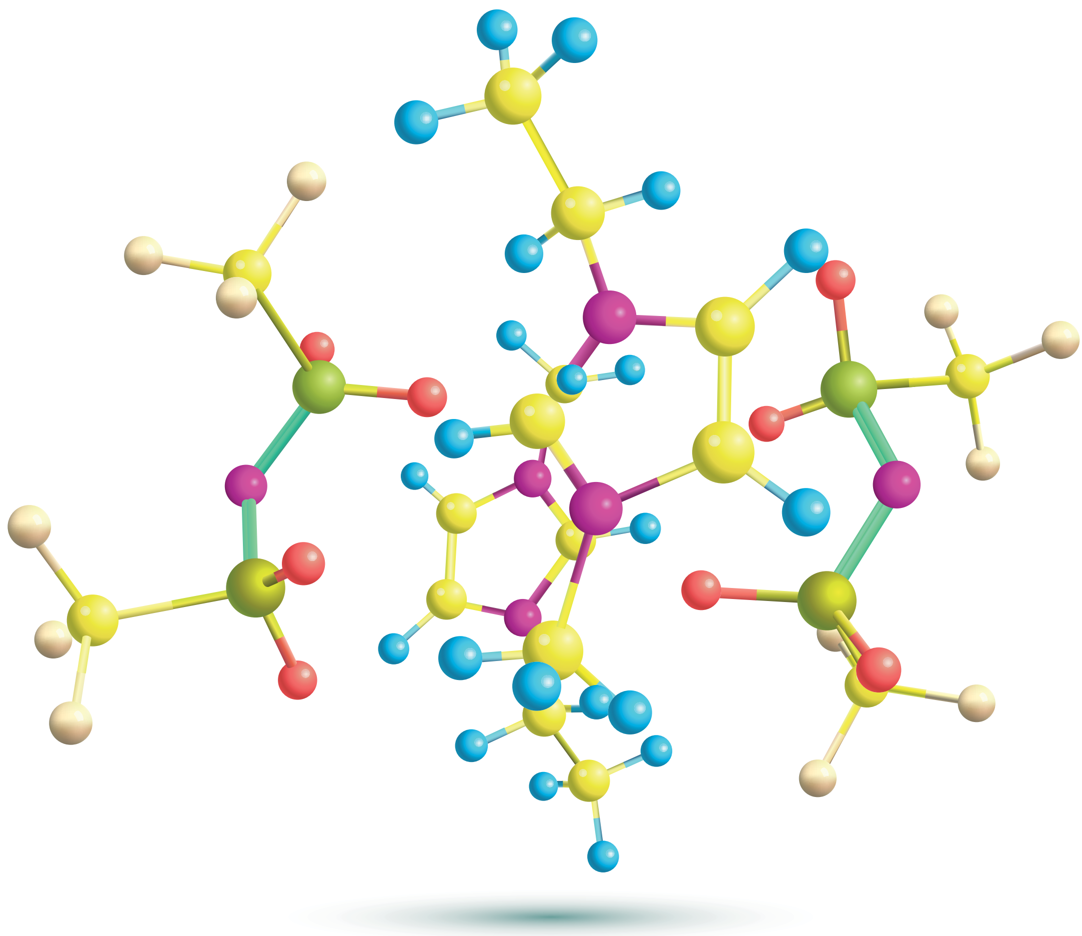
IONIC LIQUIDS

Significance in Renewable Energy Production



Sustainable supply of energy poses a huge challenge in today's day and age. A combination of concerns regarding contribution of fossil fuels to greenhouse gas-induced climate change and their long term supply compels the urgent development of alternative approaches to energy generation and storage. At the same time, a huge potential exists for the discovery and application of new materials that offer significant improvements in the way energy is generated, stored, and delivered. In this context, ionic liquids are one such entity that exercise an impact on a broad range of energy technologies, insofar as their performance may be optimized in a variety of contexts. **M P Sudhakar** and **V Shashirekha**, in this article enumerate the properties, scope, and application potential of ionic liquids.

Evolution of Ionic Liquids

Ionic liquids (ILs) are defined as organic salts in the liquid state wherein the ions are poorly coordinated. They can be synthesized using chemicals or from renewable sources. They generally consist of a large asymmetrical organic cation which when combined with an anion results in liquid molten salts at temperatures below 100 °C. ILs are considered as 'greener' and environment-friendly solvents and thus, have been applied in various fields such as synthesis, extraction, separation, and energy production.

In 1988, Gabriel and Weiner reported the first IL ethanolammonium nitrate with melting point between 52 °C–55 °C. However, the truly room temperature IL, ethylammonium nitrate with melting point as low as 12 °C, was synthesized by Paul Walden in 1914 while testing new explosives for the replacement of nitroglycerin. In 1934, the first patent on industrial application of ILs in the preparation of cellulose solutions was filed by Graenacher. During the Second World War, the use of ILs, as mixtures of aluminium chloride (III) and 1-ethylpyridinium bromide, for the electro deposition of aluminium were obtained and patented. In the early 1970s, ILs were initially developed by electrochemists, for use as battery electrolytes. Over the past few years, research on the synthesis of novel ILs as well as of task specific compounds, that are air and water stable and their possible applications have increased significantly.

Properties of ILs

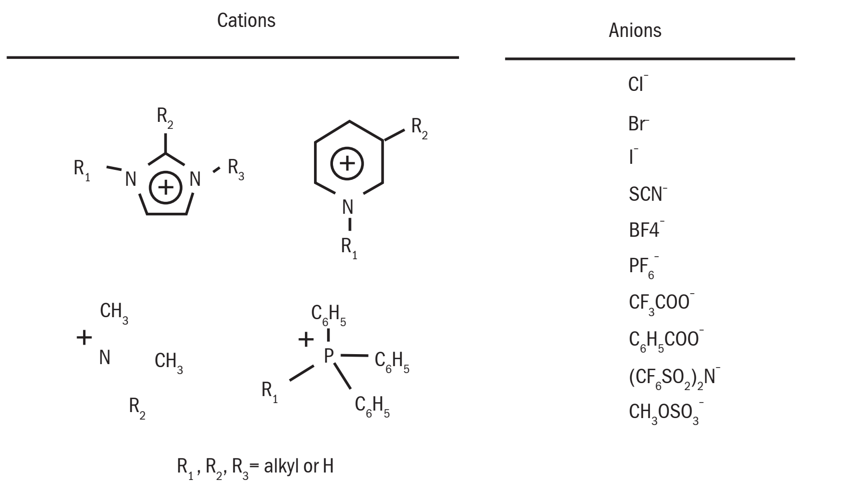
The most important properties of ILs are identified as their immeasurably low or almost negligible vapour pressure and low volatility. For this reason, they are known as 'green solvents' in contrast to the traditional Volatile Organic Solvents (VOS).

In addition, ILs also display many more attractive as well as unique properties such as:

» Chemical stability
» Thermal stability up to 300 °C
» Inflammability
» High ionic conductivity
» Low nucleophilicity
» A wide electrochemical potential window
» Capability of providing weakly coordinating or non-coordinating environment
» Capacity to dissolve numerous polar and non-polar compounds
» Excellent solvent properties for a wide variety of organic, inorganic, and organometallic compounds.
» Immiscibility with many organic solvents

In some cases, the solubility of certain solutes in room temperature ionic liquids (RTILs) can be several orders higher magnitude than those in traditional solvents. Hence, ILs are being used in different extraction and separation processes.

ILs can be prepared with different cation and anion combinations. While their physical properties are determined by a mutual fit of cation and anion, size, geometry, and charge distribution, their chemical properties, such as acidity and basicity, water miscibility, and immiscibility, hydrophilicity, and hydrophobicity result from the composite nature of cations and anions. The chemical structures of some common ILs are represented as follows:



Adopted from Farrán et al. 2015

RTILs are salts that are liquid at room temperature; commonly referred to as 'designer solvents' since their solvent properties can be tuned for a specific application by varying the anion–cation combinations. They have been recognized as the environmental benign alternative to VOS.

Applications of ILs

The application of ILs in chemical processes has flourished within the last decade. In this context, they have been extensively studied as solvents, co-solvents, co-surfactants, electrolytes, adjuvants or co-catalysts in various reactions, including organic catalysis and inorganic synthesis, bio-catalysis, and polymerization. They are also used in the creation of IL-supported materials for separation and purification purposes and reaction media in biochemical and chemical catalysis as replacement for VOS. They have also been explored extensively in the separation techniques, such as capillary electrophoresis (CE), gas chromatography (GC) and liquid chromatography-like thin layer chromatography (TLC), and high performance liquid chromatography (HPLC).

It has been recently demonstrated that hydrophilic ionic liquids induce the formation of aqueous biphasic systems (ABS) or aqueous two-phase systems (ATPS) in the presence of inorganic salts with water-structuring properties. ATPS are being considered as novel liquid separating systems due to their stability, enhanced activity, and enantioselectivity of enzymes in aqueous solution of ionic liquids water-rich phases protect biomolecules against denaturation. ATPS have largely been used in biotechnology for the separation of biomolecules, such as cells, organelles, membrane fractions and proteins, such as bovine serum albumin, lysozyme, trypsin, myoglobin, and so on. They have also been used for the recovery of small organic and inorganic molecules, such as metal ions, radiochemicals, dyes and pigments, and drug molecules. This method appears to be an effective alternative to conventional extraction methods, such as liquid-liquid extraction and solid-phase extraction, due to the fact that the process of isolation, purification, and enrichment of biomolecules can be carried out simultaneously.

ILs in Renewable Energy Production

The niche application of ionic liquids in the renewable energy sector is attributed to their significant role in the extraction of lipids from wet biomass at low temperatures in lesser time than traditional lipid extraction methods. The most promising approach for ionic liquid-based wet extraction lies in the fractionation and recovery of multiple biomolecules from the biomass, such as lipids, carbohydrates, and pigments like carotenoids, and so on, in a single extraction process. The IL-based biomass fractionation is interesting because some ILs can dissolve the biomass itself, some are specific for cellulose or lignin, and some can destroy enzymes. Thus, the ILs-based process is considered five times less energy intensive than other processes that are solvent and /or energy-based.

Certain constraints however, continue to exist with reference to algae-sourced biodiesel commercialization owing to the high cost and energy consumption in lipid extraction from biomass. It is in this context that several specific applications of ILs in algal biomass

Table 1: ILs for extraction of bioactive compounds from biomass

Ionic liquids	Usage	Reference
Trihexyltetradecylphosphonium dicyanamide ($P_{666,14}[N(CN)_2]$)	Aromatics extraction from pyrolytic sugars	Li *et al.* 2016
Pyridinium, Ammonium, and Phosphonium-based ILs	Lipid extraction from microalgae	Orr *et al.* 2016
1-ethyl-3-methylimidazolium acetate, [Emim] [OAc]	Agarose extraction	Trivedi and Kumar, 2014
Choline acetate, [Ch] [OAc]		
1-ethyl-3-methyl imidazolium diethyl phosphate [Emim] [Dep]		
1-Ethyl-3-methylimidazolium chloride [EMIM][Cl]	Cellulose to glucose	Mäki-Arvela *et al.* 2011
1-alkyl-3-methylimidazolium chloride $[C_2mim]Cl$, $[C_4mim]Cl$, $[C_6mim]Cl$, $[C_{10}mim]Cl$, and $[C_{12}mim]Cl$	Bioactive compounds	Martins *et al.* 2016
1-n-butyl-3-methylimidazolium hydrogen sulfate 1-allyl-3-methylimidazolium chloride 1-n-ethyl-3-methylimidazolium chloride $[BMIM]H_2PO_4$ $[BMIM]NO_3$ [BMIM]pTsO	Polysaccharides into simple sugars	Malihan *et al.* 2014
1-ethyl-3-methylimidazolium thiocyanate, $[C_2C_1im][SCN]$ 1-ethyl-3-methylimidazolium dicyanamide, $[C_2C_1im][N(CN)_2]$ 1-n-butyl-3-methylimidazolium thiocyanate, $[C_4C_1im][SCN]$ 1-n-butyl-3-methylimidazolium dicyanamide, $[C_4C_1im][N(CN)_2]$ 1-ethyl-3-methylimidazolium tricyanomethanide, $[C_2C_1im][C(CN)_3]$ 1-ethyl-3-methylimidazolium tetracyanoborate, $[C_2C_1im][B(CN)_4]$	Dissolution of cellulose, Glucose solubility	Batista *et al.* 2016

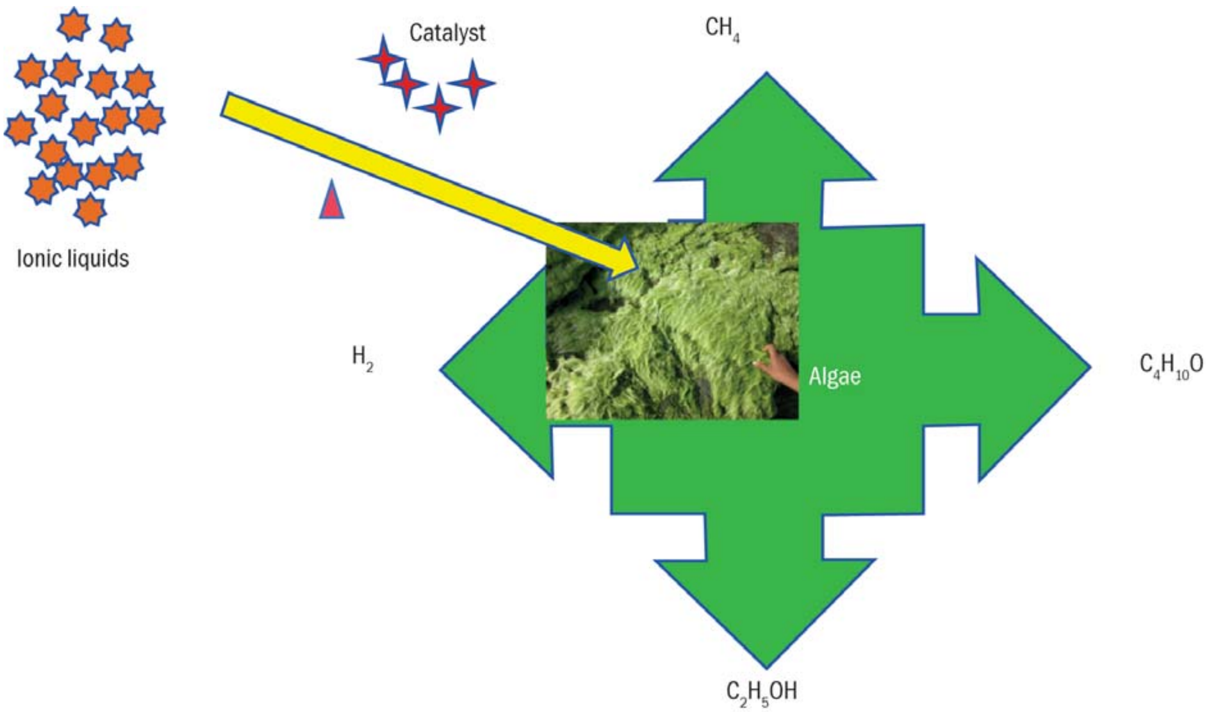


Figure 1: Schematic representation of IL application in algal biomass for renewable energy production

processing have recently emerged. A hydrophilic IL namely, 1-butyl-3-methylimidazolium has demonstrated to possess the ability to lyse the microalgae cell wall and form two immiscible layers, one of which contains the lipid content of the lysed cells. Gravity causes the hydrophobic lipid phase to move to the top phase from where it can be separated from the mixture and purified. The hydrophilic IL can also be recycled to lyse new micro-algal suspensions.

R&D on Use of IL in Lipid and Carbohydrate Extraction

The mixture of [BMIM][CF_3SO_3] and methanol has been shown to enhance the lipid extraction from the green microalga *Chlorella vulgaris* to the order of 1.7-folds when compared to the conventional extraction methods using solvents. This is because the dipolarity/polarizability and hydrogen bond acidity of ILs is more important than their hydrogen bond basicity for effectively extracting lipids from algal biomass.

The use of a hydrated phosphonium ionic liquid, [$P(CH_2OH)_4$]Cl, for the extraction of lipids from microalgal species, *Chlorella vulgaris* and *Nannochloropsis oculata*, for biodiesel production has been evaluated. Although the conventional methanol chloroform extraction method proved to be more efficient in terms of lipid recovery from the biomass, the IL extraction showed high affinity to neutral/saponifiable lipids, resulting in the highest fatty acid methyl esters (FAMEs)—biodiesel yield (4.5%), especially in *Chlorella vulgaris*. In

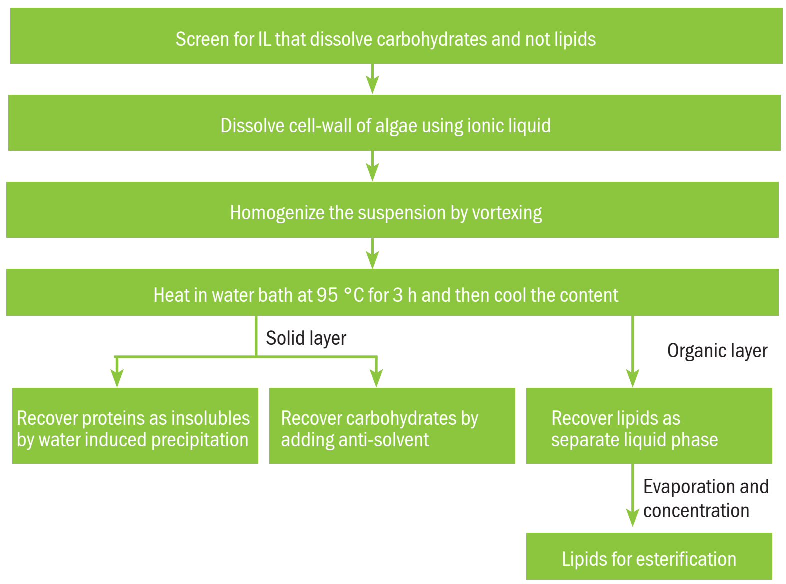


Figure 2: Outline for recovering bioactive components with special reference to lipids from algal biomass using ILs

Nannochloropsis aculata, the IL extraction proved especially suitable for lipid extraction from wet biomass, giving even higher extraction yields than from dry biomass at 14.9% and 12.8%, respectively. Interestingly, IL extraction process at ambient temperature has recorded 75% of lipid and 93% of FAMEs recovery after thirty minutes which is comparable to the solvent extraction method at 100 °C for one day. Furthermore, it has been proved that the IL remains unchanged after treatment and its recyclability is excellent.

A study on the use of low-cost protic ILs based on tetramethylguanidinium and 1,8-diazabicyclo[5.4.0]undec-7-ene cations for lipid extraction from wet biomass of *Scenedesmus obliquus* with about 85% moisture has recorded high extraction yields (up to 88%) when compared to the conventional solvents, namely hexane–methanol. Furthermore, the use of [HDBU][MeOCO$_2$/HCO$_3$] and [HTMG][MeOCO$_2$/HCO$_3$] was found to be very effective in the direct isolation of fatty acid methyl esters [(FAMEs)-biodiesel], formed *in situ* through transesterification reactions.

Besides the usage of ILs, application of techniques like microwave-assisted extraction (MAE), ultrasonic-assisted extraction (UAE) or liquid–liquid extraction (LLE), supercritical extraction, and so on, not only improves the extraction efficiency and thus, the yield but also reduces the time. In a study to establish the role of microwave in extraction of lipid from three algal species in 1-butyl-3-methylimidazolium hydrogen sulfate ([BMIM][HSO$_4$]), microwave irradiation promoted the extraction rate over 15 times for *Chlorella sorokiniana*, nealy 100% for *Nannochloropsis salina*, and over 10 times for *Galdieria sulphuraria* when compared with the conventional solvent extraction method. The study has also proved that [BMIM][HSO$_4$] is quite stable under extraction conditions.

The vast variety of cation-based ILs that are commercially produced include imidazolium-, phosphonium, ammonium-, piperidinium-, pyridinium-,

and pyrrolidinium-based, combined with anions, such as chloride (Cl^-), bromide (Br^-), acetate ([CH3CO2]$^-$), bis(trifluoromethylsulfonyl)imide ([NTf2]$^-$), hexafluorophosphate ([PF6]$^-$), and tetrafluoroborate ([BF4]$^-$). However, the development of novel ILs replaced these fluorinated anions, some presenting a poor water-stability and the renewable, non-toxic, and biodegradable alternatives synthesized, namely based on carboxylic acids, amino acids, and mandelic acid-derived anions, often combined with the cholinium cation.

Algal sugars have the potential to transform into valuable chemicals or fermented into bioethanol. However, aromatic compounds present in the solvent extraction are inhibitory to most microorganisms during the fermentation process. Hence, removal of these contaminants is necessary prior to fermentation. Next to sugars, the aromatics can also be valorized towards transport fuels or phenol formaldehyde resins. Similarly, the use of salts for dissolution of biomass requires an additional step of neutralization which can be eliminated by IL application.

Novel ionic liquid blend system, such as solvent IL for biomass dissolution and an acidic IL for acid-catalyzed hydrolysis (pretreatment) of polysaccharides into simple sugars, has been developed and tested in the macroalgae *Gelidium amansii*. There are many ways to convert renewable biomass into fermentable liquids but ionic liquid pre-treatment releases many pyrolytic sugars for ethanol production.

Cellulose dissolution has also been investigated in different ionic liquids using diluted mineral acids as catalysts recently. The dissolution temperature was only 90 °C when 25 parts of ionic liquid [EMIM][Cl] and 1 part of catalyst (50% sulfuric acid) were used. About 58% of cellulose was converted to glucose in about 30 minutes and nitric acid and trifluoroacetic acid were also used as catalysts.

Conclusion

The interactions between glucose and water are weaker than glucose and the ILs. The interactions with ILs are mainly mediated by the anion with the establishment of H-bonds having enthalpies three times stronger than those with water molecules. Hence, ionic liquids are a more suitable solvent for sugar extraction from renewable sources and help to improve the biofuel production in terms of cost as well as on account of reliability and reusablity .

The lack of volatility in ILs is a major development in the reduction of the environmental footprint. However, a complete life cycle assessment for ILs-based processes is essential to support their suitability, especially from a 'greener' and sustainable perspective. The recovery and reusability of ILs and their solutions are imperative in order to support the economic viability and also to minimize the environmental footprint of the proposed processes. The ILs field is slowly drifting towards an era of renewable resources, that is, the cheaper and more environmentally benign ILs, such as carboxylate-, amino-acid-, carbohydrate-, and cholinium- based ILs from the present imidazolium-based ILs. Therefore, more work should be devoted to these alternatives. In the future, ILs may play a major role in the renewable energy sector in India. Future research is imperative for the green synthesis of ILs in terms of cost effectiveness and reproducible stuff. EF

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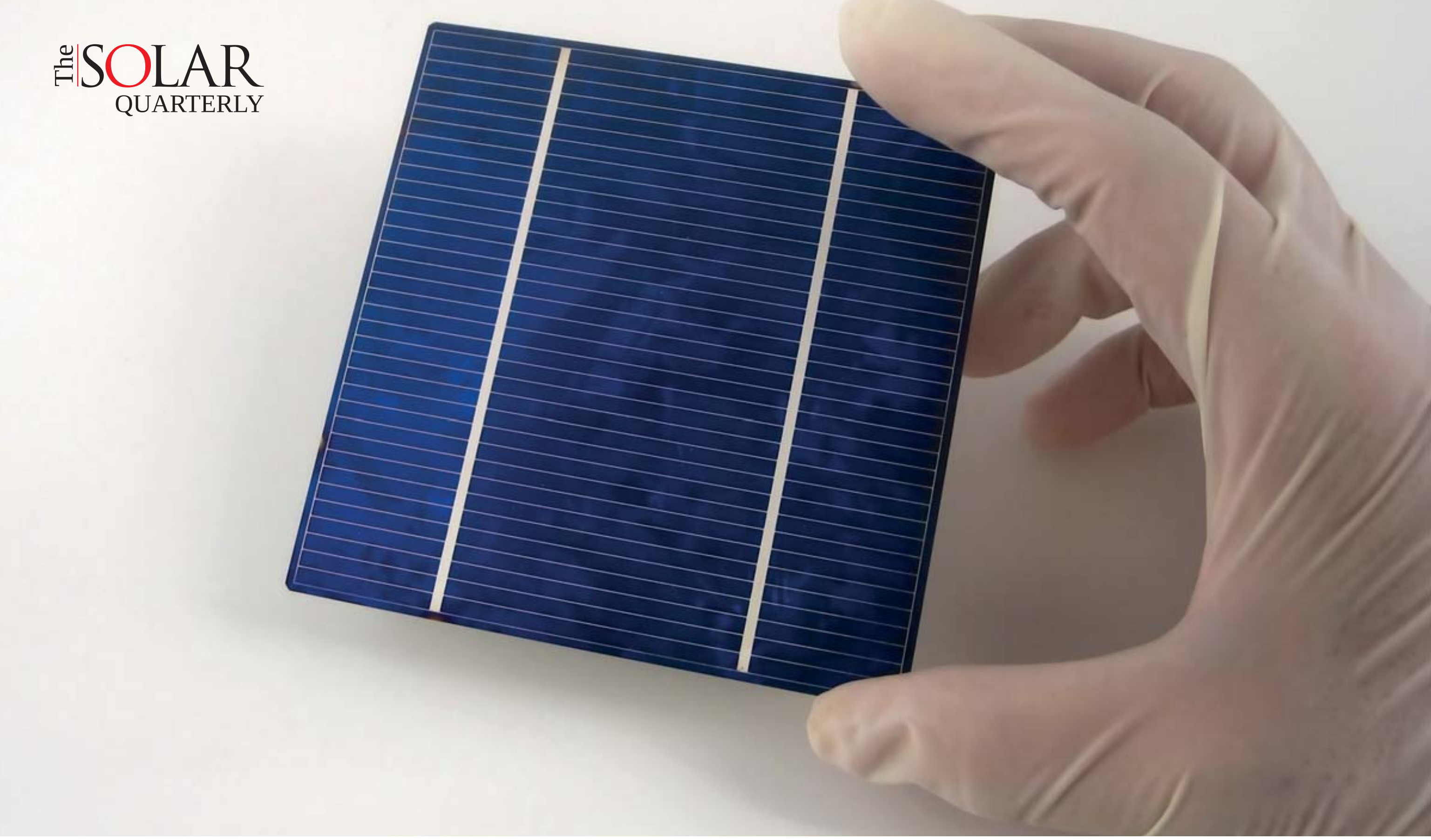

MODELLING, SIMULATION, AND PERFORMANCE ANALYSIS OF MONOCRYSTALLINE AND POLYCRYSTALLINE PANELS

The modelling and simulation of photovoltaic model using MATLAB/Simulink software package has been presented in this article. Significantly, the modelling and simulation has been conducted for monocrystalline and polycrystalline panels of 40 W, comprising total 37 cells wherein 36 cells were connected in series and 1 cell in parallel. For both type of panels, the electrical characteristics are plotted and temperature effect is analysed. Performance analysis of monocrystalline and polycrystalline solar photovoltaic panels was conducted considering certain parameters, that is, analysis of V-I curve, effect of variation in tilt angle on PV module power, effect of shading on PV module power, effect of increase of temperature on PV module power, efficiency, space efficiency, and cost. In fact, both the panels were compared on the basis of these parameters. Through this article, **Er. Neelam Rathore**, **Dr Surendra Kothari**, **Er. Kapil Samar**, and **Er. Kirtika Sharma** elaborate on the usefulness of the proposed model for engineers dealing with PV system designing.

Introduction

Photovoltaic (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductor by photovoltaic effect. Over the years, the modelling and simulation of photovoltaic has undergone great transition and forms an important part of power generation in the present era. The cost and the performance of PV plants is strongly contingent on the modules. The ideal photovoltaic module consists of a single diode connected in parallel with a light generated current source (I_{SC}) as visible in Figure 1.

The following equations were written in MATLAB for an ideal photovoltaic module that consists of single diode connected in parallel with a light generated current source (I_{SC}) as shown in the figure:

$I = I_{SC} - I_{RS}$

where I_{SC} is photocurrent which is the light-generated current at the STP condition (25 °C and 1000W/m^2).
The equations of Reverse Saturation Current and photocurrent are given by:

$I_{RS} = I_{scref}[e\ (\ ]$

$I_{SC} = [\ I_{scref} + K\ (T\ T_{ref})]$

The equation that describes I-V characteristic of the circuit as shown in Figure 1 is given by

$I_{SC} - I_D - V_D / R_P - I_{PV} = 0$

Output of PV Module: It represents the output current generated which depends on the PV module voltage, solar irradiance on PV module, wind speed, and ambient temperature.

$I_{PV} = N_P I_{SC} - N_S I_O \{ \exp (q(V_{PV} + I_{PV} R_S)/ N_S AKT) - 1\} - V_{PV} + (I_{PV} R_S / R_P)$

where k is the Boltzmann constant (1.38 x 10^{-23} JK^{-1}), q is the electronic charge (1.602 x 10^{-19} C), T is the cell temperature (K), A is the diode ideality factor, the series resistance R_S (Ω), and is the shunt resistance R_P (Ω), N_S is the number of cells connected in series = 36, Np is the number of cells connected in parallel and $V_{OC} = V_{PV}$.

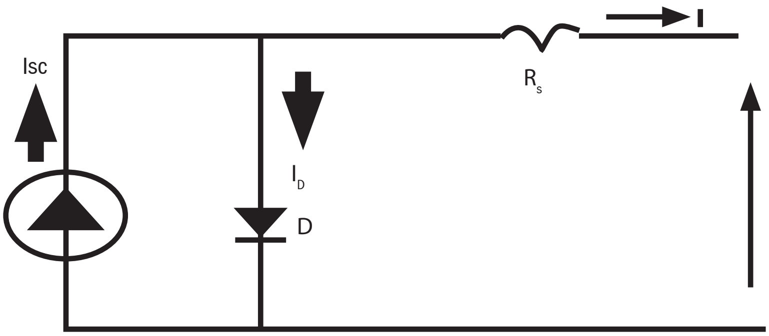

Figure 1: Solar cell model using single diode with R_S

Theoretically, the observations were recorded using MATLAB and practically, the characteristics were plotted using the Solar PV Training and Research Kit, as visible in Figure 2. Figure 3 shows the circuit diagram to analyse the V-I characteristics.

Results and Discussion

V-I and P-I characteristics at 25 ˚C for both types of panels were observed so that power can be observed at any radiation using MATLAB as shown in Figures 4 and 5.

As it can be seen from the graphs, at constant module temperature, it is observed that with increase of solar irradiance, there is an increase in short-circuit current and open circuit voltage. Therefore, higher the irradiation, greater

Figure 2: Solar PV Training and Research Kit

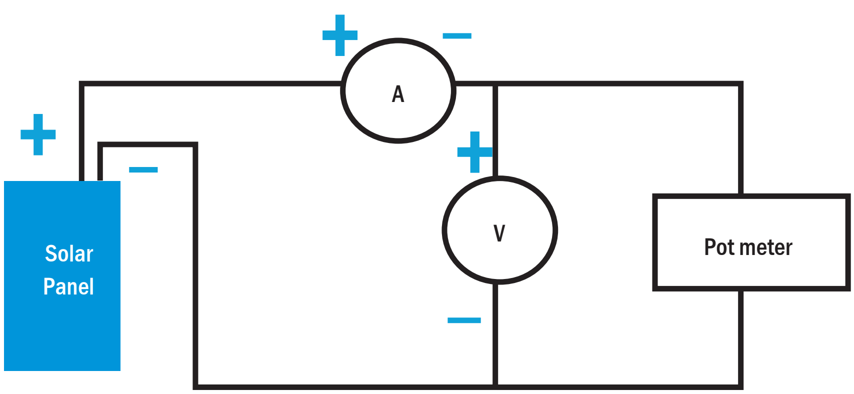

Figure 3: Circuit diagram to analyse V-I characteristics

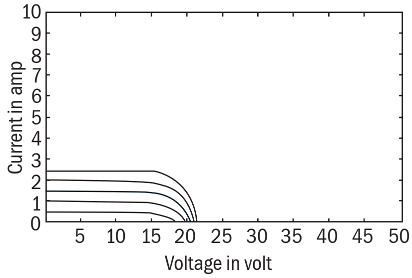

Figure 4: MATLAB V-I characteristic for varying irradiance at 25° C (polycrystalline panel)

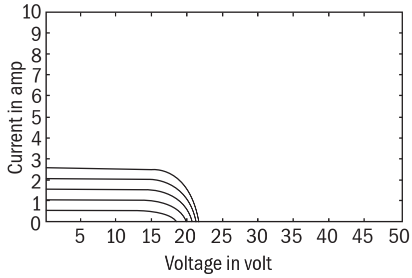

Figure 5: MATLAB V-I characteristic for varying irradiance at 25° C (Monocrystalline panel)

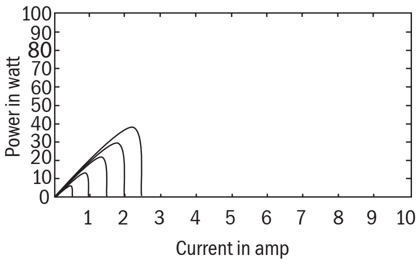

Figure 6: MATLAB P-I characteristic for varying Irradiance at 25° C(Polycrystalline panel)

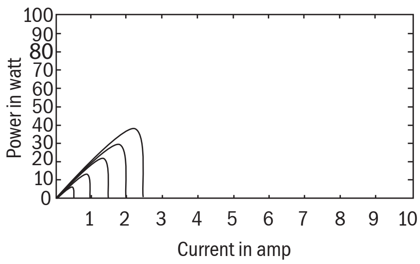

Figure 7: MATLAB P-I characteristic for varying Irradiance at 25° C (Monocrystalline panel)

is the current. Contrary to the influence of the solar irradiance, the increase in the temperature around the solar module has a negative impact on the power generation capability. Table 1 shows that as temperature increases, power decreases but the decrement of power is more for monocrystalline panel as compared to polycrystalline panels. Open circuit voltage is another parameter that is affected. As temperature increases, open circuit voltage decreases while short circuit current remains unchanged.

Effect of increase of temperature on PV module power

Figure 8 shows the effect of increase of temperature on PV module power for monocrystalline and polycrystalline PV panels wherein the operating temperature of the solar panel, at 25°C is always greater than the ambient temperature. As temperature increases, the power decreases but the decrement of power is slightly lower for a polycrystalline panel as compared to a monocrystalline panel.

Effect of shading on PV Module power

Readings were noted for 0 cell shading, 2 cell shading, 4 cell shading, 9 cell shading, and the power was observed at different shading. In case of shading power, a decrement of 23.9% was observed in polycrystalline while only 19.37% of power was reduced in the monocrystalline panel. A monocrystalline panel is less affected by shading and works well in shady conditions as compared to a polycrystalline panel as the drop

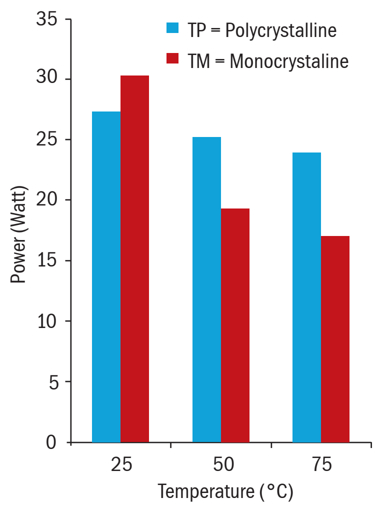

Figure 8: Curve showing effect of increase of temperature on PV panels

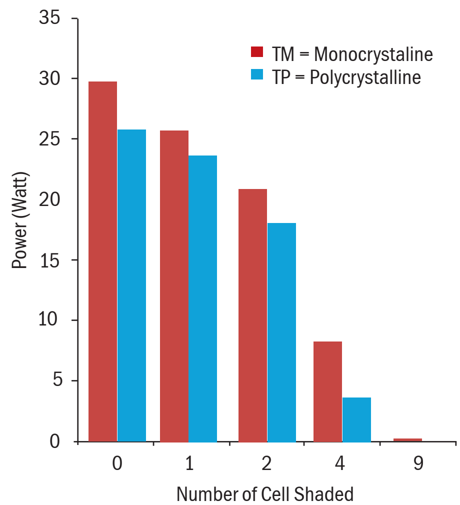

Figure 9: Comparison Curve showing effect of shading for both panels

Table 1: Effect of variation of temperature on power (MATLAB results)

Temperature	Open Circuit voltage (Volt)		Power(watt)	
	Polycrystalline Panel	Mono crystalline Panel	Polycrystalline Panel	Mono crystalline Panel
25° C	22	22	37	39
50° C	21	17	35	28
75° C	19	15	31	24

in power was more in the case of polycrystalline panel during shading as shown in Figure 9.

Efficiency

Power was observed for full day (i.e. 7 a.m. to 5 p.m.) hence efficiency was calculated. Efficiency of mono crystalline varies between 3% to 14% whereas from polycrystalline panel it is 2.5% to 9.5%.

Space Efficiency

As two panels were considered while taking observations for different parameters and the area of monocrystalline panel was 0.18 m^2 while for that of polycrystalline panel was 0.20 m^2 for 40 W. A monocrystalline panel occupies small space as compared to polycrystalline panel for the same amount of power. Monocrystalline panel supplies power about 222 W/m^2 while polycrystalline supplies power about 200 W/m^2.

Cost

At present, the cost of both panels has been steadily decreasing. Mono crystalline solar panels are expensive because of their purity while polycrystalline cells are made up of multiple crystals and are generally less expensive to manufacture than mono cells.

Conclusion

Since the power output from a monocrystalline panel is more than that from a polycrystalline panel, therefore the former tends to perform better than similarly rated polycrystalline at low light conditions. Theoretically and practically, the effect of increase of temperature on PV module power was observed and it was concluded as the temperature increases, the power decreases but the decrement of power is slightly lower for polycrystalline panel as compared to monocrystalline panel. While temperature increases from 25°C to 50°C, the power decreases by 5.40% in the case of polycrystalline and power decrement of 28.20% has been observed in monocrystalline panels.

Effect of shading on PV module power was conducted and it was observed that monocrystalline panel is less affected by shading and works better in shady condition as compared to polycrystalline panel. In case of shading, a power decrement of 23.9% was observed in polycrystalline while only 19.37% of power was reduced in monocrystalline panel.

Both monocrystalline and polycrystalline panels are a good choice but polycrystalline panel tends to be less space efficient as monocrystalline panel occupies smaller space in comparison to a polycrystalline panel for the same amount of power. EF

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9TH GRIHA SUMMIT 2017

In a developing country such as India, access to affordable housing is vital and the key to achieving a number of social policy objectives such as reducing poverty. According to 'White Paper – Indian Housing Industry' by RNCOS, the shortage of urban housing stood at 18.8 million units in 2012, which is expected to grow to 34.1 million units by 2022 (compound annual growth rate of 6.6% for 10 years). The Government of India has taken steps to counter this demand by launching the 'Housing for All' scheme which aims to bring *pukka* houses to every family in urban cities by 2022, thus implying exponential growth of the construction sector.

In this context, the 9th GRIHA Summit was organized on the theme 'Sustainable is Affordable', in New Delhi, from 18–19 December 2017. In his message on the occasion, Shri Hardeep Singh Puri, Minister of State (I/C), for Housing & Urban Affairs, Government of India, said, "The theme for the GRIHA Summit—'Sustainable is Affordable' is apt and am sure shall dispel the myth that sustainable is not affordable".

HE Dr Andres Baum, Ambassador of Switzerland to India and Bhutan, inaugurated 'Praroop – GRIHA Green Mart', an exhibition set up to demystify the myth that 'sustainable is not affordable'. Sharing his thoughts on the 9th edition of the GRIHA Summit, Dr Ajay Mathur, President, GRIHA Council, said, "Over the years, the GRIHA Council has played a pivotal role in providing solutions to various challenges faced by the built environment".

'GRIHA Rating for Affordable Housing' was also launched during the inaugural session of the Summit. The Summit brought together experts from the industry, financial institutions, policy makers, decision makers, buyers, and sellers in a bid to develop and drive new initiatives, provide insights and showcase sustainable product development and green business opportunities. Projects rated in the year 2017 were conferred their respective GRIHA rating. The GRIHA Council also recognized the efforts of project team in developing strategies implemented/ proposed for various projects registered under GRIHA Rating by awarding them with 'Exemplary Awards'.

The two-day Summit served as a platform for knowledge sharing and was attended by over 1,000 professionals from the construction and building industry. EF

INTERSOLAR INDIA

Identified as the flagship exhibition and conference for the solar industry in India, besides being the perfect venue for connecting solar businesses, Intersolar India, organized at Bombay Exhibition Centre, from December 5–7, 2017, was attended by more than 13,000 solar and energy storage experts and 241 exhibitors who showcased their latest products and solutions.

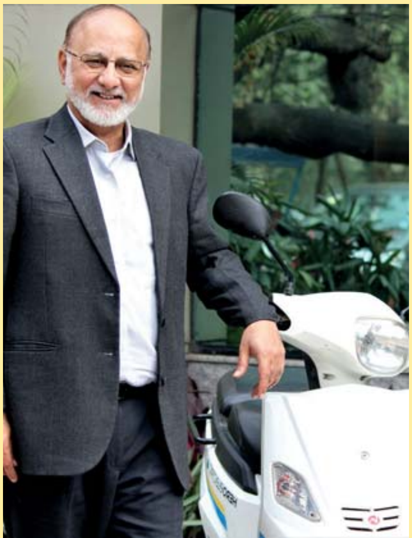
Mercom India, a subsidiary of Mercom Capital Group and Intersolar India's official knowledge partner, exclusively released a white paper on the drivers and challenges of India's PV market during the event.

Exhibitors described Intersolar India 2017 as ideal for generating leads and building lasting relationships. There were more than 30 presentations on mini-/micro grid, e-mobility, PV manufacturing, skill council for green jobs forum as well as numerous exhibitor presentations. Various product launches, award ceremonies, and the networking event highlighted the event as an important meeting point for complete solar and energy storage industry in India.

Intersolar India's honoured guests included Shri Upendra Tripathy, Interim Director General of International Solar Alliance; Kuljit Singh Popli, Chairman & Managing Director of Indian Renewable Energy Development Agency Ltd (IREDA); Dr R Harikumar, Director of the Agency for Non-conventional Energy & Rural Technology (ANERT), Government of Kerala; and Dr Thomas Reindl, Deputy-CEO of the Solar Energy Research Institute of Singapore (SERIS). The conference programme comprised 19 exciting and diversified sessions on the Indian PV market, rooftop systems, project financing, innovative technologies, PV quality assurance, agro-PV, floating PV, among others. Trainings and workshops also enriched the overall event programme. EF

For more information and programme details, please visit Intersolar India's website <www.intersolar.in>

"Take care of the common man; the country will take care of itself"



In the backdrop of the announcementthat India will have an all-electric vehicle fleet by 2030, there are concerns with respect to its practicality and viability in the present day. Apart from tackling the severe effects of pollution and climate change, the move has been welcomed by all the key stakeholders involved. **Mr Sohinder Gill**, Global CEO, Hero Eco and Director, Corporate Affairs, Society of Manufacturers of Electric Vehicle (SMEV), in conversation with **Anushree Tiwari Sharma** for *Energy Future*, decodes this announcement and its implications for India's mobility sector.

According to you, does the feasibility of having an all-electric car fleet by 2030 bode well for fostering the e-vehicle industry in India?

First of all, it is significant to mention that it is not car fleet that we're talking about but electric vehicles wherein cars come the last. This is a misnomer, especially in India (elsewhere it is cars) in the absence of charging infrastructure and unaffordability in the electric segment such that cars are low on priority. In India's case, electric vehicles would imply public transport, as the number one priority and two wheelers because of the sheer population of 18 million per year, projected to be about 30–35 million by 2030. According to *India Leaps Ahead: Transformative Mobility Solutions for All*, a joint report of the NITI Aayog (also the coordinating agency for electric vehicles) and Rocky Mountain Institute, there are two low-hanging fruits—electric two wheelers and public transport. These are the two extremes and the third part is shared mobility. In a way, shared mobility also implies public transport. It can even translate to two-wheelers being referred to as e-bike taxis later. Essentially, in cars it will be taxis while it is already present in buses, and in two wheelers, it will be e-bike taxis or e-motorcycle taxis. The way I see it, although the e-mobility intentions are clear,the route to accomplishing the goals is unclear. The first part of the government policy, that is FAME I concluded around 1.5 years back and is today, limping on its own legs because there is no 'fame' to it. Despite the positives, FAME I also had certain pitfalls. The lessons of FAME I are supposed to be introduced via FAME II. So, unless, FAME II is announced, expected in March or April 2018, the industry is unaware of the government's thinking and has retreated. So, today we are in a flux situation where lot of churning is taking place. The next three months will decide the course of action and hopefully, the industry, the customer, and the government will think alike for integrated action.

In that case, is 2030 a little ambitious?

The government's statement of "achieving an all-electric car fleet by 2030" is to be understood as a directional statement insofar as the country wishes to achieve milestones. We may not reach a 100% electric milestone but that does not mean that we should not aim for it. That's the Indian way of doing it as against other countries announcing their goals and also achieving it by 100%. In India, once we announce our goal, we say that we intend to achieve it. For example, trucks, the road transport or freight, comprising a huge part of India's logistics, can never be electric by 2030. So while we're all talking about cars, motorcycles, scooters, and public transport but we're forgetting the overloaded trucks on roads which will be very little electric by 2030. However, what can be really all electric, are two wheelers. As on date, there are already 500,000 electric two wheelers on Indian roads. It is pertinent to mention at this point that the technology is already available, the economics is well established, and with Lithium batteries in place, people are beginning to adapt to it much faster. If we compare a petrol two wheeler with an electric two wheeler, pollution reduction in case of this equation is higher than any other equation. Also, for the mobility giants, Hero Honda, Bajaj, and others to achieve results on these lines is easier, since they have everything except the electric part which is easy to manufacture. As against 300+ moving parts, the electric two wheeler has only 22 moving parts. I'll also give you an example of the financials involved in a petrol two wheeler and an electric two wheeler. For instance, a petrol scooter today costs between ₹50,000–₹60,000 and in the next five years, one spends a litre petrol per day, so in five years, around 1,600 litres of petrol is spent which amounts to ₹1 lakh. Therefore, ₹1 lakh and ₹60,000 make it ₹1,60,000, followed by maintenance of around ₹30,000, so around ₹1.9 lakh to ₹2 lakh

is spent during the entire five year period.

On the contrary, an electric scooter (nearly equal in performance)after subsidy,costs around ₹85,000 as against ₹60,000. However, this ₹85,000 is accompanied by a five year petrol free period which is also the expected life of the battery. The only thing required is charging the battery which costs around ₹15,000 per 15–16 days, that is, ₹10 per day. So ₹15,000 and ₹ 85000 is equal to ₹1 lakh. The cost of maintenance of an electric two wheeler is another maximum ₹5000 to ₹10000. However, there is no maintenance for maybe upto 10,000 km. So ₹1,10,000 versus ₹2 lakhs is a difference of ₹90,000. So, if such a product is available with manufacturers, why should people not switch over? Should a person buy a petrol two wheeler only because he feels the first 25,000 km difference and perhaps, the lack of confidence that he has not seen many such two wheelers on the road? Also, the feeling that perhaps a person is unsure about the performance of the two wheeler is the only quotient. The only thing to be cracked here is to put the first 1 million on the road and increase the visibility and awareness levels and spread the positivity by word of mouth. So, imagine, if there were 1 or 2 million such scooters on the road, the rest will happen automatically. So, that is the equation for two years.

The purchase of electric cars is guided by three pointers. The first is for the purpose of inter-city (not intra-city) travel insofar as people wish to go outside the city, that is from Mumbai to Pune or from Delhi to Jaipur or Chandigarh, at least sometimes; second is aspirational, implying that it is not purely economic but the fact that they wish to buy a gizmo but the fact that they do not want to lose on the total cost of operation. So, how do we make a car go 300–400 km at a stretch? Either we make a Tesla which is going to cost three times of a normal car and is unaffordable in India. The only plausible option is to create vandal-proof charging infrastructure on the roads or parking lots in the country since lack of maintenance plagues infrastructure in the country. Keeping in mind the amount of electricity involved in fast charging, personal cars can only function intra-city as a second car insofar as people buy such cars in order to make a statement about being eco-friendly. In such cases, battery swapping also does not work due to sophistication of the battery type and different sizes of the battery and car models. It is easier for taxi services, such as Ola and Uber, as they are commodity products but not for cars. In two wheelers, battery swapping is easier thing to accomplish since Lithium batteries are portable in nature and weigh about 6–7 kg. In this context, talks are underway with Indian Oil and BPCL such that they equip all their fuel stations with battery swapping facilities throughout the country and perhaps begin the same with three cities initially. The same staffing of petrol pump personnel who fill up the petrol in two minutes will swap in about 1 minute. Essentially, one needs to pull out a battery, place it in the swapping machine and swipe the card/ take cash. Simply put, these fuel stations are selling the charge instead of selling petrol. Interestingly, this idea is going well with the public sector pumps but replicating the same for cars looks unlikely anytime soon. So, in the event of initiation of battery swapping, the cost of battery is 55% of the cost of two wheeler, that is of the whole two wheeler, more than half is the cost of the batteries. Imagine the cost of two wheeler, if it is ₹85000 or ₹90000, the battery cost will be ₹45000 because batteries will be like petrol. So if the cost is also less than the petrol two wheeler, it cost only ₹40000 or ₹35000 after subsidy to a customer and he is paying much less than a litre of petrol at ₹65/- per day, he pays only ₹20/- per day for charge. If this works, there will be an explosion of electric two wheelers due to swapping stations.

So, in that case, swapping is better than pure charging?

Yes, pure charging means that you're taking the vehicle home, removing the battery, taking it inside your residence, plugging in the socket, and waiting for three hours to make sure that the battery is completely charged. Swapping, however, allows one the liberty to travel inter-city since you continues to swap and travel another 60 km and so on, wherever there is a petrol pump.

We also need to take into account public transport. As is evident through statistics, in toto while there are 500,000 two wheelers, there are less than 5,000 cars and (less than) 300 buses on Indian roads. Worldwide also, except China, the number of buses is miniscule. Significantly, it does not really make sense to create electric buses, other than the fixed route school buses, intra-city, airport transfers, and short distance buses. If the long-route buses need to be electric, the amount of subsidy required by the government to fund the same will run to more than ₹1 crore per bus. In this context, the question arises if the government really wants to spend this kind of money to electrify modes of public transport since the current lithium battery prices are quite high. Perhaps in the next three years, the cost of Li batteries will reduce to half

and at that time, the subsidy burden may reduce to ₹50 lakhs. Therefore, the government needs to take a call and decide on the same. On SMEV's part, we propose that instead of creating one electric bus, it is better to manufacture 600 electric scooters. The government ultimately needs to take a call on its mode of action.

I believe personally that the government should first push for a common man mobility solution. Other things, perhaps, can wait. It is important to mention at this juncture that nearly 40–50 crore of the population still moves either on foot or uses public transport. The only alternative for such people is either to travel through rickshaws and *grameen sewa* or on the already overloaded buses. Why are we leaving electric mobility for those 50 crore people and instead offer them their personal transport solutions? As on date, they cannot afford even a scooter or electric scooter because even that will cost them ₹40,000 without a battery. In petrol two wheelers, it is not possible to downsize an engine and that is why there was no mobility solution all these years because less than a 50 cc engine was not possible. For example, if you try to make an engine for a cycle, it will become costlier than for a scooter; aeroplane engines are five times costlier! So in an engine, it is difficult to ensure mobility solutions for the common man but in electric, one can go as micro as possible. It is imperative that we create and offer cheaper options—either electric or assisted electric wherein they can travel faster to the workplace in a cleaner way and save time for their families and they even go farther distances than today. There is a need to think on these lines without placing a burden on the already heavily subsidized national public transport. As I reiterate, this segment is missing today and there is no thought process involved towards its creation either. In fact, as probable solutions, first, I propose creation of millions of good looking electric cycles estimated at around ₹15,000 with the help of government subsidy to counter the problem of pollution and congestion on roads by running at 20 km/hour. Even the average traffic speed is 15–20 km per hour only so this poses a workable solution. A second feasible solution could be found in downsizing our present-day modes of transportation methods. The thrust areas of the government wherein all the economics and prudence ought to be placed include electric cycles, low-end electric scooters and motorcycles, basic motorcycles, public transport, and short-distance public transport. I constantly emphasize how electric mobility is one of the most crucial, important, and radical decisions of the century and taking two wrong steps may lead to us something that we may repent for the future generations. It is essential, therefore, that we retain certain dynamics in mind, such as our Lithium sources and its availability over a period of time, its alternatives, if any, among others. A decision of this nature and significance accords a certain level of gravity and depth, active involvement of all the concerned stakeholders, and a long-term point of view due to its deep-rooted impact. It is a matter of concern today that, despite all the meta-analysis and discussions, the much needed critique on policies is somehow missing and there continues to be one-way traffic.

So, is it right to say that this is where the SMEV comes into play and your organization plays a part?

Indeed. My take on this topic essentially emphasizes on engaging stakeholders in the policy making process and adopting a multidimensional approach. It is important that we do not get swayed by multinational corporations trying to push electric cars through the backdoor and re-evaluate the current expenditure on converting long-route buses electric.

So, is it right to say that you are pushing electric vehicles and at the same time being the voice of reason?

As a registered association of 29 members of e-vehicle makers, there is no association like the SMEV. However, we are only critiquing the manner in which this is being done. Keeping the target of March 2018 in mind, either it will be delayed for one year or if March is so near, we should have completed certain other processes as of now.

So, is that also the challenge then you are facing?

Obviously, since the industry is today facing a challenge of a black hole, being unable to decide, with marginal investments. The need for clarity is extremely high.

Also, is the proposal of leasing of e-vehicles by the government a good idea?

Any idea which changes CapEx* to Opex is a good idea for India, if handled properly. Removing the battery at petrol pump is, in a way, renting out and so it is a partial leasing model. The same model, if extended to the entire vehicle is a good idea insofar as one is not spending ₹60,000 but only ₹200 or ₹100 per day and you own a vehicle. The question that arises is whether it is feasible for the government to conduct the leasing operations and whether it is equipped to do so? They cannot buy 10,000 e-ricks and manage the leasing out! After all, this is not like the LED bulb. So the leasing model *per se* is great but it is best left to the leasing companies and there has to be an indirect type of impetus. In fact better than leasing, is sharing. If we are somehow able to inculcate a culture of sharing in India wherein one is not owning a vehicle but merely using and leaving it, that does take care of the environment. On the contrary, in leasing one is forced to own a vehicle, at least till the time it is captive to you.

In India, pollution and congestion are the two major problems. Leasing, subsidies, and electrification all contribute towards reduction of pollution while congestion, a massive problem for Indian cities, continues to persist. The urban mess, continuously created through addition of new vehicles every day, cannot be resolved via electrification of transportation (electrification only makes the environment cleaner). That will only happen if we go for sharing of vehicles. Also, it needs to be mentioned that we are not referring to public transport in this case since that was always a shared mobility. Instead we need to

inculcate a habit and a culture of shared mobility because today, according to statistics, the utilization of cars is less than 3%. Active time, out of 24 hours, is 3%–7% depending on the city; rest of the 93% of time, the car is just lying somewhere not being used at all and just occupying a parking lot or parked on the roadside. Sharing will definitely contribute towards reducing congestion and perhaps the greed of owning bigger cars as well. And this may work as the right answer for India since the growth in population also leads to people aspiring to spend unnecessarily and in the process create problems for the city rather than spend on life improvement.

But then, isn't that slightly utopian since it involves changing the mindset?
I shall illustrate through an example. A section of society, primarily comprising youth, is today using and spreading awareness about usage of cycles. There can be two types of cycles, the basic cycle and the good-looking electric cycle. So, the way I see it, there will be at least another 5% to 7% population which will graduate towards the good looking and light electric cycle which gradually becomes part and parcel of their life. Eventually, they will stop thinking of buying a car because they have an electric cycle as well as a good public transport system. This, however, is a 20 year plan and will appear utopian if it is considered as a two year plan. This also entails creating roads only for movement of cycles and we need to remember that such roads are perhaps easiest to create.

It is important therefore to exercise clarity in our approach and devise solutions specific to a particular country rather than mere emulation of perspective of another country. It is important to understand that the approach of China and Europe may not necessarily work for us. We need to remember that it is not only pollution and crude oil considerations but also congestion that we need to find a solution to and the same involves getting rid of our ownership of vehicles. In the backdrop of concentrated city planning and percentage of migratory population, the imposition of shared mobility is required.

In terms of oil economy and creation of jobs, how do e-vehicles fit in?
This, I believe, is one field that is unnecessarily being drummed up by industry due to an inertia. For the millions of people employed as mechanics and providing after sales service, they don't really need to fear because even today, the entire automobiles sector is growing at the rate of around 10% to 15% every year. As on date, the whole electric vehicle industry is 40,000 which is less than 2 hours of the total sale of non-electric vehicles. In the next 4–5 years, if this growth goes up to 7% to 10%, it will be huge. However, even that will not become electric in the next 4–5 years which means that the present volumes of automobiles—petrol and diesel—will continue to be manufactured, sold, and serviced. If business runs as usual, sustenance of the existing businesses will continue uninterrupted and nothing is hitting in your face from tomorrow. What perhaps will undergo a change is only the engine and that too half of will still be manufactured inside the factories. Therefore, they can easily absorb and change the line to electric. So, it is all humbug.

Are there any concerns about the mass adoption of e-vehicles?
At the macro level, obviously, since Lithium is a geopolitical issue insofar as power blocks are shifting from one part of the block to another. The Chinese and South Asian block comprise one part for which there are answers and research and development is already underway.

There is nothing to panic in the context of growth of electric vehicles hampering employment prospects. The amount of electricity required for electric vehicles is an issue. If 4–5 years from now, the electric vehicles are super charged or charged through fast chargers, then it is okay. If they are charged slowly, the balancing of the grid will take care because India is already power surplus in more ways than one.

At the technological level, there is the issue of whether e-vehicle technology will be superseded by fuel cells or hydrogen in around a decade. It is also an infrastructure issue because if one wants hydrogen, the requisite infrastructure will have to be created. So, the issue lies in terms of whether we are deciding this issue of the century at the macro level or whether we will have to reverse it in the next 10 years.

Finally, if we were to speak about crude oil, it will be overflowing everywhere as a surplus. As a result of all the electricity-driven modes being encouraged all over the world, oil may eventually be cheaper than mineral water and may be sold at ₹5 or ₹10 a litre. This may lead citizens to question about 'why should they go electric?' And whatever the government is charging as tax on oil (comprising 1%–1.5 % of the gross domestic product), they will henceforth tax on electricity to make sure that they do not lose revenue. Essentially, the country has to decide the way forward since every issue *per se* is manageable. If we are serious about 2030, the next 2–3 years, the first phase or 25% of this time has to be very well sensitized in planning. The entire nation has to be involved in a modulated manner, ranging from educational institutions, politicians, bureaucrats, industry, and other stakeholders.

Your message to the potential EV owners and other stake holders.
Take care of the common man; the country will take care of itself. As of now, we are not really taking care of the common man. We're just trying to perform lip service for public transport. Leave the rich people to do what they want to do. It is imperative that we exercise sustainability in our actions. EF

CURRENT R&D RENEWABLE

Labile Soil Organic Matter in Response to Long-term Cattle Grazing on Sloped Rough Fescue Grassland in the Foothills of the Rocky Mountains, Alberta

Geoderma, Volume 318,
May 2018, Pages 9–15
Bin Zhang, Ben W Thomas, Ryan Beckb, Kui Liu, Mengli Zhao, Xiying Hao

Globally, livestock grazing has pronounced effects on soil carbon (C) and nitrogen (N) cycling, but how labile soil organic matter responds to grazing at different slope positions is uncertain. This study investigated how labile soil organic matter responded to cattle stocking rates and slope position on a rough Fescue grassland. Cattle have been grazing at four stocking rates, 0, 1.2, 2.4, and 4.8 animal unit months (AUM) ha– 1 since 1949, representing Control (CK), Light, Heavy and Very Heavy grazing intensities, respectively. Soil samples were collected from the bottom and top slope landscape positions for each grazed paddock (but only from the top position for Control) in May and September 2016. Soil samples were analysed for organic carbon (OC), total nitrogen (TN), active C (permanganate-oxidizable C), microbial respiration C, available N, potentially mineralizable N (PMN), soil protein, water extractable organic carbon (WEOC), and nitrogen (WEN). Most variables responded to cattle stocking rate ($P < 0.05$) and the responses depended on slope position. Specifically, in the bottom position, OC, TN, active C, NH4+-N, soil protein, and WEN contents were higher with Light grazing than with Heavy or Very Heavy grazing. In contrast, for the top position, no significant differences were found among the three grazing treatments for OC, active C, NH4+-N, and PMN and all variables were lower than with CK except for PMN with Heavy grazing. As expected, soil OC and TN contents were similar between sampling dates in May and September ($P > 0.05$) while active C, NH4+-N, WEOC, and WEN contents were higher ($P < 0.05$) in May than September. Our study suggests that grazing may detrimentally affect grassland soil C and N and slope position plays an important role in regulating the response of labile soil organic matter to grazing. Therefore, there is a need for researchers and range managers to consider developing 'slope-specific' grazing strategies to optimize grazing effects. EF

Estimation of Environmental Kuznets Curve for CO_2 *emission: Role of* Renewable Energy Generation in India

Renewable Energy, Volume 119,
April 2018, Pages 703–711
Avik Sinha, Muhammad Shahbaz

The existing literature on environmental Kuznets Curve (EKC) is mainly focused on finding out the optimal sustainable path for any economy. Looking at the present renewable energy generation scenario in India, this study has made an attempt to estimate the EKC for CO_2 emission in India for the period of 1971–2015. Using unit root test with multiple structural breaks and autoregressive distributed lag (ARDL) approach to cointegration, this study has been found the evidence of inverted U-shaped EKC for India, with the turnaround point at USD 2937.77. The renewable energy has found to have significant negative impact on CO_2 emissions, whereas for overall energy consumption, the long run elasticity is found to be higher than short run elasticity. Moreover, trade is negatively linked with carbon emissions. Based on the results, this study concludes with suitable policy prescriptions. EF

Energy Sufficiency Aspirations of India and the Role of Renewable Resources: Scenarios for Future

Renewable and Sustainable Energy Reviews, Volume 81,
Part 2, January 2018, Pages 2783–2795
Rhythm Singh

The Indian energy scenario has been suffering perennially from problems like energy deficit, energy inequity, and threats to energy security. Conventional power-resources like coal, oil and gas, large hydro and nuclear have inherent shortcomings,

especially in the Indian context, which make them fall short of fulfilling the energy sufficiency aspirations of India. The present paper assesses the validity of the promise offered by renewable energy technologies in this context. The existing trends of cumulative installed capacity growth of solar, wind, small hydro, and biomass power in India have been fitted to simple logistic models to forecast the future growth trajectory. Similarly, long-term electricity demand projections have been made using logistic models. Two renewable growth scenarios and three demand growth scenarios have been combined to generate six combined electricity demand-renewable growth scenarios. The analysis done in the present paper shows that in the most desirable electricity demand-renewable growth scenario, the percentage share of renewable electricity in the overall electricity mix of India rises steadily from the current 6% to around 43%–44% by 2031–32, and then decays gradually to saturate at around 26%–27% by 2063–2065; whereas, in the most likely scenario it rises steadily to around 29% by 2030–31 and then decays gradually to settle at around 21% by 2064–65. This leaves policymakers with a lot of thinking to do regarding the viability of other alternatives in long-term power planning, and underscores the need for path-breaking R&D in the sector. EF

Forecasting the Impact of Renewable Energies in Competition with Non-renewable Sources

Renewable and Sustainable Energy Reviews, Volume 81, Part 2, January 2018, Pages 1879–1886

Claudia Furlan, Cinzia Mortarino

The diffusion dynamics of traditional and clean energy systems, in the energy mix, are studied in a competition modeling, where their interacting life cycles are jointly described. Competition has only been considered recently since diffusion competition models are not easy to be implemented. Data are represented by yearly consumptions (in Mtoe) of traditional sources (coal, oil, gas, and nuclear systems) and a selection of renewable sources (hydroelectric, wind, and solar power) for the US, Europe, China, and India from 1965 to 2014. For each case, we will investigate whether the diffusion level of traditional sources sustains or prevents the spread of renewables and vice versa. For the US and Europe, we will take into account the link between the 2008–09 financial crisis and the slowdown in consumptions. As a matter of fact, the energy sector is characterized by uncertainty due to the depletion of finite energy sources, the technological and economical problems of renewables, and the hypothesis of shale gas as a possible bridge to renewables that could delay the spread of latter ones. In this scenario, six-year forecasts are provided until 2020. EF

Drying Kinetics and Quality Analysis of Black Turmeric (*Curcuma caesia*) Drying in a Mixed Mode Forced Convection Solar Dryer Integrated with Thermal Energy Storage

Renewable Energy, Volume 120,
May 2018, Pages: 23–34

D V N Lakshmi, P Muthukumar, Apurba Layek, Prakash Kumar Nayak

Performances of a mixed mode forced convection solar dryer integrated with paraffin wax based thermal energy storage have been studied for drying the sliced black turmeric (*curcuma caesia*). Thin layer drying kinetics of sliced black turmeric dried in a solar dryer has been compared with the open sun drying. Two 200 g samples of black turmeric were chosen and one was placed in the solar dryer and another was placed in the open sun. The samples were dried from initial moisture content of 73.4% (w.b) to 8.5% (w.b) in 18.5 hr in the solar dryer and the sample took 46.5 hr in open sun drying. Ten thin layer drying kinetic models were fitted with experimental data and Two term model and Page model were found to be best suited for predicting the drying kinetics of sliced black turmeric dried in the solar dryer and in open sun, respectively. The overall solar air heater efficiency and the overall solar dryer efficiency were found to be 25.6% and 12.0%, respectively. Quality analyses of fresh, solar dried, and open sun-dried samples were also carried out in terms of colour, anti-oxidant activity, and flavonoids. EF

SMART

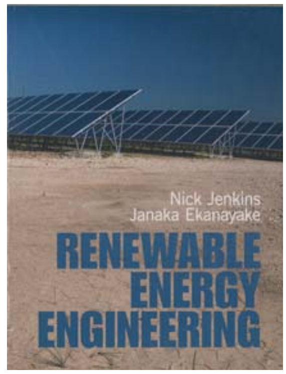
WASTE DISPOSAL

Swachh Bharat Abhiyan (SBA) or Swachh Bharat Mission (SBM), also referred to as the Clean India Mission is a campaign, initiated on October 2, 2014, by India's Prime Minister, Shri Narendra Modi, aims to clean the streets, roads and infrastructure of India's cities, smaller towns, and rural areas.

In order to ensure ecologically sustainable development, efficient management, transportation, and treatment of waste is imperative. The dustcart, a battery-operated compact electric vehicle manufactured and supplied by VGLAN Buildcon Pvt Ltd, aids in proper and hygienic disposal of toxic and harmful waste. The vehicle requires minimal maintenance and comprises an inbuilt battery charger leading to less noise and zero air pollution. High grade strength and low weight makes it safe to use and compact size allows easy access even in congested and crammed spots. The completely covered bucket or garbage box atop the dustcart is made of high grade plastic and hence does not corrode. Besides, the presence of a partition in the box for wet and dry waste, respectively, allows transportation of a higher amount of waste. Installation of the electric hydraulic installed in the box allows automatic lifting of the boxes at the time of disposal. Safety, sturdiness, and durability of the garbage box make it indispensable for transporting waste in hospitals, markets, factories, temples, parks, schools, construction sites, and municipal corporations, amongst others. EF

Renewable Energy Engineering

This book provides a quantitative yet accessible overview of renewable energy engineering practice and the technologies that will transform our energy supply system over the coming years. Covering wind, hydro, solar thermal, photovoltaic, ocean, and bioenergy, the text is suitable for engineering undergraduates as well as graduate students from other numerate degrees. The technologies involved, background theory and how projects are developed, constructed, and operated are described. Worked examples of the simple techniques used to calculate the output of renewable energy schemes engage students by showing how theory relates to real applications. Tutorial chapters provide background material, supporting students from a range of disciplines and ensuring they receive the broad understanding essential for a successful career in the field. Over 150 end-of-chapter problems are included with answers to the problems available in the book and full solutions at <www.cambridge.org/jenkins>, password-protected for instructors.

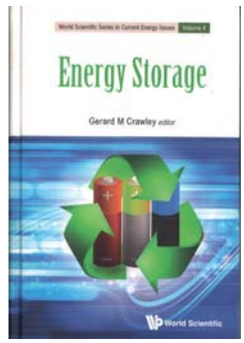


Authors: Nicholas Jenkins and Janaka Ekanayake
Publisher: Cambridge University Press;
Year: 2017

Energy Storage: 4 (World Scientific Series in Current Energy Issues)

The subject of energy storage is extremely important for the increased utilization of renewable energies, such as solar and wind energy, in times when their sources (e.g. the sun and wind) are unavailable. The ability to store energy can also level out the demand curve for electricity and thus lead to a decrease in the peak requirements of energy production. A storage system for ground transportation is also important as a potential replacement for fossil fuel powered transportation.

Energy Storage offers a comprehensive look at the possible approaches to energy storage which are relevant to various situations; from smoothing demand in electrical energy production, applications of energy storage, to transportation. The book covers a variety of approaches to the storage of energy. Beginning with a discussion of the critical importance of energy storage, the book discusses various possible storage options, including hydro storage, compressed air energy storage, and electrical and chemical storage in batteries, capacitors, and fuel cells. There is also a chapter on the mechanical storage of energy with flywheels using advanced materials. The various applications to power production and transportation are also included. The expertise and active involvement of the authors of the various chapters ensures that the information is reliable, current, and forward looking.



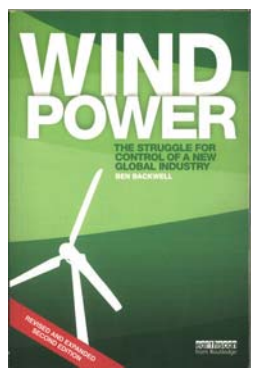
Editor: Gerard M Crawley
Publisher: WS Professional
Year: 2017

Wind Power: The Struggle for Control of a New Global Industry

The wind power business has grown from a niche sector within the energy industry to a global industry that attracts substantial investment. In Europe, wind has become the biggest source of new power generation capacity, while also successfully competing with the gas, coal, and nuclear sectors in China and the US.

Wind Power looks at the nations, companies, and people fighting for control of one of the world's fastest growing new industries and how we can harness one of the planet's most powerful energy resources. The book examines the challenges the sector faces as it competes for influence and investment with the fossil fuel industry across the globe. Over the course of this volume, the author analyses the industry climbers, the investment trends, and the technological advancements that will define the future of wind energy. This second edition is revised throughout and contains new material on frontier wind markets and industry consolidation, as well as the cost reductions and market gains that led to 2015 being a landmark year for the big wind turbine companies.

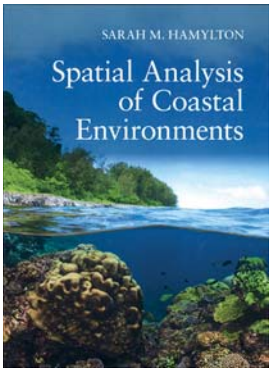
This is an important resource for professionals working in wind and wider renewable industries, energy finance, conventional energy companies, and government as well as researchers, students, journalists, and the general public.



Author: Ben Backwell
Publisher: Routledge, second edition
Year: 2018

Spatial Analysis of Coastal Environments

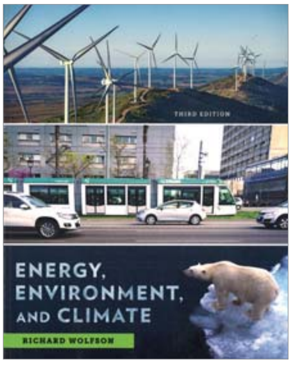
At the convergence of the land and sea, coastal environments are some of the most dynamic and populated places on Earth. This book explains how the many varied forms of spatial analysis, including mapping, monitoring, and modelling, can be applied to a range of coastal environments, such as estuaries, mangroves, seagrass beds, and coral reefs. Presenting empirical geographical approaches to modelling which draw on recent developments in remote sensing technology, geographical information science and spatial statistics, it provides the analytical tools to map, monitor, and explain or predict coastal features. With detailed case studies and accompanying online practical exercises, it is an ideal resource for undergraduate courses in spatial science. Taking a broad view of spatial analysis and covering basic and advanced analytical areas, such as spatial data and geostatistics, it is also a useful reference for ecologists, geomorphologists, geographers, and modellers interested in understanding coastal environments. EF



Author: Sarah M Hamylton
Publisher: Cambridge University Press
Year: 2017

Energy, Environment, and Climate

We live in a world where humans are using more energy with each passing year. This popular text explores the science behind energy production and its impact on the planet. While acknowledging that energy-driven climate change is the dominant energy issue of this century, the author Richard Wolfson, allows the science to speak for itself and accordingly the students receive the tools and information they need to weigh challenging trade-offs and draw informed conclusions. EF



Author: Richard Wolfson
Publisher: W.W. Norton & Company; Third edition
Year: 2017

RENEWABLE ENERGY TECHNOLOGY DEVELOPMENT

New fractal-like concentrating solar power receivers are better at absorbing sunlight

Sandia National Laboratories engineers have developed new fractal-like, concentrating solar power receivers for small- to medium-scale use that are up to 20% more effective at absorbing sunlight than current technology. The receivers were designed and studied as part of a Laboratory Directed Research and Development project and are also being applied to Sandia's work for the Solar Energy Research Institute for India and the United States or SERIIUS.

SERIIUS is a five-year project co-led by the Indian Institute of Science and the National Renewable Energy Laboratory, sponsored by the U.S. Department of Energy and the government of India that aims to develop and improve cost effective solar technology for both countries by addressing the barriers and challenges of each market. Sandia has led the group's research in concentrating solar power, focussing on scalable systems.

» Sandia engineers developed and tested the new receivers at the National Solar Thermal Testing Facility, studying their ability to withstand high temperatures and pressures while absorbing sunlight as heat that can be stored or transferred to a power cycle to generate electricity.
» At Sandia's facility, rows of mirror-like heliostats are aimed at a tall building with a central receiver installed at the top. The heliostats reflect and concentrate the sunlight on the receiver, which absorbs the sunlight's heat and transfers it to gas flowing through the receiver's paneling.
» The gas can then be used in a conventional power plant cycle to produce electricity or used with a storage system to be saved for on-demand electricity production when the sun is not shining.

Conventional receiver designs usually feature a flat panel of tubes or tubes arranged in a cylinder. These designs can absorb about 80% to 90% of the concentrated sunlight directed at them when considering reflections and heat loss. The new designs work with conventional heat-transfer fluids

for concentrating solar power, including molten salts and steam, but they can also be used by other media for heat transfer and storage.

https://www.sciencedaily.com/releases/2017/10/171025122437.htm

Stretchable biofuel cells extract energy from sweat to power wearable devices

A team of engineers has developed stretchable fuel cells that extract energy from sweat and are capable of powering electronics, such as LEDs and Bluetooth radios. The biofuel cells generate 10 times more power per surface area than any existing wearable biofuel cells. The devices could be used to power a range of wearable devices.

The epidermal biofuel cells are a major breakthrough in the field which has been struggling with making the devices that are sufficiently stretchable and powerful. Engineers from the University of California, San Diego, were able to achieve this breakthrough with the help of a combination of clever chemistry, advanced materials, and electronic interfaces. This allowed them to build a stretchable electronic foundation by using lithography and by using screen-printing to make 3D carbon nanotube-based cathode and anode arrays.

» The biofuel cells are equipped with an enzyme that oxidizes the lactic acid present in human sweat to generate current. This turns the sweat into a source of power.

In a published paper, written by the team, they described how they connected the biofuel cells to a custom-made circuit board and demonstrated how the device was able to power an LED while a person wearing it exercised on a stationary bike.

» To be compatible with wearable devices, the biofuel cell needs to be flexible and stretchable. So engineers decided to use "bridge and island" structure which was developed by

them. The cell is made up of rows of dots that are each connected by spring-shaped structures. Half of the dots make up the cell's anode; the other half is the cathode. The spring-like structures can stretch and bend, making the cell flexible without deforming the anode and cathode.

» The basis for the islands and bridges structure was manufactured via lithography and is made of gold. As a second step, researchers used screen printing to deposit layers of biofuel materials on top of the anode and cathode dots.

» The researchers' biggest challenge was increasing the biofuel cell's energy density. Increasing energy density is the key to increasing performance for the biofuel cells. To increase power density, engineers screen printed a 3D carbon nanotube structure on top of the anodes and cathodes. The structure allows engineers to load each anodic dot with more of the enzyme that reacts to lactic acid and silver oxide at the cathode dots. In addition, the tubes allow easier electron transfer which improves biofuel cell performance.

» **Testing applications:** The biofuel cell was connected to a custom-made circuit board which is a DC/DC converter that evens out the power generated by the fuel cells which fluctuates with the amount of sweat produced by a user, and turns it into constant power with a constant voltage. Researchers equipped four subjects with the biofuel cell-board combination and had them exercise on a stationary bike. The subjects were able to power a blue LED for about four minutes.

After all the technical adjustment and advancement, the team is exploring a way to store the energy produced while the concentration of lactate is high enough and then release it gradually as future work is required in two areas, firstly the silver oxide used at the cathode is light sensitive and degrades over time and in the long run, researchers will need to find a more stable material.

https://www.sciencedaily.com/releases/2017/08/170822092209.htm

Producing fertilizer from air could be five times as efficient

A researcher brings this prospect closer with a revolutionary reactor that coverts nitrogen from the atmosphere into NOx, the raw material for fertilizer. This method, in theory, is up to five times as efficient as existing processes, enabling farms to have a small-scale installation without the need for a big investment.

The production of one of the key raw materials for fertilizer, ammonia (NH_3) or nitrogen oxide (NOx), is a very energy-intensive process that is responsible for about 2% of all global CO_2 emissions. However, it is hardly possible any longer to cut the energy consumption via current production processes since the theoretically minimal feasible energy consumption has already been more or less reached.

Two types of reactor: The researcher sought the alternative methods to produce ammonia and nitrogen oxides, building two types of reactors, the Gliding Arc (GA) reactor and the Dielectric Barrier Discharge (DBD) reactor. In the experiments, the GA reactor in particular appeared to be the most suited to producing nitrogen oxides. In this reactor, under atmospheric pressure, a plasma-front (a kind of mini lightning bolt) glides between two diverging metal surfaces, starting with a small opening (2 mm) to a width of 5 centimeters. This expansion causes the plasma to cool to room temperature. During the trajectory of the 'lightning', the nitrogen (N_2) and oxygen (O_2) molecules react in the immediate vicinity of the lightning front to nitrogen oxides (NO and NO_2).

So in order to make this materialized, he optimized this reactor and at a volume of 6 liters per minute and managed to achieve an energy consumption level of 2.8 MJ/mole, quite an improvement on the commercially developed methods that use approximately 0.5 MJ/mole. With the theoretical minimum of reactor, however, being that much lower (0.1 MJ/mole), in the long term this plasma technique could be an energy-efficient alternative to the current energy-devouring ammonia and nitrate production. An added benefit is that this method requires no extra raw materials and production can be generated on a small scale using renewable energy, making this technique ideally suited for application in remote areas that have no access to power grids, such as parts of Africa, for instance.

The German Evonik Industries, who was involved in this research project, is right now working on the further development of the reactor.

https://www.sciencedaily.com/releases/2017/05/170515095230.htm

Converting waste toilet paper into electricity

A team of researchers and scientists have published the first techno-economic analysis of converting waste toilet paper into electricity. In the journal, *Energy Technology*, they propose a two-step process and calculate a cost per kWh, comparable to that of residential photovoltaic installations.

Waste toilet paper (WTP) is not often considered an asset yet it is a rich source of carbon, containing 70%–80 wt% of cellulose on a dry basis. On average, people in Western Europe produce 10–14 kg waste toilet paper per person per year. Accumulating in municipal sewage filters, it is a modest yet significant part of municipal waste, therefore toilet paper is considered as an extremely attractive resource.

WTP offers a great opportunity for closing loops, increasing resource efficiency, and creating a truly circular economy. Since the cellulose in WTP comes from trees, the electricity produced is renewable. This offers a great opportunity for matching society's demand for renewable energy. Renewable resources often show discontinuous peaks. Plant stems can be recycled, but only after the harvest; sunlight is available in the daytime (and depends on cloud cover); and wind supply is as predictable as the weather. Waste toilet paper, however, is a continually available resource.

This research project proposed a simple two-step process for the conversion of WTP, creating a direct route from unwanted waste to a useful product. They examined the possibility of combining devices for the gasification of WTP (step 1) with high-temperature solid oxide fuel cells (SOFCs) able to directly convert the WTP-gas into electricity.

The project's goal was to assess the feasibility of such a WTP-to-electricity system at a scale of 10,000 ton WTP per year, based on real-life parameter values. Using techno-economic analysis methods, the team presented a basic process design, an overall energy balance, and an economic study for this concept. Data for the experiments and calculations were obtained in collaboration with the Amsterdam waste-to-energy company. The researchers present the basic system design, as well as its electricity yield and overall efficiency, based on detailed mass and energy balance calculations. The project team concludes that there is a future in turning waste toilet paper into electricity.

https://www.sciencedaily.com/releases/2017/09/170915170204.htm.

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NATIONAL AND INTERNATIONAL EVENTS

NATIONAL	INTERNATIONAL
All India Seminar on Green Energy and Challenges Over Smart Grid **March 10–11, 2018** Nagpur Website: http://greenenergy2018.in/	**Energy Storage Summit** **February 27–28, 2018** London, United Kingdom Website: http://storage.solarenergyevents.com/
SOLAR TODAY EXPO **April 10–12, 2018** Bengaluru Website: http://www.solartodayexpo.com/	**Ukrainian Energy Forum** **February 27–March 1, 2018** Kiev, Ukraine Website: http://www.ukrainianenergy.com/
2nd GLOBAL RE-INVEST **April 19–21, 2018** Greater Noida Website: https://re-invest.in/	**Powering Africa Summit** **February 28–March 2, 2018** Washington DC, USA Website: https://www.poweringafrica-summit.com/
ELECRAMA **March 10–14, 2018** Greater Noida Website: https://elecrama.com/	**RETECH Energy Egypt** **March 4–6, 2018** Cairo, Egypt Website: http://smbegypt.com/RETECH/index.html
World Utility Summit **March 11–13, 2018** Greater Noida Website: https://www.worldutilitysummit.org/	**International Renewable Energy Storage Conference (IRES)** **March 13–15, 2018** Düsseldorf, Germany Website: https://www.eurosolar.de/en/index.php/events/ires-conference-eurosolar/814-international-renewable-energy-storage-conference-ires-2018
RenewX **April 13–14, 2018** Hyderabad Website: http://www.renewx.in/	**Solar Wind Earth Energy Trade Show (SWEET)** **March 14–16, 2018** Gwangju, South Korea Website: http://www.sweet.or.kr/fairDash.do?hl=ENG

RENEWABLE ENERGY AT A GLANCE

Ministry of New & Renewable Energy			
Programme/ Scheme wise Physical Progress in 2017/18 & cumulative up to the month of January, 2018			
Sector	**FY-2017/18**		**Cumulative Achievements (as on 31.01.2018)**
	Target	**Achievement (April–January, 2018)**	
I. GRID-INTERACTIVE POWER (CAPACITIES IN MW)			
Wind Power	4000.00	597.91	32877.66
Solar Power—Ground Mounted	9000.00	5804.70	17382.75
Solar Power—Roof Top	1000.00	361.44	1072.25
Small Hydro Power	200.00	73.80	4453.65
BioPower (Biomass & Gasification and Bagasse Cogeneration)#	340.00	232.10	8413.80
Waste to Power	10.00	0.00	114.08
Total	**14550.00**	**7069.95**	**64314.19**
II. OFF-GRID/ CAPTIVE POWER (CAPACITIES IN MWEQ)			
Waste to Energy	15.00	7.62	178.70
Biomass(non-bagasse) Cogeneration	60.00	10.70	662.61
Biomass Gasifiers	7.50	0.92	163.37
Aero-Genrators/Hybrid systems	.50	0.14	3.29
SPV Systems	150.00	129.43	591.97
Total	**233.00**	**148.81**	**1599.94**
III. OTHER RENEWABLE ENERGY SYSTEMS			
Family Biogas Plants (in Lakhs)	1.10	0.23	49.82
Water Mills/Micro Hydel (Nos.)	150/25	0.00	2690/72

Progress of Biomass has been revised to installed capacity from exportable power

* Cumulative achievement as on February 2017

Source: www.mnre.gov.in

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Ad location	Back cover	Inside back cover	Inside front cover	Inside full page	Inside half page
Single issue	60,000	50,000	50,000	30,000	18,000
Three issues	171,000	142,500	142,500	85,500	51,300
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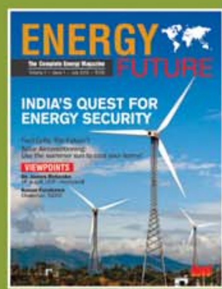

Circulation information

Industries, Ministries, PSUs, Corporates, Multi and Bilateral Agencies, Universities, Educational Institutions, and Research professionals.
Readership of 25,000.

General information

- Quarterly
- All colour
- Matte paper
- Number of pages: 96

Technical specifications

Finished size:	20.5 cm × 26.5 cm
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