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About TERI

We are an independent, multi-dimensional organization, with capabilities in research, policy, consultancy and implementation. We are innovators and agents of change in the energy, environment, climate change and sustainability space, having pioneered conversations and action in these areas for over four decades.

We believe that resource efficiency and waste management are the keys to smart, sustainable and inclusive development. Our work across sectors is focused on

- Promoting efficient use of resources
- Increasing access and uptake of sustainable inputs and practices
- Reducing the impact on environment and climate

Our research, and research based solutions have had a transformative impact on industry as well as communities. We have fostered international collaboration on sustainability action by creating a number of platforms and forums. We do this by translating our research into technology products, technical services, as well as policy advisory and outreach.

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Solar Power Lighting of Village Streets: A Case Study of Assam

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ABSTRACT

Solar power-based operation of LED street light is getting huge recognition across the globe. Installation of solar street lights (SSLs) in the rural villages of Assam has built up confidence among people to protect themselves from thefts and ensure safety from wild animals that pass through village roads at night and damage houses and injure people. Therefore, 84 SSLs were installed in the village 1 No. Napathar in Golaghat district of Assam. This article evaluates the efficacy and effectiveness of SSLs in the rural village. It also delves upon the acceptance of SSLs by people, which has helped prevent the release of 8437 MT/annum of carbon dioxide, 64.14 kg/annum of sulphur dioxide, and 39 kg/annum of nitric oxide with respect of thermal power generation, and development mechanism for providing long-term sustenance for SSLs in the village.

Keywords: Solar street light, Solar power, Solar technology, Hot dip octagonal pole, Lithium ferrous phosphate battery

INTRODUCTION

The village 1 No. Napathar is located on the banks of river Dhansiri and near the reserve forest area in the block Numaligarh, district Golaghat in the state of Assam. A main road divides the village into two parts. Most of the village people are living in houses that can be characterized as pucca, semi-pucca, and kutcha houses with the sheet metal roofs. Kutcha houses are built of bamboo and all the walls of bamboo are coated with clay. The bamboo is easily available locally at a reasonable cost and much cheaper compared to other building materials and their transportation cost. The village is partially electrified and about 8–10 households have electricity connections, and some have been lighting their houses by using solar home lighting systems. This is because the area is prone to heavy rainfall and earthquakes. Earlier the provision of street lights was lacking in the village.

INITIATIVE OF SOLAR STREET LIGHTS

It has been increasingly realized that the dependence on grid electrification and the use of the conventional sources of energy need to be reduced and more use of non-conventional and clean energy sources should be encouraged. The advantage of solar energy is that it is abundantly available during most of the daytime and energy can be produced at the same place where it needs to be consumed. These advantages have fostered the idea of implementing solar street light project at large scale in rural villages.

Village streets or roads are most essential to rural life. The development and management of pucca roads in the village is the responsibility of the village panchayat and the electrification of roads is the task of the state government. In the past, people of the village were afraid to use the road in dark due to the fear of possible attacks by wild animals like elephant, snake bites, and so on. Several incidents of damage to houses caused by elephants and attack on people had occurred in the past. Therefore, to address the safety concern of people using the village roads in night-time, Numaligarh Refinery Limited (NRL), which operates a refinery in the area, has illuminated the village roads with the non-conventional source of energy, that is, solar energy, and 84 SSLs were installed in the month of April 2019 under their CSR initiative with The Energy and Resources Institute (TERI) as the implementation partner [1].

COMMUNITY SENSITIZATION

The user sensitization was carried out in the village with the support of the officials of the implementing agency. The prime goal of this exercise was to sensitize villagers towards the usage of solar street lights as a cost-effective and cleaner option of energy for illuminating the roads. The objective was to understand the actions that people undertake in the absence of electricity at household and community levels and to talk about the project interventions. Such user interactions brought out many pointers which were properly summarized by the implementing agency to chalk out the intervention plan.

INSTALLATION OF SSL

SSLs are elevated light sources that are energized through solar panels, which are normally mounted on the top of a GI pole. The solar panel charges a rechargeable battery, which supplies power to the

LED lamp during the night. The installation of SSLs was carried out through trained technicians of the manufacturing firm under the supervision of TERI at the village 1 No. Napather. The main features of SSLs are as follows: Solar panel – 100 Wp, lighting fixture – 24 W, rechargeable battery – lithium ferrous phosphate (LiFePO₄), which is 12V 48Ah, and hot dip galvanized octagonal pole – 6 m height [1]. The light is designed to sustain the illumination of luminary for about 18 h on full charging of the battery.

Installation of SSLs in the village has yielded multiple benefits as the villagers can now walk on the village roads during night. Villagers can move around at night without the fear of snake bites and theft. The presence of light during night has also helped control the attack by wild animals (e.g., elephants, wild boars). Moreover, there is no issue of power outage because the operation of SSLs is based on solar energy.

SUSTENANCE OF SKILL

In order to maintain the sustainable operation of lights, two local technicians were provided on-the-job training for repair and maintenance of SSL components during the implementation phase of the project. A stock of spare components, such as LED light, battery, panel, nuts and bolts, and so on, has been created at a centralized location in Golaghat, Assam. A service mechanism was evolved with the help of these technicians and local villagers such that the technicians would receive complaints from the village in case of any non-functionality and resolve the issue within 3–4 days.

SOLAR POWER GENERATION AND CONSUMPTION

The annual cumulative power generation for all the SSLs is 9072 kWh and the consumption is about 4709 kWh (Table 1). The SSLs have been designed in such a way that there is a provision of power backup for 2 days in case of non-sunny, cloudy, or rainy days. The excess solar power generated is stored as captive power in these SSLs for charging of batteries during cloudy or rainy days. Moreover, advanced lithium ferrous phosphate battery ensures full charging even if sunlight is available for only 3–5

h. Thus, the system has been designed in such a way that SSLs can operate on a sustainable basis and also have enough backup captive power for non-sunny days.

Table 1 Details of energy generation and consumption

Parameters	Particulars	
Solar panel capacity (W)	100	
Solar LED luminary capacity (W)	24	
Daily effective sunshine time (h/day)	4.5	
Efficiency of power from solar panel (%)	80	
Daily lighting time (h)	12	
Full bright mode (h)	8	
Percentage of lighting time (%)	60	
Dimmer mode time (h)	4	
Percentage of lighting time (%)	40	
Annual sunny days (days/annum)	300	
Annual light usage time (days)	365	
No. of SSLs installed	84	
Power generation of SSLs	9,072,000	Wh
	30.24	kWh/day
	9072.00	kWh/annum
Power consumption of SSLs	12,902.40	Wh
	12.90	kWh/day
	4709.38	kWh/annum

BENEFITS

Some of the important benefits of SSLs are as follows:

- It improves safety for drivers, riders, and pedestrians.
- It provides safety from theft and robbery.
- No conventional fuel is involved and so the day-to-day functioning cost is zero.
- It is environment-friendly because its panels are solely dependent on the sun, and hence it reduces carbon footprints.
- Electricity produced from solar panels is absolutely pollution free and clean.
- It requires much less maintenance as compared to the conventional street lights.
- The lifespan of rechargeable LiFePO_4 is higher compared to the lead acid battery.
- Owing to the use of SSLs, 8437 MT/annum of carbon dioxide, 64.14 kg/annum of sulphur dioxide, and 39 kg/annum of nitric oxide that could have been generated from coal-based thermal power plants can be prevented [2].
- Self-discharge is less than half that of nickel-based batteries [3].



Figure 1 SSLs in the village

LIMITATIONS

- Dust accumulates on solar panel, which over a period of time reduces the energy generation if not cleaned regularly.¹
- Risk of theft is higher for solar panels.
- Rechargeable batteries need replacement after their operational life, which have a cost component.

CONCLUSION

A total of 84 SSLs were installed on the main roads of the village 1 No. Napathar. The current project was able to provide access to clean lighting at the village roads during nights. The SSLs have the annual cumulative power generation capacity of 9.07 MWh and consumption is about 4.71 MWh.

In these villages, earlier people were afraid to walk on village roads at night due to possible attacks by wild animals such as elephant, snake bites, theft and robbery, and so on. Now they move around freely as these street lights provide lighting during the entire night.

These villages fall within the working area of NRL, where clean and quality lighting facilities are provided to help in the development of village infrastructure and also protection from wild animals, reptiles, and so on. Many such interventions can be implemented to illuminate other rural village roads with clean solar powered LED lights in a sustainable way with the joint efforts of TERI and NRL.

¹ Details available at <https://www.solarlightsmanufacturer.com/the-advantages-and-disadvantages-of-solar-street-lights/>, last accessed on 12 September 2019.

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Media Review

Media on Energy and Environmental Issues

TCS, Infosys, 14 other Indian firms say climate change will impact business

Business Standard, July 16, 2019

As many as 16 Indian companies, including IT big companies Infosys and TCS, have expressed worries about the risks of climate change to their businesses in the next 5 years, according to a report. The 16 Indian companies are in various sectors, such as banking, cement, IT, consumer goods, automobiles, electric utility, mining, gas processing and distribution, business and financial services, and textiles, the report by global forum Carbon Disclosure Project (CDP) stated.

Ethanol biorefinery to come up in Vidarbha

The Hindu, July 19, 2019

Bharat Petroleum Corporation Limited (BPCL) will set up Maharashtra's first ever ethanol biorefinery in Vidarbha's Bhandara district at a cost of nearly ₹1500 crore. "The state government has finalized the location along with BPCL and it will be set up in Bhandara's Makardhokda village. The plant will manufacture ethanol from rice straw and will be set up on 46 hectares of land that is currently with the revenue department," said Parinay Fuke, Guardian Minister of Bhandara. The project will utilize 2 lakh tonnes of rice straw annually and has a capacity to produce 700 tonnes of biofuel. This project is one among 12 such refineries planned in different states.

Government approved transmission schemes under 66.5 GW renewable projects

The Hindu Business Line, July 19, 2019

To fast track the deployment of renewable energy in the country, the government has approved a proposal to give early regulatory approval to

transmission schemes identified for 66.5 GW National Renewable Energy Mission (NREM) projects by Central Electricity Regulatory Commission (CERC). In order to achieve the renewable energy target of 175 GW by 2022, the Ministry of New and Renewable Energy in consultation with the Central Electricity Authority and Central Transmission Utility (CTU) has identified transmission schemes for around 66.5 GW of renewable energy generation – around 28 GW under Phase I and around 38.5 GW under Phase II.

India set to breach top 50 in Global Innovation Index

Business Standard, July 24, 2019

India is set to break into the club of the 50 most innovative nations once the Global Innovation Index (GII) is launched, according to sources. The index tracks innovation both in government policies and in industry practices, and a concerted push by the Prime Minister's Office in promoting innovation in the digital economy, start-ups, and ease of doing business has helped India. Department for Promotion of Industry and Internal Trade (DPIIT) along with the World Intellectual Property Organization will release the Global Innovation Index 2019 that details the metrics about the innovation performance of 129 countries around the world. Its 80 indicators explore a broad vision of innovation, including political environment, education, and infrastructure and business sophistication. Themed around medical innovation this year, the index will analyse the medical innovation landscape and dynamics of medical innovation in healthcare and its potential influence on economic growth.

Climate change: current warming 'unparalleled' in 2000 years

BBC, July 24, 2019

The speed and extent of current global warming exceed any similar event in the past 2000 years, researchers say. They show that famous historic events like the 'Little Ice Age' don't compare with the scale of warming seen over the last century. The research suggests that the current warming rate is higher than any observed previously.

Green panel approves creation of reservoirs on Yamuna floodplains

The Hindu, July 26, 2019

The National Green Tribunal (NGT) approved a Delhi government's proposal to create water bodies and reservoirs on the Yamuna floodplains. The reservoirs, which will be created between Palla and Wazirabad, will store water overflowing from the Yamuna during monsoons and help recharge the groundwater. This will help tackle water crisis in the capital. In view of the fact that the project is not expected to disturb the main direction of this tribunal for rejuvenation of river Yamuna and is to be executed subject to the conditions imposed by the committee, the same may proceed in accordance with law subject to any challenge thereto. An NGT appointed principal committee had imposed conditions to be taken into consideration during the execution of the project.

Only 20% of treated waste water being used in Delhi: National Green Tribunal

The Hindustan Times, July 28, 2019

Delhi produces around 459 million gallons per day (MGD) treated water from wastewater through its sewage treatment plants (STPs). But only 89 MGD – which is less than 20% of what is being produced – is being used, according to a report placed before the National Green Tribunal. As far

as the treated water being produced at the various common effluent treatment plants (CETP) in industrial areas is concerned, only 10% of this is being utilized. It takes more than Rs 22,000 to treat each MGD of wastewater. In a bid to increase the utilization of this treated water, the two-member NGT appointed committee for monitoring pollution in the Yamuna River has urged the tribunal to issue directions to make the use of treated water mandatory by bulk consumers, such as shopping malls, farmhouses, and government agencies (e.g., railways and DDA). According to the report, of the 459 MGD wastewater that is being treated in the STPs, Delhi has to mandatorily release 267 MGD in the Yamuna as a part of its commitment to the Upper Yamuna River Board. While only around 89 MGD is used in various parks and gardens, another 103 MGD goes to waste.

Smart meters help discoms trim losses in Delhi, Meerut

The Financial Express, July 30, 2019

Intervention of technology in power distribution has started showing its effect with revenue rising from consumers in New Delhi, Meerut, and Kanpur after installation of smart meters. According to the Energy Efficiency Services Limited (EESL), the average monthly revenue from consumers in high-loss-making areas in Meerut has increased by more than 21% to ₹1260 after the new meters were installed. Average revenue from consumers in Kanpur – unpopular for its power pilferage – has increased by almost 9% to ₹1923. There was a 15% rise in revenue from 24,000 consumers in the New Delhi Municipal Council area. EESL charges ₹75–95 a month for the upkeep of smart meters. As many as 4.5 lakh smart meters have been installed in Uttar Pradesh, Delhi, Haryana, Bihar, and Andhra Pradesh.

Government revises solar pumps costs before installing 17.5 lakh units

The Financial Express, July 31, 2019

The Ministry of New and Renewable Energy (MNRE) has revised the benchmark costs of solar pumps for FY20. The latest benchmarking comes at a time when the government is preparing to install 17.5 lakh stand-alone solar pumps and connect 10 lakh existing agriculture pumps with solar power through the recently approved Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan (PM KUSUM) scheme. Since all components purchased through the scheme will have to be manufactured domestically, it opens up a potential market of over 8000 MW for domestic solar panels makers who are currently struggling to sustain themselves against cheaper imported products flooding the market. The MNRE has subdivided the costs of solar pumps into seven categories according to load bearing capacities ranging from 0.5 HP (horse power) to 10 HP. Each load category is further split into different varieties of solar pumps, specifying separate costs for surface and submersible types.

Tata Power Solar commissions 70 kW solar rooftop installation at India International Centre, New Delhi

Business Standard, August 5, 2019

Tata Power Solar, India's largest integrated solar company and Tata Power's wholly owned subsidiary, has commissioned 70 kW solar rooftop installation at the eminent India International Centre. Tata Power Solar joined hands with India International Centre, one of the most premier cultural institutions of the country, to promote green energy. The project entails energy efficiency of 90,000 kWh annually, along with reducing carbon emissions by 63 tonnes. This installation will help India International Centre save ₹10 lakh on their electricity bill annually. The uniqueness of this installation was that the engineering team had to cast the RCC beams to

fit the ballast structure to the curved roof. The plan was executed ensuring that the structure is not hampered from any end. The roof mounting in the project was planned in an unconventional way as IIC has parabolic rooftops. Each project of Tata Power Solar is designed keeping in mind the safety of the team and surroundings.

Policy to make Rajasthan a solar energy hub

The Hindu, August 8, 2019

A new policy will be announced shortly to make Rajasthan the solar energy hub, protecting the rights of consumers opting for the renewable energy sector. A target would be set to produce 10,000 MW of additional electricity from solar and wind power in the next 5 years. The policy would help develop a large number of solar power plants and attract fresh investments. A robust power transmission infrastructure is taking shape in the form of a green corridor in the western Rajasthan and 1.25 lakh hectare of government land is available for setting up the plants. The state government would make suitable provisions for storage of solar energy and its production at low cost.

World food security increasingly at risk due to 'unprecedented' climate change impact

UN News, August 8, 2019

More than 500 million people live in areas affected by erosion linked to climate change, the UN has warned in a recent report, urging all countries to commit to sustainable land use to help limit greenhouse gas emissions before it is too late. Produced by 107 scientists from more than 50 countries across all regions of the world – with more than half of the contributing authors from the developing nations – the IPCC report provides a peer-based review of the latest research on land use. According to the IPCC report, agriculture, forestry, and other land use contribute to around a quarter of greenhouse gas emissions, a fact that policymakers should consider when considering

how they should invest to adapt to climate change and mitigate its effects.

Maharashtra to set up task force on climate change

The Hindu, August 9, 2019

In the wake of an unprecedented flood-like situation and record rainfall this season, the Maharashtra government will constitute a task force comprising local and global experts to study the impact of climate change on Mumbai. The task force will study measures taken against flooding and unplanned reclamation in cities such as Venice, Geneva, and London and coordinate with the European Climate Change Programme of the European Union to prepare a blueprint.

Paddy stubble burning declines in western UP, Haryana and Punjab: ICAR

The Financial Express, August 14, 2019

Indian Council of Agricultural Research (ICAR) has stated that incidents of crop residue burning have reduced by 40–45% in Haryana, 25% in western Uttar Pradesh, and 14–15% in Punjab after farmers switched to happy seeder machine that helps them earn more while also reducing air pollution. As harvesting of the kharif paddy crop may start from October in these states, ICAR is geared up to distribute over 55,000 happy seeder machines this year. So far, 4500 villages (covering 8 lakh hectares) in Punjab, Haryana, and UP have been declared as ‘zero stubble burning’ and the number will increase this year after distribution of these machines. With the support from the states, ICAR has been demonstrating to farmers the utilities of these machines by which not only air pollution will reduce, but also income of farmers will be increased. The happy seeder machine is mounted on a tractor to sow wheat into the soil. While doing so, it simultaneously cuts and lifts the paddy straw, which is then used as mulch. ICAR has estimated that when the crop residues

burning will stop in the entire area under the rice–wheat cropping system, it will generate additional benefits worth ₹900 crore for farmers.

Sembcorp invests ₹521 crore in Indian renewable business

Mint, August 19, 2019

Sembcorp Industries, the Singapore-based energy and urban development company, has made an equity infusion of ₹521 crore (S\$101.6 million) into its Indian arm, Sembcorp Energy India Ltd. The funds will be used to expand its renewable energy portfolio in India, a senior company official stated. Earlier this week, Sembcorp Industries reported its half-yearly earnings for January–June 2019 with net profit at S\$191 million, up from S\$159 million in 1H2018, on improved performance from the energy business. Profitability in India continued to improve with net profit growing by 46% from the year-ago period to S\$35 million (₹179.56 crore). The turnover was S\$4.9 billion compared with S\$6.1 billion in 1H2018, the company revealed in a press release.

NTPC to set up 5,000-MW ultra mega solar park in Gujarat, Rajasthan

The Financial Express, August 20, 2019

NTPC is likely to sell around 60–70% of power produced on merchant sale basis and keep only around 30% on PPA basis to begin with, the company management told analysts in a meet. The UMSP comes after the not so successful launch of ultra mega power projects (UMPPs). NTPC, India’s largest power producer, is planning to set up ultra mega solar parks (UMSPs) of 5000 MW capacity across solar radiation rich states of Gujarat and Rajasthan to help India meet its 2022 renewable energy target and reduce its overall dependence on fossil fuels. NTPC will not only invest in development of these UMSPs, but will also act as an enabler to invite investment from developers and investors who can also buy power

from the projects if required. This is in deviation from the previous model where developers were not allowed to invest in solar parks.

Coal-based power makes India top global SO₂ emitter: Greenpeace

The Times of India, August 20, 2019

Sulphur dioxide (SO₂), a significant contributor to air pollution, may be within the national ambient air quality standard in all major cities in India, but the country is the largest cumulative emitter of this pollutant in the world and thus prone to being a victim of a cocktail of several toxic air pollutants. These are the findings of a new report by Greenpeace, a global environmental NGO, which analysed sulphur dioxide hotspots detected by US space agency NASA's OMI (Ozone Monitoring Instrument) satellite. As a reactive pollutant, SO₂ reacts with other air pollutants to form sulphate particles and makes a significant part of particulate matter (PM_{2.5}), which has the largest public health impact. It is estimated that SO₂ commonly makes up more than 10% of the deadly fine particles in India and China. Though Russia's Norilsk smelter complex is the largest individual SO₂ emission hotspot, India figured at the top, contributing to more than 15% of all anthropogenic sulphur dioxide hotspots globally in 2018. The primary reason for the country's high emission output is the expansion of coal-based electricity generation over the past decade.

India to study climate change in deep oceans

Deccan Herald, August 19, 2019

India is all set to study climate change in the deep oceans as part of an ambitious ₹6500 crore Deep Ocean Mission, Secretary, Ministry of Earth Sciences, Mr M Rajeevan said. Studying climate change, marine biodiversity, and survey for compounds such as hydrocarbons and minerals will be part of the Deep Ocean Mission. Institutions, including the National

Institute of Ocean Technology (NIOT), Indian National Centre for Ocean Information Services and Centre for Marine Living Resources and Ecology, are involved in the mission.

Discoms made the nodal points in Phase-II of rooftop solar scheme to get incentives

The Hindu Business Line, August 23, 2019

The Ministry of New and Renewable Energy (MNRE) has issued guidelines for the implementation of Phase-II of the rooftop solar programme, which envisages a greater involvement of power distribution companies (discoms). Under Phase-II, the government aims to set up 40 GW of rooftop solar projects by 2022. In 2015, the Centre had approved Phase-I of the rooftop solar scheme for a capacity of 4200 MW by 2019-20. Of this, 2,100 MW was to be through central financial assistance (CFA) and the balance without the central aid. In order to address several major issues identified during the Phase-I programme, and especially the fact that the consumer had to approach multiple agencies for getting a rooftop solar plant installed, it has been decided to implement the programme by making the discoms and their local offices as nodal points for implementation of the RTS programme, the guidelines document stated.

Climate change to hit 150 Himalayan fish species

The Times of India, August 27, 2019

An internal study of the Wildlife Institute of India reveals that climate change will adversely affect around 150 native fish species of the Himalayan states, including Uttarakhand, Himachal Pradesh, Jammu and Kashmir, and Arunachal Pradesh. Common snowtrout, found in the Himalayas and much sought after as food, alone is likely to lose around 21% of its existing space of 16,251 km².

Solar power company to invest over ₹600 crore to develop 450 MW projects in Haryana

The Pioneer, September 2, 2019

Gurugram-based Rays Power Infra, a solar power company, is all set to invest an amount of over ₹1,700 crore to develop and construct accumulative of 450 MW solar projects under open access regulations selling power to commercial and industrial consumers as part of its IPP business. The company has specifically planned to invest 600 crore in Haryana. The company has already started site activities on projects in the state of UP, Haryana, and Karnataka. The company in the past has successfully developed and executed over 200 MW projects.

Ethanol price reset to add sugar mills revenue, reduce surplus

The Financial Express, September 6, 2019

The decision of Cabinet Committee on Economic Affairs (CCEA) to revise the prices of ethanol for supply to OMCs will be positive for the sugar industry in terms of profitability and reduction in the surplus sugar stock. CCEA has increased the basic price of ethanol produced from B-grade molasses by ₹1.84/litre (or 3.5%) while largely maintaining the ethanol price produced from C-heavy molasses and direct sugarcane juice for the procurement season 2019-20 (starting December 2019). The CCEA decision implies that the oil marketing companies will procure ethanol produced from C-grade molasses, B-grade molasses, and sugarcane juice at ₹43.75/litre, ₹54.27/litre, and ₹59.48/litre in 2019-20 as against ₹43.46/litre, ₹52.43/litre, and ₹59.10/litre in 2018-19, respectively, for blending with petrol. The price support aims at increasing the participation of the sugar mills in the Ethanol Blended Petrol Programme (EBP) by providing remunerative and stable prices to suppliers and reducing the dependence on crude oil imports.

India's per capita water availability to fall further

The Financial Express, September 06, 2019

Indian Council of Agricultural Research (ICAR) is working on crop planning for the entire country, under which it will recommend which crops to be grown in how much area in a district based on local climatic conditions, water availability, and overall demand-supply situation. This may help government to plan its incentives in such ways that farmers will adopt those recommended crops. ICAR's National Institute of Agricultural Economics and Policy Research (NIAP) and Modipuram-based Indian Institute of Farming Systems Research are the nodal agencies working jointly to develop the crop planning for the entire country.

Microplastics in Arctic snow point to widespread air contamination

The Hindu, September 6, 2019

Minute microplastic particles have been detected in the Arctic and the Alps, carried by the wind and later washed out in the snow, according to a study that called for urgent research to assess the health risks of inhalation. Every year, several million tonnes of plastic litter course through rivers and out to the oceans, where they are gradually broken down into smaller fragments through the motion of waves and the ultraviolet light of the sun. The new study conducted by scientists at Germany's Alfred Wegener Institute and Switzerland's Institute for Snow and Avalanche Research found that microplastic particles can be transported to tremendous distances through the atmosphere. These particles, defined as shreds less than 5 mm in length, are later washed out of the air by precipitation, particularly snow.

130 wetlands to be restored on priority

The Times of India, September 7, 2019

Underlining the importance of wetlands not only as a source of water but also as ecosystems that

prevent land degradation and desertification, the Centre has identified 130 wetlands for priority restoration in the next 5 years and asked states to submit their respective integrated management plans by October 15. The highest number of such identified wetlands are in Uttar Pradesh (16) followed by Madhya Pradesh (13), Jammu and Kashmir (12), Gujarat (8), Karnataka (7), and West Bengal (6). Each of these wetlands will be restored under a comprehensive scheme of the National Plan for Conservation of Aquatic Ecosystems (NPCA) for conservation and restoration of wetlands and lakes.

Govt to give renewables their moment in the sun

Mint, September 12, 2019

In a renewed push to cut India's dependence on fossil fuels, the central government wants state-run companies to build massive clean energy parks at a cost of around \$2 billion each, with built-in incentives to ensure states and operators invest in the success of the parks. The proposed ultra mega renewable energy power parks (UMREPP) of 2000 MW (megawatts) each will help developers achieve economies of scale and further bring down solar and wind power tariffs. Setting up such parks will bolster India's image as a clean energy champion at a time the world is grappling with concerns related to climate change. Clean energy projects now account for more than a fifth of India's installed power generation capacity. These green energy parks will be set up under the existing solar park scheme, which provides the building blocks – land and grid connectivity – and will be implemented by a special purpose vehicle (SPV).

The adverse impact of climate change

The Hindustan Times, September 17, 2019

The human cost of climate change is increasing every year. According to a report in the Hindustan Times, monsoon of 2019 saw the highest

number of extreme rainfall events (1800), and 142 people were killed during the season. Data also showed that monsoon-related deaths were more widespread across India in 2019 than in any previous year, with the highest toll of 317 in Maharashtra, followed by 203 in West Bengal and 200 in Madhya Pradesh. It is not just rain-related deaths; other extreme weather-related events, such as heat waves and cyclonic storms, are also having huge impact on the people, especially the poor.

112 countries, including China and a few EU nations, ready to scale up targets by 2020 to combat climate change

The Times of India, September 19, 2019

India and the United States may not revise their climate action targets by 2020 but 112 countries, including the biggest greenhouse gas (GHG) emitter China and a few European Union nations, have indicated that they will either enhance their goals or update them with the current emission data by the next year as part of joint global efforts to reach net-zero emission by mid-century. Though it will not be possible for the world to reach net-zero emission without America and India, the fourth biggest current emitter after China, US and EU, on board, 75 of 112 countries have expressed their intention to ratchet up their ambition while responding to a call by UN Secretary-General Mr Antonio Guterres.

Delhi is first state where 95% industries use CNG

The Hindustan Times, September 20, 2019

Delhi has become the first state in India to have 95% of its industries fuelled by CNG, a report by the Delhi Dialogue Commission (DDC) said. The DDC report revealed that out of the total 1542 industries in the city, at least 1457 have switched to CNG over the last one year. A statement released by the Delhi government said it is now

making efforts to convert 85 more industries into CNG fuelled ones. The feat was achieved primarily because of the government's ban on fuels that cause pollution such as petroleum, tire oil, and other types of chemicals used in industries, the government statement added. The findings of DDC also highlighted how the switch of industries to compressed natural gas (CNG) fuel over the last year has improved the quality of lives for thousands of workers employed in these units.

Climate change to impact monsoon in India: Report

The Hindustan Times, September 21, 2019

Sea-level rise of several metres and major disruption to monsoon rains and river flows in India are among the biggest global economic risks from climate change, a policy report by leading economists and scientists said. "Climate change is likely to mean monsoon systems affect larger areas over longer timescales, and rainfall during monsoon season is likely to intensify while becoming less predictable. The largest effect, which is already being observed today, is an increase in the year-to-year variability of the monsoon strength and the associated extremes of rainfall," said the report.

Rising sea levels may sink Mumbai by 2100: IPCC report

Mint, September 26, 2019

Global sea levels are set to rise by at least 1 m by 2100 if carbon emissions go unchecked, submerging hundreds of cities, including Mumbai and Kolkata, and in some cases entire countries, warned a UN report. Extreme events such as storm surges are likely to occur once a year rather than once a century because of accelerated global warming, said the report approved by the

Intergovernmental Panel on Climate Change (IPCC). The dire warnings are a call to action for governments and business leaders across the world to reduce carbon emissions that can jeopardize life on the only habitable planet known to humanity.

2% of India's forest land is encroached

The Hindustan Times, September 28, 2019

Nearly 2%, or 13,000 sq km, of India's total forest area is occupied by encroachers, the environment ministry has said in reply to a query filed under the Right to Information Act. India's total forest cover is 708,273 sq km. Encroachment of forest area is highest in Madhya Pradesh, with about 5347.17 sq km, or nearly 7% of 77,414 sq km of forests, followed by Assam (11.28%) and Odisha (1.5%), according to the ministry. The environment ministry data is significant because the Supreme Court is hearing an 11-year-old public interest litigation (PIL) filed by wildlife activists challenging the Forest Rights Act (FRA). They contend that bogus claims filed under the FRA, which gives legitimate forest dwellers the right to reside in, cultivate, and conserve forest land, have undermined efforts to conserve forests.

Climate change may cause water scarcity in wheat-growing regions

The Hindu Business Line, September 28, 2019

The impending climate change may have an adverse impact on global wheat production in the years to come. Scientists involved in a new modelling study found that many wheat-growing regions in the world – as much as 60 per cent – will face a severe water scarcity in a few decades from now due to climate change, leading to a drop in the production of the cereal, which currently provides 20 per cent of all calories to humans.

TECHNOSCAN

FROM NEWSPAPERS, MAGAZINES, AND TRADE JOURNALS

Telangana solar model helps save over ₹500 cr

The Hindu Business Line, April 27, 2019

The distributed solar photovoltaic project model as opposed to the Solar Park model, mooted a few years ago, has helped save more than ₹500 crore for the Telangana government. The state has already set up about 3600 MW of solar power projects, thereby becoming the leader in the country along with Karnataka. The state has managed to do so by taking up the deployment through the distributed solar power project model. The state has managed to save more than ₹500 crore through the distributed solar PV project model. While ₹50 crore was saved annually in transmission costs by curbing transmission and distribution losses, about ₹450 crore was saved as no separate transmission network was created to evacuate power.

Solar energy could turn the belt and road initiative green

Science Daily, June 27, 2019

The West and South Asia region covered by the Belt and Road Initiative (BRI) has a significant potential to be powered by solar energy, researchers report in the journal *Joule*. Less than 4 percent of the maximum solar potential of the region could meet BRI's electricity demand for 2030. The research suggests a possible solution to reduce BRI countries' need for fossil fuels as they develop. This is the first time the renewable energy potential of the West and South Asia region is quantified. The team selected 66 BRI countries that are connected geographically and built an integrative spatial model to calculate their solar power potential with high-resolution data. The team first identified areas suitable

for building solar farms. These areas would receive sufficient solar radiation and have lower land value otherwise – places like forests and agriculture land are excluded. Then they computed the spacing and packing density of solar panels, which absorb sunlight and generate energy, that would maximize power yield for each area. Finally, they calculated the energy outputs of the areas in each hour after considering limiting factors like shading and temperature, which affect the performance of solar panels. The team found that these countries can generate as much as 448.9 petawatt hour of energy, which is about 41 times the demand for electricity in these countries in 2016. Their 2030 electricity need could be met by converting only 3.7 percent of the region's solar energy. To achieve this, it would require an investment of \$11.2 trillion and a land area of 88,426 km².

Window film could even out the indoor temperature using solar energy

Science Daily, July 8, 2019

A window film with a specially designed molecule could be capable of taking the edge off the worst midday heat and instead distributing it evenly from morning to evening. The molecule has the unique ability to capture energy from sun's rays and release it later as heat. This is shown by researchers at Chalmers University of Technology, Sweden in the scientific journal *Advanced Science*. The molecule is part of a concept that the research team calls MOST, which stands for 'Molecular Solar Thermal Storage'. The research has shown that at dawn when the film has not absorbed any solar energy, it is yellow or orange since these colours are the opposite of blue and green, which is the light spectrum that the

researchers have chosen to capture from the sun. When the molecule captures solar energy and is isomerized, it loses its colour and then becomes entirely transparent. As long as the sun is shining on the film, it captures energy, which means that not as much heat penetrates through the film and into the room. At dusk, when there is less sunlight, heat starts to be released from the film and it gradually returns to its yellow shade and is ready to capture sunlight again the following day.

TIFR desalinates seawater without electricity

The Hindu, July 14, 2019

Using gold nanoparticles that absorb sunlight over the entire visible region and even the near infrared light, researchers at the Tata Institute of Fundamental Research (TIFR), Mumbai have been able to desalinate seawater to produce drinking water. Unlike the conventional reverse osmosis that is energy intensive, the gold nanoparticles require no external energy to produce potable water from seawater. Using 2.5 mg of gold nanoparticles, the team led by Vivek Polshettiwar from TIFR's Department of Chemical Sciences was able to use sunlight to heat water to 85°C and generate steam to produce drinking water from seawater. Since the temperature reached is high, about 10% of seawater becomes steam (and hence drinking water) in about 30 min. Alternatively, gold nanoparticles can be used to convert carbon dioxide into methane. This happens when the light absorbed by the gold nanoparticles excites the electrons, and the excited electrons when transferred to carbon dioxide converts it into methane in the presence of hydrogen. The hydrogen comes from the water that is used as a reaction solvent.

Govt goes for 3D mapping of all villages for water conservation

The Times of India, July 23, 2019

The Centre is carrying out 3D aquifer mapping of every village, which will help it take specific

water conservation measures at the micro level across the country. The deficit so identified will help the government to carry out its recharge plan, where the treated grey water can also be used. Grey water or sullage is defined as all wastewater generated in households, except from toilets. Sources of grey water include sinks, showers, baths, clothes washing machines, or dish washers. Managing the wastewater and solid waste has been identified as the major focus area under Swachh Bharat Mission after achieving 100% toilet coverage in rural areas. The ongoing exercise of 3D aquifer (underground layer of water-bearing rock) mapping at the micro level will enable the government in estimating quantity and quality of groundwater in a particular village or cluster of villages and help in assessment of a sustainable level of ground extraction. The mapping is being undertaken by the Central Ground Water Board on the scale of 1:50,000 in 3D. Currently, 1034 blocks (groundwater assessment units) out of 6584 are overexploited, which means withdrawal of groundwater is more than recharge in those particular units.

New perovskite material shows early promise as an alternative to silicon

Science Daily, August 8, 2019

Silicon dominates solar energy products as it is stable, cheap, and efficient at turning sunlight into electricity. Any new material taking on silicon must compete, and win, on those grounds. As a result of an international research collaboration, Shanghai Jiao Tong University, the Ecole Polytechnique Fédérale de Lausanne (EPFL), and the Okinawa Institute of Science and Technology Graduate University (OIST) have found a stable material that efficiently creates electricity – which could challenge the silicon hegemony. The collaborating teams show how the material CsPbI₃ has been stabilized in a new configuration capable of reaching high conversion efficiencies. This study explored

the crystal in its beta phase, a less well-known arrangement of the structure that is more stable than its alpha phase. This low efficiency partly results from the cracks that often emerge in thin-film solar cells. These cracks induce the loss of electrons into adjacent layers in the solar cell – electrons that can no longer flow as electricity. The team treated the material with a choline iodide solution to heal these cracks, and this solution also optimized the interface between layers in the solar cell, known as energy level alignment. By repairing the cracks that naturally emerge, this treatment led to an increase in conversion efficiency from 15% to 18%. While that leap may seem small, it brings CsPbI₃ into the realm of certified efficiency, the competitive values offered by rival solar materials. Although this early result is promising, inorganic perovskite is still lagging. For CsPbI₃ to truly compete with silicon, the team will next work on the trinity of factors allowing silicon's reign to continue – stability, cost, and efficiency.

Cost-effective fuel cell technology

Science Daily, August 20, 2019

Fuel cells are pollution-free power sources that convert chemical energy to electricity with high efficiency and zero emissions. Fuel cell cars, trucks, and buses would allow people to travel long distances with convenient refuelling and less of a carbon footprint.

Researchers at the University of Delaware (UD) are working on the technology to make fuel cells cheaper and more powerful so that fuel cell vehicles can be a viable option for all someday. Traditional fuel cell research involves hydrogen fuel cells, but the UD researchers are engineering fuel cells that utilize ammonia instead.

In a new analysis, a team of engineers at the Center for Catalytic Science and Technology found that among fuels produced from renewable energy, ammonia has the lowest cost per equivalent gallon of gasoline.

“As a nitrogen-based liquid fuel, ammonia is cheaper to store and distribute than hydrogen and avoids the carbon dioxide emissions of other liquid fuels, which are expensive to capture” said one of the lead authors and a postdoctoral associate at UD.

The challenges, however, are that ammonia does not work in a proton exchange membrane fuel cell and that ammonia is more difficult to oxidize than hydrogen, which causes ammonia fuel cells to produce less power than hydrogen fuel cells.

The team solved the first problem by using hydroxide exchange membrane fuel cells that have been studied for over a decade in the lab of a distinguished engineering professor at UD.

Assisted by a grant from the REFUEL program of the Advanced Research Projects Agency-Energy (ARPA-E) in the U.S. Department of Energy, the UD team engineered a fuel cell membrane that can operate at higher temperatures to speed up ammonia oxidation. They also identified catalysts that were not poisoned by ammonia.

With these improvements, they believe that they have demonstrated a new direct ammonia fuel cell prototype with a peak power density of 135 milliwatts per square centimeter, which closes much of the performance gap compared to hydrogen.

IIT, IET develop tech to treat arsenic contaminated water

The Pioneer, August 28, 2019

Researchers from IIT Varanasi and Institute of Engineering and Technology (IET) Lucknow have developed cost-effective absorbents made of commonly available guava leaf biomass, mango barks, and bagasse to treat arsenic contaminated water, which has become a threat to over 22 lakh people in the country. According to doctors, long-term exposure to arsenic in drinking water and food can lead to cancer and skin lesions and has been associated with

the incidence of diabetes. Extensive laboratory investigations were conducted to evaluate the adsorptive capability of low-cost adsorbents prepared from the three products for adsorption of arsenic, added the researchers. The results are significant given that several technologies that are available now for the treatment of arsenic contaminated water, amongst which the most common techniques are oxidation/precipitation/filtration, coagulation/electro-coagulation/co-precipitation, ion exchange resin, membrane techniques like ultra/nano-filtration/ reverse osmosis/electrolysis, and so on.

Natural wastewater treatment

The Hindu, September 2, 2019

A pilot project to naturally treat 10 lakh litres of wastewater per day will be commissioned in October, said officials of the Irrigation and Flood Control Department. The treated water will be supplied to a two-acre dry waterbody, which is 1.2 km from the project and will help recharge the groundwater. ₹1.85 crore Irrigation and Flood Control Department project in Ghoga village, north Delhi, treats the polluted water by first passing it through a settlement chamber and then through chambers of plants and rocks. The officials added that they have also tested a pipeline between the project and the waterbody.

To rid electric grid of carbon, shore up green energy support

Science Daily, October 28, 2019

A team of researchers from Cornell University and Northwestern University have created an energy model that helps to remove carbon-generated power from the U.S. electric grid – replacing it with a greener, financially feasible wind, solar and hydro energy system. As per one of the researchers, they are trying to balance the priorities of maintaining a reliable, low-cost, efficient electricity system, while shifting to a cleaner, greener system.

In the last three decades, electric utilities throughout the United States, which once controlled both power generation and transmission, have shifted towards restructured markets. These foster more competition than the once-traditional monopoly utility model and electric energy now can be created by one company and transmitted by another.

- Choices made in the design of these restructured markets, however, make it easier for investors to fall back on carbon-based ways – such as natural gas – to make electricity.
- Developing a new model keeps the creation of wind, solar, nuclear and hydro power economically competitive and aligns markets towards a green future.

As per one of the researchers, about two-thirds of the country participates in restructured electricity markets. When these markets were established, solar and wind made very little contribution to the overall energy mix. The complexity of electricity makes it difficult to have completely free markets. Instead, competition happens within the context of administrative rules.

Using mountains for long-term energy storage

Science Daily, November 11, 2019

Batteries are rapidly becoming less expensive and might soon offer a cheap short-term solution to store energy for daily energy needs. However, the long-term storage capabilities of batteries, for example, in a yearly cycle, will not be economically viable. Although pumped-hydro storage (PHS) technologies are an economically feasible choice for long-term energy storage with large capacities – higher than 50 megawatts (MW) – it becomes expensive for locations where the demand for energy storage is often smaller than 20 MW with monthly or seasonal requirements, such as small islands and remote locations.

In a study published in the journal *Energy*,

IIASA researchers propose MGES to close the gap between existing short- and long-term storage technologies.

- MGES constitutes of building cranes on the edge of a steep mountain with enough reach to transport sand (or gravel) from a storage site located at the bottom to a storage site at the top.
- A motor/generator moves storage vessels filled with sand from the bottom to the top, similar to a ski lift. During this process, potential energy is stored. Electricity is generated by lowering sand from the upper storage site back to the bottom. If there are river streams on the mountain, the MGES system can be combined with hydropower, where the water would be used to fill the storage vessels in periods of high availability instead of the sand or gravel, thus generating energy.
- MGES systems have the benefit that the water could be added at any height of the system, thereby increasing the possibility of catching water from different heights in the mountain, which is not possible in the conventional hydropower.

One of the benefits of this system is that sand is cheap and, unlike water, it does not evaporate,

and so one can never lose potential energy and it can be reused innumerable times. This makes it particularly interesting for dry regions.

In addition, PHS plants are limited to a height difference of 1200 m due to very high hydraulic pressures. MGES plants could have height differences of more than 5000 m. Regions with high mountains, for example, the Himalayas, Alps, and Rocky Mountains, could therefore become important long-term energy storage hubs. Other interesting locations for MGES are islands, such as Hawaii, Cape Verde, Madeira, and the Pacific Islands with steep mountainous terrain.

In the explanation, researchers propose a future energy matrix for the Molokai Island in Hawaii, using only wind, solar, batteries, and MGES to supply the island's energy demand. They also emphasized that the MGES technology should not be used for peak generation or storing energy in daily cycles – instead it fills a gap in the market for locations with long-term storage. MGES systems can, for instance, store energy continuously for months and then generate power continuously for months or when there is water available for hydropower, while batteries deal with the daily storage cycles.

Abstracts of Current Research

- Abstracts grouped under 40 headings
 - Every abstract is verified against the original source
 - Photocopies of original documents available
 - All published abstracts available for search
 - List of source documents consulted for this issue appears below
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OTHER SYNTHETIC AND NATURAL FUELS

[14565]

Assali A, Khatib T, and Najjar A. 2019

Renewable Energy **136**: 254–263

Faculty of Educational Sciences and Teachers

Training, An-Najah National University, 97300

Nablus, Palestine

Renewable energy awareness among future generation of Palestine

This study aims to measure the level of university students' knowledge regarding renewable energy, including technical, economical, and policy aspects. Thus, a questionnaire is developed and distributed to students from all faculties of An-Najah National University. The results show that there is no significant difference in students' knowledge of renewable energy considering gender, educational level of study, and parental education level. Meanwhile, faculty choice and high school specialization have a strong correlation with the level of knowledge as compared to other demographic variables. In specific, students who come from vocational schools are usually more aware of renewable energy than other university students. In addition to that, this study shows that 45.6% of the students thought that Palestine has high wind potential, while more than 40% of the participants believe that Palestine has a very high potential of solar energy. However, only 22.8% of the students think that Palestine is making use of this potential as one of the renewable energy sources. In contrast, 71.3% of the respondents believe that the investment in RE projects is successful, and 70.4% of students confirmed using solar energy for water heating. As a result, students' awareness and knowledge about renewable energy are found limited. (13 Figures, 11 Tables, 34 References)

[14566]

Bose A S and Sarkar S. 2019

Renewable and Sustainable Energy Reviews **112**: 762–774

XLRI, Xavier School of Management, Jamshedpur, India

India's e-reverse auctions (2017–2018) for allocating renewable energy capacity: An evaluation

In the renewable energy sector of India, the system of feed-in-tariff (FIT) is being rapidly replaced by the mechanism of e-reverse auctions to discover the lowest tariff. 23.375 GW of solar, wind, and hybrid capacity has been auctioned by central and state agencies during the period 2017–2018. The auctions resulted in historical low bids due to the expectation of low price of capital goods like solar modules. The highest winning bids in solar auctions were, on an average, 36.49% less than the ongoing solar FIT in the states that held the e-reverse auctions. Consequently, the FIT has been revised downward. While the auctions proved to be cost-effective, commissioning of projects remains a suspect. Only 58.6% of solar capacity allocated through the auctions held in 2017 got commissioned by the end of 2018. Project developers face the winner's curse due to increased import price of solar modules. The bids were revised upward in 2018 due to expected cost escalation because of safeguard duty imposed on import of solar panels. 8 GW solar bids got cancelled in FY 2018–19. Deployment of projects got affected as the distribution companies attempted to force winners of auctions to match tariff with lowest bids in subsequent auctions. This article evaluates the e-reverse auctions on account of their impact on price, deployment, and financing of projects. (4 Figures, 4 Tables, 119 References)

[14567]

Dai W, Yang Z, Yu J, Zhao K, Wen S, Lin W, and Li W.

2019

Energy **187**: 115975

State Key Laboratory of Power Transmission

Equipment & System Security and New Technology,

School of Electrical Engineering, Chongqing

University, Chongqing, 400030, China

Security region of renewable energy integration: Characterization and flexibility

This paper proposes a security region evaluation method for obtaining every feasible point rather than the only maximum output point of renewable generators. This evaluation method is based on multi-parametric programming considering network operational constraints, including N-1 security constraints and variable limits. In the obtained security region, each feasible point can map the values of the objective function and optimal variables of the OPF model, which is beneficial for the real-time dispatch. Furthermore, the flexible spaces, including the deep peak regulation of generators and the emergency transmission rates of lines, are considered to extend the security region of renewable energy integration. The security regions of renewable generator outputs and the transmission power of tie lines, which reflect the range of renewable energy self-accommodation and outside accommodation, are quantified considering these flexible spaces. The proposed method is tested on the IEEE 39-bus and IEEE 118-bus systems. (17 Figures, 2 Tables, 43 References)

[14568]

Dawn S, Tiwari P K, and Goswami A K. 2019

Energy **181**: 709–723

Electrical Engineering Department, National Institute of Technology Silchar, India

An approach for long term economic operations of competitive power market by optimal combined scheduling of wind turbines and FACTS controllers

This paper presents an efficient optimization approach to achieve the maximum social welfare and profit of consumers as well as maximum profit of generation companies by minimizing the adverse effect of imbalance cost which is the product of uncertain wind penetration. The optimal placement of thyristor controlled series compensator (TCSC) and unified power flow controller (UPFC) devices with optimal wind generator placement has been incorporated in the proposed method. The real-time data for actual and forecasted wind speed has been collected from different identified places of India. Modified IEEE 14 bus and modified IEEE 30 bus test systems are considered in this work for validating and analysing the effectiveness of the proposed approach. (11 Figures, 8 Tables, 32 References)

[14569]

Lamsal D, Sreeram V, Mishra Y, and Kumar D. 2019

Renewable and Sustainable Energy Reviews **113**: 109245

The University of Western Australia, School of Electrical, Electronic and Computer Engineering, Perth, Australia

Output power smoothing control approaches for wind and photovoltaic generation systems: A review

This paper presents an extensive review of the output power smoothing methods considering the use of the energy storage system (ESS). In general, the smoothing of fluctuating power is carried out with an ESS, such as a battery energy storage system, fuel cell/electrolyzer, superconducting magnetic energy storage, flywheel energy storage system, energy capacitor system, as well as without any energy storage system. As the installation and maintenance costs of ESS-based smoothing methods are high, the existing approaches of power smoothing can be broadly categorized into with and without ESS. This paper discusses the merits and demerits of the existing research in power smoothing approaches and proposes key future directions.

Moreover, a comparative study of some well-known smoothing techniques is presented for a simple power system with wind, photovoltaics, and batteries. (31 Figures, 5 Tables, 133 References)

[14570]

Olabi A G. 2019

Energy **181**: 50–454

Sustainable and Renewable Energy Engineering
Department, University of Sharjah, P.O. Box 27272,
Sharjah, United Arab Emirates

Circular economy and renewable energy

Papers discussed different topics related to renewable energy, energy storage systems, and some environmental issues related to transportation. During this conference, Prof Olabi presented a keynote talk on the relation between circular economy and renewable energy; case studies about implementing this concept in Scotland were included in his presentation. This editorial will give a short description on the relation between circular economy and renewable energy and then it will be followed by addressing the accepted papers in this special issue. (2 Figures, 105 References)

[14571]

Sanajaoba S. 2019

Solar Energy **188**: 655–666

Manipur State Power Company Ltd. (MSPCL), Imphal,
Manipur 795001, India

Optimal sizing of off-grid hybrid energy system based on minimum cost of energy and reliability criteria using firefly algorithm

This paper attempts to develop an optimal hybrid energy system model using available solar and wind energy resources with battery storage for fulfilling the electrical needs of three un-electrified remote villages located in Senapati district of Manipur, India. A firefly algorithm based approach is used to find the optimal hybrid system configuration based on minimum cost of energy (COE) while satisfying

specified reliability criteria identified with loss of load probability (LOLP) reliability index. Further, system investigation has been carried out for optimal system feasibility at various values of LOLP. The optimal hybrid energy system is able to provide feasible solutions for LOLP values lying between 0 and 0.03. For LOLP value above 0.03, the system becomes infeasible as the COE increases with increase in LOLP. (12 Figures, 5 Tables, 29 References)

BIOMASS

[14572]

Avcioglu A O, Dayioglu M A, and Türker U. 2019

Renewable Energy **138**: 610–619

Ankara University, Faculty of Agriculture, Department
of Agricultural Machinery and Technologies Eng, P.O.
Box 06130, Ankara, Turkey

Assessment of the energy potential of agricultural biomass residues in Turkey

In this study, the energy potential of agricultural biomass residues was explored for Turkey using conducted studies of agricultural biomass residues characteristics in several countries located at different geographic regions. Data on characteristics of agricultural biomass residues were used from 16 European Union countries, as well as India, Cameroon, China, Pakistan, Nigeria, Uganda, and Turkey. Some residue characteristics such as residue product ratios, moisture levels, and lower heating calorific values of dry matter were taken into account. Furthermore, a mathematical model was defined for the calculation of the energy potential of Turkey's agricultural biomass residues. Theoretical biomass amount and theoretical energy potential, as well as available energy potential values of agricultural biomass residues, were determined. The total amounts of biomass residues obtained from arable field crops and horticultural crops in Turkey were estimated as 59,432 and 15,652 kilotonnes, respectively. The theoretical energy potentials of these agricultural biomass residues were calculated as 908,119 and 90,354 TJ, respectively. The

available energy potentials from agricultural biomass residues were calculated as 298,955 TJ for arable agricultural field crops and 65,491 TJ for horticultural crops. (5 Figures, 7 Tables, 50 References)

[14573]

Joshi R K and Dhyani S. 2019

Acta Ecologica Sinica **39**(4): 289–299

Jawaharlal Nehru University, New Delhi, India

Biomass, carbon density and diversity of tree species in tropical dry deciduous forests in Central India

Present study assesses the carbon stock of tropical dry deciduous forests varying in tree density, basal cover, and diversity in Singrauli district of Madhya Pradesh in Central India. Field sampling was carried out in six forest sites, namely, Chitrangi, East Sarai, Gorbi, Renukoot, West Sarai, and Waidhan, of Singrauli. A total of 29 tree species belonging to 18 families were recorded across the forest ranges, where tree density, basal area, and diversity values varied from 702 (Gorbhi range) to 1671 (East Sarai range) individuals per hectare; 15.43 (Renukhund range) to 71.76 m²/ha (Chitrangle range); and 0.69 (West Sarai range) to 2.52 (Gorbi range), respectively. Total biomass estimated ranged from 103.32 (Renukhund range) to 453.54 Mg/ha (Chitrangle range), while the total tree carbon density varied from 48.97 to 214.97 Mg C/ha. The variation in carbon storage in the studied ranges was found to be dependent on the density of trees in different diameter and age classes and tree species diversity. *Diospyros melanoxylon*, *Butea monosperma*, *Shorea robusta*, *Senegalia catechu*, *Spondias pinnata*, and *Lagerstroemia parviflora* were the dominant species at different study sites (forest ranges) and contributed towards higher carbon storage in respective forest ranges. Study endorses field-based approach for carbon estimations based

on above- and belowground assessments as a more realistic approach to understand sink potential of natural forests. (5 Figures, 4 Tables, 82 References)

[14574]

Kumar S A A, Sakthinathan G, Vignesh R, Banu J R, and Al-Muhtaseb A H. 2019

Fuel **253**: 921–929

Department of Automobile Engineering, Madras Institute of Technology, Anna University, Chennai, India

Optimized transesterification reaction for efficient biodiesel production using Indian oil sardine fish as feedstock

This experiment focused on biodiesel production using Indian oil sardine fish as a new low-cost feedstock. Bligh and Dyer's method was followed for oil extraction from Indian oil sardine fishes. Biodiesel was produced by KOH catalyzed transesterification reaction with a reaction temperature of 150°C. Optimization of the process parameters influencing the biodiesel production was performed using response surface methodology (RSM). Box–Behnken experimental design was used for the statistical analysis. The effects of methanol vol%, KOH wt%, and reaction time over the reaction were studied. Chemical characterization of the biodiesel produced was carried out by gas chromatography-mass spectroscopy (GC-MS) analysis. Physicochemical properties of the biodiesel were characterized according to the ASTM 6751 standard. The optimum process conditions for the biodiesel yield of 96.57% were found to be 20 vol% methanol, 1.25 wt% KOH, and 25 min reaction time. The 150°C reaction temperature used in this process enhances the transesterification reaction by reducing the reaction time from the normally observed 60–120 min to 25 min with a high yield of biodiesel. (5 Figures, 5 Tables, 45 References)

[14575]

Nirmalkar J, Deshmukh D K, Deb M K, Tsai Y I, and Pervez S. 2019

Atmospheric Pollution Research **10**(3): 817–826

School of Studies in Chemistry, Pt. Ravishankar

Shukla University, Raipur 492010, India

Characteristics of aerosol during major biomass burning events over eastern central India in winter: A tracer-based approach

Size-segregated aerosol samples collected from a rural site (Rajim: 20°59'N and 81°55'E) in the eastern central India during the winter of 2011 were analysed for anhydrosugars, sugar alcohols, and primary sugars to better understand their potential sources and formation. Anhydrosugars showed the predominance of levoglucosan, whereas sugar alcohol showed the predominance of mannitol, with glucose as a major primary sugar in the sub-micron ($D_a < 1.1 \mu\text{m}$) and super-micron modes ($D_a > 1.1 \mu\text{m}$). Levoglucosan gave a bimodal size distribution pattern with a major peak at 0.43–0.65 μm in the sub-micron mode during period 2 and period 3, suggesting its origin from biomass burning, whereas the major peak during period 1 was found at 4.4–5.8 μm in super-micron mode, which may be due to the mixing of biomass burning derived particles with soil dust particles. Sugar alcohols (arabitol and mannitol) and primary sugars (glucose and trehalose) showed bimodal size distribution trend with a major peak at 4.4–5.8 μm in super-micron mode during all periods, perhaps due to fungal activity and soil dust re-suspension, respectively. The potential ingress of biomass burning derived particles into the lungs was calculated to be high, whereas fungal spores and soil particles were more likely found in the upper respiratory tract. Principal component analysis and correlation analysis showed that biomass burning was a major source in the sub-micron mode, whereas fungal spores

and vegetative soil were dominant sources for quantified sugars in super-micron mode.

[14576]

Parihar A K S, Sethi V, and Banerjee R. 2019

Renewable Energy **134**: 1400–1422

Department of Energy Science and Engineering, India

Sizing of biomass based distributed hybrid power generation systems in India

A methodology for optimum sizing of battery integrated biomass gasifier based distributed power generation systems is discussed. Typically, biomass gasifier systems are sized considering peak demand resulting into lower operational efficiency due to part load operation during low demand period. The proposed methodology using design space approach enables designer with multiple combinations of gasifier engine and battery systems for given load profile from which an appropriate combination may be identified considering specific objective or constraints if any. Two gasifier operational strategies are discussed and compared using cost of energy. The methodology is further extended for sizing of hybrid systems incorporating gasifier, solar PV, and battery system. The proposed methodology is illustrated using a realistic load profile generated through a structured household survey of an un-electrified hamlet. For given load profile, battery integrated gasifier engine system in intermittent operation mode has the lowest cost of electricity, followed by gasifier engine system alone, hybrid system, and solar PV battery system. Sensitivity analysis is done to incorporate uncertainty related to variation in key input parameters. The proposed sizing methodology may be helpful in wider replication of gasification systems by providing cost-effective sizing of such systems. (23 Figures, 4 Tables, 48 References)

[14577]

Puthiyamadam A, Adarsh V P, Mallapureddy K K, et al. 2019

Bioresource Technology **289**: 121633

Biofuels and Biorefineries Section, Microbial Processes and Technology Division (MPTD), CSIR-National Institute for Interdisciplinary Science and Technology, Thiruvananthapuram 695019, India

Evaluation of a wet processing strategy for mixed phumdi biomass conversion to bioethanol

The present study evaluated the possibility of using the fresh (non-dried) mixed biomass harvested from phumdis, which are floating vegetation unique to Loktak lake in Manipur, India, for bioethanol production. Pretreatment with dilute alkali (1.5% at 120°C for 60 min) resulted in 36% lignin removal and an enhancement of cellulose content to 48% from 37%, and enzymatic hydrolysis released 25 g/L glucose. Fermentation of the hydrolysates was highly efficient at 95%, attained in 36 h and 80% in just 12 h. The new wet processing strategy could help in value addition of mixed phumdi biomass. (2 Figures, 2 Tables, 12 References)

[14578]

Shaik D S, Kant Y, Mitra D, Singh A, Chandola H C, Sateesh M, Suresh Babu S, and Chauhan P. 2019
Journal of Environmental Management **244**: 328–343

Marine & Atmospheric Sciences Department, Indian Institute of Remote Sensing, ISRO, Dehradun, India

Impact of biomass burning on regional aerosol optical properties: A case study over northern India

The crop residue burning over the northwest IGP (Punjab) significantly affects the aerosol optical properties locally as well in the downwind regions during post-monsoon season, that is, crop residue fires increased by 4% (170 fires per year) with corresponding AOD, AAOD, and AI increased by 8%, 9%, and 11%, respectively. The satellite observation

shows large gradient of aerosol parameters from north-west to south-east along the Himalayan foothills, which indicates the regional transport of smoke aerosols over the region. This is also supported by ground-based AOD observations at four locations (Patiala, Delhi, Dehradun, and Kanpur) and black carbon measurements at two locations (Patiala and Dehradun). The climatological averaged values of ground-based AOD₅₅₀ for Patiala, Delhi, Dehradun, and Kanpur are 0.52 ± 0.26 , 0.75 ± 0.40 , 0.45 ± 0.24 , and 0.57 ± 0.29 , respectively, whereas BC concentrations are $8.43 \pm 3.14 \mu\text{g}/\text{m}^3$ and $3.36 \pm 1.26 \mu\text{g}/\text{m}^3$ for Patiala and Dehradun, respectively. Comparison of MODIS derived AOD agrees well with ground-based AODs (overall $R = 0.86$ and $\text{RMSE} = 0.14$). In addition, CALIPSO shows the maximum amount of biomass burning smoke aerosols present within the atmospheric boundary layer and extending up to 2–3 km altitudes in some cases. The smoke aerosol transport pathways originated from crop residue burning were analysed using HYSPLIT forward trajectories. The results reveal that majority of smoke aerosols are transported to eastern IGP, central India, and adjacent oceanic regions during post-monsoon season. (11 Figures, 4 Tables, 77 References)

[14579]

Suresh N S, Thirumalai N C, and Dasappa S. 2019
Applied Thermal Engineering **160**: 114121
Centre for Sustainable Technologies, Indian Institute of Science, Bengaluru 560012, Karnataka, India
Email: chairman@astra.iisc.ernet.in

Modeling and analysis of solar thermal and biomass hybrid power plants

This paper presents thermodynamic modeling for sizing a steam Rankine cycle based solar–biomass hybrid power plant. Solar system uses parabolic trough technology, and biomass system uses fluidized bed combustion technology to generate steam for power generation. The biomass system plays a significant role in the

hybrid operation during the solar intermittency periods. Also, the boiler in a stand-alone mode can generate power after sunshine hours to meet the power demand. Further, the paper presents a case study to emphasize parameters such as solar field area requirements, biomass requirements, system efficiency, intermittency aspects, capacity utilization factor, CAPEX, and leveled cost of electricity for various scales of hybrid systems. The results suggest that hybridization could be a possible sustainable solution. (27 Figures, 4 Tables, 59 References)

SOLAR ENERGY

[14580]

Dasari H, Desamsetti S, Langodan S, *et al.* 2019
Applied Energy **248**: 354–371

Physical Sciences and Engineering Division, King
Abdullah University of Science and Technology
(KAUST), Thuwal, Saudi Arabia

High-resolution assessment of solar energy resources over the Arabian Peninsula

This study presents a high-resolution spatial and temporal assessment of the solar energy resources over the Arabian Peninsula (AP) from 38 years (1980–2017) reanalysis data generated using an assimilative Weather Research and Forecasting Solar model. The simulations are performed based on two two-way nested domains with 15 and 5 km resolutions using the European Centre for Medium-Range Weather Forecasts as initial and boundary conditions and assimilating most of available observations in the region. Simulated solar energy resources, such as the Global Horizontal Irradiance (GHI), Direct Normal Irradiance (DNI), and the Diffuse Horizontal Irradiance (DHI), are first validated with daily observations collected at 46 in-situ radiometer stations over Saudi Arabia for a period of 4 years (2013–2016). Observed and modelled data are in good agreement with high correlation coefficients, index of agreements,

and low normalized biases. The total mean annual GHI (DNI) over the AP ranges from 6000 to 8500 Wh/m² (3000–6500 Wh/m²) with significant seasonal variations. The diffuse fraction (the ratio of the DHI to the GHI) is high (low) over the northern (southern) AP in winter, whereas it is high (low) over the central to southern (northern) AP during summer, indicating a significant modulation of the sky clearness over the region. Clouds over the northern AP in winter and the aerosol loading due to desert dust over the central and southern AP in summer are the major factors driving the variability of the DHI. The effects of dust and clouds are more pronounced in the diurnal variability of the solar radiation parameters. Our analysis of various solar radiation parameters and the aerosol properties suggest a significant potential for solar energy harvesting in the AP. In particular, the southeastern to northwestern Saudi Arabia are identified as the most suitable areas to exploit solar energy with a minimum cloud coverage over the region. (15 Figures, 88 References)

[14581]

Dehra H. 2019

Energy Procedia **158**: 5162–5168

Egis India Consulting Engineers Pvt Ltd., Egis Tower,
Plot # 66, Sector 32, Gurugram (Haryana) 122001,
India

Modeling of energy conversion and noise characterization in outdoor ducts exposed to solar radiation

The energy conversion and noise characterization in an exterior rectangular duct is important, for example, in modeling PV solar wall and transpired unglazed structures. The energy conversion in an exterior rectangular duct is a function of solar irradiation, air gap width, mass flow rate and pressure, wall and air temperatures. A generalized two-dimensional thermal analysis of an outdoor duct is presented by placement of surface and air nodes into two

adjacent stacks of control volumes representing outer and inner walls of duct. A matrix solution procedure is adopted by constituting conjugate heat exchange of conduction, convection, radiation, and ventilation heat transport. Noise characterization due to energy conversion in outdoor ducts is also presented. The energy conversion and noise characterization is supported with some experimental results of a photovoltaic (PV) solar wall installed in an outdoor test room. Furthermore, some examples of noise characterization calculations are illustrated using devised noise measurement equations. (2 Figures, 6 Tables, 13 References)

[14582]

Gupta A, Kumar A, and Khatod D K. 2019

Energy **183**: 716–732

Department of Hydro and Renewable Energy (HRED)
(formerly Alternate Hydro Energy Centre (AHEC)),
Indian Institute of Technology Roorkee, Roorkee,
Uttarakhand, 247667, India

Optimized scheduling of hydropower with increase in solar and wind installations

The existing hydropower plants that were built to serve the base load in the past are now made to run as standby units to take up the variation in generation caused due to the increasing solar and wind energy in the grid. This reduces both generation and revenue of these plants and creates a conflict of interest between generating companies and system operators. Thus, a need arises to revise the operating policies of the existing hydropower plants not only for the present capacities of solar and wind but also taking future additions into the account. This problem is taken up in this study on behalf of the state power generating company for their existing hydropower plants. The optimization is carried out using two algorithms, that is, non-linear optimization and logical optimization. The optimization results provide certain operational observations on many powerhouses, following which the generation could be increased without any additional investment. The

algorithms, when used for the future additions of solar, wind, and thermal, is found to be quite sensitive to the reservoir inflow data. The critical comparison of the used algorithms reveals that this rule of thumb can also perform very well when compared with the true optimization. (14 Figures, 5 Tables, 66 References)

[14583]

Indora S and Kandpal T C. 2019

Renewable Energy **143**: 1531–1543

Centre for Energy Studies, Indian Institute of
Technology Delhi, Hauz Khas, New Delhi, 110016, India

A framework for analyzing impact of potential financial/fiscal incentives for promoting institutional solar cooking in India

A framework to estimate the extent of various incentives required to ensure financial attractiveness of institutional solar cooking is presented with typical examples from India. Incentives such as capital subsidy/viability gap funding, accelerated depreciation, interest subsidy, and investment tax credit have been considered for three commercially available designs of solar cookers that can be used for institutional cooking (SK-23, Scheffler dish (direct), and Scheffler dish (steam)). Depending on the location, the extent of viability gap funding (VGF) for Scheffler dish (steam) solar cooking system varies from 18.7% to 66.5% of the capital cost, while the same for SK-23 and Scheffler dish (direct) varies from 8.7% to 82.9% and from 33.4% to 94.5%, respectively. From the government point of view, the provision of accelerated depreciation for incentivizing institutional solar cooking is found to be the least cost option, followed by viability gap funding, investment tax credit, and interest subsidy in the order of increasing cost to the government. At locations in the cold and cloudy climatic zone of India, there is invariably a need to provide a combination of incentives (as the current provision of 30% capital subsidy is not adequate) to ensure a breakeven condition. (7 Figures, 6 Tables, 48 References)

[14584]

Kumar R and Bansal H O. 2019

Electric Power Systems Research **177**: 105957

Power Electronics & Drives Lab., Department of Electrical and Electronics Engineering, Birla Institute of Technology and Science, Pilani, Rajasthan, India

Investigations on shunt active power filter in a PV-wind-FC based hybrid renewable energy system to improve power quality using hardware-in-the-loop testing platform

This paper presents an intelligently controlled hybrid energy system (HES) integrated with shunt active power filter (SAPF) to address the power quality problems. Renewable sources such as wind, PV, and fuel cell (FC) are integrated into HES and are regulated using artificial intelligence techniques that are also implemented for maximum power point tracking (MPPT) in both PV and wind energy systems. The dynamic performance of SAPF is optimized using fuzzy logic, neural network, and adaptive neuro-fuzzy inference system (ANFIS) based control algorithms. These controllers provide the smooth DC-link voltage and minimize the total harmonic distortion (THD) produced by the balanced/unbalanced and nonlinear loads. Comparison of these reveals that the ANFIS based algorithm provides minimum THD. The system is tested in real-time using hardware-in-the-loop (HIL) set-up. The control schemes are executed on FPGA-based computational engine of OPAL-RT4510 with microsecond step. (26 Figures, 2 Tables, 52 References)

[14585]

Paliwal N K, Singh A K, and Singh N K. 2019

Journal of Energy Storage **25**: 100877

Electrical Engineering Department, MNNIT Allahabad, India

A day-ahead optimal energy scheduling in a remote microgrid along with battery storage system via global best guided ABC algorithm

This paper deals the optimal energy scheduling

in stand-alone MG consisting of wind turbine (WT), photovoltaic (PV), diesel engine generators (DEs) and BSS, which is not an easy task because of uncertainty in nature, dynamic market bid, and demand profiles. The BSS is operated in three different strategies based on fluctuation in RES power, load, and market bid to obtain the optimal energy scheduling of MG in continuous and discrete operation modes of DEs. The scheduling strategies maximize the arbitrage of MG system in both modes of DEs operation. The problem is simulated in MATLAB® environment using artificial bee colony (ABC) and its variant global best (Gbest) guided ABC (GABC) algorithms and other existing algorithms as particle swarm optimization (PSO) and genetic algorithm (GA). The obtained results show that the GABC provides better revenue and exploration and exploitation capabilities in all operational strategies compared to ABC, PSO and GA algorithms. The operational strategy based on variable market bid, load, and RES power gives optimal revenue and reduced or equal greenhouse gases (GHG) emissions than other strategies in the considered modes of DEs operation. (14 Figures, 6 Tables, 38 References)

[14586]

Yadav P, Davies P J, and Palit D. 2019

Energy Strategy Reviews **26**: 100392

Department of Environmental Sciences, Macquarie University, NSW, 2109, Australia

Distributed solar photovoltaics landscape in Uttar Pradesh, India: Lessons for transition to decentralised rural electrification

The energy poverty cycle continues to pose a major challenge for governments in emerging economies. Electrification has typically been delivered through centralized generation and distribution that has not always afforded equitable or efficient access. Decentralized solar technologies are fast approaching financial parity and have certain environmental

advantages over grid extension, especially in rural and remote societies. We explore the emergence of decentralized energy systems in the state of Uttar Pradesh, India's most populated state, with notable energy access and equity challenges. We suggest that future electrification policies and strategies should be based on the principles of diversity in technology use, localized implementation, and centralized planning and enforcement to address energy poverty conundrum in the state of Uttar Pradesh or similar economies. (2 Figures, 4 Tables, 119 References)

WIND ENERGY

[14587]

Basu M. 2019

Renewable Energy Focus **30**: 107-122

Department of Power Engineering, Jadavpur University, Kolkata 700098, India

Economic environmental dispatch of solar-wind-hydro-thermal power system

Economic environmental dispatch (EED) is a significant chore in solar-wind-hydro-thermal power system comprising multi-reservoir cascaded hydro plant with time delay, thermal plants with non-smooth fuel cost, NO_x emission level and SO_2 emission level functions, wind power generating units, solar PV plant, and battery energy storage system. It is an extremely restricted multi-objective optimization problem linking conflicting objectives with both equality and inequality constraints. Here, non-dominated sorting genetic algorithm-II (NSGA-II) has been suggested for solving EED of the solar-wind-hydro-thermal power system with battery energy storage system where generations are allocated among the online units such that cost, NO_x emission level, and SO_2 emission level are optimized simultaneously while fulfilling all operational constraints. Test results of two test systems acquired from the suggested technique have been fit to that acquired from strength

Pareto evolutionary algorithm 2 (SPEA 2). (7 Figures, 8 Tables, 50 References)

[14588]

Bharani R and Sivaprakasam A. 2019

Data in Brief **25**: 104291

Department of Electrical and Electronics Engineering, Anna University, Chennai, 600025, India

A large volume wind data for renewable energy applications

The objective of the collection of dataset is to calculate the wind energy potential in the selected location using large volume of wind dataset. The wind energy potential data were collected at 100 m height from MSL (mean sea level) from 2014 to 2016. The wind speed and direction were used to analyse wind energy characteristics and suitable site for wind turbine installation. The maximum wind power density was observed at monitoring sites S1, S2, S3, and S4. The altitude of the monitoring station and geomorphology of the site significantly control the wind power density. (2 Figures, 2 Tables, 4 References)

[14589]

Chaithanya S, Reddy V N B, and Kiranmayi R. 2019

Ain Shams Engineering Journal **10**(2): 411-417

Department of Electrical Engineering, Jawaharlal Nehru Technological University Anantapur, Anantapuramu, Andhra Pradesh, India

Modeling & analysis of grid-tied PMA based offshore wind energy system using PSCAD/EMTDC

This paper proposes an improved dynamic system for controlling a current source inverter (CSI) with a generic current controller (GCC) using voltage dependent current limits (VDCL). This technique is employed to maintain the continuity of DC link current irrespective of the load conditions and grid voltage with real and reactive power transfer capabilities. The proposed controller reduces the complexity and maintains suitable gate pulse distribution for CSI. Furthermore, the

proposed controller is independent of external current limiters, additional monitoring devices, and grid voltage and frequency. Simulation results illustrate the proper performance of the developed dynamic model of the wind turbine and control scheme performance. (16 Figures, 2 Tables, 27 References)

[14590]

Gupta D, Das A, and Garg A. 2019

Energy **181**: 1064–1074

Indian Institute of Management Ahmedabad, Public Systems Group, Dorm 29, Room 17, New Campus, IIM Ahmedabad, Vastrapur, 380015, Ahmedabad, Gujarat, India

Financial support vis-à-vis share of wind generation: Is there an inflection point?

This paper analyses the relationship between financial mechanisms and wind capacity and wind power generation across 15 countries and 10 US states over 2006–2017. These countries/states contribute to 88% of the total wind generation capacity in 2017, and the contribution of their individual wind capacities to overall electricity generation rose from 0.15–24.2% (2006) to 1.2–38.5% (2017). Our analysis indicates that the trend of financial support reverses beyond an inflection point vis-à-vis the share of wind power in the total power generated. The inflection point exists for all countries, but the value varies across countries. The relationships are statistically significant. This has important policy implications with regard to the governments' approach towards promoting wind power as share of wind generation increases. (5 Figures, 5 Tables, 68 References)

[14591]

Jamil E, Hameed S, Jamil B, and Qurratulain. 2019
Sustainable Energy Technologies and Assessments **35**: 98–116

Department of Electrical Engineering, Aligarh Muslim University, Aligarh 202002, India

Power quality improvement of distribution system with photovoltaic and permanent magnet synchronous generator based renewable energy farm using static synchronous compensator

This paper presents power quality improvement for effective power transfer in a grid-integrated solar photovoltaic-wind energy hybrid system. The hybrid system constitutes a renewable energy farm, based on photovoltaic energy generation system and wind energy conversion system. The system experiences frequent disturbances in AC loads and power output from the renewable farm. This creates reactive power mismatch and raises voltage instability and power quality issues. This gap can be eliminated using an adjustable reactive power source (i.e., static synchronous compensator). Three case scenarios of the hybrid system, that is, hybrid system in (I) standalone mode, (II) grid-integrated mode, and (III) grid-integrated mode with STATCOM, are tested to compare their dynamic and transient performances. Results show that scenario-III best fulfilled the dynamic compensation requirement among all cases. Under this scenario, load bus voltage is regulated at around 1.0 p.u. and total harmonic distortion in voltages/currents is maintained at around 1%. Furthermore, this scenario demonstrated superior transient response towards a step change in reactive power load, significantly reducing maximum peak deviation by 73.4% and settling time by 75% in load voltage compared to the worst case of scenario-I. (20 Figures, 7 Tables, 51 References)

[14592]

Kumar S V V A, Nagababu G, and Kumar R. 2019

Energy **185**: 599–611

Earth, Ocean, Atmosphere, Planetary Sciences and Applications Area (EPSA), Space Applications Centre (ISRO), Ahmedabad, Gujarat, India

Comparative study of offshore winds and wind energy production derived from multiple scatterometers and met buoys

The present article provides an extensive comparison of four scatterometers, namely, QuikSCAT, OSCAT, ASCAT-A, and ASCAT-B, with long-term in-situ wind datasets over the North Indian Ocean. Results show that the QuikSCAT and the OSCAT wind data have a lesser bias with the range from 0.15 m/s (2.4%) to 0.83 m/s (15.1%) before adjustments. For adjusting the satellite wind speeds, linear regression was used. Further, the synergetic approach of linear regression adjustments and the combination of scatterometer data have resulted in smaller differences. The absolute deviation in mean wind speed between co-located buoy data and combined scatterometer data is less of the order 2.1%, and the mean power density showed a difference of 2.5%. The study revealed that the combined scatterometer datasets would help in the accurate assessments of wind resource rather than a single scatterometer. (7 Figures, 5 Tables, 43 References)

[14593]

Lakhanpal S. 2019

Environmental Development **30**: 51-60

ATREE (Ashoka Trust for Research in Ecology and the Environment), Bangalore, India

Contesting renewable energy in the global south: A case-study of local opposition to a wind power project in the Western Ghats of India

This study employs ethnographic methods to analyse the case of local opposition to a 113 MW wind power project located in the Western Ghats of India. India, an emerging economy, is the fourth largest producer of wind energy worldwide and is expanding the share of renewable energy through national and provincial level policies. The Western Ghats are a designated UNESCO world heritage site for their exceptional biodiversity and the wind power project conflicted with natural resource-based livelihoods of indigenous populations and threatened to their subsistence agricultural

practices along with posing a threat to the ecology of the landscape. As a result, local activists protested against the wind power project and this contestation was animated and influenced by a variety of public, civic and private actors and institutions across scale. This paper uses insights from political ecology and energy geography to shed light on the interaction between these multiple actors and how this interaction mediated the contestations around renewable energy. It focuses on the micropolitics of this contestation to highlight the social and political processes that underpin the transition to sustainable energy. It sheds light on local struggles and contestations around renewable energy projects in conjunction with national and global commitments and shows how contestations around renewable energy in the Global South are distinct from the largely prevalent NIMBY approaches in the developed countries. This study contributes to global debates around governing renewable energy, particularly in developing countries. (1 Figures, 1 Table, 34 References)

[14594]

Sahoo B, Routray S K, and Rout P K. 2019

Engineering Science and Technology, an International Journal **22**(3): 11-826

Department of Electrical Engineering, SOA University, Bhubaneswar, Odisha

Repetitive control and cascaded multilevel inverter with integrated hybrid active filter capability for wind energy conversion system

This manuscript presents a repetitive control (RC) method and 31-level reduced switch cascaded inverter topology (31-level RSCI) with an integrated hybrid active filter capability for a grid-connected doubly-fed induction generator (DFIG) based on wind energy conversion system (WECS). Repetitive control approach is considered for the inverter operation due to its better controllability and accuracy under

periodic disturbance conditions. Further, to enhance the system performance by supplying the desired reactive power to DFIG and harmonic reduction, a 31-level RSCI topology with a reduced number of unidirectional switch operations is proposed and implemented in the rotor side converter (RSC). This leads to benefit of highest power extraction and offers the required reactive power to DFIG. In addition to that, an LC filter on the grid side converter (GSC) is added to work as a hybrid active filter for harmonic cancellation produced by the nonlinear load and so behaves like a static compensator (STATCOM) even under shutdown condition of the wind turbine. Indirect current control and flux oriented reference frame control are implemented for grid and rotor side converter, respectively. The proposed approach is validated with the simulated test results under both steady state and dynamic conditions. (20 Figures, 2 Tables, 37 References)

[14595]

Sharma S and Sinha S. 2019

Environmental and Sustainability Indicators 1-2:
100003

Centre for Energy & Environmental Engineering,
National Institute of Technology, Hamirpur, 177005,
Himachal Pradesh, India

Indian wind energy & its development-policies-barriers: An overview

Wind energy is one of the clean sources of energy and India has a huge potential for wind energy resources (102 GW at 80 m height and 302 GW at 100 m height). This vast potential has remained unexplored and it can be achieved through well framed policies. This paper presents a detailed study of the fiscal incentives and development schemes offered by Indian government in expanding wind energy business. Wind energy policies of India have been keenly studied and obstacles to the success of these policies and programmes have also been discussed in this paper. The outcomes of this

paper reiterate the work that has been carried out by Indian government (Central and State) in the wind energy sector involving lower renewable energy prices, improved financial incentives, opportunities in offshore wind energy, and a steady market growth. (4 Figures, 2 Tables, 54 References)

ELECTRIC POWER ENGINEERING

[14596]

Alvi S, Mahmood Z, and Nawaz S M N. 2018

Energy Reports 4: 323-327

Department of Economics, School of Social Sciences
and Humanities, National University of Sciences and
Technology, Islamabad, Pakistan

Dilemma of direct rebound effect and climate change on residential electricity consumption in Pakistan

This study is the first of its nature in Pakistan that estimates the magnitude of direct rebound effect in residential electricity consumption. Using the time series data from 1973 to 2016, we apply co-integration econometric technique and error correction model to analyse the direct rebound effect. The results indicate that the magnitude of direct rebound effect is 69.5 percent in the long run while 42.9 percent in the short run. Further, impact of climate change on electricity consumption is examined. The results indicate that consumption of energy is increasing in both short run and long run under climatic changes. These findings suggest that the Government of Pakistan needs to consider rebound effects along with climatic changes in formalizing its energy policies. (2 Figures, 3 Tables, 18 References)

[14597]

Chen K, Guo H, Hu J, Kota S, *et al.* 2019

Resources, Conservation and Recycling 142: 232-244

Department of Civil and Environmental Engineering,
Louisiana State University, Baton Rouge, LA, 70803,
USA

Projected air quality and health benefits from future policy interventions in India

In this study, the Community Multi-scale Air Quality (CMAQ) model was applied to simulate potential benefits from future emission control with unchanged meteorology. Fourteen scenarios towards energy, residential, agriculture, industry, and open burning were simulated and the changes in ozone (O_3) and $PM_{2.5}$ as well as health outcomes were evaluated. $PM_{2.5}$ concentrations decreased significantly by reducing uses of solid fuels (S4), uses of diesel generating sets (S13), and applying new standards to industry facilities (S11) with maximum reductions of $\sim 50 \mu g/m^3$, $\sim 30 \mu g/m^3$ and $\sim 15 \mu g/m^3$ in north India, separately. Reducing uses of solid fuels caused significant O_3 reduction by maximum >8 ppb (S4, December), and significant effects also occurred when applying new standards to current power plants (S1) (~ 4 ppb, October) and in S13 (~ 3 ppb, December). Combination of all possible strategies would reduce O_3 , primary PM components (PPM), and total $PM_{2.5}$ in December by >20 ppb, $>40 \mu g/m^3$, and $>60 \mu g/m^3$ in north India, while O_3 and secondary inorganic aerosol (SIA) would increase by 5 ppb and $2 \mu g/m^3$, respectively, in October in western and southern India. SIA also increased in part of northern regions in December by $\sim 2 \mu g/m^3$. A total of up to 0.68 million premature mortality and 43% years of life lost (YLL) would be avoided by applying all controlling strategies. (7 Figures, 2 Tables, 50 References)

[14598]

Zhang Y and Farnoosh A. 2019

Energy Policy 132: 678-690

China University of Petroleum-Beijing, Changping, Beijing 102249, China

Analyzing the dynamic impact of electricity futures on revenue and risk of renewable energy in China

In this paper, researchers propose a new round

of revolution in the power sector to introduce electricity futures into China with the expectation of perfecting the market and providing a proper hedging tool for renewable plants. We make an estimation of the risk premium and then simulate the futures prices in China's market. To support the establishment of the futures contracts, we also propose two pricing mechanisms, demand-side price and opportunity cost price, and study their effects on the futures. Finally, some suggestions with regard to the construction of futures market in China and the operational strategy for renewable plants are given. (16 Figures, 5 Tables, 53 References)

ENERGY PLANNING AND POLICY

[14599]

Albulescu C T, Demirerb R, Raheem I D, and Tiwari A K. 2019

Energy Economics 83: 375-388

Management Department, Politehnica University of Timisoara, Piata Victoriei No. 2, Timisoara, Romania

Does the U.S. economic policy uncertainty connect financial markets? Evidence from oil and commodity currencies

A battery of linear and nonlinear Granger-based causality tests indicate the presence of a causal relationship between economic policy uncertainty and the connectedness of oil and currency markets, particularly at low frequencies and more significantly after the outburst of the global financial crisis. While crude oil generally serves as a net transmitter of shocks to currencies across all frequency bands, the spillover effects from oil are largely concentrated towards the G10 currencies of Australian and New Zealand dollar that are often used as investment currencies in global carry trade strategies. Overall, our findings suggest the presence of a significant pass-through effect of economic policy uncertainty via oil prices, spilling over to the currency market, in line with the emerging evidence that the monetary policy

by the U.S. Fed serves as a major driver of a global financial cycle that describes patterns in global capital flows, credit activity, and asset prices across financial markets. (4 Tables, 73 References)

[14600]

Arias-Gaviria J, Ximena Carvajal-Quintero S, and Arango-Aramburo S. 2019

Renewable Energy **139**: 1111-1119

Decision Sciences Group, Facultad de Minas, Universidad Nacional de Colombia, Carrera 80 No 65-223, Office M8A-403, Robledo, Medellin, Colombia

Understanding dynamics and policy for renewable energy diffusion in Colombia

Direct incentives, such as price based, are not included in the law. Experiences in other countries have proven that direct incentives are more efficient than indirect ones to promote RE. The purpose of this study was to evaluate incentives for RE diffusion in Colombia through a simulation model for energy policy recommendations. We tested four incentives (i.e., tax reduction, feed-in-tariffs, tradable certificates, and technical subsidies) and four RE sources (i.e., small hydro, biomass, wind, solar and geothermal). Simulation results show that a combined scenario using feed-in-tariffs and technical subsidies can boost the deployment of RE, avoiding significant price increases for the final consumer. None of the incentives leads to reaching the RE target, given the growing demand for energy. Complementary policies could focus on improving energy efficiency. (4 Figures, 2 Tables, 57 References)

[14601]

Aurangzeb M and Jana A K. 2019

Applied Thermal Engineering **147**: 1009-1023

Energy and Process Engineering Laboratory, Department of Chemical Engineering, Indian Institute of Technology Kharagpur, 721 302, India

Vapor recompression with interboiler in a ternary dividing wall column: Improving energy efficiency and savings, and economic performance

This work deals with a ternary dividing wall column (DWC) for improving its energetic and economic potential through thermal intensification route. In this light, a vapor recompression heat pump system in conjunction with an interboiler (IR) is proposed to configure externally with the classical DWC scheme that allows heat transfer through the dividing wall. Formulating a variable manipulation policy at dynamic state, it is investigated that the vapor recompressed DWC with inter and bottom reboiler (VRDWCIBR) shows a better performance than the VRDWC with either bottom reboiler or interboiler(s). For a ternary hydrocarbon system, the VRDWCIBR secures the best performance, providing 81.05% savings in utility consumption (which is double to that of DWC) with a thermodynamic efficiency of 55.60% and a payback time of 2.82 years. The proposed heat integration arrangement can be retrofitted with a little modification in the classical DWC column. (12 Figures, 6 Tables, 38 References)

[14602]

Can S R du, Khandekar A, Abhyankar N, Phadke A, Khanna N Z, and Zhou D F N. 2019

Applied Energy **238**: 1108-1125

Energy Analysis and Environmental Impacts Department, Energy Technology Area, Lawrence Berkeley National Laboratory, United States

Modeling India's energy future using a bottom-up approach

This study describes a bottom-up model that can be used to assess the impacts of emissions mitigation policies and the linkages between the physical drivers and energy growth of India's key industries. It focuses on capturing the main physical drivers of this growth to identify and prioritize the subsectors to address and develop

sustainable, low carbon pathways to support economic growth. This analysis shows that India can achieve its Nationally Determined Contribution (NDC) while achieving substantial economic growth using its currently planned policies. The study describes in detail the methodology and underlying assumptions that are needed by policy makers to inform targeted policy interventions and provide a baseline scenario in the case of no major new technology breakthroughs and no new adopted policies. (16 Figures, 9 Tables, 66 References)

[14603]

Chowdhury H, Chowdhury T, Thirugnanasambandam M, Farhan M, Ahamed J U, Saidur R, and Sait S M. 2019

Journal of Cleaner Production **231**: 297–306

Department of Mechanical Engineering, Chittagong University of Engineering & Technology, Kaptai Highway, Raozan, Chattogram, Bangladesh

A study on exergetic efficiency vis-à-vis sustainability of industrial sector in Bangladesh

In this context, an attempt is made to establish sustainability indicators for the industrial sector. Different measures to improve the sustainability of the industrial sector of Bangladesh are also discussed. Based on the energy consumption data during 2000–2015, energy, exergy, and sustainability analyses are performed. It is found that the energy efficiency varies from 55.01% to 59.67% and exergy efficiency varies from 53.11% to 56.97%. Exergy efficiency is found to be at the lower side due to the accounting of irreversibility. Various sustainability indicators, such as sustainability index, depletion number, exergetic renewable share, cumulative exergy loss, and non-renewable exergetic share, have been studied as well. It is observed that depletion numbers vary from 43% to 45% and the sustainability index varies from 2.21 to 2.32. Non-renewable exergetic share is as high as 98% and the maximum cumulative exergy loss is found to be 217.3 PJ in 2015.

Improvement potential shows a continuous increase from 22.75% in 2000 to 101.89% in 2015. Waste heat recovery, energy audit, waste minimization, and adopting renewable energy sources are recommended to increase the efficiency and sustainability of this sector. The outcome of this study reveals that exergy analysis is an effective technique to develop energy conservation policies for this sector. (7 Figures, 7 Tables, 59 References)

[14604]

Dhakouani A, Znouda E, and Bouden C. 2019

Energy Policy **133**: 110922

Université de Tunis El Manar, Ecole Nationale d'Ingénieurs de Tunis, LR-11-ES16, Laboratoire de Matériaux, Optimisation et Énergie pour la Durabilité, BP37, LEBELVEDERE, 1002, Tunis, Tunisia

Impacts of energy efficiency policies on the integration of renewable energy

The objective of this paper is to demonstrate how a planned decrease of power system reliability, without impacting access to energy, could lead to a better integration of renewable energies. Therefore, we have linked an energy efficiency action, the peak clipping as scheduled outages, to the power system reliability factor. This factor has been integrated in the energy planning model Open Source energy MOdeling SYstem (OSeMOSYS), which is a cost-based long-term optimization model. Enhanced OSeMOSYS has been applied to the Tunisia power system using two scenarios reflecting renewable energy sources penetration. Simulation results showed a high rate of renewable energy sources penetration with a decrease in the power system reliability relying on energy efficiency actions. (3 Figures, 1 Table, 60 References)

[14605]

Fathima A H and Palanisamy K. 2019

Renewable Energy Focus **30**: 13–20

HCL Technologies, ELCOT – SEZ, Special Economic Zone, 602/3, 138, Sholinganallur Village, Chennai, Tamil Nadu 600119, India

Integration and energy management of a hybrid Li-VRB battery for renewable applications

In this paper, an efficient energy management strategy is proposed for a VRB and Li-ion hybrid battery system to be integrated with a grid-connected wind-PV hybrid renewable energy system (HRES). The operation of the generating system and the storage batteries are evaluated using Matlab/Simulink and techno-economic analysis is carried out. The results demonstrated successful implementation of the hybrid system with improved deliver ability and storage lifetime. (15 Figures, 3 Tables, 26 References)

[14606]

Gaur A S, Das P, Jain A, Bhakar R, and Mathur J. 2019
Energy Strategy Reviews **26**: 100383

Centre for Energy and Environment, Malaviya National Institute of Technology Jaipur, Rajasthan, India

Long-term energy system planning considering short-term operational constraints

This paper utilizes unit commitment (UC) extension of TIMES modeling framework to integrate operational constraints directly in a long-term power system planning model. This strategy eliminates the complexity of handling multiple models. Results indicate that incorporation of UC constraints improves the performance of the conventional generators in terms of increased capacity utilization and helps to assess flexibility requirements with high RESs. Energy storage provides the balancing and flexibility needs with stringent generator constraints. Sensitivity analysis shows that improved flexibility of thermal generators enables increased renewable penetrations. (27 Figures, 8 Tables, 60 References)

[14607]

Haider S, Danish M S, and Sharma R. 2019
Energy Economics **81**: 454–464

School of Economics, University of Hyderabad, India

Assessing energy efficiency of Indian paper industry and influencing factors: A slack-based firm-level analysis

This study estimates efficiency in energy utilization at the firm level and the feasible energy saving target of the pulp and paper industry in India. For this analysis, data is extracted from Prowess database for a panel of 67 major pulp and paper producing firms over the period of 2003–04 to 2013–14. We employed radial and non-radial variants of data envelopment analysis to assess the feasible energy saving target with the current level of output. Particularly, we employed slack-based method with variable returns to scale as a flexible and pragmatic approach to performance analysis. Results reveal no significant improvement in the energy efficiency level of the firms over the study period and show vast energy saving potential. Results of slack-based measure of energy efficiency show the feasible energy saving potential of 40%. Further, size of the firm, age, and financial performance are important factors that influence energy efficiency. Therefore, this study recommends special attention to the paper industry while implementing energy efficiency programme. We also reviewed four major policies for industrial energy efficiency improvement initiated by Bureau of Energy Efficiency, India. (3 Figures, 6 Tables, 67 References)

[14608]

Helm C and Mier M. 2019

Energy Economics **80**: 812–830

University of Oldenburg, Department of Business Administration, Economics and Law, Oldenburg 26111, Germany

On the efficient market diffusion of intermittent renewable energies

Building on an analytically tractable peak-load pricing model, we analyse how intermittency of renewable energies affects the market diffusion that results from these lower costs. In particular, once renewables have become competitive by attaining the same levelized cost of electricity

(LCOE) as fossils, the marginal increase in efficient capacities due to a further cost reduction varies substantially. Initially, it is small and then it rises, but it falls again once renewable capacities are large enough to satisfy the whole electricity demand at times of high availability. If external costs of fossils are internalized by a Pigouvian tax, then perfect competition leads to efficient investments in renewable and fossil capacities, even though we assume that only a subgroup of consumers can adapt their demand to price fluctuations that are caused by the intermittency of renewables. Moreover, fossils receive a capacity payment through the market for their reliability in serving demand of non-reactive consumers. Maximum electricity prices rise with the share of renewables. If regulators impose a price cap, this initially raises investments in renewables, but the effect may reverse if the share of renewables is large. (3 Figures, 1 Table, 43 References)

[14609]

Heynen A P, Lant P A, Sridharan S, Smart S, and Greig C. 2019

Energy and Buildings **191**: 95–103

Energy & Poverty Research Group, School of Chemical Engineering, The University of Queensland, Brisbane, Queensland 4072, Australia

The role of private sector off-grid actors in addressing India's energy poverty: An analysis of selected exemplar firms delivering household energy

The Indian Government is making important inroads in addressing energy poverty in India, recently announcing the electrification of 100% of villages. Yet, approximately 300 million people are still without access to electricity. This vast population of energy poor, with no household connection to the electricity grid, represents a market for micro-level actors, particularly private sector firms providing off-grid solutions. However, due to the ever-expanding grid, such firms may face uncertainty and must carefully

consider their value propositions and strategies. This research analyses 10 exemplar firms in India's off-grid sector. Their responses, as part of a semi-structured interview approach, provided a unique 'insider' perspective on the role of the private sector that cannot be gained from secondary data observations or the existing literature. Two important observational clusters were found. Those firms more concerned about business risks from grid expansion generally exhibited a strong degree of social embeddedness, perhaps as a risk mitigation strategy. Firms less concerned about the grid generally had affordability as a core value proposition and operated in more remote locations. This dichotomy of perspectives gives some insight into the unique role of private sector actors in providing electricity to the dwellings of India's energy poor. (2 Figures, 4 Tables, 42 References)

[14610]

Khalid R, Javaid N, Rahim M H, Aslam S, and Sher A. 2019

Sustainable Computing: Informatics and Systems **21**: 103–118

COMSATS University Islamabad, Islamabad 44000, Pakistan

Fuzzy energy management controller and scheduler for smart homes

In this paper, the classification of appliances is introduced based on their energy consumption pattern. An energy management controller is developed for demand side management. We have used fuzzy logic and heuristic optimization techniques for cost, energy consumption, and PAR reduction. Fuzzy logic is used to control the throttleable and interruptible appliances. On the other hand, the heuristic optimization algorithms, bat inspired and flower pollination, are employed for scheduling of shiftable appliances. We have also proposed a hybrid optimization algorithm for the scheduling of home appliances, named as hybrid bat

pollination optimization algorithm. Simulation results show a significant reduction in energy consumption, cost, and PAR. (19 Figures, 8 Tables, 35 References)

[14611]

Kumar A, Meena N K, Singh A R, Deng Y, He X, Bansal R C, and Kumar P. 2019

Applied Energy **253**: 113503

College of Electrical Engineering, Zhejiang University, Hangzhou 310027, PR China

Strategic integration of battery energy storage systems with the provision of distributed ancillary services in active distribution systems

In this paper, a new bilevel optimization framework is developed to optimally allocate the intense wind power generation units and battery energy storage systems with the provision of central and distributed ancillary services in distribution systems. Two battery energy storage systems and one shunt capacitor are strategically allocated for coordination of wind power generation. One of the batteries is deployed at grid substation to participate in central ancillary services, whereas the second is participating in distributed ancillary services. At level 1, all the distributed energy resources are optimally allocated, while minimizing the annual energy loss of distribution systems. Level 2 performs hourly optimal energy and ancillary services management of distributed resources deployed at level 1. The objectives considered at level 2 are the minimization of hourly load deviation, reverse power flow towards the grid, power loss, and node voltage deviation. The proposed framework is implemented on a real-life Indian 108-bus distribution system for different cases and solved by using a genetic algorithm. The comparison of simulation results reveals the promising advantages of the proposed optimization framework. It provides more energy loss and demands deviation reduction, improved system voltage and power

factor at higher wind penetration as compared to the cases in which distributed ancillary services are ignored in the planning stage. (12 Figures, 3 Tables, 117 References)

[14612]

Lokeshgupta B and S. Sivasubramani. 2019

Sustainable Cities and Society **47**: 101458

Department of Electrical Engineering, Indian Institute of Technology Patna, Patna, 801106, India

Multi-objective home energy management with battery energy storage systems

In this paper, an intelligent multi-objective household DSM with battery storage systems is proposed to minimize both the objectives simultaneously. Generally, the residential DSM deals with various controllable appliances that normally have different operating time priorities according to consumers' preferences. Because of this, the DSM problem is modelled as a mixed integer optimization problem. In this paper, the multi-objective mixed integer linear programming technique (MOMILP) is used to solve the proposed residential DSM problem. The proposed model is tested on a system having four different residential consumers. The benefits of the battery energy storage systems are analysed by taking six different scenarios. An economic analysis of each residential consumer's battery storage system with load uncertainty modelling is also done in this paper. Simulation results of various scenarios with different objectives demonstrate the effectiveness of the proposed model. (9 Figures, 5 Tables, 28 References)

[14613]

Luqman M, Ahmad N, and Bakhsh K. 2019

Renewable Energy **139**: 1299–1309

School of Economics, Shandong Normal University, Jinan, PR China

Nuclear energy, renewable energy and economic growth in Pakistan: Evidence from non-linear autoregressive distributed lag model

This paper investigates asymmetric effects of renewable and nuclear energy on economic growth by extending production function along with labour and capital for Pakistan's economy. Paper utilizes non-linear autoregressive distributed lag model with the yearly data of 1990–2016 to extract reliable facts. Results reveal the presence of asymmetric co-integration among variables. Further, capital formation contributes positively to economic growth. In addition, two more conventional models have been constructed to investigate asymmetric impacts of economic growth, oil prices, oil consumption, and CO₂ emissions on nuclear and renewable energy consumption. Results reveal that oil consumption leads to a negative impact on renewable energy consumption, while it is neutral for nuclear energy consumption. Oil price was having neutral impact on renewable and nuclear energy consumption. Policy suggestions are given based on empirical results. (4 Figures, 7 Tables, 56 References)

[14614]

Paul B, Jinnie W, Zeba A, Emma A, Budy R, and Kenneth B G H. 2019

Energy Policy **132**: 1216–1228

Fellow, Crawford School of Public Policy, Australian National University, Canberra, AU

Overcoming barriers to solar and wind energy adoption in two Asian giants: India and Indonesia

Solar and wind electricity generation technologies have become cost competitive and account for a growing share of global investment in new electricity generation capacity. Both India and Indonesia have ambitious targets for adoption of these technologies, and India has an impressive current rate of uptake. Substantial obstacles exist, however, including the entrenched positions of coal and other fossil fuels, regulatory barriers to market access, and weak abilities of electricity utilities to manage intermittent renewables. This paper reviews these obstacles and discusses strategies to overcome them. We

focus on the use of reverse auction processes to deliver low-price solar and wind contracts, as are being successfully employed in India, on tax and subsidy reform options, on regulatory and incentive design strategies, on approaches to bolster grid management capacities, and on the importance of minimizing protectionist barriers. Our analysis covers both small- and large-scale systems. (7 Figures, 134 References)

[14615]

Plutshack V, Sengupta S, Sahay A, and Viñuales J E. 2019

Energy Policy **132**: 367–378

Energy Access Project, Nicholas Institute for Environmental Policy Solutions, Duke University, 2117 Campus Drive, Durham, NC 27708, United States

New and renewable energy social enterprises accessing government support: Findings from India

This research specifically explores how social enterprises operating in rural India with decentralized renewable energy solutions seek to access government support and what strategies they adopt to engage with the government. An inductive theory-building approach was adopted to explore this and advance current knowledge in the boundaries of social entrepreneurship and policy. We propose 'Engagement' and 'Disengagement' as the two strategies used by social enterprises in this context in accessing government support and policy. 'Engagement' is a strategy comprising the tactics: (a) leveraging policy, (b) building and leveraging relationships, (c) lobbying, and (d) monitoring. 'Disengagement' is a strategy comprising the tactics: (a) avoiding government presence and (b) disengagement from policy. (1 Figure, 4 Table, 99 References)

[14616]

Pradhan P, Gadkari P, Arora A, and Mahajani S M. 2019

Energy Procedia **158**: 3405–3410

Centre for Technology Alternatives for Rural Areas, IIT Bombay, Mumbai 400076, India

Economic feasibility of agro waste pelletization as an energy option in rural India

In this paper, an economic evaluation for agricultural waste pelletization is presented. In the view of a small scale, village level bioenergy system for India, we considered a 2 tonnes/day capacity pelletization plant as the base case. The capital investment and annual operating expenses were \$41250 and \$34282, respectively. The raw material cost shared the largest among all elements of annual operating expenses. The results showed that the pelletization plant appears to be feasible, considering the selling price of pellet is greater than \$120 per tonne. Sensitivity analysis showed a strong influence of pellet price on profitability parameters (NPV and IRR). (3 Figures, 3 Tables, 9 References)

[14617]

Rani P, Mishra A R, Pardasani K R, Mardani A, Liao H, and Streimikiene D. 2019

Journal of Cleaner Production **238**: 117936

Department of Mathematics, National Institute of Technology, Warangal, Telangana, 506004, India

A novel VIKOR approach based on entropy and divergence measures of Pythagorean fuzzy sets to evaluate renewable energy technologies in India

This paper first develops novel information measures for PFSs. Next, the VIKOR method is extended to solve the multiple-criteria decision-making (MCDM) problems with PFSs. To achieve the significant degrees of the decision-experts (DEs) and the criteria, new approaches are determined with the help of two developed measures, that is, Pythagorean fuzzy entropy and Pythagorean fuzzy divergence. Moreover, an operation is utilized to PF weighted averaging operator for integrating the individual decision information into a group decision matrix. Further, the proposed PF divergence measure is implemented to determine the particular measure of closeness of the alternatives in the present method. Finally, to exemplify the

efficiency of the proposed approach, a selection problem of renewable energy technologies is presented where the evaluation of the energy alternatives versus each criterion is expressed in terms of Pythagorean fuzzy numbers (PFNs). The results of this study demonstrated that the proposed PF-VIKOR was effective to select and evaluate renewable energy technologies. (5 Figures, 13 Tables, 85 References)

[14618]

Rehman M U, Bouri E, Eraslan V, and Kumar S. 2019
Resources Policy **63**: 101456

Informetrics Research Group, Ton Duc Thang University, Ho Chi Minh City, Vietnam

Energy and non-energy commodities: An asymmetric approach towards portfolio diversification in the commodity market

We investigate the presence of short- and long-run asymmetric relationships between energy and non-energy commodities for weekly data from January 2010 to June 2018. Using the non-linear ARDL methodology, we show that oil prices have significant long-run negative effects on the prices of gold and silver, indicating that for both metal commodities oil price increases lead to more decrease than the subsequent oil prices decrease. Crude oil, among other energy commodities, is found to offer more diversification benefits when combined with gold or silver; however, minimal diversification benefits can result from combining crude oil with wheat or platinum. Gas futures, among other energy markets, offer more diversification opportunities when combined with copper, wheat, platinum or palladium, while coal offers maximum diversification benefits when combined with gold, silver or wheat. Our results are robust when NARDL is applied to the daily data and also when the analysis is conducted using the causality-in-quantiles test. (4 Figures, 9 Tables, 40 References)

[14619]

Sankhyayan P and Dasgupta S. 2019

Energy Policy **131**: 131–143

School of Humanities and Social Sciences, Indian Institute of Technology Mandi, India

‘Availability’ and/or ‘Affordability’: What matters in household energy access in India?

This paper estimates fuel costs associated with such transitions and analyses the determinants of access to electricity for lighting and liquified petroleum gas (LPG) for cooking. State-level regression models based on data from 61st (2004–05), 68th (2011–12), and 71st (2014) rounds of National Sample Survey are used. While energy expenditures are found to be comparable for kerosene and electricity for lighting, it increases 3.6–8.8-fold for transition to LPG from the traditional fuel. Availability is important for greater uptake of electricity, that is, the higher rate of electrification helps, but the same is not true for LPG. Although untargeted tariff subsidy leads to significant budgetary pressure, it does not affect the access. States with higher income and literacy rate/women empowerment have greater access to LPG and electricity. This shows that while Indian energy policies has always focused on removal of supply-side barriers through infrastructure creation, removal of cost barrier, and subsidizing tariff, a more meaningful way to ensure access is perhaps to integrate energy policies within the broader arena of comprehensive development policies to ensure improvement in socio-economic indicators. (6 Figures, 6 Tables, 32 References)

[14620]

Santhosh M, Venkaiah C, and Kumar D M V. 2019

Sustainable Energy, Grids and Networks **19**: 100242

Department of Electrical Engineering, National Institute of Technology, Warangal, 506 004, Telangana, India

Short-term wind speed forecasting approach using ensemble empirical mode decomposition and deep Boltzmann machine

Wind energy is a fairly dependable source of renewable energy for generating electricity in spite of its highly non-linear and chaotic nature. But the prediction of such data demands highly non-linear temporal features. A new robust hybrid deep learning strategy (HDLS) is developed for enhanced prediction accuracy by preprocessing the raw input. The most effective signal decomposition technique, namely, ensemble empirical mode decomposition (EEMD), is used for preprocessing. This technique decomposes the input into finite intrinsic mode functions and a residue after which training input matrices are established. In the next step, each deep Boltzmann machine (DBM) model is constructed by stacking four restricted Boltzmann machines (RBM). The training input matrices formed by each of the extracted intrinsic mode functions and a residue are applied to each DBM. Then the summation of all the predicted results is evaluated to attain the final result of time series. For adequate performance assessment, hybrid deep learning strategy is developed for analysing wind farms in Telangana and Tamil Nadu. Finally, the proposed deep learning strategy is found to give more accurate results in comparison with existing approaches. (22 Figures, 12 Tables, 53 References)

[14621]

Sharma S and Sud M. 2019

Energy Policy **131**: 33–42

Business Policy, Indian Institute of Management Ahmedabad, Vastrapur, Ahmedabad-380015, India

Impact of regulatory framework on bidding behavior of firms: Policy implications for the oil & gas sector

This paper adopts a qualitative approach to examine bidding decisions of four petroleum

exploration firms across several bidding rounds from a resource picking mechanism perspective. Our findings suggest that uncertainties in the regulatory framework were exploited by the firms, resulting in policy inefficacy. Our research identifies four variants of uncertainties and three types of aggressive bidding behaviour. We recommend that in order to increase policy efficacy, there is a need to decrease stance uncertainty. Further adoption of a behavioral strategy lens to examine regulatory policy can inform the extant literature. (1 Figure, 6 Tables, 47 References)

[14622]

Sharma V. 2019

Energy Research & Social Science 52: 10–19

Energy and Poverty Research Group, The University of Queensland, Australia

Access for adaptation? Reviewing the linkages between energy, disasters, and development in India

This paper probes these links and argues for a critically co-dependent conceptual relationship between energy access, rural development, and climate adaptation and disaster management. It then explores how, if at all, these links may exist in Odisha, one of India's most climate vulnerable states with low socio-economic development. The paper concludes that a deep-seated policy reform is necessary to bring about a shift in how we (a) measure 'successful' disaster policy, (b) understand the role of energy in a disaster context, and (c) recognize and seek greater synergies between energy access, rural development, and climate adaptation objectives. (3 Figures, 3 Tables, 105 References)

[14623]

She S, Li P, Sheng Z, *et al.* 2019

Energy 185: 102–110

School of Materials Science and Engineering, Dalian University of Technology, Dalian, 116023, China

Energy efficiency improvement in electron beam purification of silicon by using graphite lining

Electron beam melting technology can remove volatile impurities from silicon very effectively. However, the strong cooling capacity of water-cooled copper crucible brings high energy consumption, which limits the wide application of this technology. As far as energy utilization is concerned, one can see from this paper that the refining process of silicon is improved based on numerical simulation and experimental results. The energy efficiency is increased through the use of a graphite lining between silicon and the bottom of water-cooled copper crucible. The results show that the addition of graphite lining is resulting in increased thermal resistance and the heat loss is reduced. Compared to the traditional electron beam melting technology, the temperature of the melt pool is increased with the same power accelerating purification process. The experiment results show that refining cycle time for the same amount of the material can be reduced while keeping the same purification efficiency. As a consequence, the energy consumption is reduced by 33%. (9 Figures, 4 Tables, 42 References)

[14624]

Sokolowski M M. 2019

Energy Policy 130: 60–68

Keio University, Shonan Fujisawa Campus, Faculty of Policy Management, 5322 Endo, Fujisawa-shi, Kanagawa 252-0882, Japan

When black meets green: A review of the four pillars of India's energy policy

The article discusses the pillars of India's energy policy presented by Modi in 2016. The main energy pillars (access, efficiency, sustainability, and security) are juxtaposed with the previous Indian strategic documents concerning the energy sector, including electricity (National Electricity Policy 2005, Draft National Energy Policy 2017). A climate-energy policy analysis

is extended by legal comments on Indian energy law. As a result, the article draws a picture of India's energy policy and climate agenda in 'black' (conventional energy) and 'green' (renewable capacity) colours. (2 Tables, 72 References)

[14625]

Styczynski A B and Hughes L. 2019

Environmental Innovation and Societal Transitions
31: 262–272

Jindal School of Government and Public Policy, O.P.
Jindal Global University, NCR Delhi, India

Public policy strategies for next-generation vehicle technologies: An overview of leading markets

Governments apply a range of policy instruments to promote the electrification of personal transport using technologies such as plug-in hybrid, battery electric, and fuel cell electric vehicles. We introduce a framework for comparing public policies cross-nationally to support the research, development, and deployment of electric vehicles. We use this framework to determine whether governments were using similar policy instruments to promote vehicle electrification during the period 2006–2016. We also examine the extent to which policy instruments are neutral across technologies, presenting country case studies for China, the United States, Japan, and within the regulatory framework of the European Union, Germany, and France. We find that governments have largely adopted technology neutral policies and are employing similar policy mixes in promoting vehicle electrification despite differences in governing institutions between the countries examined. We conclude by suggesting a future research agenda, including identifying plausible explanations for this outcome. (4 Tables, 78 References)

[14626]

Yadav R, Sahu L K, Tripathi N, Pal D, Beig G, and Jaaffrey S N A. 2019

Environmental Pollution 252(part A): 245–255
Indian Institute of Technology Gandhinagar, Palaj,
Gandhinagar 382355, Gujarat, India

Investigation of emission characteristics of NMVOCs over urban site of Western India

This is the first study to characterize the variation and emission of C₂–C₅ non-methane volatile organic compounds (NMVOCs) in a semi-urban site of western India based on measurements during February–December 2015. Anthropogenic NMVOCs show clear seasonal dependence with highest in winter and lowest in monsoon season. Biogenic NMVOCs like isoprene show highest mixing ratios in the pre-monsoon season. The diurnal variation of NMVOC species can be described by elevated values from night till morning and lower values in the afternoon hours. The elevated levels of NMVOCs during night and early morning hours were caused mainly by weaker winds, temperature inversion, and reduced chemical loss. The correlations between NMVOCs, CO, and NO_x indicate the dominant role of various local emission sources. Use and leakage of liquefied petroleum gas (LPG) contributed to the elevated levels of propane and butanes. Mixing ratios of ethylene, propylene, CO, NO_x, and so on show predominant emissions from combustion of fuels in automobiles and industries. The positive matrix factorization (PMF) source apportionments were performed for the seven major emission sectors (i.e., vehicular exhaust, mixed industrial emissions, biomass/fired brick kilns/bio-fuel, petrochem, LPG, gas evaporation, biogenic). Emissions from vehicle exhaust and industry-related sources contributed to about 19% and 40% of the NMVOCs, respectively. The rest (41%) was attributed to the emissions from biogenic sources, LPG, gasoline evaporation, and biomass

burning. Diurnal and seasonal variations of NMVOCs were controlled by local emissions, meteorology, OH concentrations, long-range transport, and planetary boundary layer height. This study provides a good reference for framing environmental policies to improve the air quality in western region of India. (9 Figures, 64 References)

[14627]

Ahmad A, Kashif S A R, Saqib M A, Ashraf A, and Shami U T. 2019

Energy **186**: 115818

University of Central Punjab, Lahore, Pakistan

Tariff for reactive energy consumption in household appliances

This paper reports the energy consumption pattern of mostly used household appliances individually and collectively over a year. Their power quality parameters are measured through experimentation to calculate the reactive energy consumed by household appliances. This paper also proposes the reactive energy tariff to enhance the awareness among domestic consumers to make the efficient use of household appliances. Currently, the reactive power management is being dealt for only the industrial consumer by imposing low power factor penalty. This research estimated that Lahore Electric Supply Company (LESCO) can generate revenue of almost 150 million US dollars in 1 year from household consumers by applying three-part tariff scheme on reactive energy. By improving the power factor, it is estimated that an energy conservation of 1.1×10^9 kWh per annum is also possible. Thus, the proposed tariff for reactive energy encourages the domestic consumers to get involved actively in energy conservation while enabling the energy utilities to transfer more active energy to consumers without the expansion of the distribution network. (9 Figures, 2 Tables, 42 References)

[14628]

Ali M, Geng Y, Robins D, Cooper D, and Roberts W.

2019

Science of the Total Environment **648**: 1520–1526

University of Chichester Business School, Bognor Regis Campus, Upper Bognor Road, Bognor Regis, West Sussex PO21 1HR, United Kingdom

Impact assessment of energy utilization in agriculture for India and Pakistan

This paper analysed the environmental impact of energy utilization in agriculture in India and Pakistan. More specifically, the study analyses the trends of fuel and electricity consumption for crop production in these countries during a 10-year period between 2002 and 2011. Life cycle impact assessment categories, including global warming potential, human toxicity, acidification, and eutrophication, were used to holistically analyse the end-user impact of energy consumption. Results indicated an increase in these impacts for both countries during the study period. On a per hectare basis, the assessed impacts were relatively greater in India than in Pakistan during the study period. The main reason behind larger impacts in India was its significantly greater use of coal for electricity generation. Overall, this study showed that further electrification of agriculture will not necessarily lead to cleaner environment in these countries. Due to high population growth rates, energy consumption for agriculture is expected to grow in these countries in the future. Unless cleaner sources of electricity are used, further energy intensification in agriculture will be detrimental to ecosystem and human health, which in turn will be counterproductive for sustainable agriculture. (7 Figures, 31 References)

[14629]

Bhattarai D, Somanathan E, and Nepal M. 2018

Energy for Sustainable Development **43**: 114–122

Nepal Environment Society, Nepal

Are renewable energy subsidies in Nepal reaching the poor?

This study uses nationally representative survey data to examine the extent to which these subsidies benefitted the rural poor. We find that only 5% of households who are eligible for a biogas subsidy have adopted biogas, and only 2% of biogas adopters are below the poverty line as compared to a poverty rate of 19% in the country. For solar home systems (SHS), 27% of the households eligible for subsidy have adopted the technology and 25% of the adopters are below the poverty line. The SHS subsidy programme is much more accessible to the poor as compared to the biogas subsidy programme for two main reasons. First, solar home systems are much cheaper than biogas plants, and so they are more accessible to the poor after the subsidy. Second, the SHS subsidy is geographically targeted towards poor areas, while the biogas subsidy is not. (11 Figures, 2 Tables, 17 References)

[14630]

Blank M S, Bardhan R, and Haque A N. 2019
Energy Research & Social Science **49**: 53–67
Department of Architecture, University of Cambridge,
1-5 Scroope Terrace, CB2 1PX, Cambridge, United
Kingdom

Gender, domestic energy and design of inclusive low-income habitats: A case of slum rehabilitation housing in Mumbai, India

This research adopts a gendered perspective in exploring slum rehabilitation housing in India. Based on a household survey and a focus group discussion (FGD), women's household and working practices are explored in interview narratives and systems analysis. The findings show that the relocation to slum rehabilitation housing (SRH) has radically changed women's household routines (cooking, comfort, child-rearing, working and entertainment practices) and that women are more affected by the

relocation than men. Changed practices, poor design of SRH, and lack of outdoor space have radically increased electricity use and living costs in all the surveyed households. The economic pressure forces women into lowly paid jobs or informal economy, creating a vicious circle where women's time poverty further reduces their social capital and opportunities for self-development in terms of education or formal employment. A comparison of SRH typologies shows that building design has great influence on both gendered use of space and electricity use, advocating a courtyard typology. Further, interviews with policy-makers reveal a disjuncture between the occupant realities and the policy objectives. The paper argues that gender equality can and should be influenced through energy and housing policies and offers a conceptual framework for inclusive SRH to address this disjuncture. (16 Figures, 2 Tables, 71 References)

[14631]

Goudarzi S, Anisi M H, Kama N, Doctor F, Soleymani S A, and Sangaiah A K. 2019
Energy and Buildings **196**: 83–93
School of Computing Science and Engineering,
Vellore Institute of Technology (VIT), Vellore 632014,
Tamil Nadu, India

Predictive modelling of building energy consumption based on a hybrid nature-inspired optimization algorithm

In this paper, researchers propose a lightweight IoT framework for predicting energy usage at a localized level for optimal configuration of building-wide energy dissemination policies. Autoregressive integrated moving average (ARIMA) as a statistical liner model could be used for this purpose; however, it is unable to model the dynamic nonlinear relationships in non-stationary fluctuating power consumption data. Therefore, we have developed an improved hybrid model based on the ARIMA, support vector regression (SVRs), and particle swarm

optimization (PSO) to predict precision energy usage from supplied data. The proposed model is evaluated using power consumption data acquired from environmental actuator devices controlling a large functional space in a building. Results show that the proposed hybrid model outperforms other alternative techniques in forecasting power consumption. The approach is appropriate in building energy policy implementations due to its precise estimations of energy consumption and lightweight monitoring infrastructure, which can lead to reducing the cost on energy consumption. Moreover, it provides an accurate tool to optimize the energy consumption strategies in wider built environments such as smart cities. (7 Figures, 8 Tables, 49 References)

[14632]

Iqbal J, Khan M, Talha M, Farman H, Jan B, Muhammad A, and Khattak H A. 2018
Sustainable Cities and Society **43**: 443–450
Department of Electrical Engineering, Sarhad
University of Science and Information Technology,
Peshawar, Pakistan

A generic internet of things architecture for controlling electrical energy consumption in smart homes

The application of Big Data is widely adopted in many areas such as smart home and city planning, efficient system design, and so on. However, during the developing stages of IoT, the researchers have many challenges that need to be addressed before standardizing IoT for general use. These challenges include co-existences of many communication technologies, such as Bluetooth, ZigBee, WIFI, and so on. The effect of such technologies on the communication becomes more when these technologies exist in short communication range. Similarly, other challenges include processing of huge amount of data generated by the IoT devices in real-time. Therefore, to address these challenges, we come up with a proposed scheme that

enables generic communication architecture among the IoT devices with less interference. Further, the proposed architecture consists of four main steps: (i) a system to discover and identify electrical appliances in a smart home or smart building, (ii) deployment of sensors, (iii) applying proposed load balancing on appliances and sensors, and (iv) processing the data obtained from these sensors for better usage of home and electrical appliances. The proposed scheme is tested on real electronic appliances and the energy consumption is recorded using the proposed Electronic Device Sleep Scheduling Algorithm (EDSA). Furthermore, the EDSA is responsible for controlling the activities of the sensors while it is in active, sleep, and idle modes. The results show that the proposed architecture performs better in a heterogeneous environment compared to simple wireless sensor network (WSN) based technologies. The data is also processed using Hadoop Ecosystem to maximize the efficiency and minimize the time required to process the data in real-time. (7 Figures, 1 Tables, 35 References)

[14633]

Khan M K, Teng J Z, Khan M I, and Khan M O. 2019
Science of the Total Environment **688**: 424–436
School of Economics, Northeast Normal University,
Changchun, Jilin, China
Email: kamrankhanaup@gmail.com

Impact of globalization, economic factors and energy consumption on CO₂ emissions in Pakistan

This research scrutinizes the impact of globalization, economic factors, and energy consumption on CO₂ emissions in Pakistan from 1971 to 2016 by utilizing dynamic ARDL simulations model. Dynamic ARDL simulations model has capability to predict the actual positive and negative change in the independent variables and its effect on the dependent variable. The examined results of dynamic ARDL simulations

indicates that energy consumption, financial development, trade, foreign direct investment, economic globalization, social globalization, and political globalization have a positive effect on CO₂ emissions in Pakistan, while urbanization, economic growth, and innovation have a negative effect on CO₂ emissions in Pakistan. In the short run, the examined results of dynamic ARDL simulations indicate that energy consumption, urbanization, economic growth, financial development, economic globalization, social globalization and political globalization have a positive effect on CO₂ emissions in Pakistan, while trade, innovation, and foreign direct investment have negative effect on CO₂ emissions. Based on the results of this study, policy implications are suggested for Pakistan. (9 Figures, 6 Tables, 115 References)

[14634]

Mirza F M, Fatima N, and Ullah K. 2019

Energy Strategy Reviews 25: 34–46

Department of Economics, University of Gujrat,
Gujrat, Pakistan

Impact of China-Pakistan economic corridor on Pakistan's future energy consumption and energy saving potential: Evidence from sectoral time series analysis

We estimate the impact of CPEC-related economic activities on overall energy consumption and its saving potential for Pakistan by 2030. Johansen cointegration is employed to evaluate the long-run relationship between energy consumption and its determinants at aggregate and sectoral levels and forecast future energy demand using scenario analysis. Baseline scenario results indicate that aggregate energy consumption will approximately be 41% higher in 2030 compared to 2013 levels. Energy consumption in industrial and commercial sectors in 2030 will increase by 136% and 414%, respectively, under baseline scenario. The Monte Carlo simulations incorporating

future uncertainty support the scenario analysis results. Energy saving potential suggests that energy conservation should be part of overall energy policies and sector specific energy intensity targets should be implemented to harness the energy saving potential. (7 Figures, 9 Tables, 86 References)

[14635]

Mitra K and Dutta G. 2018

International Journal of Electrical Power & Energy Systems 100: 29–41

Department of Business Management, University of Calcutta, 1, Reformatory Street, Kolkata 700 027,
West Bengal, India

A two-part dynamic pricing policy for household electricity consumption scheduling with minimized expenditure

In this paper, we propose an optimization model for scheduling electrical appliances for an individual household. Here, a customer is offered dynamic prices that are a function of that household's planned consumption and forecasted grid load. We consider a grid connected system with a battery and an in-house renewable energy generator in the proposed scheduling model. This model minimizes the customer's electricity bill subject to different constraints. We analyse our model with various pricing policies, price ranges, and appliance operation windows. We find that the expenditure of the consumer decreases considerably in our model when shifting from flat prices to dynamic prices based on the forecasted grid load and the consumer's individual planned consumption. Considerable expenditure reduction and individual load flattening are achieved with the use of a battery and an in-house renewable energy generator. Also, larger the price range, higher is the load flattening and lower is the expenditure. We show that our proposed pricing policy is beneficial to both consumers and suppliers. (2 Figures, 4 Tables, 33 References)

[14636]

Pradhan R P, Arvin M B, Nair M, Bennett S E, and Hall J H. 2019

Energy **159**: 42–53

School of Business and Global Asia in the 21st Century Research Platform, Monash University Malaysia, Jalan Lagoon Selatan, Selangor, 47500, Malaysia

The dynamics between energy consumption patterns, financial sector development and economic growth in Financial Action Task Force (FATF) countries

In this paper, using a panel vector error correction model, we study the interactions between energy consumption patterns, financial sector development, and economic growth in 35 Financial Action Task Force (FATF) countries over 1961–2015. We focus on the direction of Granger causality between the variables. Our empirical results show that both energy consumption patterns and financial sector development are significant long-term drivers of economic growth in the FATF countries. Thus, the sophistication of the financial sector and resources to develop the energy sector will contribute to enhancing the economic prosperity of the FATF countries in the long run. (1 Figure, 3 Tables, 132 References)

[14637]

Prashar A. 2019

Journal of Cleaner Production **235**: 977–996

Management Development Institute, Gurgaon, India

Towards sustainable development in industrial small and medium-sized enterprises: An energy sustainability approach

The objective of this study is to develop an easy-to-implement managerial framework for guiding the visualization, implementation, and reporting of energy sustainability (ES) for industrial enterprises. To address this objective, a three-step ES framework was developed

through a systematic literature review and an iterative process of longitudinal action research in two medium-sized industrial enterprises from geographical cluster of foundry and textile SMEs in India. The three core steps of framework emphasize on energy management organization (with energy management function and roles), energy visualization and optimization (by understanding energy use patterns to identify ES opportunities), and ES reporting (internal and external reporting based on GRI guidelines). The ES framework was validated through action research at two medium-sized SMEs operating in foundry and textile sector in India. While the foundry unit saved production costs of US\$9019 per annum, mitigated CO₂ emissions of 100.29 t (CO₂)/annum, and improved employee retention by 32%, the post-implementation benefits gained by the textile unit was cost saving of US\$2486 per annum, emission mitigation of 41.36 t (CO₂)/annum, and an eco-label certification. The study contributes to sustainability management literature by adopting an operative perspective of evaluating sustainability impact of shop floor level activities. Its contribution to energy management literature is expanding the scope of energy optimization initiatives to realizing holistic sustainability benefits. (11 Figures, 8 Tables, 76 References)

[14638]

Raza S A, Shah N, and Sharif A. 2019

Energy **173**: 706–720

Department of Management Sciences, IQRA University, Karachi 75300, Pakistan

Time frequency relationship between energy consumption, economic growth and environmental degradation in the United States: Evidence from transportation sector

This study examines the impact of energy consumption and economic growth on environmental degradation in the United States

by using the wavelet technique. In order to examine the association between variables, monthly data from 1973 (January) to 2015 (July) were used. The techniques applied on the dataset include wavelet correlation, wavelet covariance, maximal overlap discrete wavelet transform, continuous wavelet power spectrum, and wavelet coherence spectrum. The result indicated that in the short, medium, and long run, energy consumption has a positive influence over carbon emissions. Moreover, the result of causality test shows unidirectional causality running from energy consumption to carbon emissions. Therefore, it can be recommended that policy makers should pay more consideration on this. The United States is working hard to shrink its carbon emission to 50% and become a green economy by the year 2020. Along with this, an appropriate deployment of plans is essential for the feat of such initiatives, which include the encouragement of using hybrid engine vehicles or even energy effective vehicles and opting for specific economic strategies that regulate the pollution industries as this will result in the reduction of CO₂ emission in the United States. (11 Figures, 7 Tables, 45 References)

[14639]

Sahar H, Bangash A A, and Beg M O. 2019

Sustainable Computing: Informatics and Systems 21: 28–46

National University of Computer and Emerging Sciences, Islamabad, Pakistan

Towards energy aware object-oriented development of Android applications

Energy consumption has become a concern for developers due to the increasing complexity of applications that are to run on devices with limited battery power. Developers want to develop energy efficient applications; however, existing tools do not bridge the gap between understanding where energy is consumed and suggesting how the code can be modified to reduce energy consumption. A generalized

method to relate software structure with its energy consumption is hence desirable. Previous attempts to relate change in object-oriented structure to its effects on energy consumption have been inconclusive. In this paper, we proposed a methodology to relate software structural information represented as metrics to energy consumption. By employing our methodology, we empirically validated three object-oriented (OO) metric suites, namely, the Abreus Metrics (MOOD), Chidamber and Kemerer (CK) metrics, and Martin's package metric suite, and determined their relationship with energy consumption. Our results show that software structural metrics can be reliably related to energy consumption behaviour of programmes using a total of 63 releases from seven open-source iteratively developed Android applications. (14 Figures, 6 Tables, 38 References)

[14640]

Sharif A, Raza S A, Ozturk I, and Afshan S. 2019

Renewable Energy 133: 685–691

School of Economics, Finance and Banking, College of Business, Universiti Utara Malaysia

The dynamic relationship of renewable and nonrenewable energy consumption with carbon emission: A global study with the application of heterogeneous panel estimations

This present study explores the relationship of renewable and non-renewable energy consumption with carbon emission using panel data of 74 nations from 1990 to 2015. We apply the second-generation econometrics of panel data to examine the cross-section independence and control the heterogeneity between cross-sections. The CIPS unit root test, Westerlund (2007) bootstrap cointegration, Pedroni co-integration, FMOLS, and heterogeneous panel causality techniques have been applied. The outcomes affirm that all variables are integrated over the long run. The results also show that

the non-renewable energy consumption has a positive effect on environmental degradation, whereas renewable energy has a negative impact on environmental degradation and helps to reduce environmental hazards. Similarly, financial development also has a negative and significant impact on environmental degradation. Furthermore, the Kuznets hypothesis is also tested. This study provides valuable policy implications for the government and policy makers. (50 Tables, 50 References)

[14641]

Sharma S V, Han P, and Sharma V K. 2019

Energy Policy 132: 1184-1190

National Ecology and Environment Foundation (NEEF), Mumbai, 400053, India

Socio-economic determinants of energy poverty amongst Indian households: A case study of Mumbai

This study uses primary data on various socio-economic variables (SEVs) collected from 1000 households in Mumbai, equally divided into four income groups. The SEVs of the households used in the empirical analysis include their expenses on electricity services, consumption expenditure, dwelling size, education level, and awareness of energy and environment. The results of the study show that energy poverty mainly depends on the consumption expenditure of a household and it varies across four income groups. Increase in the dwelling size of households of low and very low income groups also increases their expenses on electricity and, hence, their energy poverty. Although the education level of households does not have any significant effect on their energy poverty, their awareness of energy conservation measures is linked to reduction in energy poverty, particularly in households having lower income. The study suggests that achieving sustainable energy for all households in India requires policies and strategies to improve access, availability, and affordability

of electricity and increased awareness of the masses on energy conservation. (7 Tables, 23 References)

[14642]

Waheed R, Sarwar S, and Wei C. 2019

Energy Reports 5: 1103-1115

School of Economics, Shandong University, Jinan, PR China

The survey of economic growth, energy consumption and carbon emission

The main focus of this survey is on the coverage of countries, modeling methodologies, periods, and empirical conclusions. The literature survey in this research paper is based on the causality's direction between (i) economic growth and carbon emission, (ii) economic growth and energy consumption, and (iii) energy consumption and carbon emissions. From reviewing these studies, general remark can be assumed that the literature that has been produced is paradoxical. First, most of the earlier studies have reported that economic growth and energy consumption are significant sources of carbon emission; however, the role of economic growth in carbon emission is widely reported in highly developing countries. On the contrary, in case of developed countries, carbon emission is not linked with economic development. Second, in case of developing countries, higher energy consumption leads to increase in the economic growth. For developed countries, there is less evidence of dependence between energy consumption and economic growth. Finally, in both developing and developed countries, higher energy consumption is reported as the main culprit for carbon emission. Focusing on the implications, the governments and industries have to replace the non-renewable energy sources with renewable sources for electricity generation, industrial operations, transportation, and so on. Comprehending the literature survey has provided the basis to address the designing and

implementing effective environmental as well as energy policies. (6 Tables)

[14643]

Warren R F, Edwards N R, Babonneau F, *et al.* 2019
Environmental Modelling & Software **111**: 248-258
Tyndall Centre for Climate Change Research and
School of Environmental Sciences, University of East
Anglia, Norwich, NR4 7TJ, UK

**Producing policy-relevant science
by enhancing robustness and model
integration for the assessment of global
environmental change**

We use the flexible model coupling technology known as the bespoke framework generator to link established existing modules representing dynamics in the global economy (GEMINI_E3), the energy system (TIAM-WORLD), the global and regional climate systems (MAGICC6, PLASIM-ENTS, and ClimGEN), the agricultural system, the hydrological system and ecosystems (LPJmL) together in a single integrated assessment modelling (IAM) framework, building on the pre-existing framework of the Community Integrated Assessment System. Next, we demonstrate the application of the framework to produce policy-relevant scientific information. We use it to show that when using carbon price mechanisms to induce a transition from a high-carbon to a low-carbon economy, prices can be minimized if policy action is taken early, if burden sharing regimes are used, and if agriculture is intensified. Some of the coupled models have been made available for use at a secure and user-friendly web portal. (10 Figures, 3 Tables, 5 References)

TRANSPORT AND ENVIRONMENT

[14644]

Kolluru S S R, Patra A K, and Dubey R S. 2019
Science of the Total Environment **684**: 207-220
School of Environmental Science and Engineering,
Indian Institute of Technology Kharagpur, India

**In-vehicle PM_{2.5} personal concentrations
in winter during long distance road travel
in India**

During travel, passengers are exposed to high concentrations of PM which constitute a significant fraction of daily personal exposures. Comprehensive mobile monitoring for a distance of 400 km was carried out on an Indian National Highway during the winter season to evaluate the PM_{2.5} Personal Concentrations (PC) and mass exposure in three traffic microenvironments (public bus, car with AC (Car CW), and car without AC (Car OW)) and to quantify the key factors that influence it. The mean concentrations were highest inside Car and lowest inside Car. PC during in-city highway sections were greater than out-city highway sections during Bus and Car OW journeys. PC were higher during morning than evening journeys in Bus and Car OW. Mean PC in different seating positions in Bus followed the trend: middle > rear > front. Results of the linear mixed effects models (LMM) indicated that journey timings were the significant predictors of PC for Bus and Car OW. Total mass of inhaled exposures, however, followed a different trend: Bus > Car OW > Car CW. This is because Bus needed longer duration to cover the entire distance. Car CW users experienced both the least PC and mass exposures. It was estimated that the road repairing works contributed ~22% in Bus and Car OW and ~12% in Car CW increment in mass exposures. These findings indicate that management of exposures needs to consider mass exposures in addition to PC for curtailing the adverse health effects relating to long distance journeys. Highway authorities should focus on early completion of construction and repairing activities to reduce exposures to passengers. (11 Figures, 7 Tables, 61 References)

[14645]

Kumar P, Arkatkar S, and Joshi G. 2019

Current Science 117(1): 94–103

Civil Engineering Department, Muzaffarpur Institute of Technology, Muzaffarpur 842 003, India

Examining traffic flow parameters at merging section on high-speed urban roads in India

This study analyses micro-level and macro-level traffic parameters at merging locations on high-speed urban roads in India. For this purpose, representative merging section was selected on Delhi–Gurgaon expressway. Speeds on different lanes at the merging section were found to gradually decrease from median side lane to lane closer to the merging point. At low and moderate flow conditions, most of the vehicles avoid moving in lanes closer to the merging point in the main traffic stream. This is done to reduce the crash and avoid competing for the same road space. Speed versus flow relationship developed for basic roadway section and merging section shows the difference in capacity by almost 8% due to merging operation. Moreover, stream speed at the merging is found to be the function of main stream flow and entry flow. The findings from the study would be useful in operational analysis of merging sections on high-speed urban roads in India. (8 Figures, 4 Tables, 11 References)

[14646]

Lambat N, Kapse V, and Sabnani C. 2019

Current Science 116(1): 1706–1714

Department of Architecture and Planning, Visvesvaraya National Institute of Technology, Nagpur 440 010, India

Evaluation of the decision-making process for urban public transport in India: A Delphi approach

The Government of India has proposed and constructed various mass rapid transit projects, such as metro rail and bus rapid transit system (BRTS) projects, under the purview of the

National Urban Transport Policy (NUTP), Jawaharlal Nehru National Urban Renewal Mission (JNNURM), and other such schemes. However, owing to less experience in these newly proposed and constructed systems, the projects are surrounded by controversies and doubts. Many questions have been raised regarding the decision-making process for selecting mass rapid transit systems (MRTS) modes. This study attempts to examine these doubts and identify other issues associated with the decision-making process. Thus, the study's objective is to identify and prioritize the issues associated with the decision-making process of selecting modes of public transport (MRTS) in India. The study uses the Delphi method and represents a successful application of the approach in urban transport planning. The study identifies 12 issues and their priority in the decision-making process of selecting a public transport (MRTS) mode. The study concludes that the prevailing situations in decision-making process in India contradict the guidelines suggested in NUTP. (1 Figure, 3 Tables, 34 References)

FOSSIL FUELS AND ENVIRONMENT

[14647]

Kandasamy S K, Selvaraj A S, and Rajagopal T K R.

2019

Renewable Energy 141: 411–419

Department of Mechanical Engineering, Higher College of Technology, Oman

Experimental investigations of ethanol blended biodiesel fuel on automotive diesel engine performance, emission and durability characteristics

500 h durability, performance, and emission tests are conducted on a single cylinder high speed automotive diesel engine for the ethanol blended biodiesel fuel. Esterified cotton seed methyl ester of 5% by volume is mixed with 95% neat diesel to obtain the base biodiesel fuel (B5). The base fuel is mixed with 20% pure ethanol to derive

the ethanol blended biodiesel fuel (B5E20). The parameters like blow-by, crankcase pressure, and lubricating oil consumption are experimentally investigated along with performance and emission characteristics for both the test fuelled engines. The result of these tests showed a significant loss in the maximum brake power and the maximum brake torque at the end of 500 h durability run when the engine is fuelled with B5E20. The lubricating oil consumption and positive crank pressure of B5E20 fuelled engine are comparatively higher than those of B5 fuelled engine during the durability trials. Reduction in smoke and CO emissions are noticed for B5E20 fuel over the entire range of speed, whereas NO_x and unburned hydrocarbon emissions get decreased at the lower to medium speed range and increase thereafter. As expected, all the engine emissions increase after 500 h of durability run for both the fuels. (6 Figures, 4 Tables, 51 References)

[14648]

Sharma D.K, Dhawan H, Morgan T, and Crocker M.
2019

Fuel **256**: 115981

Centre for Energy Studies, Indian Institute of
Technology Delhi, New Delhi 110016, India

Py-GCMS studies of Indian coals and their solvent extracted products

Five Indian coals having different characteristics, that is, coking, rank, grade, carbon and volatile matter (VM) content, were subjected to solvent extraction under mild, ambient pressure conditions to obtain almost ash-free coals. *N*-methyl pyrrolidone (NMP) containing a small amount of ethylenediamine (EDA) was used as the solvent, the resulting super clean coal (SCC) products being characterized by means of ultimate analysis, solid-state ¹³C NMR spectroscopy, thermogravimetric analysis (TGA), and pyrolysis-GC-MS. The super clean products were found to have the increased volatile matter content because of the

removal of disassociations and entanglements and the disruption of intermolecular forces. Based on comparison of the pyrolysis-GC-MS data for the original (raw) coals (OCs) and SCCs, the extraction led to the segregation of the coal samples into easily volatilized components and strongly cross-linked networks of polycyclic fused ring aromatic components. The polycondensed aromatic components were present in higher concentration in the super clean coals, demonstrating the selectivity of the solvents to act upon the condensed aromatic components and long chain alkanes and extract them selectively, thereby resulting in a more aromatic product. (9 Figures, 8 Tables, 50 References)

[14649]

Wang Q and Song X. 2019

Journal of Cleaner Production **230**: 286–301

School of Economics and Management, China
University of Petroleum (East China), Qingdao,
Shandong, 266580, People's Republic of China

India's coal footprint in the globalized world: Evolution and drivers

To cut India's coal demand, it is necessary to develop more effective measures through comprehensive understanding of the evolution and drivers of India's coal consumption footprint in the globalized world. To fill the research gap of the existing researches towards India's coal consumption footprint, multi-regional input–output analysis and decomposition techniques were applied to explore India's coal footprint in the globalized world. From 1995 to 2009, the coal consumption of India embodied in production- and consumption-based activities continued to grow, mainly for domestic coal consumption of electricity sectors. Owing to the development of the opening trade, the proportions of virtual coal export and import had obvious increase, and both slightly declined during 2008–09 global economic crisis. The coal intensity of India was the major driver of the

increase in India's coal consumption, following by the domestic final demand. India should pay more attention on the improvement of the energy efficiency and work with countries with more clean energy and advanced technologies to reduce the coal consumption. (11 Figures, 6 Tables, 57 References)

RENEWABLE ENERGY AND ENVIRONMENT

[14650]

Dabe S J, Prasad P J, Vaidya A N, and Purohit H J. 2019

Environmental Progress and Sustainable Energy **38**: 654–671

Business Development & Technology Transfer Division, CSIR-National Environmental Engineering Research Institute, Nehru Marg, Nagpur, Maharashtra, 440020, India

Technological pathways for bioenergy generation from municipal solid waste: Renewable energy option

This study presents an overview of pathways for the generation of the bioenergy from MSW, through the biological–chemical–thermal route of treatment, current status, deployment of biochemical–thermochemical conversion technologies for a biogenic fraction of MSW, and its challenges and performance. Currently, key challenges posed to the world are energy security, waste management, and climate change. Out of these, waste management across the world is in the dejected state due to lack of proper treatment and conversion technologies. In recent times, pressure on the global environment has increased for the use of renewable resources due to depleting fossil fuels. Energy from biomass waste is going to be one of the most crucial and dominant sources of renewable energy harness in the future. Conversion of a biogenic fraction of MSW to energy will solve the waste management issue and offer energy generation in a sustainable manner and can be termed as 'Renewable Waste'. This

study provides technological pathways for the generation of biofuels using MSW biomass as a feedstock, and the technology progression of various pathways and gaps for implementation of these technologies are also analysed in this study. (5 Figures, 9 Tables, 106 References)

[14651]

Konwar K, Nath H P, Bhuyan N, Saikia B K, Borah R C, Kalita A C, and Saikia N. 2019

Fuel **256**: 115926

Department of Chemistry, The Assam Kaziranga University, Jorhat 785006, Assam, India

Effect of biomass addition on the devolatilization kinetics, mechanisms and thermodynamics of a northeast Indian low rank sub-bituminous coal

The effect of addition of biomass on the pyrolysis behaviour of a low rank sub-bituminous coal was investigated using thermogravimetric methods (TG and DTG). Results reveal the presence of interaction between coal and biomass residues. Such synergistic effect is observed to be dependent on heating rate, coal to biomass ratio, and chemical constituents present in coal–biomass blends. Thermal decompositions of coal and coal–biomass blends follow order-based models involving one or two nuclei initially and three nuclei at the latter stages of conversion. Evaluations of synergistic, kinetics, and thermodynamic properties show that 25% replacement of coal by biomass gives best results and, therefore, can be considered as the ideal composition for the coal devolatilization process. Results also reveal that the kinetic parameters predicted by isoconversional methods are similar to the values predicted by Kissinger method. Considering the simplicity, it can be concluded that Kissinger method is one of the best methods to determine kinetic parameters of coal devolatilization process with and without the presence of biomass. Our results also reveal that the approach used for analysing TG data by Friedman method helps

significantly to find the meaningful activation energies. (10 Figures, 6 Tables, 60 References)

[14652]

Kumar A, Bali K, Singh S, Naja M, and Mishra A K.

2019

Atmospheric Research **227**: 41–51

Environmental Science and Biomedical Metrology

Division, CSIR-National Physical Laboratory, Dr K.S.

Krishnan Road, New Delhi 110012, India

Estimates of reactive trace gases (NMVOCs, CO and NO_x) and their ozone forming potentials during forest fire over Southern Himalayan region

In the present study, emission of trace gases, their ozone forming potentials, and ozone sensitivities have been investigated during the forest fire period over the Southern Himalayan region. Reanalysis data of Global Fire Assimilation System model is used to retrieve the various parameters such as fire radiative power and emission rates of various trace gases. The estimation shows major contribution of oxygenated compounds (55.2%) amidst all NMVOCs. Mean CO and NO_x emission rates are 533.81 and 13.66 mg/m²/day, respectively, during the forest fire of April months for 14 years. The emissions of NMVOCs, CO, and NO_x increased by 90.4%, 110.6%, and 132.5%, respectively and reached up to 121.1, 958.3, and 25.3, mg/m²/day, respectively, in April with respect to the non-burning period. Ozone forming potentials (OFP) of NMVOCs are also examined using the maximum incremental reactivity (MIR) method, which shows ~2 times higher OFP for total NMVOCs during 2016 compared to 2015. The ratio of NMVOCs/NO_x is <8, which indicates that the photochemical production of O₃ is mainly controlled by the levels of NMVOCs. The surface observations of ozone and CO from the Himalayan station Nainital also showed a substantial increase in concentration during the forest fire of April. The research findings are valuable for the better

understanding of chemical composition of trace gases, their role in O₃ formation, and effective control strategies of O₃ pollution during the forest fire events over the lower Himalayan region. (10 Figures, 3 Tables, 90 References)

[14653]

Manju S and Mavi S. 2019

Journal of Cleaner Production **230**: 116–128

CSIR-National Geophysical Research Institute,

Hyderabad, Telangana, India

Prediction and performance assessment of global solar radiation in Indian cities: A comparison of satellite and surface measured data

The design and performance assessment of solar photovoltaic/thermal system requires the knowledge of global solar radiation. Generalized models to assess the monthly average global solar radiation of 12 locations in India were established using sunshine hours from the World Radiation Data Centre (WRDC), Russia. Statistical analysis is carried out to assess the accurate model to estimate the global solar radiation, which includes mean bias error, root mean square error, mean absolute percentage error, the coefficient of determination and uncertainty at 95%. Also, the assessment of the global radiation values obtained from satellite data by the National Renewable Energy Laboratory (NREL) is performed. Further, global performance indicator (GPI) is introduced to find the ranking of models from the overall performance of the investigated models by scaling statistical indicators. The comparison of the NREL estimated data and WRDC data shows that the satellite data overestimates the surface measured data between 10% and 15% for seven locations, whereas for the remaining four stations, it is between 7% and 9.5%. (6 Figures, 4 Tables, 35 References)

[14654]

Mittal S, Ahlgren E O, and Shukla P R. 2019

Renewable Energy **141**: 379–389

Division of Energy Technology, Department of Space, Earth and Environment, Chalmers University of Technology, Gothenburg, Sweden

Future biogas resource potential in India: A bottom-up analysis

This paper aims to assess the future biogas potential in India from varied sources (crops residues, animal manure, municipal solid wastes, and municipal and industrial wastewater). The study uses a bottom-up, resource focused approach for the assessment of the biogas potential. The paper assesses agriculture and animal residues as well as generation, collection, and availability of municipal and industrial waste for biogas production. The results show a considerable potential of biogas in the next two decades due to rising waste generation and deployment of infrastructure for improving waste collection efficiency. The analysis estimates that the biogas potential will range from 310 to 655 billion m³/year in the year 2040 depending upon the availability of different resources. The estimated biogas potential in the year 2040 is around 36% of India's current (2015) total primary energy supply in the high availability scenario. Finally, the paper offers policy recommendations aimed at realizing the biogas potential. (11 Figures, 11 Tables, 94 References)

[14655]

Pradhan B B, Limmeechokchai B, and Shrestha R M. 2019

Renewable Energy **143**: 377–389

Sirindhorn International Institute of Technology, Thammasat University, Thailand

Implications of biogas and electric cooking technologies in residential sector in Nepal – A long term perspective using AIM/Enduse model

This paper aims to analyse the effects of biogas- and electricity-based cooking on energy use

and greenhouse gas (GHG) as well as local air pollutant emissions in the case of Nepal, which is highly dependent on traditional biomass (mainly fuelwood) for cooking. The country is rich in hydropower resources. A long-term, bottom-up energy system model has been developed using Asia-Pacific Integrated Model/Enduse (AIM/Enduse) model for the analysis. The study developed a business-as-usual (BAU) scenario and three alternative cooking scenarios. Three alternative scenarios, named as CL, CM, and CH scenarios, consider low, medium, and high levels, respectively, of penetrations of electric- and biogas-based cooking options. The changes in energy use and electricity generation in the BAU and alternative scenarios have been compared. Fuelwood consumption in the residential sector when compared to the BAU would decrease by 12.5% in CL, 19.0% in CM, and 24.2% in CH scenarios. Liquefied petroleum gas (LPG) consumption would decrease by 12.8% in CL, 16.3% in CM, and 19.6% in CH scenarios. The electricity generation requirement would increase by 9.4% in CL, 13.9% in CM, and 17.0% in CH scenarios. Finally, the assessment of GHG and local pollutant emissions shows the decrease in all gases in CL, CM, and CH scenarios when compared to the BAU. (12 Figures, 9 Tables, 60 References)

INDUSTRIAL POLLUTION

[14656]

Ali R, Bakhsh K, and Yasin M A. 2019

Sustainable Cities and Society **48**: 101553

Department of Management Sciences, COMSATS University Islamabad, Vehari Campus, Pakistan

Impact of urbanization on CO₂ emissions in emerging economy: Evidence from Pakistan

This study was designed to explore the impact of urbanization on carbon dioxide emissions in Pakistan. Autoregressive Distributed Lag (ARDL) bound testing approach to

co-integration was employed for long run and short analysis and VECM model was used for causal analysis. Results showed that there was cointegration among the variables. Urbanization was found enhancing carbon emissions both in the long run and in the short run. This study provided policy implications. Vehicular emissions can be reduced in urban areas by promoting public the urban transportation system. Government interventions are required for adaptation of green technology by urban industrial and residential sectors and campaign should be launched to educate and train people regarding mitigation and adaptation with respect to environmental degradation. (2 Figures, 6 Tables, 38 References)

[14657]

Mallik C, Mahapatra P S, Kumar P, Panda S, Boopathy R, Das T, and Lal S. 2019

Atmospheric Environment **209**: 220-232

Department of Environment and Sustainability,

Institute of Minerals and Materials Technology (CSIR),

Bhubaneswar, India

Influence of regional emissions on SO₂ concentrations over Bhubaneswar, a capital city in eastern India downwind of the Indian SO₂ hotspots

In this study, the authors report SO₂ measurements conducted at Bhubaneswar, a rapidly developing smart city in the eastern part of India. The city is ideally located just downwind of the Indian SO₂ hotspots during winter, when SO₂ concentrations are the highest, reaching 14.3 ppbv for hourly averaged data. The measurements reported here show that despite being a rapidly developing location, SO₂ over Bhubaneswar is dominated by regional emissions rather than local sources like vehicular exhausts. The influence of regional emissions is strongest in winter as the city is directly downwind of 6 of the 10 largest thermal power plants and 7 out of the 13 largest integrated steel plants in India with a mean SO₂ concentration

of 3.2 ppbv. This is evinced by multiple pointers, namely, concentration-weighted trajectory (CWT) analysis for surface SO₂ data, correlation analysis for OMI SO₂ data, analysis of surface concentrations of SO₂, organic carbon, black carbon and carbon monoxide, which reveal SO₂ emissions from the industrial and mining regions of Chhattisgarh and north-west Odisha. This is the same region that shows up as hotspots of SO₂ in OMI retrievals over India. However, despite being downwind of major SO₂ sources during winter, SO₂ concentrations in Bhubaneswar are lower than over some other cities (Kolkata, Kanpur) in the IGP due to influence of strong local sources in the latter cases. Unlike most other urban regions in India, the diurnal variation of SO₂ over Bhubaneswar shows elevated daytime values due to the predominant influence of regional emissions. (1 Figure, 3 Tables, 62 References)

[14658]

Mishra A K, Jain M K, and Dash S K. 2019

Current Science **116**(11): 1905-1909

Paradeep Phosphates Limited, Odisha 770 017, India

Ambient air quality and indexing with reference to suspended particulate matter and gaseous pollutants around a cement plant in OCL India Limited, Rajgangpur, Odisha, India

Cement industry is a potential anthropogenic source of air pollution. Emissions from cement plants are one of the major sources of global warming. The dusts produced are very hazardous, which affect the surrounding environment. The present study was undertaken to analyse the air quality around a cement plant (OCL India Ltd, Odisha) within 2 km radius for a period of 8 months at four different locations with meteorological parameters. The observed values of air pollutants are found within the prescribed standards of Central Pollution Control Board (CPCB), New Delhi. This has been possible because of the initiative taken by industries for

installing advanced air trapping devices. The results of this study were presented in the form of air quality index, where we found the study area in moderate (PM_{10}) and good categories (SO_2 and NO_x). (3 Figures, 5 Tables, 40 References)

[14659]

Mohan S and Saranya P. 2019

Journal of the Air & Waste Management Association **69**(9): 1079–1095

Environmental and Water Resources Engineering Laboratory, Department of Civil Engineering, Indian Institute of Technology Madras, Chennai, India

Assessment of tropospheric ozone at an industrial site of Chennai megacity

This paper presents the temporal variation in surface-level ozone (O_3) measured at Gummidipoondi near Chennai, Tamil Nadu. The site chosen for the present study has high potential for ozone generation sources, such as vehicular traffic and industrial activities. The site is also located near a hazardous waste management facility. The key sources of nitrogen oxides (NO_x), which are considered to be an important precursor of O_3 , include hazardous waste incineration, trucks bringing the hazardous wastes, and vehicles plying on the nearby National Highway 16 (NH 16). The measurements clearly showed diurnal variation, with maximum values observed during the noon hours and minimum values observed when solar radiation was less. It was found that the polluted air mass originated from the Southeast Asian region and the Indo-Gangetic Plain. The polluted air mass, which advected large amounts of carbon monoxide (CO) plumes, was analysed using the Measurement of Pollution in the Troposphere (MOPITT) retrievals. The correlations of O_3 with temperature ($r = 0.746$; $P < 0.01$) and solar radiation ($r = 0.751$; $P < 0.01$) were strongly positive and those with NO_x were found to be negative. Stronger correlation of O_3 with NO_x was observed during pre-monsoon months ($r = 0.627$; $P < 0.01$) and the following

hours of photochemical reactions. There were substantial differences in concentrations between weekdays and weekends, with higher nitric oxide (NO) and nitrogen dioxide (NO_2), but lower O_3 concentrations on weekdays. A substantial weekday–weekend difference in O_3 , which was higher on weekends, appears to be attributable to lower daytime traffic activity and hence reduced emissions of NO_x to a NO_x -saturated atmosphere. (13 Figures, 6 Figures, 42 References)

POWER SECTOR AND ENVIRONMENT

[14660]

Baloch M H, Wang J, Kaloi G S, Memon A A, Larik A S, Sharma P. 2019

Environmental Progress & Sustainable Energy **38**(2): 706–720

Department of Electrical Engineering, Shanghai Jiao Tong University, Shanghai, China

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Techno-economic analysis of power generation from a potential wind corridor of Pakistan: An overview: Wind energy conversion system, power generation, wind corridors, ac/ac converter and HVDC system

Since the consumption of non-renewable sources is diminishing day-by-day, most of the developing countries across the globe are facing a severe energy crisis. This energy crisis affects the developing countries such as Pakistan so extensively that the population is facing a crucial problem of load shedding for long hours. Thus, there is a fundamental need for alternative and economical energy resources, for example, solar, wind, and biofuel energy. Meanwhile, out of all the financially viable ways of power generation, the wind energy is considered as the most economical way. However, in this study, authors selected six potential wind zones that lie within 1100 km of coastal zones. In this study, only 1-year wind speed raw data is considered

and taken from appropriate wind zones at various heights with the support of Pakistan Meteorological Department. Moreover, this project encourages the domestic and the foreign investor to invest in the wind energy projects at windy zones, which basically opens the business doors for the community of Pakistan for power generation, leading to overcoming the energy crisis along the countryside. (30 Figures, 5 Tables 45 References)

[14661]

Singh C P, Agrawal H, Mishra A K, Singh P K. 2019
Journal of Mines, Metals and Fuels **67**(7): 345-350

Department of Mining Engineering, IIT (ISM),
Dhanbad, India

Reducing environmental hazards of blasting using electronic detonators in a large opencast coal project – A case study

This paper deals with as to how the environmental impacts due to ground vibrations of rock blasting are reduced, resulting in no complaints from dwellers and any authorities in and around Khadia project. The core objective of the Ministry of Coal, India in its vision statement is securing the availability of coal to meet the demand of different sectors of economy in an eco-friendly and sustainable manner. Coal India produced 567.37 million tonnes of raw coal in 2017-18, out of which contribution from opencast mines was 536.82 million tonnes (i.e., 95%). In case of deep hole blasting for high capacity excavators like draglines, 20 cum shovels becomes imperative for achieving high production targets. Thus, environmental hazards associated with deep hole blasting are also bound to happen. One of the serious problems associated with the deep hole blasting is that of ground vibrations. In case of Khadia opencast coal project, Rihand dam is in vicinity and there is presence of local population in and around mines. Therefore, controlling ground vibration was of paramount importance for the project. Hence, it became

a challenge for reduction of environmental hazards involving deep hole blast for dragline, shovels using electronic detonators for providing precision delay and maximizing the vibration of explosive energy. The blast design parameters using electronic detonator for various blasts of dragline benches were tried to know the resultant profile of ground vibrations near human settlement of Khadia project. This has also resulted in improvement of powder factor (volume of rock fragmentation per kg of explosive used). (8 Figures, 2 Tables, 14 References)

[14662]

Valsala K D, Premkumar K, and Beevi A B. 2019
Environmental Progress and Sustainable Energy **38**
(2): 570-583

ANERT, Trivandrum Kerala, India

Email: kamaljayakumar@gmail.com

Development of battery intervention power supply for solar roof top installations

In India, battery storage and time-based tariff are yet to be introduced in solar microgrid tied inverters. In this article, the authors propose an improved multistage converter topology intended for single phase solar rooftop applications with battery storage. It works in six modes depending on solar-load-battery-grid profiles. The whole strategy is implemented in a battery intervention power supply (BIPS) that uses energy storage integrated with the solar generator that helps in smoothing of power, load shifting, load dispatch, and load angle control. Notably, load dispatch decision is arrived based on several independent parameters that take different values at a time. A Boolean equation is derived relating the different parameters so as to arrive at a single decision. This is achieved by a variable entity k-map. A voltage control is also implemented, which is done by load angle control of the inverter current. (15 Figures, 2 Tables, 63 References)

HAZARDOUS WASTES AND ITS MANAGEMENT

[14663]

Jobayer A A and Akter K S. 2019

Journal of Civil & Environmental Engineering 9(1)

Department of Civil Engineering, Military Institute of Science and Technology, Dhaka, Bangladesh

A study on solid waste generation of household and potential of resource recovery in Dhaka, Bangladesh

The purpose of this work is to identify the present waste generation per person (kg/person/day) in a housing society of Dhaka city and possible resource recovery potential of solid waste of the area so that the correspondent authority can have a scope of finding a framework for effective management of solid waste. The survey was conducted in 100 households of Mirpur Defense Officers' Housing Society (DOHS), Dhaka. These households were classified into five groups according to monthly income ranging from 60,000 BDT to 160,000 BDT. The total population of the area was around 15,000. Average waste generation was found to be 0.74 kg/person/day. Around 11.10 tonnes of solid waste was generated per day and the major fraction was food waste (on average 69.90%). About 226 kg of solid waste can easily be achievable for using as compost component every day. Possible energy recovery from generated waste was equivalent to 3428.70 kWh of electricity per day. (1 Figure, 2 Tables, 16 References)

[14664]

Kathavarayan V, Avudainayagam S, Banu K S P, Chandrasekharan N, Karthikeyan S, Bhuvaneswari K, Ramesh P T. 2019

Current Science 117(3): 448-459

Department of Environmental Science, Tamil Nadu Agricultural University, Coimbatore 641 003, India
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Bioavailability of heavy metals and polycyclic aromatic hydrocarbon in long-term sewage-drained soils of Tamil Nadu

Heavy metals and organic contaminants are reported in sewage discharged sites. Screening and assessment of their toxic concentration in soils of the discharged sites of major cities in Tamil Nadu, India have been carried out in the present study. The major cities included Coimbatore (Ukkadam; U), Madurai (Avanaiyapuram; A), Tiruchirappalli (Rettamalai; R), Nesapakkam (N), and Koyambedu (K) Chennai Corporation. The total aqua-regia extractable concentrations of cadmium, chromium, lead, and nickel were measured and found to be highest in U, followed by A, R, N, and K. With regard to organic contamination, the major pesticides belonged to 13 organochlorine, 10 organophosphate, and 8 synthetic pyrethroids reported below detectable concentration. Among the 16 US EPA priority polycyclic aromatic hydrocarbons (PAHs), 15 were detected. However, PAHs were found to be less than the permissible concentration for soils (0.3 mg/kg) in sewage-contaminated sites. The results show that there is a potential risk of transfer of heavy metals to the higher trophic level of the food chain. (3 Figures, 10 Tables, 53 References)

[14665]

Khandelwal H, Thalla A K, Kumar S, and Kumar R. 2019

Bioresource Technology 288: 121515

National Institute of Technology Karnataka, Surathkal, Mangalore 575 025, Karnataka, India

Life cycle assessment of municipal solid waste management options for India

The present study aims to evaluate the impact of MSWM (municipal solid waste management) system in Nagpur city, India under four different scenarios. They are composting combined with landfilling (S1), material recovery facility (MRF) & composting combined with landfilling (S2), MRF & anaerobic digestion (AD) combined with landfilling (S3), and MRF, AD & composting

combined with landfilling (S4) using LCA tool. The sensitivity analysis was also performed for evaluating the influence of the recycling rate of valuable resources in all the considered scenarios. The scenarios were compared using Gabi 8.5.0.79 model and CML-1A impact characterization method. S2 was found to have the least environmental impacts on global warming, human toxicity, eutrophication, and photochemical ozone creation potential categories. The sensitivity analysis indicated an inversely proportional relation between change in recycling rate and total environmental burdens. (4 Figures, 2 Tables, 35 References)

[14666]

Pujara Y, Pathak P, Sharma A, and Govani J. 2019
Journal of Environmental Management **248**
Department of Environmental Engineering, Marwadi
University, Rajkot, Gujarat 360 003, India

Review on Indian Municipal Solid Waste Management practices for reduction of environmental impacts to achieve sustainable development goals

Open dumping is a common practice for MSW disposal in most of the Indian cities apart from the metro-cities. This practice poses significant environmental and health risks due to toxic and greenhouse gases (GHGs) emission through direct combustion and decay of wastes. Therefore, integrated solid waste management (ISWM) using different methods, namely, incineration, composting, anaerobic digestions, refuse derived fuel, material recovery facility, and sanitary landfilling, is much needed. Accordingly, three waste management case scenarios were studied by keeping weightage of 2030 Sustainable Development Goals of India. Case I depicts present scenario of waste management in India where 164–735 tonnes/year of wastes would be generated. Further, 60% of waste can be treated in case II, which would help in reducing the land requirement up to 40% from estimated conditions of 2031. The case III is the most ideal waste management condition for the year 2031 to

reduce 80% waste, and hence landfill requirement would minimize where population is at controlled conditions. This article concludes that the formal handling and treatment of ISWM would minimize the landfilling, where LCA can be an antidote to achieve sustainable development goals. (8 Figures, 9 Tables, 92 References)

[14667]

Saha P and Sarkar S. 2019
Current Science **116**(9): 1515–1524
Environment Research Group, Research and
Development, Tata Steel Ltd, Jamshedpur 831 007,
India

Valuable utilization of ferrochrome slag for wastewater treatment

During ferrochrome production, slag is discarded as a waste material in huge quantities. A relatively small percentage finds application, whereas majority of the slag is held in dumps. The purpose of the study is valuable utilization of ferrochrome slag. The experimental results showed that 99% removal of chromium (Cr(VI)) was achieved in 1 h by ferrochrome slag from the water of Sukinda chromite mines. There is an in situ generation of ferrous sulphate by the effect of oxidizing agent and iron content of ferrochrome slag which is capable of reducing Cr(VI) to trivalent chromium. Water samples from the surrounding of the slag dumped area were checked to find out the extent of the problem. There is no adverse effect of Cr on the surrounding water samples. Toxicity characteristic leaching procedure test revealed that the slag is environmentally stable. This research concludes that used ferrochrome slag could be utilized as a wastewater treatment. (8 Figures, 5 Tables, 43 References)

[14668]

Sathish N, Jeyasanta K I, and Patterson J. 2019
Marine Pollution Bulletin **142**: 112–118
44 - Beach Road, Suganthi Devadason Marine
Research Institute, Tuticorin, Tamil Nadu, India,
E-mail: narsathish16@gmail.com

Abundance, characteristics and surface degradation features of microplastics in beach sediments of five coastal areas in Tamil Nadu, India

This study undertook to investigate the occurrence of microplastics (MPs) in the high and low tide sediments of five coastal areas in Tamil Nadu, India. The MP polymers found in the study sites are polyethylene (73.2%), polypropylene (13.8%), nylon (8.2%), polystyrene (2.8%), and polyester (2%). The weathered surfaces might act as high-capacity carriers and this was confirmed by SEM-EDX. The results of an analysis of the textures of the sediments do not ascribe any influence on microplastic abundance. The recreation, religious, and fishing activities are the major contributors to plastic pollution in these beaches, which is borne out by the high abundance of MPs in the study sites. A regular and permanent waste management system should be put in place for the protection of beaches. (9 Figures, 1 Table, 50 References)

[14669]

Thakur A K, Pappu A, and Thakur V K. 2019
Journal of Cleaner Production **230**: 11–20
CSIR-Advanced Materials and Processes Research
Institute, Habibganj Naka, Hoshangabad Road,
Bhopal, 462026, India

Synthesis and characterization of new class of geopolymer hybrid composite materials from industrial waste

In this work, the authors explore the effective utilization of marble waste as a reactive filler and binder for the development of fly ash-based geopolymer hybrid composite materials using the extrusion process. The effect of marble waste content on the physico-chemical and mechanical characteristics of prepared hybrid materials was studied through various characterization techniques. The geopolymerization was conducted at two different molarities of sodium hydroxide in which the effects of materials properties were studied. The results indicate that the

materials prepared at higher molarity exhibit better performance in terms of compressive strength. The silicon dioxide present in fly ash reacts with calcium hydroxide present in marble waste forming calcium silicate hydrate network and possibly contributes to the increment in the interfacial bonding in marble waste infiltrated geopolymer matrix. Overall, this improved interfacial adhesion not only yielded an increase in compressive strength and bulk density but also decreased the water absorption of the developed material. The results of this study not only indicate an effective utilization of marble waste for the production of geopolymer hybrid composite materials via an eco-friendly route but also provide an economical and sustainable route for management of marble waste currently generated in various countries of the world. (13 Figures, 4 Tables, 31 References)

HEALTH EFFECTS

[14670]

Ahmed A S S, Rahman M, Sultana S, Babu S M O F, and Sarker Md S I. 2019
Marine Pollution Bulletin **145**: 436–447
Department of Fisheries and Marine Science,
Noakhali Science and Technology University,
Bangladesh
E-mail: sayeedrrahman@gmail.com

Bioaccumulation and heavy metal concentration in tissues of some commercial fishes from the Meghna River Estuary in Bangladesh and human health implications

Despite the beneficial aspect of aquatic food's consumption, bioaccumulation of toxic metals in fish can enhance the health risk for consumers. Heavy metals were measured from edible tissues of some commercial fish species such as *Lates calcarifer*, *Silonia silindia*, *Clupisoma garua*, *Planiliza subviridis*, *Otolithoides pama*, *Tenulosa ilisa*, *Rhinomugil corsula*, and *Aila coila* in the Meghna River Estuary in

Noakhali district. Heavy metals such as As, Pb, Cd, Cu, and Cr were detected by ICP-MS, which were significantly different. The mean BAFs of the contaminants were found in the following order: Pb (1042.29) > Cr (1036.47) > As (934.84) > Cd (832.77) > Cu (772). Further, *L. calcarifer*, *S. silondia*, *C. garua*, and *P. subviridis* showed the bioaccumulative status. To assess the health risk effects, estimated daily intake (EDI), target hazard quotient (THQ), and carcinogenic risk (CR) were conducted. THQs for both adult and children consumers were <1, indicating that consumers would not experience the non-carcinogenic health effects. Although children were more susceptible than adults, CR for all the consumers was found in the acceptable range (10^{-6} to 10^{-4}). (5 Figures, 4 Tables, 175 References)

[14671]

Das J and Saibal M. 2019

Marine Pollution Bulletin **145**: 436–447

Jayati Das, Associate Professor, Shri Shikshayatan College, Geography, 11 Lord Sinha Road, Kolkata, West Bengal 700064, India

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Air pollution a major factor in asthma predictability index among children living in and around Kolkata metropolis

Deterioration in urban air quality in most megacities is quite profound and Kolkata Metropolitan City is no exception to this. An assessment of Kolkata air quality is done in which the annual average concentrations of listed pollutants (RPM, SPM, NO₂ and SO₂) are classified into four different categories: critical, high, moderate, and low pollution. There are 17 monitoring stations in Kolkata, out of which five fall under the critical category and the remaining 12 locations fall under the high category of NO₂ concentration. Regarding RPM, 4 stations are critical and 13 stations record data that are under the high pollution

category. Model questionnaires were run through 10% of the households to assess socio-economic conditions, critical environmental conditions, nature and types of health burdens, as well as gauge the attitude in the direction of health care facilities. A comprehensive and up-to-date knowledge about the seasonal and spatial variation of asthma and the air quality of the area was obtained. Mapping through GIS was done. It is desirable to construct an accurate model (Asthma Prediction Index) to predict whether a child will develop asthma in the future due to the deteriorating air pollution in the city. (5 Figures, 1 Tables, 8 References)

[14672]

Forsyth J E, Nurunnahar S, Islam S S, Baker M, Yeasmin D, Islam M S, Rahman M, Fendorf S, Ardoin N M, Winch P J, and Luby S P. 2019

Environmental Research **179**(Part A): 108722

Emmett Interdisciplinary Program in Environment and Resources, Stanford University, Stanford, CA, USA

Turmeric means “yellow” in Bengali: Lead chromate pigments added to turmeric threaten public health across Bangladesh

The authors aimed to assess the practice of adding yellow pigments to turmeric as well as the producer, consumer, and regulatory factors affecting this practice across the supply chain in Bangladesh. They identified and visited the nine major turmeric-producing districts of Bangladesh as well as two districts with minimal turmeric production. In each district, they conducted semi-structured interviews and informal observations with individuals involved in the production, consumption, and regulation of turmeric. Perceptions of and preferences for turmeric quality were explored. They collected samples of turmeric, pigments, dust, and soil from turmeric polishing mills to assess the evidence of adulteration. Interviews were analysed through an inductive, thematic coding process, with the focus on perceptions of and preferences

for turmeric quality. Samples were analysed for Pb and chromium (Cr) concentrations via inductively coupled plasma mass spectrometry and X-ray fluorescence. In total, we interviewed 152 individuals from across the supply chain and collected 524 samples of turmeric, pigments, dust, and soil. Turmeric Pb and Cr concentrations were highest in Dhaka and Munshiganj districts, with maximum turmeric powder Pb concentration of 1152 µg/g compared to 690 µg/g in the nine major turmeric-producing districts. The results from this study indicate that PbCrO₄ is being added to turmeric by polishers, who are unaware of its neurotoxic effects, in order to satisfy wholesalers who are driven by consumer demand for yellow roots. The authors recommend immediate intervention that engages turmeric producers and consumers to address this public health crisis and ensure a future with Pb-free turmeric. (3 Figures, 2 Tables, 50 References)

[14673]

Memon Q U A, Wagan S A, Chunyu D, Shuangxi X, Jingdong L, and Damalas C A. 2019
Science of the Total Environment **685**: 659-666
 College of Economics and Management, Anhui
 Agricultural University, Hefei, Anhui, China;
 Department of Agricultural Economics, Sindh
 Agriculture University Tando Jam, Sindh, Pakistan

Health problems from pesticide exposure and personal protective measures among women cotton workers in southern Pakistan

The present study illustrates health problems from pesticide exposure during cotton harvest and the use of personal protective measures among 260 female cotton-picking workers from Shaheed Benazirabad District of Sindh Province in southern Pakistan. Skin injury, eye injury, headache, stomach ache, and fever were the main health problems due to pesticide exposure according to workers' experience. Medical treatment costs of health problems

were more than double (2.48 times higher) than preventive measures costs. More than half of the cotton workers surveyed did not use any protective measure during cotton picking, while 22.3% used a muffler/scarf/cloth for covering their face, and 10.8% used gloves. The use of protective measures was positively correlated with education and some experience in cotton picking. Binary logistic regression showed that advanced age and high picking experience were positively associated with the use of personal protective measures, while illiteracy, traditional treatment, and medical treatment in case of illness were negatively associated with the use of personal protective measures. Findings shed new light on the topic of personal safety among women cotton pickers in Pakistan. Increasing formal education and implementing training programmes for personal protective measures are important to reduce health risk and health cost from pesticides among women workers. (3 Figures, 7 Tables, 51 References)

[14674]

Naik R.K, Naik M.M, D'Costa P.M, and Shaikh F. 2019
Marine Pollution Bulletin **149**: ArticleID_110525
 ESSO, National Centre for Polar and Ocean Research,
 Headland Sada, Vasco-da-Gama, Goa 403 804, India

Microplastics in ballast water as an emerging source and vector for harmful chemicals, antibiotics, metals, bacterial pathogens and HAB species: A potential risk to the marine environment and human health

Microplastic pollution in marine waters around the globe is increasing exponentially. This is the first comprehensive review that focuses on microplastics as a source and vector for metals, antibiotics, toxic chemicals, pathogenic bacteria (*Vibrio cholerae*), and harmful algal bloom (HAB) forming dinoflagellates across the continents through ballast water. Microplastics in ballast waters serve as 'hotspots' for the

development and spread of multiple drug-resistant human pathogens through co-selection mechanisms. Microplastic inoculation at distant countries through ballast water may pose a serious threat to human health due to higher incidences of bacterial disease outbreaks and HABs. The authors conclude that there is a pressing need to include microplastics in the ballast water management convention as a hazardous material. Efficient on-board ballast water treatment strategies and effective limits for microplastics in ballast waters need to be developed. (4 Figures, 132 References)

[14675]

Parial K, Mukherjee S, Ghosh A R, and Sengupta D. 2019

Current science **116**(10):1683

Department of Geology and Geophysics,
Indian Institute of Technology Kharagpur, Kharagpur
721 302, India

A GIS-based approach for radiation risk assessment around a thermal power plant towards adopting remedial measures

Coal combustion in thermal power plants releases ash, which is reported to cause adverse health hazards in humans and other organisms. Owing to the presence of radionuclides, it is also considered as a potential radiation hazard. In this study, based on the surface radiation measurements and relevant ancillary data, expected radiation risk zones were identified with regard to human population residing near a thermal power plant using GIS. With population density as the vulnerability determining criterion, about 20% of the study area was in the 'high' risk zone and another 20% in the 'low' risk zone. The remaining 60% was under 'medium' risk zone. Based on the findings of this study, greenbelt locations have been proposed as a remedial measure. (6 Figures, 2 Tables, 33 References)

ENVIRONMENTAL PLANNING,

MANAGEMENT AND POLICY ISSUES

[14676]

Ballukraya P N and Srinivasan V. 2019

P N Ballukraya, formerly Professor of Applied Geology,
University of Madras, Chennai 600 025, India
Current Science **117**(1): 130-138

Sharp variations in groundwater levels at the same location: A case study from a heavily overexploited, fractured rock aquifer system near Bengaluru, South India

Analyses of 83 borehole camera video scans revealed that (i) measured groundwater levels show variations of up to about 200 m, even in borewells located in close proximity to each other, (ii) water-bearing joints located at shallow depths in deeper borewells often produce cascades of water which flow downhole till they meet the water level, (iii) the downward flow of recharging waters directly through the existing borewell shafts leads to the formation of a dewatered zone below the recharge zone and above the saturated zone, and (iv) the borewells completed in the dewatered zone show a direct relationship between water level and well depth – the deeper the borewell, the deeper is the water level. Only the currently yielding borewells, with at least one water-yielding joint below the water level, give a fair estimate of the regional groundwater table. (8 Figures, 18 References)

[14677]

Bhattacharya A K, Lodh R, Roy A K, Karthik D M P, Singh A, Kumari S, Kumari V, Daksh K, Kumar P, and Anurag. 2019

Electronic Journal of Geotechnical Engineering **24**:
1-34

Chairman and Managing Director, MultiSpectra
Consultants, 23, Biplabi Ambika Chakraborty Sarani,
Kolkata – 700029, West Bengal, India

An analysis of arsenic contamination in

the groundwater of India, Bangladesh and Nepal with a special focus on the stabilisation of arsenic-laden sludge from arsenic filters

This paper starts by presenting an overview of the arsenic contamination in the groundwater in different parts of India. Then it goes on to present standards regarding arsenic in drinking water and proceeds further to give a state-wise status of arsenic contamination. Adverse effects of arsenic on the health of human beings, accumulation of arsenic in the food chain, and ill-effects of using arsenic-laden water for irrigation are elaborated. The paper explores technological options to deliver arsenic-free water by various ways and means. Providing medical relief to affected people is also included. Methods for safe disposal of arsenic-laden sludge from arsenic filters and various issues related to the same are also key aspects of the paper. (14 Figures, 38 References)

[14678]

Hoque S F, Hope R, Arif S T, Akhter T, Naz M, and Salehin M. 2019

Science of the Total Environment **679**: 23–34

School of Geography and the Environment and Smith School of Enterprise and the Environment, University of Oxford, UK

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A social-ecological analysis of drinking water risks in coastal Bangladesh

Groundwater resources in deltaic regions are vulnerable to contamination by saline seawater, posing significant crisis for drinking water. Current policy and practice of building water supply infrastructure, without adequate hydrogeological analysis and institutional coordination, are failing to provide basic drinking water services for millions of poor people in such difficult hydrogeological contexts. A social-ecological systems approach has been to examine interdisciplinary data from

hydrogeological mapping, a water infrastructure audit, 2103 household surveys, focus group discussions and interviews to evaluate the risks to drinking water security in one of 139 polders in coastal Bangladesh. It was found that increasing access through public tubewells is common but insufficient to reduce drinking water risks. In response, there has been a fourfold growth in private investments in shallow tubewells with new technologies and entrepreneurial models to mitigate groundwater salinity. Despite these interventions, poor households in water-stressed environments face significant trade-offs in drinking water quality, accessibility, and affordability. The authors argue that institutional coordination and hydrogeological monitoring at a systems level are necessary to mitigate socio-ecological risks for more equitable and efficient outcomes. (7 Figures, 69 References)

[14679]

Huq Md E, Fahad S, Sha Z, Sarven M S, Al-Huqail A A, Siddiqui M H, Rahman M H ur, Khan I A, Alam M, Saeed M, Rauf A, Basir A, Jamal Y, and Khan S U. 2019

Journal of Environmental Management **242**: 199–209

State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing, Wuhan University, 129 Luoyu Road, Wuhan, 430079, Hubei, China

High arsenic contamination and presence of other trace metals in drinking water of Kushtia district, Bangladesh

A hydrochemical approach was employed in 50 drinking water samples (collected from Kushtia district, Bangladesh) to examine the occurrence of geogenic As and the presence of trace metals (TMs), as well as the factors controlling As release in aquifers. The results reveal that the drinking water of shallow aquifers is highly contaminated by As (6.05–590.7 µg/L); 82% of samples were found to exceed the WHO recommended limit (10 µg/L) for potable water, but the concentrations of Si, B, Mn, Sr, Se, Ba,

Fe, Cd, Pb, F, U, Ni, Li, and Cr were within safe limits. The study also reports that the occurrence of high As and the presence of TMs in drinking water may be a result of local anthropogenic activities, such as irrigation, intensive land use, and the application of agrochemicals. The insignificant correlation between As and SO_4^{2-} demonstrated that As is released from SO_4^{2-} minerals under reducing conditions. An elevated pH value along with decoupling of As and HCO_3^- plays a vital role in mobilizing As to aquifer systems. Moreover, the positive relationship between As and Si indicated that As is transported in the biogeochemical environment. The reductive suspension of Mn(IV)-oxyhydroxides also accelerated the As mobilization process. Overexploitation of tube well water and the competitive ion exchange process are also responsible for the release of As in aquifers. (7 Figures, 3 Tables, 87 References)

[14680]

Khan S N, Yasmeen T, Riaz M, Arif M S, Rizwan M, Ali S, Tariq A, and Jessen S.

Environmental Pollution **253**: 384–392

Department of Environmental Sciences and Engineering, Government College University Faisalabad, Faisalabad 38000, Pakistan

Spatio-temporal variations of shallow and deep well groundwater nitrate concentrations along the Indus River floodplain aquifer in Pakistan

This study was conducted along the seasonally flooded alluvial agricultural area of Indus River Basin to determine the spatial and temporal dynamics of nitrate concentrations in the groundwater along the river. A total of 112 samples were collected from shallow (30–40 ft) and deep groundwater (120–150 ft) wells at seven sites, 25 km apart from each other and covered an area of 170 km along the river, during four sampling campaigns. The study period covered the whole agricultural cycle, including the wet

summer season with no agricultural activities under flooding, and the sampling sites were always less than 2 km from the river bank. Nitrate concentrations of shallow wells were 15–54 and 20–45 mg/L during the start and middle of the dry season, respectively. However, at the end of the dry season, the highest nitrate concentrations of 35–75 mg/L were recorded and 70% of these samples contained nitrate concentrations above the permissible limit of 50 mg/L. Similar seasonal patterns of nitrate concentrations were observed in deep wells. The results illustrated that high nitrate concentrations in shallow wells were associated with high ^{-18}O values, indicating that the quantity of evaporated water infiltrated from the floodplain, possibly from distribution channels, along with the nitrate polluting shallow wells was more than the deep wells. At the end of the dry season, nitrate concentrations exceeded the permissible limits in both shallow and deep wells, which possibly happened due to the horizontal movement of groundwater along with the nitrate mixing during vertical seepage of river water to the aquifers. (6 Figures, 1 Table, 49 References)

[14681]

Khanoranga, Sofia K. 2019

Journal of Cleaner Production **229**: 727–738

Fatima Jinnah Women University, The Mall, Rawalpindi, Pakistan

E-mail: khanoranga.achak@gmail.com

Phytomonitoring of air pollution around brick kilns in Balochistan province Pakistan through air pollution index and metal accumulation index

This study was carried out to assess the sensitivity and tolerance of plants species against air pollution around brick kilns in Balochistan province, Pakistan. Plant species were collected from the study sites and were evaluated against pollution by making use of air pollution tolerance index and metal

accumulation index. The susceptibility of plants to different pollutants was determined by analysing various biochemical parameters (i.e., total chlorophyll content, ascorbic acid, pH of the leaf extract, and relative water content) and the heavy metal(loid)s level of the investigated plant species. The pollution tolerance level of the analysed plant samples showed that *Morus alba* was the most tolerant and *Convolvulus arvensis* the most sensitive species to the air pollution. The metal accumulation index value was found highest for *Lepidium sativum* and lowest for *Malcolmia africana*, indicating their metal accumulation capacity. Moreover, it was found that the pollution level of all the analysed heavy metal(loid)s was beyond the permissible limits of WHO except Mn. Keeping in view this research, it is suggested that the mentioned tolerant plant species grown in the vicinity of brick kilns may serve as sinks for pollution, whereas the sensitive ones may be used for monitoring of the pollution level. (1 Figure, 12 Tables, 94 References)

[14682]

Kiran V R, Ratnam M V, Murthy B V K, Kant Y, Prasad P, Raman R M, Rao S V B, Kumar T V L, and Maitra A. 2019

Environmental Pollution **254**: 112932

National Atmospheric Research Laboratory (NARL), Gadanki, Tirupati, Andhra Pradesh, India

Email: ravikiranv@narl.gov.in

An empirical method for source apportionment of black carbon aerosol: Results from aethalometer observations at five different locations in India

Black carbon (BC) aerosol emitted in incomplete combustion process is known for causing warming in the climate system and also poses serious health issues. Identification of the sources of BC is essential for the development of mitigation strategies to regulate their effects in changing climate. Among different observational and analytical techniques currently available,

source apportionment methods based on optical measurements are relatively simple. This method has been applied to aethalometer observations from five different locations (rural, semi-urban, and urban) over Indian subcontinent to quantify sources of BC. Fossil fuels are found to be the major sources of BC (~70%) irrespective of the location. Collocated measurements of carbon monoxide (CO) over the rural site correlated well with derived biomass fraction. Results from this study demonstrated the capabilities of the empirical method and shall provide spatiotemporal variability in sources of BC if applied to more locations. (1 Figure, 22 References)

[14683]

Laxmankumar D, Satyanarayana E, Ratnakar D, and Saxena P R. 2019

Groundwater for Sustainable Development **8**: 474-483

Department of Applied Geochemistry, Osmania University, Hyderabad

Hydrogeochemical characteristics with respect to fluoride contamination in groundwater of Maheshwaram mandal, RR district, Telangana state, India

Groundwater samples were collected in Maheshwaram mandal, Ranga Reddy district, Telangana, India for two seasons (pre-monsoon and post-monsoon) and analysed for chemical parameters with respect to fluoride. The fluoride concentration ranges from 0.31 to 3.03 mg/l and 0.28–2.58 mg/l during pre-monsoon (PRM) and post-monsoon (POM) seasons, respectively. Results showed that water samples were contaminated with fluoride ions. High fluoride concentration was recorded during PRM 62% and POM 38% when compared with World Health Organization tolerance limit of 1.5 mg/l. The higher ratio of Na/Ca indicates dissolution of fluoride minerals at higher pH and that of HCO_3/Ca ratio indicates the condition favouring the dissolution of fluoride

ions. Hydrogeochemical facies distribution indicates that water-rock interaction resulted in occurrence of high fluoride concentration in groundwater. Analytical results plotted on Gibbs diagram indicate rock and evaporation dominance. Principal component analysis indicates that hydrogeochemical processes such as weathering, ion exchange, and anthropogenic activities contribute to groundwater chemistry. (9 Figures, 7 Tables, 52 References)

[14684]

Ravindra K, Thind P S, Mor S, Singh T, and Mor S. 2019 *Environmental Pollution* **255**(1)

Department of Community Medicine and School of Public Health, Post Graduate Institute of Medical Education and Research (PGIMER), Chandigarh, 160012, India

E-mail khaiwal@yahoo.com

Evaluation of groundwater contamination in Chandigarh: Source identification and health risk assessment

The major objective of the current study is to estimate the groundwater quality and identify the likely sources of contamination in Chandigarh, India. Total 80 groundwater samples were collected from different locations and at various depths. The groundwater samples collected from shallow water sources contain higher concentration of total dissolved salts. EC, TA, Cl⁻, TH, Na⁺, and K⁺ were found relatively higher in the shallow aquifer (<150 ft). Based on the location of pollution sources at the surface and the consecutive geo-statistical distribution of physicochemical characteristics, this study suggests that non-scientific disposal of municipal solid waste, dumping of industrial waste, and agricultural activities in the nearby areas lead to the deterioration of groundwater of shallow aquifer. These observations were also confirmed using various water quality indices and outcomes of multivariate modeling, including principal component analysis. Health risk assessment for nitrates indicated that 29

groundwater samples pose non-carcinogenic health risks for children due to dermal and oral exposure. Hence, there is a need to establish a system for regularly assessing the groundwater quality to minimize public health risks. (7 Figures, 1 Table, 68 References)

[14685]

Rawat P, Sarkar S, Jia S, Khillare P S, and Sharma B. 2019

Atmospheric Environment **209**: 167–181

Department of Earth Science, Indian Institute of Science Education and Research (IISER), Kolkata, Mohanpur, Nadia-741246, India

Regional sulfate drives long-term rise in AOD over megacity Kolkata, India

This article presents the first long-term (2001–2017) record of aerosol optical depth (AOD; interchangeably AOT) and contributions of aerosol chemical components to light extinction over Kolkata, the second most polluted metropolis in India. For this purpose, we use daily gridded MODIS AOD measurements coupled with modeled AOT for five major aerosol constituents, namely, sulfate, sea salt, dust, organic carbon (OC) and black carbon (BC), from the MERRA-2 reanalysis system. We find that AOD over Kolkata has increased significantly (32% overall, 0.010 y⁻¹; Mann-Kendall test with Theil–Sen slope estimation; $p < 0.01$) over the past 17 y to a mean of 0.74 ± 0.10 in 2017, and an overwhelming majority of this increase is driven by a concurrent rise (70% overall, 0.007 y⁻¹, $p < 0.01$) in sulfate AOT. This is followed by smaller but significant enhancements in OC (40% overall, 0.002 y⁻¹, $p < 0.01$) and BC (20% overall, 0.0004 y⁻¹, $p < 0.01$) AOT. Although a non-trivial fraction (24%) of AOT is associated with natural emissions (sea salt and dust), these do not exhibit significant trends over time and therefore are not instrumental in driving the observed AOD rise. A concentration-weighted trajectory (CWT) analysis shows that sulfate aerosol over Kolkata

is mostly regional (within ~250 km) during winter and post-monsoon with significant footprints over thermal power plant clusters in neighbouring states and areas with considerable residential biofuel use (eastern Indo-Gangetic Plain (IGP) and the Ganges-Brahmaputra Basin). In comparison, BC and OC AOT show a significant long-range component (~1800 km) originating from northwestern and central IGP, especially during post-monsoon, when open agricultural residue burning is rampant. Overall, these results provide a preliminary indication that a considerable fraction of aerosol light extinction over Kolkata might be related to non-local, atmospherically transported aerosol. Once validated by ground-based measurements, these results would reinforce the need to bring regional and long-range emissions, in addition to within-the-city emissions, under the purview of air quality management policies.

[14686]

Sarkar C, Venkataraman C, Yadav S,
and Phuleria H C. 2019

Environmental Pollution **254** (Part B): 113077
Inter Disciplinary Program in Climate Studies, Indian
Institute of Technology, Bombay, Powai, Mumbai,
400076, India
Email: chirantanbi@gmail.com

Origin and properties of soluble brown carbon in freshly emitted and aged ambient aerosols over an urban site in India

This work investigates the absorption properties of soluble brown carbon (BrC), extracted in methanol and water, from ambient aerosol (PM_{10}) samples collected over an urban background site in Mumbai, India. Compared with afternoon samples, the morning samples of MSOC and WSOC had increased BrC concentrations and absorption coefficients ($b_{abs-365}$; 40%–65%). The correlation between $b_{abs-365}$ and EC, $ns-K^+$, and NO_3^- in the morning samples indicated contributions from primary

sources, including both biomass and vehicular sources. The decreased $b_{abs-365}$ in the afternoon samples was partly explained by mixing layer dilution, accompanied by a reduction in the concentrations of primary aerosol constituents. Furthermore, in the afternoon samples, ^1H NMR spectroscopy revealed the presence of more oxidized functional groups and significantly higher OC/EC and WSOC/OC ratios, indicating the greater aging of afternoon aerosol. (6 Figures, 1 Table, 65 References)

[14687]

Shetye S S, Rudraswami N G, Nandakumar K,
and Manjrekar S. 2019

Marine Pollution Bulletin **143**: 1–5
CSIR-National Institute of Oceanography, Dona Paula
403 004, Goa, India
E-mail: s.shetye@nio.org

Anthropogenic spherules in Zuari estuary, south west coast of India

In this study, silica-rich anthropogenic spherules from the marine environment is reported. Spherical, dumbbell, teardrop, and fused spherules in Zuari estuary (near the Dona Paula Jetty), south west coast of India, was found. The spherules were composed of SiO_2 (69.8%), Na_2O (13.2%), CaO (8.8%), MgO (3.8%), and traces of Al_2O_3 and FeO . Their high Na and Ca content rules out the possibility of being an impact spherule or microtektite, or anthropogenic spherules coming from fly ash. Their elemental composition suggests that these are glass micro beads that have many applications, including production of road and pavement marking materials such as traffic paints. Considering that the glass micro beads are known to have high concentrations of Pb, As, and Sb that can leach into the marine environment, this study also raises questions regarding the impact of such spherules on marine biota and highlights the need for further detailed study. (4 Figures, 2 Tables, 25 References)

[14688]

Singh R, Gupta P, Jangid A, Sharma A, and Kumar R. 2019

Soil, Air Water 47: 1-10

Department of Chemistry, Faculty of Science,
Dayalbagh Educational Institute (Deemed University),
Dayalbagh, Agra, India

Assessment of fractionated aerosols at a semiarid region over the Indo-Gangetic Basin

The present study examines the mass concentration of particulate matter (PM) of different sizes between January and December at Agra, a semiarid region in the Indo-Gangetic basin. The observed $PM_{2.5}$ and PM_{10} concentrations are considerably higher than standard values set by the World Health Organization, United States Environmental Protection Agency, and National Ambient Air Quality Standard (India). Higher concentrations of PM_{10} and $PM_{2.5}$ are observed in November and January, respectively. The highest and lowest concentrations of PM_{10} and $PM_{2.5}$ are measured in winter and monsoon seasons, respectively. The $PM_{2.5}/PM_{10}$ mean mass concentration ratio is 0.44, indicating the dominance of coarse particles. The exceedance factor (EF) for PM_{10} is >1.5 , indicating a critical level of PM_{10} , whereas the EF for $PM_{2.5}$ is <1.5 indicating a high level of pollution load. The trajectory analysis showed the effect of long-range transported particles on this region. (7 Figures, 3 Tables, 62 References)

[14689]

Tripathi C. B, Baredar P, and Tripathi L. 2019

Current Science 117(7): 1153-1160

Maulana Azad National Institute of Technology,
Bhopal 462051, India

Air pollution in Delhi: Biomass energy and suitable environmental policies are sustainable pathways for health safety

Air pollution causes severe environmental problems and has become a major health risk for livelihood in Delhi. With increase in population, there is an increase in emissions from various

utilities as well. The main source of air pollution is crop residue burning, followed by vehicular and industrial emissions. Crop residue burning during winter produces a thick cloud of smoke and causes major threats to human health by deterioration in air quality. This crucial matter was also discussed in the Indian Parliament. The National Green Tribunal and various Courts of India have directed the Delhi government and various concerned agencies to resolve the air pollution problem. This study discusses human health safety caused by air pollution, analysis and mitigation of air pollution using suitable environmental policies, and application of biomass energy. (1 Figure, 2 Tables, 65 References)

ENVIRONMENTAL LAWS AND REGULATION

[14690]

Datar M N, Dongre S, and Gadgil M. 2019

Current science 117(5): 776-782

Biodiversity and Palaeobiology Group, Agharkar
Research Institute, G.G. Agarkar Road, Pune 411
004, India

A critical evaluation of environmental impact assessments: A case study of Goa mines, India

Environmental impact assessments (EIAs) form the basis of estimation of environmental and socio-economic impacts of developmental projects. This study examines EIA reports of 65 mines in Goa. It is mandatory that the reports should provide, among others, lists of plant species from 314.2 and 78.5 sq. km area for lease areas of mines above 0.5 and below 0.5 sq. km, respectively. On the basis of available data covering different spatial scales for the Western Ghats, we determined the species-area relationships and the expected numbers of species in area of these sizes. We find the plant lists in the EIA reports to be highly incomplete and defective in many ways, including with respect to the information on water resources

and ore transport by trucks and barges. We conclude by recommending a set of measures focusing on transparency and public involvement to correct the situation. (3 Figures, 3 Tables, 38 References)

SUSTAINABLE DEVELOPMENT

[14691]

Athira G, Bahurudeen A, and Appari S. 2019
Journal of Cleaner Production **236**(1): 117598
Department of Civil Engineering, Birla Institute of Technology and Science Pilani, Hyderabad, Telangana, India

Sustainable alternatives to carbon intensive paddy field burning in India: A framework for cleaner production in agriculture, energy, and construction industries

The recent literature indicates an increased interest in rice straw valorisation, possibly in response to the increasing concerns over paddy field burning. However, a systematic study that compiles and compares various rice straw valorisation routes is lacking in the existing literature. This paper provides a comprehensive review of the literature on various alternative uses of rice straw in energy and construction industries. The effective use of rice straw as a biomass fuel in the energy sector not only reduces the field burning, but also decreases the dependency on non-renewable fossil fuels. Moreover, the proposed utilization of secondary by-products from rice straw-based energy production in the construction industry can help attain the goals of resource cascading. The availability of rice straw in major rice producing states of India and the feasibility of establishing rice straw-based power plants are also examined in this study. The potential reduction in harmful emissions from such resource recycling has been determined as per the guidelines issued by the Intergovernmental Panel on Climate Change. From the review of literature and the findings of the present study, a sustainable framework

has been developed with well-defined cleaner production pathways to create a seamless material flow chain between the agricultural, energy, and construction sectors. (14 Figures, 14 Tables, 157 References)

[14692]

Nath A, Kumar R, Behura A K, Tara K, and Sundararajan M. 2019
Indian Journal of Environmental Protection **39**(6): 545-550
Indian Institute of Technology (Indian School of Mines), Dhanbad 826 004, Jharkhand, India

Corporate social responsibility for sustainable development

Corporate social responsibility (CSR) can be a good tool for sustainable development in the mining regions of the country. CSR can be defined as the impact that the businesses have on the society and in turn the expectations of the society from them. The companies nowadays seriously undertake corporate social responsibility activities as they feel their responsibility towards the society where it operates. This paper aims to take a close look at the community development initiatives of a few large-scale coal mining companies in India. With a few case studies, an attempt is being made to understand the term corporate social responsibility and its role in sustainable development. Case studies of a few coal mining companies, namely, Eastern Coalfields Limited, Central Coalfields Limited, and Northern Coalfields Limited, have been considered here. These examples show how the businesses have realized their existence in economic, social, and environmental terms and as such they are equally showing their inclination for environment and the society, besides looking for the profit. (6 Figures, 10 Tables, 14 References)

CLIMATE CHANGE: ISSUES AND POLICY

[14693]

Banerjia U S, Bhushana R, and Jullc A J T. 2019
Quaternary International **507**: 172–187
 Physical Research Laboratory, Navrangpura,
 Ahmedabad 380009, Gujarat, India

Signatures of global climatic events and forcing factors for the last two millennia from the active mudflats of Rohisa, southern Saurashtra, Gujarat, India

The limited extent of instrumental records going back in time and control of various climatic variables on Indian Summer Monsoon (ISM) has reinvigorated the unprecedented effort in documenting climate changes for the last two millennia. Although extensive studies on late Holocene ISM reconstruction are available, comprehensive understanding on the influence of natural forcing factors on ISM and their plausible signatures is not arrived till date. In view of this, the present study attempts to address the ISM variations during the last two millennia with special emphasis on natural forcing factors (solar and volcanic) and climate variables (ocean-atmospheric processes). The Saurashtra peninsula of Gujarat in western India receives majority of rainfall during ISM and hence it provides an ideal test bed to study the ISM variability. A multiproxy approach has been adopted on a sediment core retrieved from the active mudflat of southern Saurashtra which was chronologically supported by ^{210}Pb , ^{137}Cs , and ^{14}C . The present study demonstrates vacillating climate with strengthened ISM during Roman Warm Period and Medieval Warm Period (2000–950 cal year BP) as a result of increased solar irradiance interrupted by reduced ISM during Dark Ages Cold Period. (10 Figures, 1 Table, 201 References)

[14694]

Bhadwal S, Sharma G, Gorti G, and Sen S M. 2019
Environmental Development **31**: 68–77
 The Energy and Resources Institute (TERI),
 Darbari Seth Block, IHC Complex, Lodhi Road, New
 Delhi 110 003, India

Livelihoods, gender and climate change in the Eastern Himalayas

The Hindu Kush Himalayan region encompasses a large area covering many countries in the North, South, and Central parts of Asia. People living in these mountains face huge complexities arising from a number of factors, including terrain characteristics, micro-climates, environmental degradation, and access to basic services. Climate change impacts are disproportionate and influence lives and livelihoods variedly. One crucial determinant of these disproportionate impacts is gender – existing social norms determine roles and responsibilities, entitlements, and capabilities, thereby influencing the individual perceptions of shocks and susceptibility that vary across gender groups. The paper seeks to draw insights from the various field studies conducted in these locations to understand the gender vulnerabilities that manifest through a combination of complex and interlinked factors. It seeks to understand the existing social practices typically associated with these gender groups and how changes in the climate potentially influence vulnerability. The study reiterates the role of place-based vulnerability in influencing lives and livelihoods and emphasises on the lack of access to human, financial, and natural capitals as predominantly driving gendered vulnerabilities. (4 Figures, 4 Tables, 20 References)

[14695]

Chanda M M, Carpenter S, Prasad G, Sedda L, Henrys P A, Gajendragad M R, and Purse B V. 2019

Scientific Reports 9: 4229

Centre for Ecology and Hydrology, Benson Lane,
Crowmarsh Gifford, Oxfordshire, OX10 8BB, UK

Livestock host composition rather than land use or climate explains spatial patterns in bluetongue disease in South India

Culicoides-borne arboviruses of livestock impair animal health, livestock production, and livelihoods worldwide. As these arboviruses are multi-host, multi-vector systems, predictions to improve targeting of disease control measures require frameworks that quantify the relative impacts of multiple abiotic and biotic factors on disease patterns. The authors develop such a framework to predict long-term (1992–2009) average patterns in bluetongue, caused by bluetongue virus, in sheep in southern India, where annual bluetongue outbreaks constrain the livelihoods and production of smallholder farmers. Since buffalo are resistant to clinical signs of bluetongue, this finding suggests they are a source of infection for sympatric susceptible sheep populations. Landscape factors, namely, the coverage of post-flooding, irrigated and rainfed croplands, had weak positive effects on outbreaks. The intimate links between livestock host, vector composition, and agricultural practices in India require further investigation at the landscape scale. (3 Figures, 4 Tables, 80 References)

[14696]

Dwivedi A K, Kumar A, Baredar P, and Prakash O. 2019

Forest Policy and Economics 102: 66–74

Energy Centre, Maulana Azad National Institute of Technology (MANIT), Link Road Number 3, Near Kali Mata Mandir, Bhopal 462 003, Madhya Pradesh, India

Bamboo as a complementary crop to

address climate change and livelihoods – Insights from India

Bamboo has the potential to generate carbon credits due to high carbon sequestration rates, which can be traded internationally. Farmers can use bamboo farming in sub-optimal land to generate additional income and improve the fertility of the land. This study is about the ‘twofold potential’ of bamboo in improving financial conditions of farmers by utilization of cultivable wasteland and helping in climate change mitigation by avoided deforestation, afforestation, and carbon sequestration. India has approximately 146 million hectares of degraded land. Bamboo cultivation can generate around 10 CERs per hectare annually, which can be traded as carbon credits. Additionally, under-employed farmers can work as skilled workers in bamboo handicraft industry and earn up to US\$2700 annually at current exchange rates, which is significantly higher than the present average income (US\$1750/annum) of farmers. (4 Figures, 2 Tables, 78 References)

[14697]

Liao X, Xu W, Zhang J, Li Y, and Tian Y. 2019

Science of the Total Environment 663: 644–653

Academy of Disaster Reduction and Emergency Management, Ministry of Emergency Management and Ministry of Education, Beijing Normal University, Beijing 100875, China

Global exposure to rainstorms and the contribution rates of climate change and population change

Based on daily precipitation data from the NEX-GDDP dataset, rainfall from rainstorms is first calculated by a multi-model ensemble method for four periods from 1986 to 2100. Combined with population data from the SSP2 scenario, the global population exposure to rainstorms is then calculated and analysed. Finally, the contribution rates of climate change effect, population change effect, and joint change effect on exposure change are quantitatively assessed.

The results showed that population exposure to rainstorms shows a linear upward trend from base period to the late 21st century period in most regions, and the mid-21st century period compared with the base period has the fastest rate of increase. The spatial patterns of population exposure to rainstorms are very similar for the four periods and the areas with high exposure are mainly distributed in Asia, and population exposure of Africa is gradually increasing. The change in total exposure is mainly due to population change. Based on the composition of the total exposure change for each country, the number of countries whose climate change effect is greater than that of population change is gradually increasing, and this number reaches more than a quarter of the total when the late 21st century period is compared with the mid-21st century period. (8 Figures, 3 Tables, 31 References)

[14698]

Paetha H, Steger C, Li J, Pollinger F, Mutz S G, and Ehlers T A. 2019
Global and Planetary Change **177**: 10–26
 Institute of Geography and Geology, Department
 of Geography and Geology, University of Würzburg,
 Oswald-Külpe-Weg 86, D-97074 Würzburg, Germany

Comparison of climate change from Cenozoic surface uplift and glacial-interglacial episodes in the Himalaya-Tibet region: Insights from a regional climate model and proxy data

The main objective of the study is to delimit the range of climate variability due to important natural drivers in the region by comparing climate changes during the main Cenozoic uplift period with climate anomalies during the last glacial maximum and the mid-Holocene optimum. This helps to interpret environmental changes documented by proxy data and to benchmark man-made climate changes expected during the 21st century. The innovative aspects of this study pertain to the use of a consistent high-resolution

modeling framework and a multivariate statistical assessment of climate types and their shift during the various paleoclimatic episodes. Reduced plateau elevation leads to regionally differentiated patterns of higher temperature and lower precipitation amounts on the plateau itself, whereas surrounding regions are subject to colder conditions. In particular, Central Asia receives much more precipitation prior to the uplift, mainly due to a shift of the stationary wave train over Eurasia. (15 Figures, 1 Table, 85 References)

[14699]

Parousos L, Mandel A, Fragkiadakis K, Fragkos P, Hinkel J, and Vrontisi Z. 2019
Nature Climate Change **9**: 542–546
 Paris School of Economics, University Paris 1
 Pantheon-Sorbonne, 12 Place du Panthéon, 75231
 Paris, France

Climate clubs and the macro-economic benefits of international cooperation on climate policy

The Paris Agreement has provided a new framework for climate policy. Complementary forms of international collaboration, such as climate clubs, are probably necessary to foster and mainstream the process of gradual and voluntary increase in nationally determined contributions. The authors provide a quantitative macro-economic assessment of the costs and benefits that would be associated with different climate club architectures. The authors find that the key benefits that could structure the club are enhanced technological diffusion and the provision of low-cost climate finance, which reduce investment costs and also enable developing countries to take full advantage of technological diffusion. Although they face the highest absolute mitigation cost, China and India are the largest relative winners from club participation because the burden faced by these countries to finance their energy transition can be massively reduced following their participation

in the club. (29 References)

[14700]

Roy S S. 2019

Weather and Climate Extremes **24**: 100203

Department of Geography, University of Miami, 1300
Campo Sano Drive, Department of Geography, Coral
Gables, FL 33124, USA

Spatial patterns of trends in seasonal extreme temperatures in India during 1980–2010

Station level daily maximum and minimum temperature data spread across India were analysed for trends in seasonal extreme temperature indices. The trends were calculated for the recent period of 1980–2010, when some of the warmest temperatures were recorded at the global scale. The results of the analysis revealed substantial variations in the spatial patterns of the trends. The majority of the study areas experienced declining trends in diurnal temperature range during all seasons. However, substantial variations were observed for the different extreme temperature indices. During the first half of the year, which constitutes the drier summer and winter months, a declining trend in extreme maximum and minimum temperature indices was observed over most of the peninsular India and the reverse in the northern India. The spatial patterns were in general similar for the first half of the year, winter and summer, which constitute the drier months. The spatial patterns can be attributed to both local and regional level processes, such as aerosol levels and land use land cover changes. (6 Figures, 1 Table, 32 References)

[14701]

Shea M M and Thornton T F. 2019

Global Environmental Change **58**: 101973

School of Geography and the Environment, University
of Oxford, South Parks Road, Oxford, OX1 3QY, UK

Tracing country commitment to

indigenous peoples in the UN Framework Convention on Climate Change

The paper proposes an empirical method for tracking the country representation of indigenous peoples and traditional knowledge within the UNFCCC using text analyses of nationally determined contributions (NDCs) and official side events. The authors show that while some references to IP exist in NDCs, the language is often found in less substantive portions of the texts. Official side events on indigenous topics are one-third as likely to have been sponsored by individual countries as events on other topics. Thus, centralized discourses around IP in the UNFCCC do not necessarily translate to individual country priorities and actions on climate change. While larger structural changes are necessary to include IP in the UNFCCC, understanding this insufficient country inclusion of indigenous topics points to further avenues for increasing indigenous representation in the UNFCCC. (5 Figures, 52 References)

[14702]

Singh R and Kumar R. 2019

Global and Planetary Change **177**: 1–9

Indian Institute of Technology Bombay, Powai,
Mumbai 400 076, Maharashtra, India

Climate versus demographic controls on water availability across India at 1.5°C, 2.0°C and 3.0°C global warming levels

In this study, the authors quantify the changes in mean annual per capita water availability (PCWA) across India under 1.5°C, 2.0°C, and 3.0°C levels of global warming. The authors utilize projections of future climate from several general circulation models (GCMs) under three different representative concentration pathways (RCPs) along with projections of future population from five socio-economic pathways (SSPs). Using the estimated PCWA from these GCM-RCP-SSP combinations, the authors perform a sensitivity analysis to ascertain the relative importance of climatic

(precipitation and temperature change) and demographic (population) factors in affecting per capita freshwater availability in a region. The analysis shows that PCWA over India will decrease across all warming scenarios. In addition, a transition from the 1.5°C warmer world to the 2.0°C warmer world leads to a reduction in PCWA for a majority (92.8%) of regions across India. Regions with historically lower populations and lower aridity indices tend to be more sensitive to population changes. On the other hand, as historical population of a region increases, sensitivity to changing climate (mainly mean annual precipitation) increases. These results indicate the complex interactions between demographic and climatic changes that need to be accounted for in policies that aim to manage water scarcity by either controlling global warming or via socio-economic interventions. (8 Figures, 75 References)

[14703]

Vu H T, Liu Y, and Tran D V. 2019

Global Environmental Change 58: 10194

William White School of Journalism & Mass

Communications, University of Kansas, Stauffer-Flint

Hall, 1435 Jayhawk Blvd., Lawrence, 66045, KS, USA

Nationalizing a global phenomenon: A study of how the press in 45 countries and territories portrays climate change

This study investigates the news coverage of climate change in 45 different countries and territories. Using the news framing approach, this study identifies the connections between several national socio-economic, governance, and environmental traits and the portrayals of climate change. Although climate change is a global issue that affects every country in the world, how the news media frame it varies from country to country. Such a variation is related to each country's economic development, climate severity, and governance. The findings of this study contribute to framing literature by assessing frame use in national contexts, filling

in the gap in the application of this theoretical framework. (2 Figures, 1 Table, 76 References)

[14704]

Yadav R K and Roxy M K. 2019

Global and Planetary Change 179: 23–32

Plants, Soils and Climate Department and Utah

Climate Center, PSC Department, Utah State

University, 4820 Old Main Hill, Logan, Utah, UT

84322-4820, USA

On the relationship between north India summer monsoon rainfall and east equatorial Indian Ocean warming

Generally, a strong north India summer-monsoon rainfall (NISR) is associated with anomalous upper troposphere ridge over northwest of India. This ridge triggers anomalous northerly winds over Tibetan Plateau and easterlies over India. The easterly anomaly over India reduces the tropospheric wind shear, while the northerly at Tibetan plateau allows frequent intrusions of high-latitude dry and cold meridional winds to interact with the lower level relatively warm and moist easterly monsoonal flow, enhancing the NISR. The study, using a suite of observations, reanalysis products and numerical model sensitivity experiments, explores the changes in NISR and its association with the warming in the equatorial Indian Ocean. In the recent two decades (1996–2017), the NISR has been exhibiting a decreasing trend with increased variability, much larger than the earlier period (1979–2000). The current analysis indicates that the warmer SST (sea surface temperature) induces strong convection and associated northward propagating off-equatorial Rossby gyres to the west of the equatorial eastern Indian ocean, spreading the tropospheric heating towards the northeast of India, thereby elevating the geopotential height. This creates upper troposphere low pressure anomaly at the northwest of India. These factors are consistent with the suppression of the NISR, resulting in the observed decreasing trend in the recent

decades. (6 Figures, 43 References)

[14705]

Yang Z. 2019

Energy Economics **83**: 208–216

Department of Economics, Binghamton University,
4400 Vestal Parkway East, PO Box 6000,
Binghamton, NY 13902-6000, USA

Increasing returns to scale in energy-intensive sectors and its implications on climate change modeling

Increasing returns to scale (IRS) phenomena are widely present in economies, and integrated assessment models (IAMs) for climate change generally assume constant returns to scale (CRS). This paper studies the connection between IRS in energy-intensive sectors and the regions' attitude towards climate change. In a model of detrimental (negative) externality, the authors proved that if some agents' activities related to externality generation exhibit IRS, their optimal target in the efficient externality provision can be very close to their inefficient non-cooperative Cournot-Nash equilibrium position. The numerical simulations in this paper confirm the analytical conclusion. The analytical results point out the potential biases of IAMs under the CRS assumption and provide a better explanation of difficulties in international climate negotiations. Finally, the paper offers some policy suggestions on climate negotiation in the presence of IRS. (2 Figures, 2 Tables, 41 References)

[14706]

Zhao Y, Damgaard A, Xu Y, Liu S, and Christensen T H. 2019

Applied Energy **247**: 237–253

School of Environment, Beijing Normal University,
Beijing 100875, China

Bioethanol from corn stover – Global warming footprint of alternative biotechnologies

Bioethanol from residual corn stover could

contribute to lowering CO₂ loads within the transport sector if used as an amendment to gasoline. The authors modelled through life cycle assessment and Monte Carlo simulation seven different technological configurations for producing bioethanol from corn stover based on consistent mass flows and estimated ethanol production extracted from 141 datasets of reasonable quality. By parametrizing key processes and determining their statistical distribution based on actual data, the authors were able to estimate the global warming potential (GWPs) for all the alternative technologies on a system level. Most of the individual cases showed a net saving in GWP when the savings obtained from recovering energy from anaerobic digestion of the liquid residues and incineration of the solid residues were included. The 'best practice', defined as the top 15% cumulative probability with respect to GWP, suggests that technologies based on steam explosion and ammonia-based pretreatment appear statistically the most promising and could contribute, with residue energy recovery, to GWP savings of 850–1050 kg CO₂-eq/ton dry corn stover solids and produce in the range of 178–216 kg of bioethanol. This paper provides insights into the key parameters for bioethanol production from corn stover and suggests areas for further research. (5 Figures, 4 Tables, 165 References)

CLIMATE CHANGE: IMPACT, ADAPTATION, AND VULNERABILITY

[14707]

Ahmed A, Deb D, and Mondal S. 2019

Current Science **117**: 794–803

ICAR Research Complex for Eastern Region,
ICAR Patna, P. O. Bihar Veterinary College,
Patna 800 014, Bihar, India

Assessment of rainfall variability and its impact on groundnut yield in Bundelkhand region of India

Bundelkhand region, one of the vulnerable

areas in the central India, is prone to frequent drought and crop failure due to annual rainfall variability. In this study, long-term (113 years) fine resolution daily gridded rainfall data has been analysed to depict a spatial variation of annual rainfall over Bundelkhand. An increase in annual rainfall has been observed from north to south of the study area. A declining trend varying from 0.49 to 2.16 mm/year is observed in annual rainfall time series in most parts of the study area. Trend analysis of monsoon rainfall shows overall declining trend over the study area. Rainfall events are categorized in various classes and their spatial trends over Bundelkhand are depicted. Kharif crop calendar (July–September) as well as its yield in India, including Bundelkhand, is primarily based on monsoonal rainfall parameters. This study depicts rainfall pattern over the study area and identifies the vulnerable areas that are likely to experience more water stress due to rainfall variability. (5 Figures, 1 Table, 54 References)

[14708]

Akter A, Howladar M F, Ahmed Z, and Chowdhury T R. 2019

Environmental Systems Research 8(1)

Department of Petroleum & Mining Engineering,
Shahjalal University of Science and Technology,
Sylhet 3114, Bangladesh

Email: farhad-pme@sust.edu

The rainfall and discharge trends of Surma River area in north-eastern part of Bangladesh: An approach for understanding the impacts of climatic change

Bangladesh is known as a deltaic plain at the confluence of the Ganges, Brahmaputra, and Meghna (GBM) river basins and their tributaries. The rainfall pattern of the north-eastern part of Bangladesh is changing along with the discharge pattern of Surma River. In this study, the changes in precipitation of Sylhet and river discharge of Surma River and the relationship between

them were investigated. The study focuses on the influence of climatic component (rainfall) on the hydro characteristics of river. The time series data from 1973 to 2016 (44 years) of rainfall and river discharge of Surma River were collected and analysed. The rainfall trend shows moderate year-to-year variability although there is an indication of declining rainfall trend. As with rainfall, the river discharges show moderate year-to-year variations that are related to the variability in rainfall. It can be noticed that the rainfall in Sylhet reduced from the time 1973 to 2016, which directly affected the discharge of Surma River. Consequently, this result might be the indication about the effect of climatic change at the local and global levels. (7 Figures, 6 Tables, 40 References)

[14709]

Chattopadhyay N, Sahai A K, Guhathakurta P, Dutta S, Srivastava A K, and Attri S D. 2019

Current Science 117: 480–486

India Meteorological Department, Shivajinagar, Pune 411 005, Maharashtra, India

Impact of observed climate change on the classification of agroclimatic zones in India

The classification of agroclimatic zones in India was made in the 1990s for identifying priorities and developing strategies for location-specific and need-based research as well as overall agricultural development in the country. Long-term climatic parameters, particularly temperature and rainfall, along with soil and crop information were used for the classification of agroclimatic zones. It has been documented with a fair degree of accuracy that overall climate is changing, particularly with respect to temperature over the Indian region. Thus, it is anticipated that in the recent past climate change may be reflected in the agroclimatic zones as well and ultimately may affect the criteria of their classification based on climatic parameters. The objective of the present study is to examine

the trends and spatial/temporal variability of temperature, rainfall, rainy days, and heavy rainfall in different agroclimatic zones of the country, which may help in better understanding of the further initiatives on reclassification of agroclimatic zones, if required. It has been observed that there are significant changes in temperature and rainfall, both temporally and spatially, across India and there is a definite shift in temperature and rainfall patterns in the recent past compared to 1951–1980. (5 Figures, 9 References)

[14710]

Chena X, Qia Z, Guia D, Gu Z, Ma L, Zeng F, and Li L.

2019

Agricultural Water Management **222**: 231–241

Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Xinjiang, 830011, China

Simulating impacts of climate change on cotton yield and water requirement using RZWQM2

Assessing the potential impacts of climate change on cotton (*Gossypium hirsutum* L.) yield and water demand is crucial in allocating water resources. In this study, cotton yield and water requirement under future climate scenarios were evaluated in Qira oasis, China. Six general circulation models (GCMs), under moderate and high representative concentration pathway (RCP) scenarios (4.5 and 8.5) and elevated CO₂ (eCO₂) concentration (218–502 ppm), were used to project climate for near (2041–2060) and far future (2061–2080) periods. With current management practices, the impacts of climate change on cotton yield and water requirement were simulated using the Root Zone Water Quality Model (RZWQM2), which was calibrated with experimental data (2007–2014) in a previous study. For the study region, the GCMs predicted an increase of 2.38°C and 3.24°C in temperature and 3.5% and 5.3% mm in precipitation during the growing seasons (April–October) for 2041–2060 and

2061–2080, respectively. For 2041–2060, seed cotton yield was projected to increase under RCP8.5 compared to the baseline yield. The increased cotton yield was mainly attributable to the fertilization effect of eCO₂ dominating the detrimental effects of shorter growing seasons (8.0–9.5 days). Alleviated low-temperature stress also slightly promoted cotton yield. The results suggest that the region's agricultural water crisis may be alleviated in the future. (7 Figures, 4 Tables, 63 References)

[14711]

Cheng S T, Cangemi I, Trostle J A, Remais J V, and Eisenberg J N S. 2019

Global Environmental Change **58**: 101960

Johns Hopkins Bloomberg School of Public Health, Department of Epidemiology, 615 North Wolfe Street, W6508, Baltimore, MD 21205, USA

Social cohesion and passive adaptation in relation to climate change and disease

The authors developed an agent-based model in which household agents can choose between two behavioral strategies that offer different levels of protection against environmentally mediated disease transmission. One behavioral strategy is initially set as more protective, leading households to adopt it widely, but its efficacy is sensitive to variable weather conditions and stressors such as floods or droughts that modify the disease transmission system. The efficacy of the second strategy is initially moderate relative to the first and is insensitive to environmental changes. The authors examined how social cohesion (defined as the average number of household social network connections) influences health outcomes when households attempt to identify an optimal strategy by copying the behaviors of socially connected neighbours who seem to have adapted successfully in the past. In the face of uncertainty in predicting future environmental stressors due to climate change, strategies to improve effective adaptation to optimal disease prevention strategies should

balance between intervention efforts that promote protective behaviours based on current scientific understanding and the need to guard against the crystallization of inflexible norms. Developing generalizable models allows us to integrate a wide range of theories and multiple datasets pertaining to the relationship between social mechanisms and adaptation, which can provide further understanding of future climate change impacts. Models such as the one the authors present can generate hypotheses about the mechanisms that underlie the dynamics of adaptation events and suggest specific points of measurement to assess the impact of these mechanisms. They can be incorporated as modules within predictive simulations for specific socio-ecological contexts. (6 Figures, 48 References)

[14712]

Conway D, Nicholls R J, Brown S, Tebboth M G L, and Neil W. 2019

Nature Climate Change **9**: 503–511

Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science, Houghton Street, London, WC2A 2AE, UK

The need for bottom-up assessments of climate risks and adaptation in climate-sensitive regions

Studies of climate change at specific intervals of future warming have primarily been addressed through top-down approaches using climate projections and modelled impacts. In contrast, bottom-up approaches focus on the recent past and present vulnerability. The authors examine climate signals at different increments of warming and consider the need to reconcile top-down and bottom-up approaches. The authors synthesize insights from recent studies in three climate-sensitive systems where change is a defining feature of the human–environment system. Although top-down and bottom-up approaches generate complementary insights

into who and what is at risk, integrating their results is a much needed step towards developing relevant information to address the needs of immediate adaptation decisions. (112 References)

[14713]

Djalante R. 2019

Progress in Disaster Science **1**: 100001

United Nations University, Institute for the Advanced Study of Sustainability (UNU-IAS), 5-53-70

Jingumae, Shibuya-ku, Tokyo 150-8925, Japan

Key assessments from the IPCC special report on global warming of 1.5°C and the implications for the Sendai Framework for Disaster Risk Deduction

The paper reviews key assessments from the IPCC Special Report on Global Warming of 1.5°C and examines the implications for the Sendai Framework for Disaster Risk Reduction (SFDRR). Disaster risks are expected to be higher at 1.5°C and continue to increase at 2°C. Current and future disaster risk management, particularly those that deal with the impacts of coastal flooding, heat-related health impacts, sea level rise, and forest fires, is to be strengthened. The Arctic, Caribbean, SIDS, and low-lying coastal areas are particularly at risk. SFDRR implementation requires focusing on low-lying countries and Small Island Developing States, complemented with development of financial risk sharing and insurance mechanisms, and ensuring coherence between SFDRR, Paris Agreement and the Sustainable Development Goals. (Table, 42 References)

[14714]

Emodi N V, Chaiechi T, and Beg A B M R A. 2019

Science of the Total Environment **676**: 545–563

Department of Economics, College of Business, Law and Governance, Division of Tropical Environments and Societies, James Cook University, PO Box 6811, Townsville, QLD 4811, Australia

The impact of climate variability and

change on the energy system: A systematic scoping review

The energy system is a vital infrastructure which can be vulnerable to climate variability and change impacts. Understanding the impacts can prevent disruption and inform policy decision-making. This study applied a scoping review in a systematic manner following the Joanna Briggs Institute guidelines to identify consistent patterns of the impacts on the energy system, map and locate research gaps in the literature. A total of 176 studies were identified as eligible for inclusion in the review. This study found evidence of consistent increase in energy demand for Africa, the Americas, and Asian continent. Consistent decrease was found in Northern and Eastern Europe, while increase in residential demand was projected in Oceania. There was evidence of consistent decrease in thermal power plant output globally. Solar photovoltaic showed a robust consistent pattern of increase in the Caribbean and Central America, Northern and Southern Africa, and Oceania. As the global climate is changing in a future that is highly uncertain, the energy system should also evolve in order to adapt to the changing climate. Future impact assessment must integrate the impact of CV&C on power demand and supply while considering socio-economic dynamics, cross-sectoral linkages and back-loops in a complete energy system model. (10 Figures, 2 Tables, References)

[14715]

Gogoi P P, Vinoj V, Swain D, Roberts G, Dash J, and Tripathy S. 2019

Scientific Reports 9: 8859

School of Earth, Ocean and Climate Sciences, Indian Institute of Technology Bhubaneswar, 752 050, Odisha, India

Land use and land cover change effect on surface temperature over Eastern India

Land use and land cover (LULC) change has

been shown to have a significant effect on climate through various pathways that modulate land surface temperature and rainfall. However, few studies have illustrated such a link over the Indian region using observations. Through a combination of ground, satellite remote sensing and reanalysis products, the authors investigate the changes to land surface temperature in Odisha between 1981 and 2010 and assess its relation to LULC. The analysis reveals that the mean temperature of the state has increased by $\sim 0.3^{\circ}\text{C}$ during the past three decades with the most accelerated warming ($\sim 0.9^{\circ}\text{C}$) occurring during the recent decade (2001 to 2010). The study shows that 25–50% of this observed overall warming is associated with LULC. Further, the authors observe that the spatial pattern of LULC changes matches well with the independently estimated warming associated with LULC, suggesting a physical association between them. This study also reveals that the major changes are linked to changing vegetation cover as evidenced by changes to both LULC classes and normalized difference vegetation index. (8 Figures, 4 Tables, 71 References)

[14716]

Goodrich C G, Udas P B, and Spencer H L. 2019

Environmental Development 31: 9–18

International Centre for Integrated Mountain Development (ICIMOD), Khumaltar, Lalitpur, Kathmandu 44700, Nepal

Email: info@icimod.org

Conceptualizing gendered vulnerability to climate change in the Hindu Kush Himalaya: Contextual conditions and drivers of change

Manifestations of vulnerability to climate change vary in different groups of people based on their position in a social and gender structure in a particular location and at a particular time. There is a need to understand the pre-existing conditions, what is termed 'contextual conditions' that underlie experiences of vulnerability and

lead to its complexity and reproduction. This paper is based on a literature review and takes the standpoint that not only is gender a powerful and pervasive contextual condition, but it also intersects with other contextual conditions to shape vulnerabilities. Further, gender and other contextual conditions also influence and are influenced by socio-economic drivers of change to produce differential gendered vulnerabilities. Therefore, manifestations of gendered vulnerability to climate change are the result of complex and interlinked factors that cannot be simplified for the sake of efficiency. This paper offers a conceptual framework bringing together these interlinkages and intersectionalities in understanding differential gendered vulnerabilities. (2 Figures, 137 References)

[14717]

Gupta R and Mishra A. 2019

Agricultural Systems **173**: 1–11

Agricultural and Food Engineering Department,
Indian Institute of Technology Kharagpur, Kharagpur
721 302, West Bengal, India

Climate change induced impact and uncertainty of rice yield of agro-ecological zones of India

An innovative approach of using agro-ecological zones (AEZs), instead of using political boundaries, has been adopted for climate change impact analysis on rice production of India. The analysis has been carried out by using a process-based Crop Simulation Model (CSM)-CERES-Rice fed with improved state-of-the-art bias corrected climate projections from eight global climate models (GCMs) for four expected climatic scenarios – representative concentration pathways (RCP 2.6, 4.5, 6.0, and 8.5). Using weather-soil-crop information along with year-wise effect of CO₂ increase assumption for different RCPs as input to the crop model, simulations were performed for the base period (1976–2005) as well as three future periods (2020s: 2006–2035, 2050s: 2036–2065,

and 2080s: 2066–2095) for understanding of climate change impact on rice yield. The overall change in spatial rice yield in India taking all used GCM-RCP combinations in consideration is expected to vary from 1.2% to 8.8%, 0.7% to 12.6%, and –2.9% to 17.8% due to the expected climate change in 2020s, 2050s, and 2080s, respectively. (7 Figures, 4 Tables, 43 References)

[14718]

Haque U, Silva P F D, Devoli G, Pilz J, and Zhaog B.
2019

Science of the Total Environment **682**: 673–684

Department of Geography, University of Florida, 3141
Turlington Hall, P.O. Box 117315, Gainesville, FL
32611-7315, USA

The human cost of global warming: Deadly landslides and their triggers (1995–2014)

The research presented in the paper hypothesizes that climate change associated with extreme rainfall and population distribution is contributing to a higher number of deadly landslides worldwide. This study maps and identified deadly landslides in 128 countries and it encompasses their role, for 20 years period from January 1995 to December 2014, considered representative for establishing a relationship between landslides and their meteorological triggers. A database of georeferenced landslides, their date, and information on casualties, duly validated, was implemented. A hotspot analysis for the daily record of landslide locations was performed, as well as a percentile-based approach to evaluate the trend of extreme rainfall events for each occurrence. The relationship between casualty, population distribution, and rainfall was also evaluated. For 20 years, 3876 landslides caused a total of 163,658 deaths and 11,689 injuries globally. They occurred most frequently between June and December in the Northern Hemisphere and between December and February in the Southern Hemisphere. A

significant global rise in the number of deadly landslides and hotspots across the studied period was observed. Analysis of daily rainfall confirmed that more than half of the events were in areas exposed to the risk of extreme rainfall. The relationships established between extreme rainfall, population distribution, seasonality, and landslides provide a useful basis for efforts to model the adverse impacts of extreme rainfall due to climate change and human activities and thus contribute towards a more resilient society. (7 Figures, 2 Tables, 28 References)

[14719]

Jha S, Das J, Sharma A, Hazra B, and Goyal M K.

2019

Global and Planetary Change **176**: 23–35

Discipline of Civil Engineering, Indian Institute of Technology Indore, Khandwa Road, Simrol, Indore 453552, Madhya Pradesh, India

Probabilistic evaluation of vegetation drought likelihood and its implications to resilience across India

Understanding the response of vegetation to hydroclimatic disturbances such as droughts is crucial in context of climate change. The sensitivity of terrestrial ecosystem to drought is difficult to measure because of problems related to drought quantification, variable response of vegetation types, and changing climate-vegetation dynamics. Since India is hugely dependent on its vegetation and cropland, identifying the impact of droughts on vegetation is essential. In this study, the authors estimate the likelihood of vegetation droughts across India in changing scenarios of temperature, precipitation, and soil moisture content. The authors also study the resilience of vegetation cover to disturbances induced by a dry condition. From the investigation, it is observed that at least half the area of 16 out of 24 major river basins is facing high chances of vegetation droughts due to lowered soil moisture levels. The croplands are most likely to be affected by drought, which is of paramount concern for

country's food security. Further investigation suggests that at least one-third area of 18 river basins is non-resilient to vegetation droughts. Moreover, more than 50% of each vegetation type is non-resilient, which points out the fragility of country's terrestrial ecosystems. This study facilitates the understanding of vegetation drought hotspot regions, factors risking the terrestrial ecosystem, and their ability to withstand such conditions. These findings provide useful insights for policy makers to develop effective strategies for vegetation drought mitigation and sustainable ecosystem management. (7 Figures, 2 Tables, 111 References)

[14720]

Li L, Cao K, Wei K, Wang W, and Chen L. 2019

Journal of Cleaner Production **217**: 216–224

State Key Laboratory of Water Environment

Simulation, School of Environment, Beijing Normal

University, Beijing, 100875, China

Adapting climate change challenge: A new vulnerability assessment framework from the global perspective

Climate change has caused worldwide concern due to its adverse effects on the global ecosystem, economy, and society. In this study, a new integrated framework was proposed for assessing the national vulnerability to climate change by considering both the sensitivity and the adaptive capacity. Then, a first assessment of the spatial-temporal change in national vulnerability from 1996 to 2008 was provided from the global perspective. Finally, 171 countries were grouped and hotspots of climate change were identified. Based on the results, the earth is more vulnerable than invulnerable, and the average rate of increase in the vulnerability index from 1996 to 2008 was 0.30%. African countries were identified as hotspots of vulnerability and instability in the changing climate, and eight groups were clustered based on the key influencing index of 171 countries. The results of this new framework are consistent

with the previous Fragile State Index and World Risk Index, but provide more details and quantitative vulnerability analysis. The methods and results presented in this paper could be used as references for climate change adaption and policy at the global scale. (8 Figures, 3 Tables)

[14721]

Manoli G, Fatichi S, Schlöpfer M, Yu K, and Crowther T W. 2019

Nature **573**: 55–60

Department of Civil, Environmental and Geomatic Engineering, University College London, Gower Street, London, WC1E 6BT, UK

Magnitude of urban heat islands largely explained by climate and population

Urban heat islands (UHIs) exacerbate the risk of heat-related mortality associated with global climate change. The intensity of UHIs varies with population size and mean annual precipitation, but a unifying explanation for this variation is lacking, and there are no geographically targeted guidelines for heat mitigation. The authors introduce a coarse-grained model that links population, background climate, and UHI intensity and show that urban–rural differences in evapotranspiration and convection efficiency are the main determinants of warming. The direct implication of these nonlinearities is that mitigation strategies aimed at increasing green cover and albedo are more efficient in dry regions, whereas the challenge of cooling tropical cities will require innovative solutions. (3 Figures, 69 References)

[14722]

Martins M A, Tomasella J, and Dias C G. 2019
Agricultural Water Management **216**: 339–350
CEMADEN, Centro Nacional de Monitoramento e Alertas de Desastres Naturais, Cachoeira Paulista, SP, São José dos Campos - SP, 12247-016, Brazil

Maize yield under a changing climate in the Brazilian Northeast: Impacts and adaptation

This paper assessed the potential impacts of

climate change on maize productivity in the Brazilian Northeast. To achieve this objective, bias-corrected regional downscaled scenarios from three global models for the representative emission pathways, RCP4.5 and RCP8.5, for the periods 1980–2005, 2007–2040, 2041–2070, and 2071–2099 were used as input data for a crop productivity model. Because increased temperatures are likely to shorten the crop cycle length, thus reducing productivity, the authors investigated the lengthening of the growing cycle as an adaptation strategy. The use of maize cultivars with a longer crop cycle for rainfed agriculture was likely to increase the average productivity in all scenarios, although it came at the expense of increasing the risk of crop failure. Regarding the use of irrigation, there was an improvement in productivity for both short- and long-cycle cultivars, although longer crop cycle cultivars had a decisive advantage, with a drop in yield of less than 20% for all RCP4.5 scenarios and for the RCP8.5 scenario until 2070 compared to the present climate. The authors estimated the total production and the increase in water demand based on the existing and projected irrigated areas in the region and concluded that it is possible to avoid significant losses in total maize production in the region for all scenarios, with the exception of the 2071–2099 RCP8.5 scenario. However, sustaining such levels of production requires a significant increase in water consumption (up to 140%). (7 Figures, 66 References)

[14723]

Matsumoto K. 2019

Journal of Cleaner Production **216**: 528–541

Graduate School of Fisheries and Environmental Sciences, Nagasaki University, 1-14 Bunkyo-machi, Nagasaki 852-8521, Japan

Climate change impacts on socioeconomic activities through labor productivity changes considering interactions between socioeconomic and climate systems

While human socio-economic activity leads

to climate change, the latter also affects the former; socio-economic and climate systems have considerable interactions. Some studies have looked at the effects of climate change on labour productivity and gross domestic product, yet they have not considered the interaction between socio-economic and climate systems. This study examined the aspect as well as the economic impact of climate-change-induced labour productivity change. The results show that global economic impacts of climate-change-induced labour productivity change have not been large. A negative effect on economic activities was found when the relationship between climate change and labour productivity was considered in the economic model. Although such impacts were larger in the business-as-usual scenario, that was not the case in the 2°C scenario. The results suggest that greater levels of climate change are in accordance with greater socio-economic impact at the global level. In particular, impact on high-temperature regions was found to be considerable. Some regions in the low- to medium-temperature zones received a positive economic effect because of comparative advantage resulting from differences in labour productivity changes among regions. The coupled modeling scheme ultimately was effective in evaluating the interaction. Expanded assessment of climate change, mitigation, and adaptation will aid further understanding of the interaction of climate change and socio-economic activities. (11 Figures, 4 Tables, 75 References)

[14724]

Mishra A K. 2019

Dynamics of Atmospheres and Oceans **86**: 163–171
Centre for Remote Sensing and Geoinformatics
Sathyabama Institute of Science and Technology,
Jeppiaar Nagar OMR Road, Chennai 600119, Tamil
Nadu, India

On the linkage between changes in cloud

cover and precipitation extremes over Central India

In this study, linkage between changing characteristics of precipitation extremes and cloud covers over Central India is explored during summer monsoon period using Satellite data (1998–2015). This is a first attempt to relate the changes in cloud cover to the changes in precipitation extremes. Non-rainy cirrus clouds are excluded from this study. Results show that heavy rainfall (>60 mm/day) is associated with cold cloud tops ($T_b < 220$ K), while moderate rainfall (<60 mm/day and >20 mm) occurs mostly with middle clouds ($T_b > 220$ K and <245 K). Low level clouds ($T_b > 245$ K) are responsible for light rainfall (<20 mm/day). Increases in top 20%, 10%, 5%, and 1% heavy precipitation relate well with the increases in very deep convective, deep convective, and convective cloud cover. Among these relations, increase in top 5% heavy precipitation relates best with increase in very deep convective cloud cover. Decrease in bottom 30% low precipitation relates with decrease in low level cloud cover. The results reported in this study fit into the framework of how weather extremes respond to climate change. (8 Figures)

[14725]

Nayak K, Shahid M, Nayak A D, Dhal B, Moharana K
C, and Mondal B. 2019

Ecological Processes **8**

ICAR-National Rice Research Institute, Cuttack
753006, Odisha, India

Email: Ak.Nayak@icar.gov.in

Assessment of ecosystem services of rice farms in eastern India

Rice is a major cereal crop and staple food of eastern India, and most farmers depend solely on rice for their livelihood. Rice farming provides both tangible and intangible benefits to ecosystems which need to be maintained and enhanced. These benefits are provided through ecosystem services (ES) that include both

marketable and non-marketable. In this study, the rice farms in eastern India were valued by quantifying the economic value of the services under the conventional method of rice cultivation and the gap of ecosystem services value and farm income per unit area were assessed. The authors suggest various measures to reduce the economic gap, including payments for ecosystem services for rice farming for sustainability of the ecosystem and agricultural development, while ensuring reliable farm income. (2 Figures, 6 Tables, 110 References)

[14726]

Nori-Sarma A, Anderson G B, Rajiva A, Azhar G S, and Gupta P. 2019

Environmental Research **176**: 108546

Yale School of Forestry & Environmental Studies, 195 Prospect Street, New Haven, CT 06511, USA

The impact of heat waves on mortality in Northwest India

Heat waves are anticipated to worsen with climate change. India, an understudied area with >15% of the world's population, commonly experiences temperature extremes and already resembles potential future climates of more temperate regions. Registry data from local municipal corporations and government offices were collected and translated, yielding daily all-cause mortality for four communities in northwest India for all or part of the period 2000–2012. Heat waves were defined as >2 days with local temperature >97th percentile for that community. An alternate definition matching that used by the Indian Meteorological Department was also developed to enhance policy relevance. Evidence of effect modification by heat wave characteristics (intensity, duration, and timing in season) was limited. Findings indicate health risks associated with heat waves in communities with high baseline temperatures. Results can enable heat wave-health assessments in temperate regions in future and improve the understanding of temperature-health

associations under climate change. Further investigation of potential effect modification by heat wave characteristics is needed. (3 Figures, 5 Tables, 33 References)

[14727]

Shaffril H A M, Ali Z, Samaha A A, and Samsuddin S F. 2019

Journal of Cleaner Production **232**: 104–117

Institute for Social Science Studies, Universiti Putra Malaysia, Putra Infoport, 43400, Serdang, Selangor, Malaysia

Mirror-mirror on the wall, what climate change adaptation strategies are practiced by the Asian's fishermen of all?

This systematic review article focuses on the adaptation strategies of Asian fishermen towards climate change impacts. The study reviewed a considerable amount of past studies on the act of adjusting with environmental change among the Asian fishermen, which is known as one of the communities that are highly dependent on the nature stability. Meanwhile, Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was adopted for the review of the current research which utilized two main journal databases – Scopus and Web of Science. Accordingly, the searching efforts resulted in a total of 18 articles that can be analysed systematically. Most importantly, the review managed to formulate five main themes, namely, livelihood diversification, social, physical infrastructure, awareness-knowledge-experience, and conservation and enforcement based on the thematic analyses. Overall, further analysis of the five themes resulted in the establishment of a total of 21 sub-themes. Finally, a number of recommendations were presented at the end of this research for the reference of future scholars. (57 References)

[14728]

Suna Q, Miao C, Hanel M, Borthwick A G L, and Duoying Ji Q D. 2019

Environment International **128**: 125–136

State Key Laboratory of Earth Surface Processes and Resource Ecology, Faculty of Geographical Science, Beijing Normal University, Beijing 100875, China

Global heat stress on health, wildfires, and agricultural crops under different levels of climate warming

The effects of heat stress are spatially heterogeneous owing to local variations in climate response, population density, and social conditions. Using global climate and impact models from the Inter-Sectoral Impact Model Intercomparison Project, the analysis shows that the frequency and intensity of heat events increase, especially in tropical regions (geographic perspective) and developing countries (national perspective), even with global warming held to the 1.5°C target. An additional 0.5°C increase to the 2°C warming target leads to >15% of the global land area becoming exposed to levels of heat stress that affect human health; almost all countries in Europe will be subject to increased fire danger, with the duration of the fire season lasting 3.3 days longer; 106 countries are projected to experience an increase in the wheat production-damage index. Over 95% of countries will face exposure to health-related heat stress, with India and Brazil ranked highest for integrated heat-stress exposure. The magnitude of the changes in fire season length and wildfire frequency is projected to increase substantially over 74% global land, with particularly strong effects in the United States, Canada, Brazil, China, Australia, and Russia. The study should help facilitate climate policies that account for international variations in the heat-related threats posed by climate change. (9 Figures, 3 Tables, 58 References)

[14729]

Thomas K A and Warner B P. 2019

Global Environmental Change **57**: 101928

Temple University, 1801 N. Broad Street, Philadelphia, PA 19122, USA

Weaponizing vulnerability to climate change

There is mounting evidence that adaptation and vulnerability are linked, such that ostensibly adaptive responses can have negative consequences and augment people's vulnerability. The authors analysed several climate change responses at various scales and developed a typology of five discrete but related modes by which the vulnerability of already vulnerable populations is being [re]produced. The study suggests that for at least one of these modes, the vulnerability of other groups is perversely inverted, such that relatively secure populations perceive themselves to be at risk. The cases that the paper presents illustrate that people's vulnerability is being used against them or, put another way, is being weaponized. The typology provides a theoretical intervention by illustrating how climate vulnerability and security are co-produced, as well as a practical tool to help decision-makers to adopt more just and equitable climate policies. (2 Figures, 1 Table, 132 References)

[14730]

Verburg R, Rahn E, Verweij P, Kuijk M, and Ghazoul J. 2019

Environmental Science & Policy **97**: 16–24

Copernicus Institute of Sustainable Development, Utrecht University, Princetonlaan 8a, 3584 CB, Utrecht, The Netherlands

An innovation perspective to climate change adaptation in coffee systems

Climate change is expected to have strong implications for smallholder coffee farmers and implementing adaptation measures would lessen their vulnerabilities. Adaptation measures have been identified in the literature, but how these can be implemented remains unclear. Current

certification programmes have the potential to provide guidance on how sustainability criteria can be addressed and taken up by farmers. The authors identify climate change adaptation options, their scale of application, and the necessary implementation steps. The authors show that implementation complexity strongly increases with the degree of climate change. With modest climatic changes, incremental adaptations might suffice, but more substantial climatic change will require radical social-institutional changes for adaptation uptake and interventions. For the majority of smallholders, the implementation of any measure is largely constrained by a lack of access to knowledge networks and training material, organizational support, and resources (mainly financial). (1 Figure, 4 Tables, 85 References)

[14731]

Woodward A. 2019

Global Transitions 1: 44–49

Section of Epidemiology and Biostatistics, School of Population Health, University of Auckland, Private Bag 92019, Auckland, 1142, New Zealand

Climate change: Disruption, risk and opportunity

Rising greenhouse gases are heating the globe faster than has ever occurred before, and record-breaking intense, extreme weather is becoming more common. In the past 3 years, unexpectedly severe hurricanes, heat waves, and forest fires have affected millions of people. The author suggests that low predictability, high scale, speed, and lack of reversibility are good guides. Risks to health are direct and indirect and also include the ‘transition risks’ associated with responses to climate change. The co-benefits agenda (justifying climate interventions on the basis of positive outcomes in other sectors) is promising: it promises a relatively smooth way forward, but might an emphasis on win-win interventions distract from the radical changes that are needed. There are other reasons for

caution – the intersection of climate and health policies may contain trade-offs as well as synergies, and the prospect of future gains that outweigh immediate losses is seldom, on its own, sufficient to change in-grained behaviours and policies. (48 References)

[14732]

Xu R, Hu H, Tian F, Li C, and Khan MYA. 2019

Global and Planetary Change 175: 144–159

Department of Hydraulic Engineering, Tsinghua University, Beijing 100084, China

Projected climate change impacts on future streamflow of the Yarlung Tsangpo-Brahmaputra River

The Yarlung Tsangpo-Brahmaputra River (TBR) originating from the Tibetan Plateau is an important water source for many domestic and agricultural practices in countries including China, India, Bhutan, and Bangladesh. To date, only a few studies have investigated the impacts of climate change on water resources in this river basin with dispersed results. In this study, the authors provide a comprehensive and updated assessment of the impacts of climate change on YBR streamflow by integrating a physically based hydrological model, regional climate integrations from CORDEX (Coordinated Regional Climate Downscaling Experiment), different bias correction methods, and Bayesian model averaging method. The authors find that (i) bias correction is able to reduce systematic biases in regional climate integrations and thus benefits hydrological projections over YBR Basin and (ii) Bayesian model averaging, which optimally combines individual hydrological simulations obtained from different bias correction methods, tends to provide hydrological time series superior over individual ones. The change rate of streamflow shows strong spatial variability along the YBR from downstream to upstream. The increasing rate of streamflow shows an augmented trend from downstream to upstream under RCP8.5

compared to an attenuated pattern under RCP4.5. (10 Figures, 9 Tables, 70 References)

GHG EMISSIONS AND MITIGATION

[14733]

Andimuthu R, Kandasamy P, Mudgal B V, Jeganathan A, Balu A, and Sankar G. 2019

Scientific Reports **9**: 7783

Centre for Climate Change and Adaptation Research,
Department of Civil Engineering, CEG Campus, Anna
University, Chennai 600025, Tamil Nadu, India

Performance of urban storm drainage network under changing climate scenarios: Flood mitigation in Indian coastal city

In this study, the existing states of storm water drains are evaluated under current and future climate scenarios in one of the most flood-prone areas of Chennai, namely, Velachery zone. The mitigation measures are recommended to increase its resilience against floods. The Intergovernmental Panel on Climate Change (IPCC) CMIP5 models of Representative Concentration Pathways (RCP) 4.5 are used to develop possible future climate change scenarios of the city. The integrated hydraulic and hydrological modelling is carried out to assess the flood carrying capacity of storm drainage under present and future climate scenarios. The vulnerable hotspots are identified and flood mitigation measures are suggested to reduce the flood risk at Velachery. (7 Figures, 1 Table, 32 References)

[14734]

Gupta A and Paul A. 2019

Energy Procedia **160**: 848–855

Department of Applied Mechanics, Motilal Nehru
National Institute of Technology Allahabad, Prayagraj
211004, Uttar Pradesh, India
Email: arpaul2k@gmail.com

Carbon capture and sequestration potential

in India: A comprehensive review

Carbon capture and sequestration (CCS) is seen as a crucial climate protection technology for coal-rich countries like India having the potential to massively reduce CO₂ emission as compared to any other existing technology. As the third largest producer of coal and the fourth largest greenhouse gas (GHG) emitter, India's total emissions are 7% of global emissions and increasing at 4.5% per annum. India's current and expected future emissions are sufficiently massive to have an adverse effect on global mitigation efforts. The IPCC studied that without CCS, the price of achieving long-run climate goals is almost 140% more expensive. However, India has been taking a cautious approach towards CCS technology due to various factors. The paper discusses the challenges of CCS in India and a roadmap for the successful implementation of CCS in India. (4 Figures, 1 Table, 15 References)

[14735]

Balsara S, Jain P K, and Ramesh A. 2019

Environmental Pollution **252**: 863–878

Mechanical and Industrial Engineering Department,
Indian Institute of Technology Roorkee, Roorkee
247667, Uttarakhand, India
Email: registrar@iitr.ac.in

An integrated approach using AHP and DEMATEL for evaluating climate change mitigation strategies of the Indian cement manufacturing industry

Concrete, a cement-based product, is the highest manufactured and second highest consumed product after water on earth. Across the world, cement is the most energy and emission intensive industry, and hence the cement industry is currently under pressure to reduce greenhouse gases emissions (GHGEs). However, reducing the GHGEs of the cement industry, especially for a developing country like India, is not an easy task. Cement manufacturing industry needs to focus on significant climate change

mitigation strategies to reduce GHGEs to sustain its production. This study aims to identify significant climate change mitigation strategies for the cement manufacturing industry in the context of India. The findings indicate that the main factors (process emission reduction and fuel emission reduction) are categorized in cause group factors, while the remaining factors (electric energy-related emission, emission avoidance and reduction, and management mitigation measures) are in effect group factors. Present model will help supply chain analysts to develop both short-term and long-term decisive measures for effectively managing and reducing GHGEs. (5 Figures, 10 Tables, 129 References)

BIODIVERSITY AND NATURAL RESOURCES

[14736]

Ghosh-Harihar M, An R, Athreya R, Borthakur U, Chanchani P, Chetry D, and Datta A. 2019
Biological Conservation **237**: 114–124
National Centre for Biological Sciences, Tata Institute of Fundamental Research, Bellary Road, Bengaluru 560065, Karnataka, India

Protected areas and biodiversity conservation in India

Three well-supported generalizations in conservation biology are that developing tropical countries will experience the greatest biodiversity declines in the near future, they are some of the least studied areas in the world, and in these regions especially, protection requires local community support. The authors assess these generalizations in an evaluation of protected areas in India. The 5% of India officially protected covers most ecoregions and protected areas have been an important reason why India has suffered no documented species extinctions in the past 70 years. India has strong legislation favouring conservation, government investment focused on 50 tiger reserves, and government compensation schemes that facilitate local support, all of which brighten future prospects.

However, many protected areas are too small to maintain a full complement of species, making connectivity and species use of buffer zones a crucial issue. Conservation success and challenges vary across regions according to their development status. In less developed areas, notably the biodiverse northeast Himalaya, protected areas maintaining the highest biodiversity result from locally focused efforts by dedicated individuals. Across India, the study demonstrates considerable opportunities to increase local income through ecotourism. The evaluation confirms a lack of data, increasing threats, and the importance of local support. Research on biodiversity in buffer zones, development of long-term monitoring schemes, and assessment of cash and conservation benefits from tourism are in particular need. For policy makers, two main goals should be the development of monitoring plans for ‘eco-sensitive zones’ around protected areas and a strong emphasis on preserving established protected areas. (3 Figures, 125 References)

[14737]

Manish K and Pandit M K. 2019
Biological Conservation **233**: 176–184
Department of Environmental Studies, University of Delhi, University Road, Delhi 110007, India

Identifying conservation priorities for plant species in the Himalaya in current and future climates: A case study from Sikkim Himalaya, India

In recent years, scientific investigations on the effectiveness of protected areas (PAs) in conserving biodiversity and sustaining ecosystem functions under the impact of climate change have increasingly received more attention from researchers and park managers. In this study, the authors used a combination of species distribution modelling (SDM) and spatial hierarchical systematic conservation planning techniques to delineate and prioritize areas for endemic plant species conservation

under current and future (2050s, 2070s) climate conditions in Sikkim Himalaya. Data on endemic plant species occurrence were sourced from the already published studies and their potential suitable habitats under current and future climates were modelled using Maximum Entropy (MaxEnt) SDM. The MaxEnt habitat suitability projections of species were used in Zonation software to identify priority conservation areas in Sikkim Himalaya. The authors found that the existing PA network in the region was inadequate in conserving the endemic plant diversity either in the current or future climate scenarios. Based on results, the authors propose the addition of 896 sq km (square kilometres) to the existing PA network in the study area to ensure meaningful conservation goals. Additionally, the authors propose the creation of three new PAs (Yumsedong, Lachen and Chungthang) and the need for expanding the boundaries of existing PAs (Maenam, Fambong Lho, and Barsey) in the study area. The analyses show that to mitigate the effects of ensuing climate change, a single large PA with wide geographic and elevational extents instead of several smaller PAs would be a more prudent strategy for conserving the plant diversity in the Himalaya. (4 Figures, 1 Table, 69 References)

TRADE AND ENVIRONMENT

[14738]

Kompas T and Ha P V. 2019

Economic Modelling **80**: 103–110

Centre of Excellence for Biosecurity Risk Analysis, School of Biosciences and School of Ecosystem and Forest Sciences, University of Melbourne, Baldwin Spencer Building (113), Parkville, Victoria 3010, Australia

The ‘curse of dimensionality’ resolved: The effects of climate change and trade barriers in large dimensional modelling

Solving large-scale optimization problems over space and time quickly generates a

computational impasse termed the ‘curse of dimensionality’. This severely limits the practical use of economic models, especially for determining the effects of climate change and protectionist trade policies. In this paper, the authors employ an innovative approach to solving (otherwise unsolvable) large-scale systems through the use of parallel processing methods and a proper ordering of variables and equations in a ‘nested doubly bordered block diagonal’ form. The authors illustrate how the approach can be used to solve an intertemporal CGE model with more than 500 million equations. Using existing damage functions, the framework allows us to determine the impact of climate change on long-run economic growth for 112 countries as a result of the effect of sea-level rise on land endowments, variation in crop yields and productivity, and shifts in the demand for energy and transportation. The authors also compare the solution to more common (and smaller dimensional) recursive methods, in terms of both economic effects of climate change and potential increases in trade barriers, showing the power and efficiency of the computational approach and parallel processing routine. (3 Figures, 3 Tables, 32 References)

[14739]

Yi K, Meng J, Yang H, He C, Henze D K, and Liu J. 2019
Nature Communications **10**: 3281

Laboratory for Earth Surface Processes, College of Urban and Environmental Sciences, Peking University, 100871, Beijing, China

The cascade of global trade to large climate forcing over the Tibetan Plateau glaciers

Black carbon (BC) aerosols constitute unique and important anthropogenic climate forcers that potentially accelerate the retreat of glaciers over the Himalayas and Tibetan Plateau (HTP). The authors show that a large amount of BC emissions produced in India and China – a region of BC emissions to which the HTP is

more vulnerable compared with other regions – are related to the consumption of goods and services in the USA and Europe through international trade. These processes lead to a virtual transport pathway of BC from distant regions to the HTP glaciers. From a consumption perspective, the contribution from India to the HTP glaciers shows a rapid increasing trend, while the contributions from the USA, Europe, and China decreased over the last decade. International trade aggravates the BC pollution over the HTP glaciers and may cause significant climate change there. Global efforts towards reducing the cascading of BC emissions to Asia, especially the Indian subcontinent, are urgently needed. (4 Figures, 6 Tables, 64 References)

[14740]

Zhao H, Qu S, Guo S, Zhao H, Liang S, and Xu M.
2019

Journal of Cleaner Production **230**: 1013–1026

School of Economics and Management, North China
Electric Power University, Beijing, 102206, China

Virtual water scarcity risk to global trade under climate change

The effect of climate change on the global economy via reducing available water resources in some regions is investigated based on a multi-regional input-output (MRIO) model that provides information on the current global economic structure. Key nation-sectors with the greatest virtual water scarcity risk (VWSR) exports are identified under two climate change scenarios, including the agriculture sectors in Syria, Pakistan, Kazakhstan, India, Uzbekistan, Iran, and China. Improving water efficiency in these sectors is essential for increasing the resilience of the global economy against climate change-induced water scarcity. Nation-sectors with the largest VWSR imports are also identified under the two climate change scenarios, including food and beverages sectors, textiles and wearing apparel sectors, and petroleum, chemical and non-metallic mineral products

sectors in Saudi Arabia, the United States of America, Russia, Germany, Italy, and China. The evaluation demonstrates that nations should cooperatively manage water resources and be aware of the transmission of virtual water scarcity risk through international trade under climate change. Moreover, nation-sectors with high VWSR imports may reduce the reliance on water-intensive products and diversify importing sources, and national governments can encourage residents to change consumption patterns. (6 Figures, 40 References)

[14741]

Javid K, Akram M A N, Mumtaz M, and Siddiqui R.
2019

Applied Water Science **9**

Department of Geography, University of the Punjab,
Katchery Road, Anarkali Bazaar, Lahore, Punjab
54000, Pakistan

Email: Knwl.j92@gmail.com

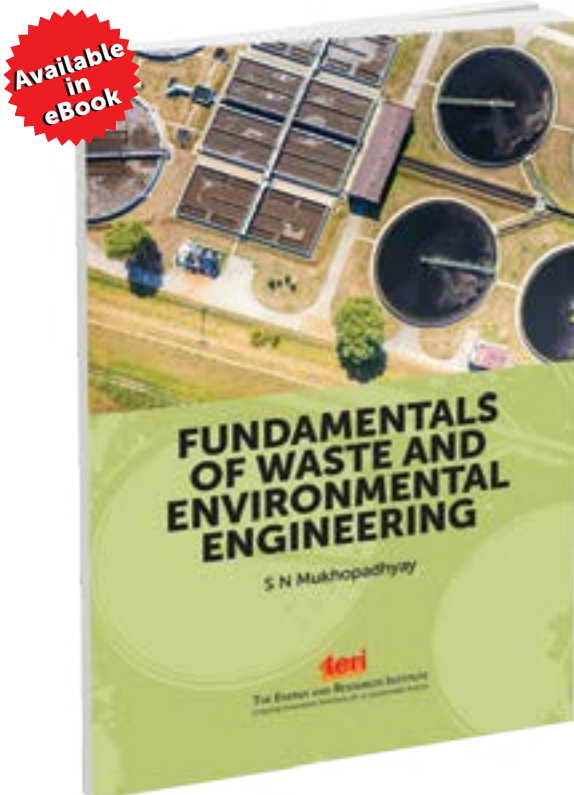
Modeling and mapping of climatic classification of Pakistan by using remote sensing climate compound index (2000 to 2018)

The entire world is collectively facing the problem of climate change. The deterioration of the earth's climate change is being noticed and felt most apparently in Southeast Asia and predominantly in Pakistan. Pakistan is a victim of climate change, due to which Pakistan faces several geographical, political, economic, and even social problems. The harmful impacts of climate change in the form of smog and abnormal heat waves have claimed the life of many Pakistanis. Climate change has brought disastrous impact on the agrarian economy of Pakistan, which has plunged the country into awful straits. Climatic change is a slow and continuous process. Climatic changes in an area should be traced out in time to face upcoming climatic challenges. This research work has traced out such changes and introduced a new climatic classification scheme for the climate of

Pakistan by using remote sensing (RS) and a new climatic compound index, that is, RSCCI, gives a calculated value that is used to describe the state and the changes in the climatic system of an area. RSCCI is the combination of different indices. On the basis of RSCCI, a climatic index, spatiotemporal investigation is conducted to measure aridity, humidity, and semi-aridity all over Pakistan. The results show

dramatic changes which advocate the need for a new climatic classification for Pakistan. This new climate classification of Pakistan is based on 18 years of data only. Dramatic climatic changes could be imagined and predicted within next 30 years in Pakistan. (4 Figures, 2 Tables, 53 References)

ENVIRONMENTAL REMEDIATION THROUGH ENVIRONMENTAL ENGINEERING



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INTERNET RESOURCES

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Centre for Environment and Development

<http://indiawastemanagementportal.org/>

The Ministry of Urban Development, Government of India has established Centres of Excellence (CoEs) in the area of Urban Development and Urban Transport in reputed institutions in the country to create the necessary knowledge base for improving municipal service delivery and management. The basic objective of these CoEs is to foster cutting edge and cross-cutting research, capacity building, and technical knowledge base in the area of urban development. The website is a repository of reports, technologies, best practices, journals, books, links, and directories in related areas. It also holds e-discussions among professionals.

Climate Change Knowledge Portal

<https://climateknowledgeportal.worldbank.org/>

The Climate Change Knowledge Portal provides an online platform for access to comprehensive global, regional, and country data related to climate change and development. The portal provides a web-based platform to assist in capacity building and knowledge development. The portal aims to provide development practitioners with a resource to explore, evaluate, synthesize, and learn about climate-related vulnerabilities and risks at multiple levels of details. Using climate science research results for the decision-making process concerning policies or specific measures needed to tackle climate impacts, or even to

understand low carbon development processes, is often a difficult, yet crucial, undertaking.

Climate Investment Funds Knowledge Center

<https://www.climateinvestmentfunds.org/knowledge-center>

The knowledge centre is a collection of reports, tools, case studies, fact sheets, investment plans, learning events, and other policy guidelines to assist policymakers in NDC implementation. The database includes country-specific reports and resources, case studies, fact sheets, investment plans, guidelines, and reports, as well as information on the Clean Technology Fund, the Forest Investment Program, the Pilot Program for Climate Resilience, and resources on how to scale up renewable energy programs in low-income countries.

E-Tutorial on Global Framework for Climate Services

https://unitar.org/gfcs-tutorial/story_html5.html

The tutorial has been designed with the aim of raising awareness about the objectives of Global Framework for Climate Services and illustrating the benefits of climate services for decision-making in selected tropical areas. This learning tool is meant for national experts as well as other interested stakeholders and the general public. The modules feature video interviews with experts from international agencies and short self-assessment exercises to test your knowledge throughout the tutorial.

Emissions Prediction and Policy Analysis Model

<https://globalchange.mit.edu/research/research-tools/human-system-model>

The Economic Projection and Policy Analysis model provides projections of world economic development and emissions along with analysis of proposed emissions control measures. It is used to analyse the processes that produce greenhouse-relevant emissions and to assess the consequences of policy proposals, providing estimates of the magnitude and distribution among nations of their costs and clarifying the ways that changes are mediated through international trade.

Energy Efficiency for Asian Companies

<http://www.energyefficiencyasia.org/>

This website has been developed for Asian companies that want to improve energy efficiency through cleaner production and for stakeholders who want to help them. The website includes methodology, case studies of more than 40 Asian companies in five industry sectors, technical information for 25 energy equipment, training materials, a contact and information database, technical tools, and downloadable publications.

Greenhouse Gas and Air Pollution Interactions and Synergies

<https://www.iiasa.ac.at/web/home/research/researchPrograms/air/GAINS.html>

Developed by International Institute for Applied Systems Analysis, GAINS is an online tool for assessing transnational strategies that reduce emissions of multiple air pollutants and greenhouse gases at least costs and minimize their negative effects on human health, ecosystems, and climate change. GAINS estimates for each country/region the potential emission reductions that are offered by about 2000 specific emission control measures and their costs.

Mitigation Action Assessment Protocol

<https://maap.worldbank.org/#/homepage>

The World Bank's Networked Carbon Markets initiative developed the Mitigation Action Assessment Protocol (MAAP) to provide a standardized yet flexible framework to quantitatively evaluate the relative mitigation outcomes and risks of heterogeneous mitigation actions from different sectors and countries. In the short run, the MAAP aims to support the design and implementation of more robust actions and track progress towards emission reduction targets. The MAAP aims to promote international cooperation through linking and finance in the new Paris Regime by enhancing the transparency and comparability of bottom-up actions.

National Toxics Network (NTN)

<https://ntn.org.au/>

The National Toxics Network (NTN) is a not-for-profit, civil society network working towards pollution reduction, protection of environmental health, and environmental justice for all. As the Australian focal point for the International POPs Elimination Network, NTN is committed to creating a toxic-free future and working towards the full implementation of the Stockholm Convention on Persistent Organic Pollutants and other global chemical conventions. The site provides a platform for community engagement with respect to pollutant removal. It also covers environmental resources, including news, reports, guidebooks, and links for benefits of users.

Pacific Climate Change Portal

<https://www.pacificclimatechange.net/>

The Pacific Climate Change Data Portal is a user-friendly tool that allows the user to visualize historical climate data in the form of trends, running and long-term averages. As the largest web-based data source for the Pacific region, this tool currently provides users access

to more than 100 individual observation sites across the Pacific Islands and East Timor. The website provides historical point-based data for climate observing sites across the Pacific.

REN21

<http://www.ren21.net>

REN21 is the global renewable energy policy multi-stakeholder network that connects a wide range of key actors from governments, international organizations, industry associations, science and academia, and civil society. It facilitates knowledge exchange, policy development, and joint action towards a rapid global transition to renewable energy. It has published several global reports on the RE sector. The recently published “Renewables Global Status Report (GSR) 2019” provides a comprehensive and timely overview of the renewable energy market, industry, investment, and policy developments worldwide. The report covers recent developments, current status, and key trends; by design, it does not provide analysis or forecast. The Renewables Global Status Report relies on up-to-date renewable energy data provided by an international network of more than 500 contributors, researchers, and authors.

Renewable Electricity Futures Study

http://www.nrel.gov/analysis/re_futures/

The Renewable Electricity Futures Study (RE Futures) presented by National Renewable Energy Laboratory (NREL) is an initial investigation of the extent to which renewable energy supply can meet the electricity demands of the continental United States over the next several decades. This study explores the implications and challenges of very high renewable electricity generation levels—from 30% up to 90%, focusing on 80%, of all U.S. electricity generation—in 2050. The report covers detailed analysis and integration of high penetrations of renewable electricity technologies from a

national perspective, focusing on key technical implications. The study explores electricity grid integration using models.

Solar Utilities Network

<http://www.solarnet.org/>

The Solar Utilities Network (SUN) is a not-for-profit informational website sponsored by the Caspar Institute in support of global efforts to reform energy use. The website provides practical information and strategies for saving energy and using renewable resources in the home. On this site are links to case studies describing the actual applications of sustainable energy technologies, do-it-yourself project ideas, and a schedule of 1996 training courses taught by experts from the SUN.

Sustainable Agriculture Network

<http://www.sare.org>

SAN (Sustainable Agriculture Network) is dedicated to the exchange of scientific and practical information on sustainable agriculture systems using a variety of printed and electronic communications tools. This can also be used as the educational resource base. The site contains publications, news, events, and a searchable database of more than 1000 research project reports.

Toolkit for Increasing Climate Change Resilience

<http://web.cedare.org/wp-content/uploads/2016/01/SEARCH-Toolkit.pdf>

The Guiding Toolkit for Increasing Climate Change Resilience provides guidance and recommendations on how to develop climate change resilient strategies and plans at national, sub-national, and local levels. The guidebook does this by delineating and sharing participatory methodologies and approaches tested by project partners to integrate climate change risks into local and national plans, policies, and strategies in the region.

Water Services Regulation Authority

<http://www.ofwat.gov.uk>

The Water Services Regulation Authority (Ofwat) is the economic regulator of the water and sewerage industry in England and Wales that works to seek value for consumers. The Ofwat

website provides a rich collection of regulations, facts and figures, reports, news, MOUs, publications, price reviews, and consultancy services. The site also provides competition framework for market players.

OCCASIONAL PUBLICATIONS

FROM STANDARDS, PATENTS, NEWSLETTERS, GOVERNMENT DOCUMENTS
AND NOTIFICATIONS, ANNUAL REPORTS, AND SO ON

PATENTS

United States Patent US 10,372,846

Granted on August 6, 2019

Invented by Bai X, Dong J, Du H, Rui X G, Wang H F, et al.

Assigned to International Business Machines

Corporation, Armonk, New York, USA

Filed on November 12, 2015

Retrieving pollution emission source using CFD and satellite data

A method for modeling air pollution includes receiving a weather model for a particular geographic region. Satellite-observed pollution observation data over the geographic region is received. A physical dispersion model for pollution over the geographic region is generated using the received weather model. The received satellite-observed pollution observation data is interpolated to the generated physical model. The interpolated satellite-observed pollution observation data and the generated physical model are combined using weighted coefficients for both the interpolated satellite-observed pollution observation data and the generated physical model. The weighted coefficients are calculated in accordance with a relative error in both the physical dispersion model and the satellite-observed pollution observation data.

Source: <http://patft.uspto.gov>, accessed on August 13, 2019

United States Patent US 10,424,709

Granted on September 24, 2019

Invented by Ahdoot Eliot

Assigned to Hypertechnologie Ciara Inc., Montreal, Canada

Filed on December 7, 2015

Apparatus for thermoelectric recovery of electronic waste heat

The present document describes an apparatus for recovering heat from an electronic

component to generate electric energy. The apparatus comprises a thermoelectric generator having a cold side and a hot side, the hot side being in thermal communication with the electronic component. The apparatus further comprises a heat dissipation device in thermal communication with the cold side of the thermoelectric generator for dissipating heat it receives, and a heat transfer device with a thermal conductivity greater than 200W/mK for directly transferring the heat from the electronic component to the heat dissipation device.

Source: <http://patft.uspto.gov>, accessed on 28 September 2019

United States Patent US 10,399,086

Granted on September 3, 2019

Invented by Waldenmaier E W, Waldenmaier H E W, and Green M W

Assigned to Viradys Medical Waste Solutions LLC, Greer, SC, USA

Filed on February 9, 2015

System and method for disinfecting medical waste

The present disclosure is directed to a system and method for disinfecting medical waste. The method includes shredding the medical waste via a shredder until the medical waste has a predetermined particle size. Further steps include spreading the medical waste onto a heating conveyor and conveying the shredded medical waste through a heating chamber via a heating conveyor. Thus, within the heating chamber, the shredded medical waste is heated via one or more infrared heating elements and at least one additional heating source, for example, induction heating, such that the medical waste is heated from a plurality of directions. The resulting treated medical waste is biologically inert and clean and can be disposed in standard

commercial garbage or roll-off bins, which are typically located at medical facilities.

Source: <http://patft.uspto.gov>, accessed on 28 September 2019

soda, synthetic fibre, and petroleum industry. These standards are based on the Environment (Protection) Rules, 1986, referred to as principal rules in all subsequent notifications.

STANDARDS

Standards for Emission or Discharge of Environmental Pollutants

Following are industry-wise permissible environmental pollutant standards for caustic

ASTM E772 – 15

Standard Terminology of Solar Energy Conversion

1. Scope

1.1 This terminology pertains to the conversion of solar energy into other forms

Industry	Parameter	Standards
Caustic soda	Concentration not to exceed milligrams per litre (except for pH and flow)	
	Total concentration of mercury in the final effluent (final effluent is the combined effluent from cell house, brine plant, chlorine handling, hydrogen handling, and hydrochloric acid plant)	0.01
	Mercury bearing wastewater generation (flow)	10 kilolitres/tonne of caustic soda produced
	pH	5.5 to 9.0
Man-made fibres (synthetic)	Concentration not to exceed milligrams per litre (except for pH)	
	Suspended solids	100
	Biochemical oxygen demand 2 (BOD 3 days at 27°C)	30
	pH	5.5 to 9.0
Petroleum oil refinery	A. Effluent	
	pH	6.0–8.5
	Oil and grease	5.0
	BOD (3 days, 27°C)	15.0
	COD	125.0
	Suspended solids	20.0
	Phenols	0.35
	Sulphides	0.5
	CN	0.20
	Ammonia as N	15.0
	TKN	40.0
	P	3.0
	Cr (hexavalent)	0.1
	Cr (total)	2.0
	Pb	0.1
	Hg	0.01
	Zn	5.0
	Ni	1.0
	Cu	1.0
	V	0.2
	Benzene	0.1
	Benzo[a]pyrene	0.2
	B. Emissions	

Industry	Parameter	Standards		
(Furnace, boiler and captive power plant)	Limiting concentration in mg/Nm ³ unless stated	Fuel type	Existing refineries	New refinery/furnace/boiler
	Sulphur dioxide (SO ₂)	Gas	50	50
		Liquid	1700	850
	Oxides of nitrogen (NO _x)	Gas	350	250
		Liquid	450	350
	Particulate matter (PM)	Gas	10	5
		Liquid	100	50
	Carbon monoxide (CO)	Gas	150	100
		Liquid	200	150
	Nickel and vanadium (Ni+V)	Liquid	5	5
	Hydrogen sulphide (H ₂ S) in fuel gas	Liquid/gas	150	150
	Sulphur content in liquid fuel, weight%	Liquid/gas	1.0	0.5
FCC regenerators	Limiting concentration in mg/Nm ³ unless stated	Existing refineries		New refinery/FCC commissioned
	Sulphur dioxide (SO ₂)	Hydro processed FCC feed	Other than hydro processed FCC feed	
	Oxides of nitrogen (NO _x)	400	450	350
	Particulate matter (PM)	100	100	50
	Carbon monoxide (CO)	400	400	300
	Nickel and vanadium (Ni+V)	2	5	2
	Opacity, %	30	30	30

Source: www.cpcb.nic.in

of energy by various means, including thermal absorption (i.e., solar thermal) and the photovoltaic effect (i.e., photovoltaics).

1.2 This terminology also pertains to instrumentation used to measure solar radiation.

1.3 This terminology also pertains to glass for solar energy applications.

1.4 Fundamental terms associated with electromagnetic radiation that are indicated as derived units in Standard IEEE/ASTM SI 10 are not repeated in this terminology.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

ASTM D3832 - 79(2017)

Standard Specification for Rubber Seals Contacting Liquids in Solar Energy Systems

This specification covers the general requirements for materials used in preformed rubber seals that contact the circulating liquid in solar energy systems. Rubber seal can be classified into types, grades, and classes. It has two kinds according to what climate they should be used: type C, which is intended for use in cold climates, and type W, which is intended for use in warm climates. Its grade designations represent differing degrees of hardness, such as Grade 3, Grade 4, Grade 5, Grade 6, Grade 7, and Grade 8. As for the classes, it should be categorized into three kinds.

Class A for seals used with aqueous liquid at a certain maximum service temperature. Class AT for seals used with aqueous liquids at an above maximum service temperature and class N for use with non-aqueous liquids. Different tests shall be conducted in order to determine the following properties of rubber seals in liquid heat transport systems: compression, resistance to heating, hardness, ultimate elongation, volume, resistance to ozone, resistance to low temperature, and resistance to liquid.

This abstract is a brief summary of the referenced standard. It is informational only and not an official part of the standard; the full text of the standard itself must be referred to for its use and application. ASTM does not give any warranty express or implied or make any representation that the contents of this abstract are accurate, complete, or up to date.

1. Scope

- 1.1 This specification covers the general requirements for materials used in preformed rubber seals that contact the circulating liquid in solar energy systems. Particular applications may necessitate other requirements that would take precedence over these requirements when specified.
- 1.2 This specification does not include requirements pertaining to the design, fabrication, or installation of the seals.
- 1.3 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

GOVERNMENT NOTIFICATIONS

GST on electric vehicles cut from 12% to 5%

The Pioneer, July 28, 2019

The high-powered GST Council decided to reduce the tax rate on electric vehicles (EVs) to 5 per cent from the existing 12 per cent, a move aimed at accelerating the adoption of eco-friendly mobility solutions. The new Goods and Services Tax (GST) rate on EVs will be effective from August 1, the Finance Ministry stated after the meeting of the GST Council. The GST rate on all EVs has been reduced from 12 per cent to 5 per cent. In addition, the tax rate on chargers or charging stations for EVs has been slashed from 18 per cent to 5 per cent. The council also approved GST exemption for hiring of electric buses (of carrying capacity of more than 12 passengers) by local authorities from August 1.

Smart meters help discoms trim losses in Delhi, Meerut

The Financial Express, July 30, 2019

Intervention of technology in power distribution has started showing its effect with revenue rising from consumers in New Delhi, Meerut, and Kanpur after installation of smart meters. According to the Energy Efficiency Services Limited (EESL), the average monthly revenue from consumers in high-loss making areas in Meerut has increased by more than 21% to ₹1260 after the new meters were installed. Average revenue from consumers in Kanpur – unpopular for its power pilferage – has increased by almost 9% to ₹1923. There was a 15% rise in revenue from 24,000 consumers in the New Delhi Municipal Council area. EESL charges ₹75–95 a month for the upkeep of smart meters. As many as 4.5 lakh smart meters have been installed in Uttar Pradesh, Delhi, Haryana, Bihar, and Andhra Pradesh.

Government revises solar pumps costs before installing 17.5 lakh units

The Financial Express, July 31, 2019

The Ministry of New and Renewable Energy (MNRE) has revised the benchmark costs of solar pumps for FY20. The latest benchmarking comes at a time when the government is preparing to install 17.5 lakh stand-alone solar pumps and connect 10 lakh existing agriculture pumps with solar power through the recently approved Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan (PM KUSUM) scheme. Since all components purchased through the scheme will have to be manufactured domestically, it opens up a potential market of over 8000 MW for domestic solar panels makers who are currently struggling to sustain themselves against cheaper imported products flooding the market. The MNRE has subdivided the costs of solar pumps into seven categories according to load bearing capacities ranging from 0.5 HP (horse power) to 10 HP. Each load category is further split into different varieties of solar pumps, specifying separate costs for surface and submersible types. The solar pump price list for FY19 notified by MNRE had only four broad segments.

LS clears bill to speed up resolution of inter-state river water disputes

Mint, August 1, 2019

The Lok Sabha passed a bill designed to speed up the resolution of long-festering inter-state water disputes by establishing a single central tribunal in place of the numerous existing ones. Inter-state River Water Dispute (Amendment) Bill, 2019, follows the failure of existing tribunals to resolve river water disputes in a time-bound manner. Of the nine tribunals set up to adjudicate such disputes, only four have given their awards and the time taken to do so ranged from 7 to 28 years. Heading the list of unresolved disputes is the one over the waters of

the river Beas, which has been awaiting an award for 33 years, followed by the Cauvery dispute (29 years). Issues related to other rivers – Krishna, Narmada, and Godavari – also continue to rage. The bill proposes to set up a dispute resolution committee of experts headed by a secretary-level officer of the government. Once a dispute arises, it would be referred to this committee, which would have a year to resolve it, with an extension of six months. If the committee fails to arrive at a conclusion, the matter would be referred to a central tribunal headed by a chairperson and comprising a vice-chairperson, three judiciary members, and three experts.

Policy to make Rajasthan a solar energy hub

The Hindu, August 8, 2019

A new policy to be announced shortly by the Congress government will make Rajasthan the solar energy hub, protecting the rights of consumers opting for the renewable energy sector. A target would be set to produce 10,000 MW of additional electricity from solar and wind power in the next 5 years. Mr. Gehlot said at a review meeting that the policy would help develop a large number of solar power plants and attract fresh investments. A robust power transmission infrastructure is taking shape in the form of a green corridor in the western Rajasthan and 1.25 lakh hectare of government land is available for setting up the plants. The government would make suitable provisions for storage of solar energy and its production at low cost. Rajasthan, which occupied third rank in the sector, would shortly be the leading state in the country.

Discoms made the nodal points in Phase-II of rooftop solar scheme to get incentives

The Hindu Business Line, August 23, 2019

The Ministry of New and Renewable Energy (MNRE) has issued guidelines for the implementation of Phase-II of the rooftop solar programme, which envisages a greater

involvement of power distribution companies (discoms). Under Phase-II, the government aims to set up 40 GW of rooftop solar projects by 2022. In 2015, the Centre had approved Phase-I of the rooftop solar scheme for a capacity of 4200 MW by 2019-20. Of this, 2,100 MW was to be through central financial assistance (CFA) and the balance without the central aid. Earlier this year, the second phase of the programme for achieving a cumulative capacity of 40 GW by 2022 was approved. It has been decided to implement Phase-II by making the discoms and their local offices the nodal points. "In order to address several major issues identified during the Phase-I programme, and especially the fact that the consumer had to approach multiple agencies for getting a rooftop solar plant installed, it has been decided to implement the programme by making the discoms and their local offices as nodal points for implementation of the RTS programme," said the guidelines document.

Delhi is first state where 95% industries use CNG

The Hindustan Times, September 20, 2019

Delhi has become the first state in India to have 95% of its industries fuelled by CNG. Out of the total 1542 industries in the city, at least 1457 had switched to CNG over the last one year. According to the government, it is now making efforts to convert 85 more industries into CNG fuelled ones. Industries are being contacted by the ministry of environment and explained about the advantages of the conversions. The feat was achieved primarily because of the government's ban on fuels that cause pollution such as petroleum, tire oil, and other types of chemicals used in industries. The ban on such fuels and chemicals was imposed in June 2018.

The findings of DDC also highlighted how over the last year, the industries' switch to compressed natural gas (CNG) fuel has improved the quality of lives for thousands of workers employed in these units.

Draft policy seeks to plug gaps in implementation of waste laws

Mint, September 25, 2019

Waste generation is inextricably linked to urbanization and economic development. From collection of waste to disposal, cities are struggling to implement an affordable and sustainable model. Currently, India generates about 62 million tonnes of municipal solid waste (MSW). It is evident that waste generation in cities is increasing by 5% each year because of growing population and consumption. It is clear that waste management is one of the key areas where significant work has not been done to push for objectives of the circular economy (CE) model. Reduced waste generation through closing the loop using CE and resource efficiency (RE) approaches will not only reduce pollution associated with waste disposal but also curtail related costs in resolving the short-term trade-offs between growth and environmental sustainability. In this context, the new draft National Resource Efficiency Policy (NREP), 2019 is guided by few key principles, namely, reduction in primary resource consumption to 'sustainable' levels, creation of higher value with less material through resource efficient and circular approaches, waste minimization, material security and creation of employment opportunities, and business models beneficial to the cause of environment protection and restoration.

BOOK ALERT

UPDATE ON LATEST BOOKS ON ENERGY AND ENVIRONMENTAL ISSUES

Thornton P K, Loboguerrero A M, Campbell B M, Kavikumar K S, Mercado L, and Shackleton S. 2019

CGIAR Research Programme on Climate Change, Agriculture and Food Security

Rural Livelihoods, Food Security and Rural Transformation under Climate Change

Despite decades of attention, poverty and food insecurity persist, especially amongst rural dwellers in Asia, Africa, and Central America. With climate change, the challenges only increase and will further intensify as extreme events and variable weather patterns make small-scale production even more difficult. This report's thesis is that transformational change in rural livelihoods is needed for climate change adaptation, that this change needs to embrace the broader food system, and that these actions can have benefits in multiple dimensions beyond climate change adaptation: poverty, nutrition, employment, and the environment.

UNCTAD. 2019

United Nations Conference on Trade and Development

SDG Investment Trends Monitor

The monitor analyses directional trends in investment in the SDGs, following the 10 SDG-relevant sectors for which investment gaps were estimated in the World Investment Report 2014 (WIR14) – adding up to a total gap of \$2.5 trillion annually. The publication responds to the Addis Ababa Action Agenda, which calls for high-quality disaggregated data and monitoring as vital inputs for evidence-based decision-making to support the SDGs.

Hans-Otto Pörtner, Debra C. Roberts, Valérie Masson-Delmotte, Panmao Zhai, *et al* (Eds.). 2019

Intergovernmental Panel on Climate Change Special Report on the Ocean and Cryosphere in a Changing Climate

Over the last decades, global warming has led to widespread shrinking of the cryosphere, with mass loss from ice sheets and glaciers, reductions in snow cover and Arctic sea ice extent and thickness, and increased permafrost temperature. This report reflects the state of science for ocean and cryosphere for low levels of global warming (1.5°C), as also assessed in earlier IPCC and IPBES reports. Enabling climate resilience and sustainable development depends critically on urgent and ambitious emissions reductions coupled with coordinated sustained and increasingly ambitious adaptation actions.

IEA. 2019

International Energy Agency

World Energy Outlook 2019

The World Energy Outlook 2019 explores the disparities that define today's energy world. It explains the impact of today's decisions on tomorrow's energy systems and describes a pathway that enables the world to meet climate, energy access, and air quality goals while maintaining a strong focus on the reliability and affordability of energy for a growing global population. The report considers three options to bring down emissions from the existing global coal fleet: to retrofit plants with carbon capture, utilization, and storage or biomass co-firing equipment; to repurpose them to focus on providing system adequacy and flexibility; and to retire them earlier.

MOSPI. 2019

Ministry of Statistics and Programme Implementation, Government of India

EnviStats India 2019, Volume I-Environment Statistics

Environment statistics describe human activities with a view to enumerate their interactions with the environment. The scope of environment statistics depends largely on the environmental problems on the political agenda. The report has been categorized into six chapters, each corresponding to one of the components of FDES 2013. Section II gives the details of the different components and their coverage in this publication. The tables relating to the topics under the components have been put together for the ease of comprehension and use.

MOSPI. 2019

Ministry of Statistics and Programme Implementation, Government of India

EnviStats India 2019, Volume II-Environment Accounts

The report focuses on assessment of quality of soil and water as also valuation of the ecosystem services provided by cropland. Environmental accounting for a megadiverse country like India is packed with challenges – from requirements of huge datasets and several microscopic studies to synchronizing all of these so that they speak to each other and can yield consistent estimates.

CALENDAR OF EVENTS

CONFERENCES, CONGRESSES, SEMINARS, SYMPOSIA, AND WORKSHOPS

- Bangkok, Thailand **7th Sustainable Development Conference [SDC 2019]**
July 7-9, 2019 *Tel.* +381 62 680 683
Website www.tomorrowpeople.org
- Rome, Italy **4th International Conference on Water Pollution and Treatment (ICWPT 2019)**
July 16-18, 2019 *Email* icwpt@cbees.net
Website <http://www.icwpt.net/>
- Singapore **International Conference on Oil and Gas**
August 5-6, 2019 Theme: Recent Trends and Advancement in Oil and Gas Field
Email oilandgas@pulsusmeet.com
Website <https://oil-gas.pulsusconference.com/>
- New Delhi, Delhi **India Refining Summit 'Refining and Petrochemicals – Synergise and Revolutionise'**
August 22-23, 2019 *Mob:* +91 98107 00266, +91 73030 27930
Tel: +91 11 6676 2374, +91 11 6676 2389
Email priyanka.rai@india.messefrankfurt.com, sanaa.firoz@india.messefrankfurt.com
Website <http://www.refining-technology.com/contact.html>
- New Delhi, India **2nd International Conference on Large-Scale Grid Integration of Renewable Energy in India**
September 4-6, 2019 Ms. Pramna Bhandari
Email registration@regridintegrationindia.org
Website <http://regridintegrationindia.org/>
- Abu Dhabi, United Arab Emirates **24th World Energy Congress**
September 9-12, 2019 Anita Mathews, Congress Director
Email anita.mathews@wec24.org
Website <https://www.wec24.org/>
- Yinchuan, China **3rd International Workshop on Energy Conservation Technologies (IWECT 2019)**
September 19-21, 2019 *Email* iwect@apise.org
Tel +852-30506939(HK)
Website <http://www.iwect.org/>
- London, UK **10th International Conference and Expo on Oil and Gas: Enhancing Industry Development Through Technology**
September 23-24, 2019 *Email* chemicalengineeringconferences@gmail.com
Website <https://oil-gas.expertconferences.org/>
- Berlin, Germany **2nd World Congress on Climate Change**
September 26-28, 2019 *Email* climatechange@innovinc.org
Website <https://wccc-2019.com/>

- London, United Kingdom
October 01–03, 2019 **Smart Grid Flexibility 2019**
Tel. 44 (0)20 3691 1700
Email registration@smartgrid-forums.com
Website <https://www.smartgrid-forums.com/forums/smart-grid-flexibility/>
- Bangkok, Thailand
October 3–4, 2019 **2nd International Conference on Global Warming and Climate Change 2019 (GlobeWarm '19)**
Tel. +94 112044480/Ext.6102
Fax. +94 112 873 371
Email secretariat@globalclimateconference.com
Website <https://globalclimateconference.com/>
- Rabat, Morocco
October 14–16, 2019 **2nd International Conference on Power and Energy Technology (ICPET 2019)**
Gina Chen
Email icpet@academic.net
Tel. +86-1348-2222-225
Website <http://www.icpet.org>
- Tokyo, Japan
October 16–17, 2019 **7th World Conference on Climate Change & Earth Science**
Theme: Global Climate Challenges, Adaptation and Management
Email climatechange@annualamericacongress.org
Website <https://climate.conferenceseries.com/sponsors.php>
- Amsterdam, Netherlands
October 20–21, 2019 **6th Global summit on Climate Change**
Theme: Climatology, The Science of Global Weather Systems over the Long Term
Email greenenergy@europemeet.com
- Sydney, Australia
October 21–22, 2019 **10th World Convention on Recycling and Waste Management**
Theme: Reduce and Recycle Waste for Sustainable Waste Management
Email wasterecycling@asiapacificmeets.com
Website <https://wastemanagement.conferenceseries.com//registration.php>
- Shandong University, Qingdao, China
October 25–27, 2019 **International Symposium on Energy, Water and Environment (SEWE 2019)**
Email sewe@cbees.net
Website <http://www.isewe.org/>
- Toronto, Canada
November 2–4, 2019 **2019 IEEE 2nd International Conference on Renewable Energy and Power Engineering (REPE 2019)**
Contact person: Ms. Teri Zhang
Tel. 86-28-83207566
Email repe@zhconf.ac.cn
Website <http://www.repe.net/>
- New York City, NY, USA
November 13–14, 2019 **6th ACM International Conference on Systems for Energy-Efficient Buildings, Cities, and Transportation**
Website <http://buildsys.acm.org/2019>
- Delhi, India
November 28–29, 2019 **Empowering a Gas Based Economy for India**
Siddharth Ranga
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- Paris, France **7th Global Summit and Expo on Pollution Control**
December 02-03, 2019 *Website* <https://pollutioncontrol.global-summit.com//registration.php>
- Perth, Australia **Towards Green and Sustainable Future**
December 10-12, 2019 Contact person: Dr Farhad Shahniah
Email icpes2019@gmail.com
Website <http://www.icpes.org/>
- Perth, Australia **9th International Conference on Power and Energy Systems (ICPES 2019)**
December 10-12, 2019 ICPES 2019 Secretary, Mr Muhammad Adnan Hayat, Engineering and Energy Discipline
Murdoch University, 90 South Street, Murdoch, Western Australia 6150, Australia
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- Munnar, India **ISSRD - Eurasia Conference On Oil Gas And Chemical Sciences (ECOC)**
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- Spanish Town, Jamaica **The World Congress on Pollution Control (WCPC-19).**
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December 19-21, 2019 Contact person: Ms. Teri Zhang
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