if 10% of the produce is saved from spoilage. So, there is a business case which buyers can make for investing in cold chain for this sector. There is also the opportunity to charge higher consumer prices for produce moved through a cold chain. In India, we have multiple channels for selling of fruits and vegetables, ranging from the roadside vendor to kirana shops, large format retail (supermarkets), and finally online retail. It is possible to create a differentiated pricing mechanism depending on the channel and freshness and quality of the produce.

One big difference between the dairy industry and the fruits and vegetables industry in India is the amount of produce that gets processed and moved through organized channels. Compared to the dairy industry in India where nearly 25% of the produce is collected by organized channels, the figure is lower than 5% for fruits and vegetables. In India, there are a few retail chains that do procure directly from farmers, but they are extremely niche at this point of time. Lack of organized players and processing means that there is very little ownership on the investment, operations, and management of cold chain in the fruits and vegetables industry.

How to Implement a Cost-Effective Cold Chain

Implementing a cost-effective cold chain from the farm to the fork needs focus on the pre-processing stage, which is the largest gap today. We would need to lower unit costs, implement systems to manage seamless operations, and provide visibility to both farmers and processors.

Unit capital costs are higher today because of the lower utilization rates at the pre-chilling stage. One option is to combine collection for multiple villages through a common chilling industry as is the norm in the dairy industry. The other option is to combine two sets of infrastructures and lower the overall costs. What if both chilling and transportation are done in the vehicle itself? A mobile chiller that collects the produce from individual villages and chills it en route from the village to factory would lower the overall system cost. At Promethean Power Systems, we have tested out this option for both milk and vegetables with very encouraging results.

Alternate sources of energy can play a huge role in reducing chilling costs. The goal should be to eliminate the diesel generator from rural chilling infrastructure. Cold rooms and bulk

milk coolers can be developed as anchor tenants for solar micro-grids. In addition to increasing the utilization of the micro-grid, there is also creation of an additional source of revenue for the entrepreneur or agent running the grid. In rural India, very often, the challenge is not the absence of grid power, but it is the unreliability of the grid power. Power may not be available when the produce needs to be chilled after harvest. Thermal energy based systems can solve this problem very easily. They use phase changing materials to store cold energy when grid power is available. The stored cold energy can then be used to chill the produce as and when required. This form of energy costs a fraction more than grid supply and can completely eliminate the diesel generator from the chilling infrastructure. Biofuel-based chillers are also gaining traction as they have the added advantage of obtaining the fuel from the village itself.

Running costs of refrigerated trucks can also be reduced by using solar or thermal energy for maintaining the temperature of the produce in the vehicle. These solutions eliminate the compressor from the vehicle that not only reduces the diesel consumed while running but also lowers the maintenance costs in the long run. Trials are also being undertaken for an electric vehicle based reefer van that can dramatically lower running costs.

Implementation of technology will provide the controls and visibility required to ensure the seamless operations of the cold chain. Use of sensors and IoT enables us to monitor the integrity of the cold chain from the source to the factory dock. We can also monitor pilferage, adulteration, and implementation of hygiene protocols. Technology can also be used to make systems simple to operate and maintain so that the operations do not require much training or skills.

To summarize, implementing a cost-effective cold chain in India would need the following:

» Focus on the pre-processing stage from the harvest of the produce to the factory dock
» Make the capital usage more efficient through the development of community level chilling centres managed by anchor buyers
» Reduce the chilling costs by eliminating the need for diesel generators using alternate sources of energy
» Use technology extensively to increase visibility and transparency and make operations easier
» Create a consumer pull through differentiated offerings having better quality, more freshness, and longer shelf life. EF

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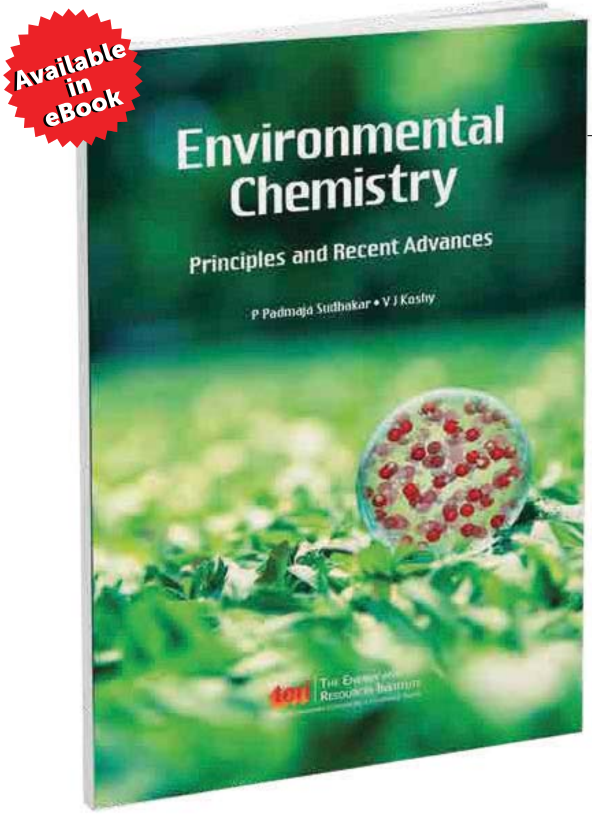
A STUDY OF THE CHEMICAL PHENOMENA IN THE ENVIRONMENT



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GREEN ENERGY AND GRID INTEGRATION

Potential and Economic Viability in India

As the costs of renewable technologies have come down, renewable markets are slowly evolving to become viable alternatives to the conventional energy. Governments across the world are reconsidering the economics of renewable energy and increasingly accommodating renewables into the complex equations of public policy. **Shreya Shekhar**, in this article, examines the renewable energy in countries that have been early movers in the market and then considers the Indian context to discuss potential and problems.

The notion that 'green' energy would not be viable has not aged well. Increasingly, the consideration that it is too expensive to adopt, even for resource-constrained countries, is changing. As the costs of renewable technologies have come down, renewable markets are slowly evolving to become viable alternatives to the conventional energy. Governments across the world are reconsidering the economics of renewable energy (RE) and increasingly accommodating renewables into the complex equations of public policy, which require balancing developmental agendas, environmental considerations, resource constraints, and political economies.

Over the last few years, India has taken up increasingly ambitious targets for RE capacity and had a total RE capacity of 84 GW in 2019–20, with renewables alone contributing 23% of the total installed electricity capacity in the country in March 2020 (CEA), even excluding large hydropower projects, which are traditionally not counted in renewable capacity estimations.

However, despite the increasing excitement surrounding a sustainable energy transition, it is important to remember that renewable energy technologies are still relatively young, and the thus the nature of the technologies available, their challenges, and the policy frameworks put in place have been continuously evolving. In this article, we follow the story of renewable energy in countries that have been early movers in the market and then consider the Indian context to discuss potential and problems.

Economics of Renewable Energy

The RE markets in other countries have developed differently over the decades. In its nascent stages, policy around RE needed a high support and subsidy base, though that has changed significantly with increasing competitiveness.

Let us start by taking a look at the strategies adopted by countries that were first movers in energy transition – Germany, which invested heavily in large-scale solar capacity (despite receiving very little sunlight), and United Kingdom, which developed technology neutral policy instruments to expand its renewable capacity.

The development of the renewable sources in the United Kingdom, though initiated in the late 1970s and early 1980s, really started taking shape with the introduction of the Renewable Energy Obligation in 2002, which necessitated that all electricity suppliers source a minimum specified amount of electricity from renewable sources.

Suppliers would be provided Renewable Energy Certificates (RECs) by generators, which serve as evidence of having met their obligations. Those who could not cover their obligations would then be required to pay a fixed rate per unit of the amount of shortfall. This opened the market for tradable Renewable Obligation Certificates (ROCs), with a set RE target that aimed to deliver the lowest cost renewable generation.

While initially there was no distinction made between different renewable energy technologies, with all of them receiving an equal amount of support per kWh, after 2009 distinctions began to be recognized between technologies of greater and lesser maturity, allowing emerging technologies to receive greater support than their more established counterparts. The combination of specific support and increasing obligations for minimum purchase (Table 1) created a conducive environment to support the establishment of large-scale renewable projects.

The feed-in tariff (FT) scheme utilized adaptable tariffs that varied by technology and the size of installation to incentivize households and smaller scale operations to take up renewable generation. While the increasing

Table 1 Size of renewable obligation

End of RO period	RO as a proportion of electricity supplied	
31-Mar-03	3.0	%
31-Mar-04	4.3	%
31-Mar-05	4.9	%
31-Mar-06	5.5	%
31-Mar-07	6.7	%
31-Mar-08	7.9	%
31-Mar-09	9.1	%
31-Mar-10	9.7	%
31-Mar-11	11.1	ROCs per 100 MWh
31-Mar-12	12.4	ROCs per 100 MWh
31-Mar-13	15.8	ROCs per 100 MWh
31-Mar-14	20.6	ROCs per 100 MWh
31-Mar-15	24.4	ROCs per 100 MWh
31-Mar-16	29.0	ROCs per 100 MWh
31-Mar-17	34.8	ROCs per 100 MWh
31-Mar-18	40.9	ROCs per 100 MWh
31-Mar-19	46.8	ROCs per 100 MWh
31-Mar-20	48.4	ROCs per 100 MWh
31-Mar-21	47.1	ROCs per 100 MWh

Source: BEIS

Renewable Obligation (RO) targets made large-scale projects more viable, the introduction of an FT scheme in 2010 opened the door for micro generators (with a capacity of 5 MW or less).

The net result of these policies was that UK had a renewable energy capacity of 44 GW by 2018, which was 33% of the total installed capacity in that year. The very success of these policies, combined with the falling cost of the technology as economies of scale could be achieved, allowed policymakers to gradually allow market mechanisms instead of government directives to drive the transition. The FT scheme closed to new applicants from April 2019, and the UK Government introduced the Contracts for Difference scheme in 2014 with the aim of progressively replacing the ROs with programmes having newer generation capacities in a phased manner from 2015 onwards.

Germany took a different path when it came to its energy transition. While energy security considerations initially led to the expansion of nuclear power in the aftermath of the oil crises of the 1970s, pushback came from increasing anti-nuclear sentiments, which were dramatically stroked in the early years by the fallout of the Chernobyl disaster in 1986 and again in 2011 by the Fukushima disaster.

The political voice found by the anti-nuclear campaign changed the direction of federal sentiment over nuclear power being made into the cornerstone of electricity generation in the country, and the turning point came when this movement turned into the Environmental Party for Germany, calling itself the 'Greens', making issues such as renewables, energy savings, low-impact lifestyles, sustainable development, mobility alternatives, and smart urban design mainstream and bringing them into legislation.

The fallout of the Chernobyl disaster in 1986 left a lasting impact on Germany and led to institutionalizing the world's first FTs in 1991. This is when investments in solar power also began to take momentum. This opened up the doors for even more dramatic changes under the Red-Green coalition in 1998 that prioritized '"ecological modernisation", which included climate protection, renewable energy expansion, energy efficiency, and sustainability measures'.

The 2000s saw the adoption of the nuclear phase out and Renewable Energy Act (EEG) that raised the FTs significantly for RE to cover for high investment costs, which was hindering its competitiveness with the

conventional energy. The grid operators had to compete with electricity and gas generated by renewable energy producers at the fixed price. This was done with the aim to stimulate investment by covering the difference between the cost of production and the market price.

These directives became national law in Germany, which in the years to follow effectively broke up the production and distribution monopolies. Priority was given to renewables in the grid, and the investment from mostly small actors, such as farmers, co-ops, citizen-led groups, and other non-industry companies, in green energy production led to the share of renewables shooting up to 14.2% in 2007 and 17% in 2010.

In 2019, they had a renewable installed capacity of 49 GW, which was 8% of the total consumption, out of a total renewable share of 43% employing over 36,000 people. Germany's solar power capacity saw rapid growth due to the EEG despite the country's modest potential for harvesting solar energy.

Today 1 in 3 photovoltaic (PV) panels in the world are German made. Further, the introduction of carbon pricing in the buildings sector and the increasing popularity of home batteries are estimated to substantially increase the value of panels for solar power users.

Transition in India

The first real steps towards a renewable energy transition started in India under the National Action Plan on Climate Change (NAPCC) that came out in 2008. One of the most successful of these eight missions is the Jawaharlal Nehru National Solar Mission (NSM), under the supervision of the Ministry of New and Renewable Energy (MNRE), whose objective is to increase the penetration of solar energy in the country. The initial target of the mission was to install 20 GW solar capacity by 2022, which has now been revised to 100 GW.

Market Set-Up

In India, a number of policy instruments have been used, with varying degrees of success, with the aim to keep renewable energy competitive. These include Renewable Purchase Obligations (RPOs), Renewable Energy Certificates (RECs), Accelerated Depreciation (AD), and Reverse Auctions (RAs).

RPOs require obligated entities, such as distribution companies (DISCOMs), to maintain a successively higher share of their electricity to be from renewable sources (the minimum obligation was raised in 2018 from 17% to 22% by 2022). RECs are an additional policy instrument whereby the electricity component of renewable energy sources can be unbundled from their 'green' component and traded separately, allowing states to meet their regulatory requirements on renewable purchase by overcoming renewable potential constraints and facilitating them to meet their RPO requirements. RPO and REC markets have had uneven success, with many states failing to meet their yearly targets. They have been insufficient in encouraging large investments due to challenges in demand and investment uncertainty in the absence of long-term targets and compliance.

The Accelerated Depreciation tax benefit is another incentive offered to renewable energy projects. An indirect support mechanism, it allows users of RE to depreciate their investment in a plant at a higher rate than that on general fixed assets, such that they can claim tax benefits on the depreciated value in that year. The government also launched competitive auctions for solar PV (in 2010) and wind (in 2017) with fixed price contracts through PPAs (power purchase agreements).

One of the most successful interventions for utility-scale renewable capacity have been the Reverse Auctions managed by the Solar Energy Corporation of India (SECI), which have contributed to accelerating deployment of both solar and wind power, while simultaneously allowing for increasingly competitive price discovery. India has also been investing in transmission through Green Energy Corridors, a project started to establish dedicated grid infrastructure to connect good performing states and enable intra- and interstate transmission to load centres.

Other economic instruments employed as incentives or bridge mechanisms to reduce the procurement tariff of RE are viability gap funding (VGF), which is subsidized funding for the gap in affordability and cost for sectors that need high capital investment, or a direct subsidy like generation-based incentive (GBI) that is easy to administer. Net metering (NM) uses the grid as a substitute for a battery in the grid integrated solar power models. Here, the user pays only for net energy used and if more energy is generated than consumed, the individual is compensated for those extra units.

The Good, Bad, and Green

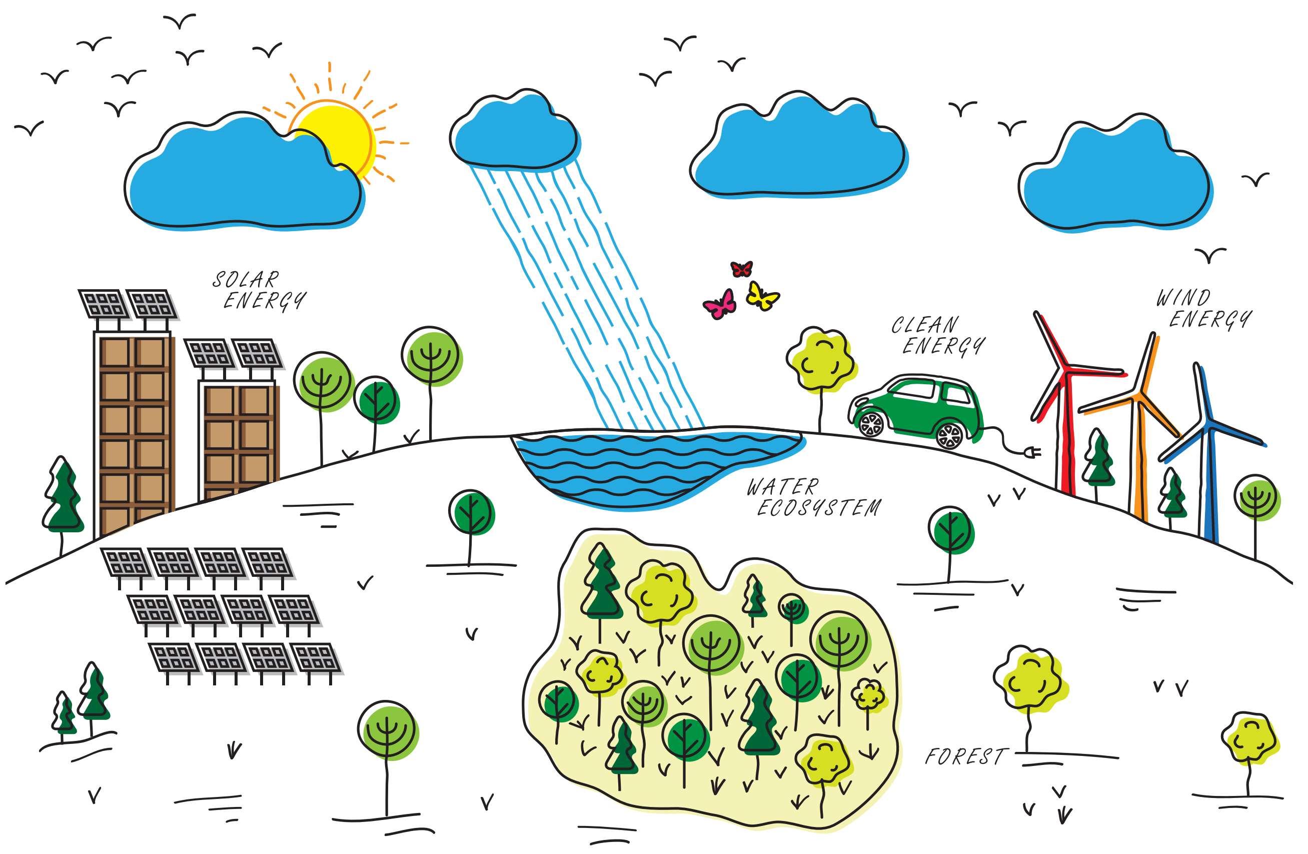
India increased solar power generation capacity by five times between 2014 and 2017, adding over 9300 MW in 2017–18 alone. It surpassed the original target of 20 GW, 4 years ahead of schedule, by putting up 34 solar parks across 21 states (each with minimum 500 MW capacity) with the help of central government funding.

Currently, India has the fourth highest wind installed capacity in the world, with total capacity of 34 GW in October 2018. The target is to achieve 60 GW by 2022. Its hydro power capacity has reached 45 GW, which is over 13% of the total renewable capacity.

Challenges

Renewable energy, particularly solar power, suffers from a set of known and recognized challenges, the most notable being investment, T&D (transmission and distribution) issues, discrepancies in state policies, and storage.

Most sources of RE have high upfront capital investment, none more notorious for it than solar power. The high-end manufacturing and installing solar panels are more often than not a barrier, making the industry very cost sensitive. At this stage of competitiveness, the government has to balance between subsidy for small consumers and



tax relief for promotion of domestic manufacturing against creating distortions in the market price.

T&D problems are a core inheritance from the conventional energy sector in the country due to the many failings of infrastructure and efficiency measures, and these problems get magnified when transmission tries to cross state lines and distribution of excess generation since the economic incentives and laws around electricity access are different in each state.

REC markets have not been able to adequately encourage large investments because of demand uncertainty in the absence of long-term targets and poor compliance. With SECI auctions, some of the limitations they have faced include land acquisition, grid integration, and connection concerns that have caused delays.

The financial viability of DISCOMs as off-taker has become jeopardized due to high commercial, technical, and consequent financial losses owing to cross-subsidizing of prices that are inadequate for costs incurred and a lack of metering and billing. As DISCOMs strive to stay profitable, encouraging adoption of solar power may present a conflict of interest, especially for those establishments that double as power generators and distributors.

Friction in funding projects involving solar irrigation pumps, rooftop solar, and mini-grids stems from difficulty in getting finance in the industry, since there is a lack of frameworks for evaluating creditworthiness smaller/decentralized companies and consumers, especially for local banks. Other persistent development risks remain, which delay project commissioning, centred on problems of land acquisition along with grid connection and availability of local infrastructure.

Unlike the conventional grid, electricity generation by solar or wind power is inconsistent, making them ill equipped to cover the base load and requires a backup or storage of power for windless or overcast days. The cost of raw materials, for storing equipment like solar batteries, such as lithium ion is also high, and the life of these batteries reduces significantly if discharged to 50% or more on an average. India has pledged to reach a target of 175 GW renewable power capacity, especially a solar target of 100 GW, so as to meet its NDC (Nationally Determined Contribution) goal of generating 40% of the total energy mix using non-fossil fuel based sources and simultaneously reduce emission intensity by 33–35% by 2030.

Thambi, Bhatacharya, and Fricko (2018) used a bottom-up energy system model to understand the future development of India's energy and commitments on climate change.

By increasing installed capacity of renewables to 175 GW by 2022, India can surpass its NDC target by 2022 and up to 11% power sector emissions can decline by 2030. With investment in the alternative energy technology, solar costs could fall by up to 50% and solar penetration in the market can increase by eight times compared to the baseline. The study also found that solar power in India is very cost sensitive and penetration of RE is highly cost elastic. Therefore, it requires continued policy support at this point.

Renewables and Energy Security

Access to energy is an important link in the development ladder. It is so crucial that former UN Secretary-General Ban Ki-moon called it the 'golden thread that connects economic growth, social equity, and environmental sustainability'.

There are over a billion people worldwide with no access to energy. As recent as May of 2019, India imported 80% of its oil needs, making it the third largest consumer in the world, and it is projected to be one of the largest consumers, accounting for almost a quarter of the total projected world demand.

This will definitely contribute to close that gap between demand and supply. As India is also the third largest contributor to total carbon emissions and it has huge solar potential, green energy can be the easy first choice for closing the gap.

While in countries such as UK and Germany, among others, gas is seen as the immediate alternative for oil for its low cost and scalability, the same is not considered a reliable alternative for India. Even with that realization, the solar plus storage path makes most sense, since the combination has the potential to be a consistent energy option, especially with cost-competitive taxes and decreasing storage costs.

India's solar energy industry is growing at a rapid pace. India's renewable energy potential remains vastly untapped. While the total solar potential of India is estimated to be 750 GW, as of March 2020 the solar installed capacity was 37.627 GW. India has a huge market potential for being a developing economy with 1.4 billion people. Ensuring Indian citizens have access to electricity and clean cooking has been at the top of the country's agenda. The government has been encouraging clean cooking with liquefied petroleum gas (LPG), solar cooking, and other off-grid electrification solutions.

India is the fifth largest clean energy investment market and stands at fifth position with regard to the most solar power installations. It is also estimated that India has the lowest total installed cost for new utilities of solar PV panels.

Considering life cycle costs and benefits, with PV panels lasting for around 25 years, the running cost of solar

power is much lower than the traditional sources, making it an optimal option for medium and long-run gains, with the potential to eliminate power bills entirely.

Life cycle of renewable energy system:

Energy capture → Conversion → Storage → Retrieval → Final use

Several countries are adopting policies to increase the renewable capacity. Especially solar has now put estimated demand where it needs to be to justify the expensive technology. The recent investment from the electric vehicle (EV) industry into lithium ions has brought down the latter's cost notably.

A major criticism of domestic policies undertaken to promote the sector has been related to the guidelines mandating 30–60% of the total system to be manufactured in India. As one would expect, this is counter-intuitive to the market response of choosing to procure modules from established international players.

The huge variations in policy regulations in the different states, as mentioned (since electricity is a concurrent subject), has also been a matter of concern. Uniformity of regulations across state lines will also reduce T&D losses in the case of interstate supply.

Setting up a solar project along with energy storage solutions (ESS) through domestic manufacturing capacity in India will generate employment in the process and address some of the sectoral issues, such as the single-tariff structure, storage solutions, and RPO trajectory.

Although guaranteed manufacturing offtake would restrict advantages of potential competition and even technology, assured offtake creates a conducive manufacturing atmosphere, with more market-centric options such as power procurement through PPAs.

The quantum of solar installations would necessitate a huge payment security fund, which may be mitigated through tripartite agreements between the RBI, the Central government, and the state government. RUMS (Rewa Ultra Mega Solar), *a* joint venture of the Solar Energy Corporation of India Limited (SECI) and Madhya Pradesh Urja Vikas Nigam Limited (MPUVNL), had tendered 1500 MW of grid connected solar projects across three parks in Madhya Pradesh in 2018.

Solar We Ever After?

There is an urgent need for mainstreaming renewables for energy security, economic growth, and environmental protection, while chasing targets of universal energy security. A rapid transition to RE will have a positive effect on India's macroeconomic performance.

Tapping into abundant indigenous renewable resources could avoid revenue outflows for expensive imported fuels, while ensuring universal access to clean fuels, an important building block for an energy secure nation. An appropriate action at this time allows developing countries like India to leap into a greener future while not compromising on basic needs and economic development. India is uniquely poised to grab this opportunity.

RE sources witnessed cost declines across the board globally, falling to record lows in 2018. Currently, India's ambitious solar programme is based on imported cells and other equipment. India's energy import dependence could jeopardize its energy security. A robust domestic manufacturing base for solar cells, modules, and other supporting equipment for self-reliance and revamping state-wise solar capacity building goals should be the focus in the near future.

The volatility in the markets brought by the novel coronavirus (COVID-19) is yet to be fully analysed and beyond the scope of this article. However, the impact on global energy demand may give rise to more low carbon power systems due to preferential access and low operating costs. It may even become the catalyst required for some countries to solidify their commitments towards renewable energy. EF

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Disclaimer: The views presented in this article are personal.

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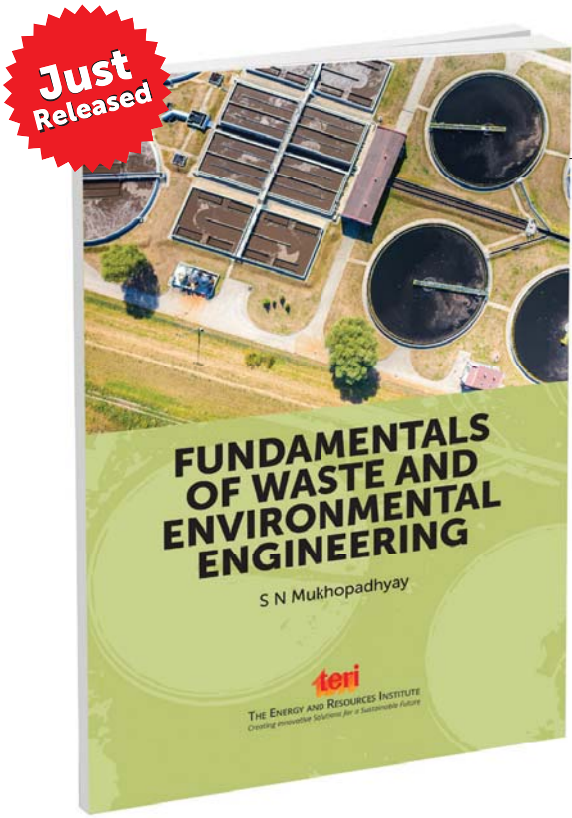
ENVIRONMENTAL REMEDIATION THROUGH ENVIRONMENTAL ENGINEERING



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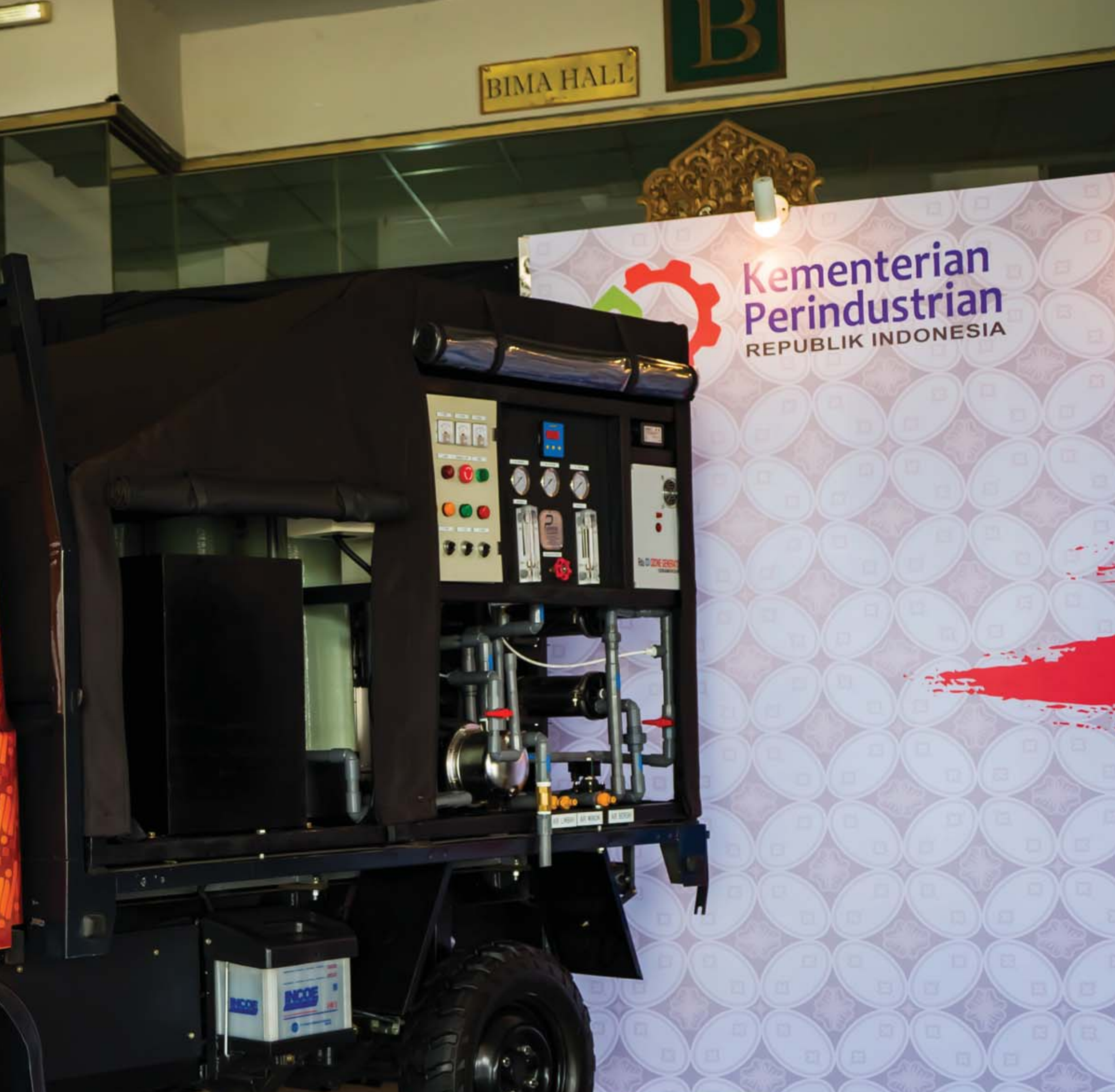


Solar Powered Mobile Water Purifiers

Various methods exist for the purification of water. The lack of fuel use has made the solar energy application relatively superior than the conventional sources of energy for water purification as it does not cause various types of pollution effects. **Suram Singh Verma**, in this article, talks about solar powered water purifiers and elaborate on their advantages and challenges.

All forms of pollution (soil, water, and air) have an impact on the environment. Everyone desires to breath pure air and drink clean water. Various methods of water purification (water purifiers) are used. They can be place specific, energy consuming, and costly. There is always a quest to find a low cost and mobile water purifier system that can cater to the growing demands of people for pure water. Low-cost solar powered water purifier is one such innovation. It can convert any source of water (e.g., seawater, rainwater, brackish tap water) into potable water and remove both inorganic contaminants (arsenic, fluoride, heavy metals, etc.) and organic contaminants (pathogenic bacteria). It does not require periodic replacement of filters. In other water purifiers, filters get clogged and become useless. It is developed by researchers at Indian Institute of Science, Bengaluru. It is easy to construct and given as an open source design so that anyone interested can download and build it. This open source solar water purifier can transform water into potable water from any source, for example, sea, river, pond, wells, or even water collected from rain. The low-cost mobile solar powered water purifier can also provide safe drinking water in areas where the only sources are contaminated with arsenic, fluoride, or sewage. This device works on the principle that impure water is evaporated using solar energy and vapours are condensed to pure water on a cold surface. During the filtering process, bacteria, heavy metals, arsenic, fluoride, and other impurities are removed and pure potable water of the order of 1.5 L from 3 L of impure water can be produced daily.

Solar water purification involves the use of solar energy in many different ways to purify water for drinking and household purposes. Solar energy treatment of water has become more common as it is a low-cost and easy technology solution that works to capture heat energy from the sun to make water cleaner and healthier for drinking and other human uses. Solar water treatment is beneficial not only in case of adverse conditions, such as floods, storms, and typhoons, but also for rural communities. People in rural areas have limited access to other forms of water purification infrastructure that are based on the use of electricity. In comparison to other water purification methodologies, the solar water purification technique has the following advantages:

- Renewable solar energy powered water purifying system requires no gasoline or other fuels.
- This technique can provide 100% safe and clean drinking water anytime and anywhere.
- It is simple to use and requires low maintenance.
- It is ideal for temporary installations and emergency situations.
- It can be used even in rural areas with no power.

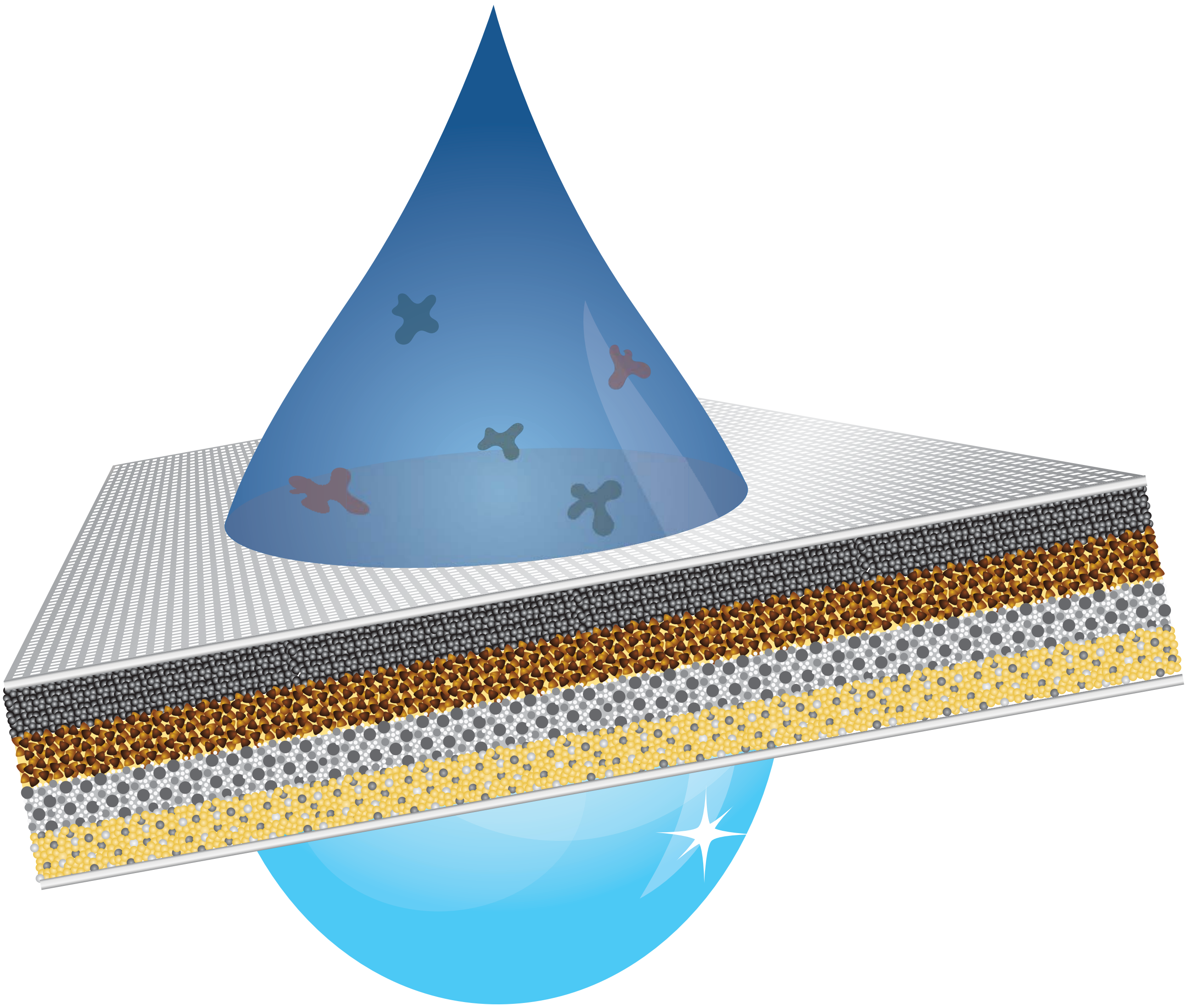
It is basically the lack of fuel use that makes the solar energy application relatively superior than the conventional sources of energy as it does not cause various types of pollution effects, such as ozone depletion, global warming, acid rain, or other local health hazards associated with pollution. Further, mobile water purifiers are still one step ahead in popularizing the solar water purification technology. These types of solar water purifiers have arrays of solar panels, batteries, and high pressure pumps and machines that are usually wind up in natural disaster zones, off-grid villages, or military operations around the world. In the solar powered mobile operating water purifying system, raw water is made to go through different filtration steps to meet the required standards of safe drinking water. This system is capable of producing 200 L of drinking water per hour. The device can be designed to be easily transported, for example, fitting into the back of a pickup truck, trailer, or a flat hull boat in case of emergency on or off land.

Designing Fundamentals

Water purification comprises various processes, such as removing suspended solid particles, undesirable chemicals, and gases from contaminated water. Most of the solar powered mobile water purifiers are generally designed to supply purified water for human consumption (drinking water), but such water purifiers may also be designed to produce pure water for a variety of other purposes, including meeting the requirements of medical, pharmacological, chemical, and industrial applications. Generally, two processes are followed in the purification of water, that is, filtration and disinfection. In the solar water purifier, both the processes are used. Water filtration is carried out using pre-filter (washable debris filter), 0.5 micron sediment filter, and activated carbon filter, which remove solid particles such as sand, debris, and fine particles from water. Water disinfection is carried out using UV filtration. As UV light from the sun is known to destroy microorganisms, the manufacturing of equipment producing UV light for residential use has started in the recent years. Low mercury vapour enclosed in a tubular lamp is the most practical system of producing ultraviolet energy radiation. Energy produced by the UV lamp has the ability to destroy microorganisms such as parasites and bacteria. For its easy transportation from one place to another in nearby locations, this water purifier is compactly assembled on a four-wheel trolley. This facilitates charging the battery from mains supply during low sunshine hours or in rainy season when the sun's radiation level is insufficient to charge the battery. External DC supply from a vehicle can also be used to operate this equipment. The design is made considering the aspect of human-machine interface. Displays are provided for the operating parameters, which makes this machine very easy to operate. A large number of solar powered mobile water purifier system have begun to appear in the market that range from the size of golf carts to food trucks, depending on the desired pure water output. Flat or folding array solar panels lie on top and generate electricity that charges GEL-sealed lead acid batteries, which in turn run the motor that pumps water through filters. Clean water comes out of a hose. Depending on the filtration process, contaminants flow out in a discharge stream or remain in mechanical membranes. Internet-connected monitors remotely are used to display output, equipment performance, and water quality. Such a system can be deployed anywhere and it can turn contaminated, poisoned water into drinking water in minutes. If the water is from sources such as ponds, lakes, or municipal taps, it is passed through filters to remove microbes, sediment, and other contaminants and then ultraviolet light is used to sterilize the filtered water. Salty water or seawater undergoes reverse osmosis, in which water is forced through a thick membrane that blocks sodium and chloride ions and allows freshwater to pass. The process uses a substantial amount of energy, and so such units require more solar panels and batteries, which increases the system cost. Lead-tainted water also requires reverse osmosis because of the low molecular weight of this metal.

Developmental Status

Various companies dealing with solar energy water purification have come up with various set-ups of solar powered mobile water purifiers. In this regard, PV Pure, a start-up founded by MIT (USA) researchers, has delivered its small units across Latin America, the Caribbean islands, and the Middle East. Tata Group is building village-scale desalination systems and solar-driven water pumps in India. The so-called Micro Production Centre (MPC), a model developed by Kenneth M. Persson and engineer Ola Hansson from Lund University in



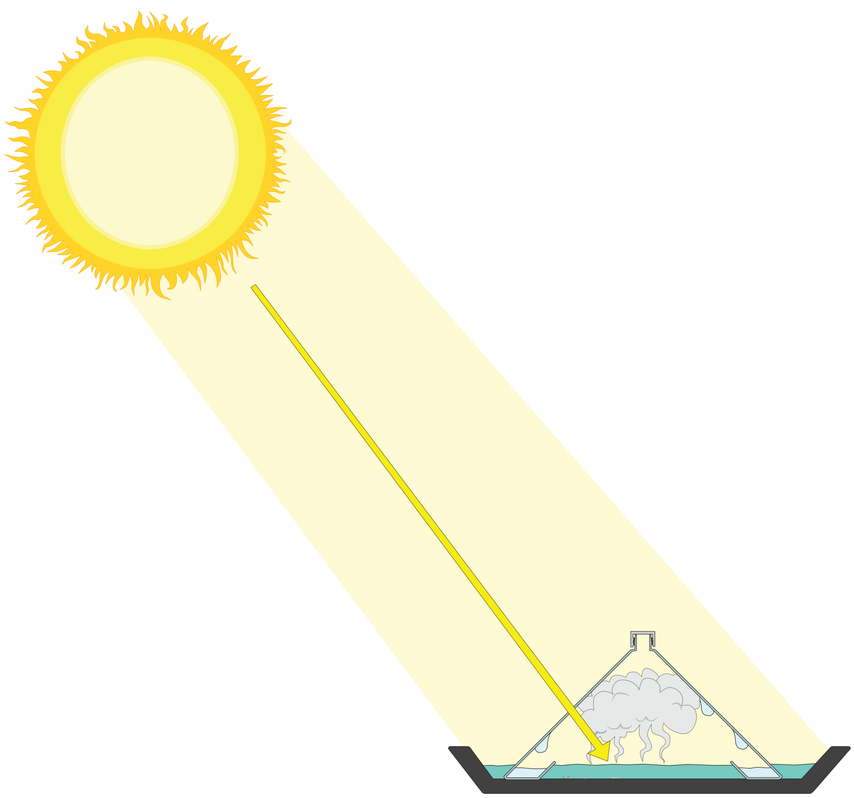
Sweden, disinfects and purifies water using the UV LED technology and it uses intelligent software and Wi-Fi connectivity for monitoring the machine. The system is very energy efficient. It can be operated by just one solar panel, and thus it is lightweight and portable. The solar panel charges a battery for backup energy so that the system can also work at night.

Advantages

- The system provides safe clean drinking water anytime and anywhere.
- It is ideal for temporary installations, emergency situations, and rural areas with no power.
- The system can be designed as a compact unit and it is easy to install and maintain.
- The system has high demand in various industries for the purification of water.
- It is constructed with the help of the modern technology and high quality raw materials and this system is provided in different technical specifications to meet the different needs of clients.
- The system has useful characteristics such as operational fluency, low power consumption, and rugged design.
- Solar powered mobile water purification systems could provide communities an affordable alternative to bottled water and home filters.
- People can now purchase inexpensive clean water. Moreover, they can also make a small profit by running water purification plants.
- This system is durable, reliable, and cost-effective.

Challenges

- The key challenge with the solar powered water purifiers is the intermittent nature of the solar energy and system operation and any fluctuations can quickly degrade the equipment. To address this problem, operators can either use small batteries to maintain steady power flows or turn the system on and off to match the sunlight.
- Scalability is a challenge for the solar powered mobile water purifier as solar arrays of large size are required for more battery storage. However, the size of solar arrays can be tackled by making folding solar arrays.
- The use of large batteries can help store power and extend operating times, but the cost of the overall system is considerably increased.
- The cost of the system also depends on the water source and capacity expectations.
- Purifiers with reverse osmosis face an additional challenge. Intermittent operations can lead to membrane fouling if not properly managed.
- Salts, microbes, and heavy metals can attach and grow on the filtration membrane. Therefore, more energy is required to force water through the filters. EF



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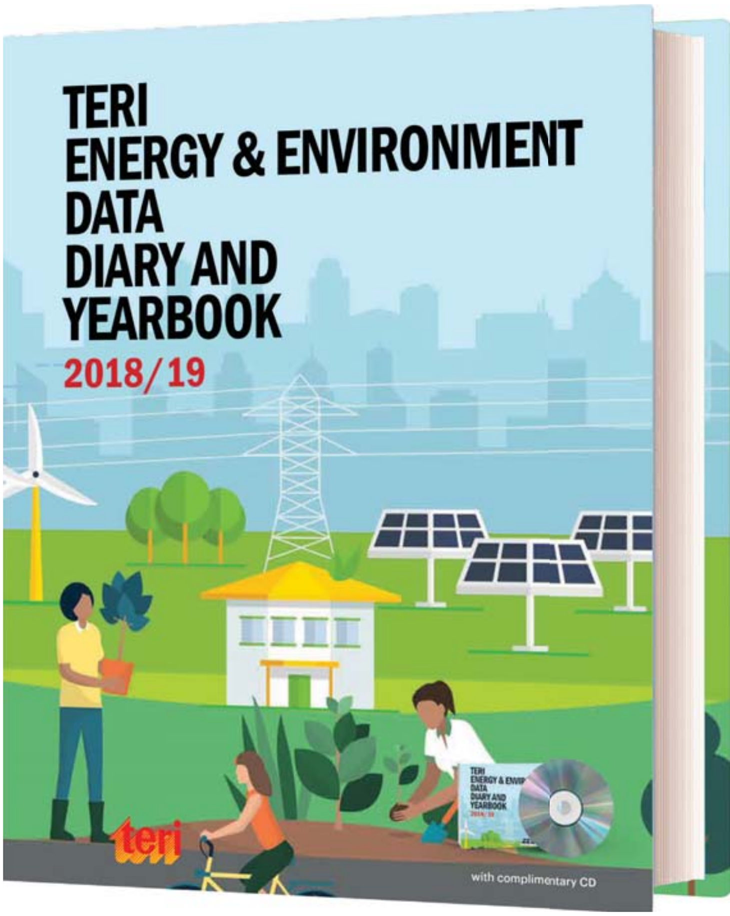

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MEETING COOLING DEMAND SUSTAINABLY

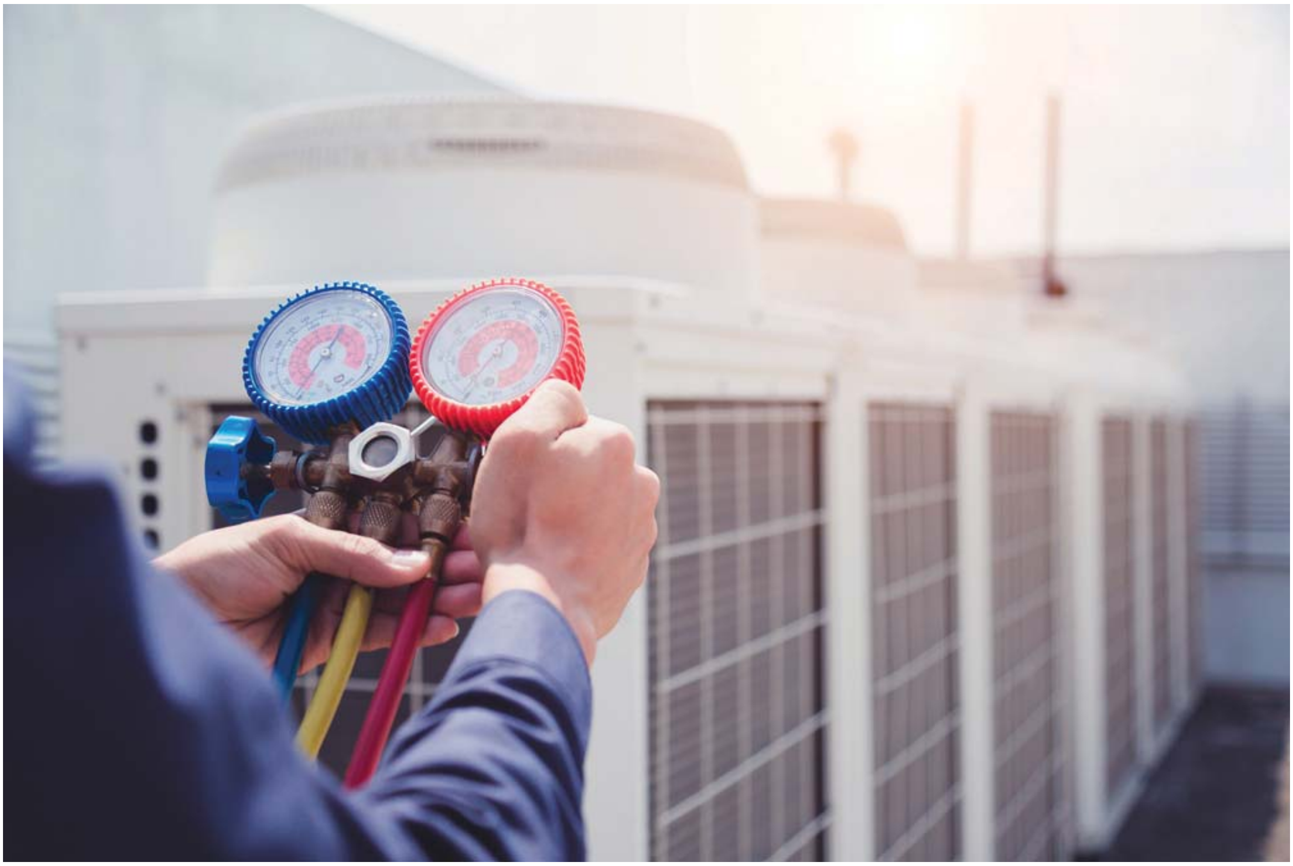
India is expected to have the highest cooling demand by 2050. The next 20 years will also see a massive increase in the building stock. **Atul Bagai**, in conversation with **TCA Avni** for *Energy Future*, talks about the major challenges that will need to be addressed through innovations such as passive cooling, renewable energy, and related new technologies.

Adequate cooling systems are essential for keeping living environments comfortable, medicines and vaccines stable, and food fresh, especially in india. However, the energy demand by this sector is enormous. Could you talk about what you see as the role renewable energy, passive cooling and related technologies can play?

I would like to start this by highlighting one very stark fact – the cooling needs in India in the coming decades, according to the IEA, are going to be so huge that India is expected to have the highest cooling demand by 2050 and rank even above China. This is going to be a huge challenge considering the levels that are present at this stage. This will be additionally exacerbated by the fact that the next 20 years will see a similarly massive increase in the building stock, as it is expected that over the next 10–20 years, the floor area of our building stock will at least double. So I think these are going to be the big challenges that will need to be addressed through innovations like passive cooling, renewable energy, and related new technologies. An important area where passive cooling can play a big role is through the stricter implementation of the ECBC (Energy Conservation Building Code). In fact, we can have a big focus on these new technologies and new approaches, since according to the India Cooling Action Plan (ICAP), just focusing on building envelopes in India can achieve almost 20% reduction in cooling demand compared to business-as-usual scenarios. If we are looking at the cooling demand and how we can address that in a way that the pressure on electricity demand does not go up, one will also have to look at the rural sector. It is not enough to just focus on the urban sector and the increasing air conditioning demand. The cold chain is also going to dramatically increase in the next 20 years, and effective and sustainable refrigeration and cooling technologies for the cold chains are going to be very critical, not only for the vaccines and medicines, but also for food security. So new technologies, new approaches, and even new refrigerants, which are more environmentally sustainable, will need to be brought in to address this increasing demand.

Could you talk a little about the recently launched Cool Coalition?

Well, considering that it is not only in India, but also the whole developing world where cooling demands are going to increase, there is a huge need for bringing in energy efficient technologies. It is a battle that needs



to be fought on two fronts – one is how to meet the increasing cooling demand through new technologies that are sustainable and the other is how this increase that is going to come can be made more energy efficient. To bring governments, businesses, and civil society together to come up with effective solutions, a Cool Coalition has been launched by UNEP. We are looking at promoting and making businesses aware of the best practices that can be adopted in this regard. One of the best practices which is right now being discussed there is the National Cooling Action Plan (NCAP, also known as the India Cooling Action Plan), which the Government of India has brought out. India was the first country in the world to come up with a very strategic national action plan on cooling. This is an approach which not only strategizes on how you are approaching the cooling demand of the next 20–30 years, but also focuses on finding solutions that are very energy efficient. This best practice is something through which India can show its leadership by disseminating that to other developing countries. Through the Cool Coalition we will be able to disseminate these best practices.

The India Cooling Action Plan has set targets to reduce cooling and refrigerant demand by 20% to 25% and cooling energy requirements by 25% to 40% by 2037–38. Could you talk about which strategies you think would be most suitable to help achieve this?

This is an issue that should be addressed at various levels. Policy certainly is one level where this problem will need to be addressed through adequate measures. For example, strengthening the ECBC and its implementation would be one level of intervention that would be needed. The second approach of implementing the ICAP will be to bring in a technological revolution in terms of bringing innovations and technologies which not only are indigenous but also cater to the demands of climatic variations in a country like India. Nature-based solutions are another very big approach that need to be strengthened in the coming years in terms of how they can be found and applied for cooling, especially through urban forestry initiatives whereby creating corridors through urban areas can reduce the demand. Finally, I think there needs to be a big push for behavioral change. This will be a very key factor in seeing that we will be able to not only address the growing demands in a way that we are able to meet the demands, but also limit our excessive energy use in the area of cooling. I will give you a small example. In households, offices, or other complexes, setting up of cooling temperatures at 16°C or 17°C is certainly not advisable. If through behavioral change, people can get adapted to 24–25°C, that is the kind of policy and approach one will need. In fact, we expect the air conditioning manufacturing industries to put 24°C as a default temperature, instead of 16°C and 17°C, and that change is going to bring in huge benefits.

Are there any low hanging fruits in technology or policy which you feel would, in the longer run, help us achieve our targets more easily?
If you are looking at India, one of the low hanging fruits is that we are one of the only countries in the world that has experimented with the most environmentally friendly technology for air conditioning. Godrej's manufacturing of R290 air conditioners is actually one of the most sustainable air conditioning systems you can adopt and they have successfully brought into market almost 1.5 million such air conditioners. There are issues of safety that are often cited in the use of R290, but I think a low hanging fruit is the experience that Godrej now has with manufacturing and maintaining 1.5 million such air conditioners. Another low hanging fruit is the wide base of manufacturing that we have in India of air conditioning. If that base can adopt such new technologies (which would not be very difficult because of the good example set by Godrej), India could be on the way of bringing in sustainable air conditioning systems. And a third low hanging fruit from a technology and design point of view is the very strong culture of the teams of architects which we have in this country, who can easily adapt the building design capabilities to designing more effective buildings that need less cooling. The whole system of traditional knowledge that is available, which has been used for the past hundreds of years, is another low hanging fruit that can be just taken over by architects and designers who are building the new stock of buildings.

What has been the UNEP's experience of the District Energy in Cities Initiative in India?
Yes, that is one of our global initiatives that has been working with India as a pilot country since 2016, and our experience has been very good. At least five cities are at various stages of procuring such systems. Rajkot and Thane are the leaders in this regard, and we are hoping that in the next couple of years, they would be able to bring in regular district energy systems into play. GIFT city near Ahmedabad is already functioning on one such system and we are also seeing real estate developers and companies such as Hiranandani, DLF, MyHome, and Infosys taking this technology seriously. While there are big challenges in terms of cost of power these DC systems have to pay and the upfront CAPEX costs, the life cycle analysis which can be done of such systems shows that it delivers long-term financial savings and is a very viable investment opportunity. If those challenges can be met at the initial stages in terms of investments, district energy systems would be a very viable alternative to the centralized chiller systems which are operating in both

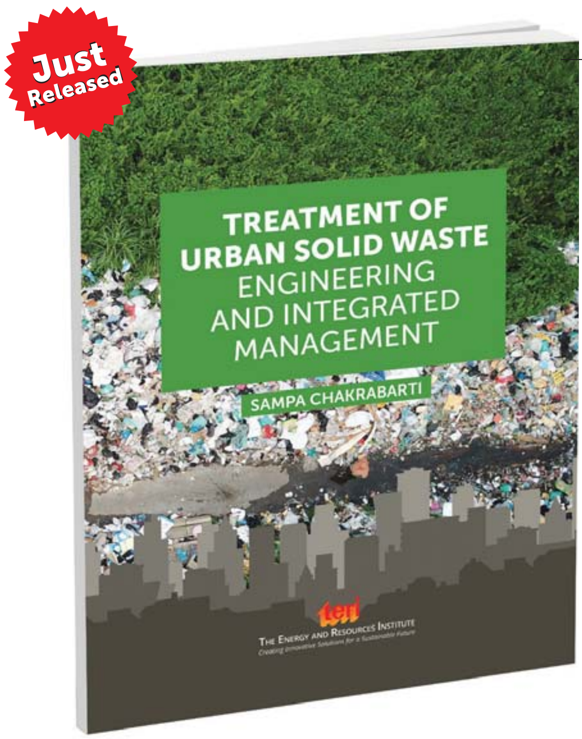
this country and the world right now and deliver significant environmental benefits, including reduced power use and significantly lower refrigerant emissions.

In terms of the plans which are being derived for the cities at present, would they be integrated across other national, state, or regional policies, or are they better done by each region approaching them individually?
Well, I won't say that they can be approached individually, but it is certainly a decentralized system and has specific concerns relating to the geography of the place where you are employing them. However, at this stage what is happening is that we are piloting them in small pockets. For example, what happened in the large European systems was that small neighbourhoods or business districts developed district cooling and then it slowly expanded and caught on. The whole approach is at a nascent stage in India, and small pilots would provide good experience for the coming years on how it can become more viable in a vast country like ours.

What do you see as the role of broader global community in supporting developing countries with financial support and technology transfer to bolster existing programmes and start new initiatives?
In the air conditioning and refrigeration field, we have the Montreal Protocol as an international convention bringing the developed and developing countries together. It has been one of the most successful environmental agreements because it has brought more resources on the table, whereby developed countries put resources to provide technology transfer and technical assistance to developing countries. I think it is a very good model that has proven to be very successful and that needs to be strengthened further. One of the steps to strengthen it further is through the ratification of the Kigali Amendment that addresses issues relating to HFCs. We are hoping that India ratifies the Kigali Amendment soon because India can assume a leadership role for developing countries in this regard. I think with the new approaches that are going to come under this amendment, the refrigeration and air conditioning industry will certainly be able to move forward to a more sustainable path. One understands that over the last 30 years this industry has faced a lot of problems in switching over from one refrigerant to another, and the global community has brought force to switch over two or three times, which has not been a very healthy thing, but as science progresses and knowledge progresses, these kinds of changes become inevitable. We are reaching a stage where natural refrigerants or what are being called HFOs with low global warming potential could be the final step in this industry in terms of making it more sustainable. EF

Atul Bagai, Head of Country Office, United Nations Environment Programme

CHALLENGES AND SOLUTIONS OF URBAN SOLID WASTE MANAGEMENT



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Lowered Total Solidification Time and Increased Discharge Rate of Reduced Graphene Oxide-Solar Salt Composites: Potential for Deployment in Latent Heat Thermal Energy Storage System

Solar Energy, Volume 204, 1 July 2020, Pages 466–475

M. K. Saranprabhu, D. Chandini, P. Bharathidasan, S. Devaraj, and K. S. Rajan

The present work explores the use of reduced graphene oxide (rGO) nanostructures as an additive to solar salt to improve its thermophysical properties. Reduced graphene oxide nanostructures at weight fractions of 0.125 wt% and 0.5 wt% were added to the solar salt, leading to rGO-solar salt composites. The time required for complete solidification of 0.125 wt% and 0.5 wt% was reduced by 43% and 49%. In the discharge cycle, the heat transfer rate was amplified by 90% and 138%, respectively, for 0.125 wt% and 0.5 wt% rGO-solar salt nanocomposites, attributable to thermal conductivity enhancement, specific heat augmentation, and heterogeneous nucleation. Thus, rGO-solar salt composites are suitable for use as latent heat thermal energy storage medium in solar thermal applications. EF

Experimental Investigation of Heat Transfer and Fluid Flow Behavior of Packed Bed Solar Thermal Energy Storage System Having Spheres as Packing Element with Pores

Solar Energy, Volume 204, 1 July 2020, Pages 530–541

Abhishek Gautam and R. P. Saini

In this paper, an experimental study has been conducted to investigate the heat transfer and fluid flow characteristics of packed bed solar thermal energy storage system. The outcomes of the experimental investigation are carried out using large size spherical shaped packing element having pores of various diameters and depths on their surface in packed bed solar thermal energy storage system for low temperature applications. The experimentations are performed for different values of sphere diameter to pore diameter ratio (D/d) from 5 to 15, sphere diameter to pore depth ratio (D/t) from 5 to 20, and Reynolds number from 200 to 800. For the range of parameters investigated, the maximum value of thermo-hydraulic parameter has been obtained as 0.241 corresponding to D/d of 5, D/t of 15 and Reynolds number of 800. Based on experimental results, it is found that using spheres having pores on the surface as packing elements improves the thermal performance and momentum transport in packed bed solar thermal energy storage system. EF

Energy Consumption Behavior: A Data-Based Analysis of Urban Indian Households

Energy Policy, Volume 143, August 2020, 111571
Sapan Thapar

Counted among the top three energy consuming nations globally, India is working towards reducing its carbon emissions. Energy efficiency interventions offer a low-cost opportunity to achieve its climate goals. Though the Indian government has rolled out several energy efficiency schemes, the rate of decrease in energy intensity is lower than expectations. One of the desirable areas for intervention is influencing energy usage in households, which consume a quarter of the total energy generated in India. The study analyses energy usage behaviour in households using a mix of primary and secondary techniques. Key findings include seasonal consumption trends correlating with climatic parameters, use of inefficient equipment, and rebound effect. Policy prescriptions include peak load clipping techniques like weatherization of homes, display of real-time consumption, rationalization of tariffs, and expanded criteria for selecting equipment under 'Star Rating Scheme'. The findings may be considered to improve energy policies towards influencing consumer behaviour in India. EF

Performance Enhancement Strategies of a Hybrid Solar Chimney Power Plant Integrated with Photovoltaic Panel

Energy Conversion and Management, Volume 218, 15 August 2020, 113020
Ajeet Pratap Singh, Amit Kumar, Akshayveer, and O. P. Singh

This paper examines the possibility of integrating a photovoltaic (PV) module in a hybrid solar chimney power plant (HSCPP). Since HSCPP is a greenhouse thermal buoyancy-driven system, the surrounding high temperature environment makes PV module temperature extremely high, resulting in lower electrical conversion efficiency. Various design configurations of collector duct and solar chimney are investigated using an experimentally validated numerical model to study the PV panel cooling and turbine power output. The results show that turbine power output is sensitive to diverging the chimney up to the maximum static pressure recovery limit, while PV module shows marginal increase in electrical efficiency. EF

The National Policy of Biofuels of India – A perspective

Energy Policy, Volume 143, August 2020, 111595
Sudip Das

The National Policy on Biofuels (NPB) was adopted in India to augment the generation of biofuels and build a sustainable biofuel ecosystem. The Biodiesel Blending Programme (BBP) got affected due to lack of sufficient feedstock coupled with an 18% Goods and Services Tax (GST). The high GST resulted in the price of biodiesel being higher than that of the conventional diesel, thereby hindering the blending mandates. Most states in India do not allow free interstate movement of molasses, resulting in artificially depressed prices besides derailing the Ethanol Blending Petrol (EBP) programme. NPB prohibits the import and export of biofuels to other nations resulting in reduced economic efficiency. The use of foodgrains as feedstock for biofuel production hampers food availability to the needy people and adversely affects food prices. The paper touches upon the key biofuel policies of various nations, features of NPB and its critical analysis, BBP and EBP programmes, and their current challenges and suggests future reforms. EF

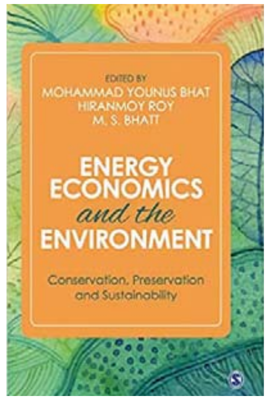
Estimating Capital Cost of Parabolic Trough Collector Based Concentrating Solar Power Plants for Financial Appraisal: Approaches and a Case Study for India

Renewable Energy, Volume 156, August 2020, Pages 1117–1131
Tarun Kumar Aseri, Chandan Sharma, and Tara C. Kandpal

An attempt has been made to estimate the unit capital cost of parabolic trough collector (PTC) based concentrating solar power (CSP) plants in India to facilitate their financial appraisal. While reviewing approaches mentioned in the literature, a significant variation is observed in unit capital cost estimates for a 50 MW wet cooled without storage PTC based plant (US $1700 to US $2662 per kW). To internalize the effect of alternate condenser cooling options and thermal energy storage on the unit capital cost, a new approach that is based on inventory of material used and associated costs has been suggested. With the use of this approach, the unit capital cost of a 50 MW wet cooled PTC plant is estimated at US $1734 per kW. Similarly, for the same nominal capacity plant with dry cooling, the unit capital cost is estimated at US $1994 per kW. Moreover, the effects of increased nominal capacity and hours of thermal energy storage on the unit capital cost have also been investigated. EF

Energy Economics and the Environment: Conservation, Preservation and Sustainability

Energy is a basic prerequisite for the growth and development of national wealth. Based on primary research, *Energy Economics and the Environment* integrates a network of diverse disciplines to provide a theoretical and practical understanding of the constantly neglected challenges associated with conservation, preservation, and sustainability of environment and energy. It highlights the issues and prospects in safeguarding environmental biodiversity and renewable energy efficiency, ecosystem chains, and human living standards. This book studies the vulnerability associated with global climate alterations that limits direct social and economic benefits from ecosystem goods and services and presents significant methods through illustrative case studies to tackle energy and environmental questions. In its final analysis, the book proposes possible unconventional mitigation strategies to restore sustainable biodiversity of ecosystems.

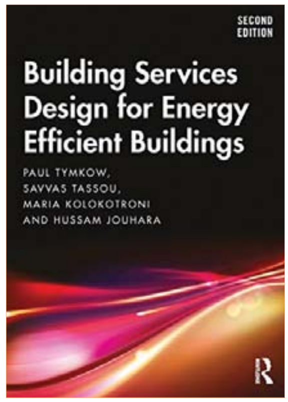


Editors: Mohammad Yonus Bhat, Hiranmoy Roy, and M. S. Bhatt
Publisher: SAGE Publications Pvt. Ltd
Year: 2020

Building Services Design for Energy Efficient Buildings

This book provides a contemporary understanding of the challenge to address climate change, together with practical approaches to energy efficiency and carbon mitigation for mechanical and electrical systems, in a concise manner. The essential conceptual design issues for planning the principal building services systems that influence energy efficiency are examined in detail. These are HVAC and electrical systems. In addition, the following issues are addressed:

- Background issues on climate change, whole-life performance, and design collaboration
- Generic strategies for energy efficient, low-carbon design
- Health and well-being and post-occupancy evaluation
- Building ventilation
- Air conditioning and HVAC system selection
- Thermal energy generation and distribution systems
- Low-energy approaches for thermal control
- Electrical systems, data collection, controls, and monitoring
- Building thermal load assessment
- Building electric power load assessment
- Space planning and design integration with other disciplines

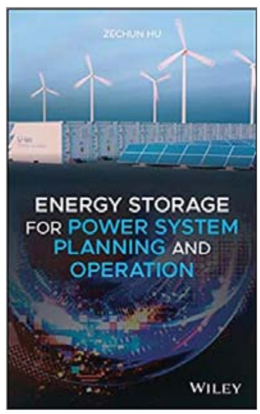


Authors: Paul Tymkow, Savvas Tassou, Maria Kolokotroni, and Hussam Jouhara
Publisher: Routledge
Year: 2020 (2nd edition)

Energy Storage for Power System Planning and Operation

To reduce the dependence on fossil energy, renewable energy generation, represented by wind power and photovoltaic power generation, is a growing field worldwide. This book offers an authoritative introduction to the rapidly evolving field of energy storage systems. Written by a noted expert on the topic, the book outlines a valuable framework for understanding the existing and most recent advances in technologies for integrating energy storage applications with power systems. The author explores the various techniques that can be employed for energy storage that is compatible with renewable energy generation. The salient features of the book are as follows:

- Provides an introduction to the systematically different energy storage techniques with deployment potential in power systems
- Models various energy storage systems for mathematical formulation and simulations
- Contains a review of the techniques for integrating and operating energy storage with renewable energy generation
- Analyses how to optimize power systems with energy storage at both transmission and distribution system levels
- Shows how to optimize planning, siting, and sizing of energy storage for a range of purposes

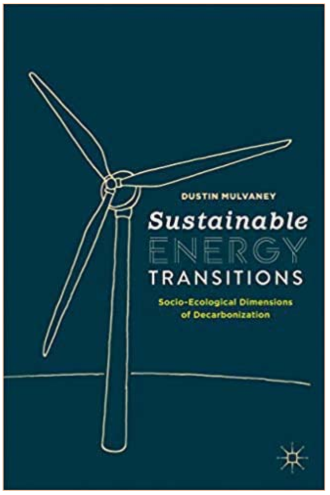


Author: Zechun Hu
Publisher: Wiley
Year: 2020

Sustainable Energy Transitions: Socio-Ecological Dimensions of Decarbonization

This textbook introduces the key concepts that underpin sustainable energy transitions. Starting with the basic biophysical principles, current sources, and environmental consequences of existing energy resource use, the book takes readers through the key questions and topics needed to understand, prescribe, and advocate just and sustainable energy solutions.

The interdisciplinary nature of the book aims to build bridges across the social and natural sciences and humanities, bringing together perspectives, ideas, and concepts from engineering, economics and life cycle assessment to sociology, political science, anthropology, policy studies, the humanities, arts, and some interdisciplinary thinkers that defy categories. This accessible approach fills the gap for a textbook that integrates sustainability science and engineering studies with strong empirical social science and it will be a useful tool to anyone interested in the socio-ecological dimensions of energy system transitions. EF



Author: Dustin Mulvaney
Publisher: Palgrave Macmillan
Year: 2020

SDG7 – Ensure Access to Affordable, Reliable, Sustainable, and Modern Energy (Concise Guides to the United Nations Sustainable Development Goals)

SDG7 aims to 'ensure access to affordable, reliable, sustainable, and modern energy for all'. Meeting the demands of the 2030 agenda will be a unique challenge. National priorities and policy action need to be strengthened in order to fulfil the ambitious energy targets that SDG7 envisions. This book examines SDG7 and its implications for how energy operates as a driver of change for jobs, security, climate change, food production, and increasing incomes. It provides a succinct overview of how SDG7 visualizes a world in which energy is universally accessible, increasingly efficient, and renewable in order to create sustainable, inclusive, and resilient communities. The key challenges such as public and private investment, regulatory frameworks, and evolving business models are also considered so that a path forward towards the achievement of the goal and the transformation of global energy systems might become clear. EF

Authors: Godwell Nhamo, Charles Nhemachena, Senia Nhamo, Vuyo Mjimba, and Ivana Savić
Publisher: Emerald Publishing Limited
Year: 2020

RENEWABLE ENERGY TECHNOLOGY DEVELOPMENT

Researchers develop computational model to build better capacitors

Researchers have developed a computational model that helps users understand how changes in the nanostructure of materials affect their conductivity – with the goal of informing the development of new energy storage devices for a wide range of electronics.

Specifically, the researchers were focused on the materials used to make capacitors – which are energy storage devices used in everything from smartphones to satellites. The material that a capacitor is made of affects its performance. So the researchers set about developing a model to understand how structural characteristics in a material affect the material's conductivity. This model looks at multiple spatial scales simultaneously, capturing everything that is happening from the device-level scale to the nanoscale. The model looks at things like defects and grain boundaries. Defects are things like missing atoms in a material's structure, or where the 'wrong' atoms are found in the structure. Grain boundaries are where different crystalline structures run into each other. This model looks at how things such as defects and grain boundaries affect the presence

and movement of electrons through a material. Because different ways of processing a material can control the presence and distribution of things like defects and grain boundaries, the model gives insights that can be used to engineer materials to meet the demands of specific applications.

https://phys.org/news/2020-07-capacitors.html

New solar forecasting model performs best

A new mathematical model for predicting variations in solar irradiance has been developed at Uppsala University. It may help to promote more efficient use of electricity from solar energy.

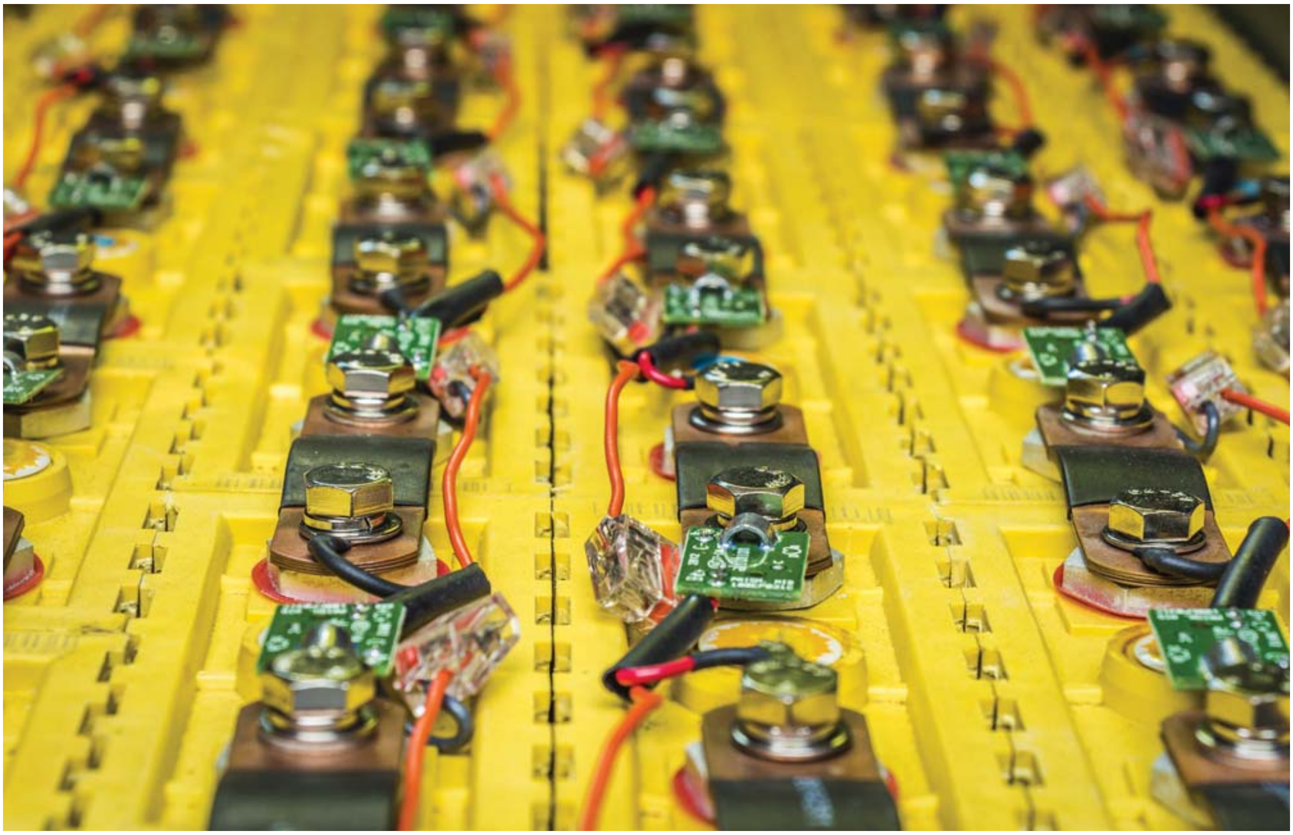
As clouds pass overhead, solar power generation from a photovoltaic system fluctuates from one minute to the next. Local producers of their own solar energy wishing to adjust their electricity use according to supply may need to know in detail how the amount of sunlight is changing. Forecasts of solar irradiance may be a way of achieving greater control of solar power production. According to the researchers, the MCM (Markov chain mixture) model serves to predict what will happen in the next minute, hour, or day, based on what usually follows a particular solar irradiance level. This model has a simple design, is easy to train and use, and provides surprisingly accurate solar irradiance forecasts. The MCM distribution model divides solar irradiance into levels and calculates the probabilities of sunlight in the next and the subsequent time periods being at the various levels. On this basis, it is possible to forecast when, and between which levels, sunlight will vary and to compare the forecasts with actual observations to see how well the former match reality.

The model has now been tested by both scientists who have worked on it previously and other researchers. This has included test runs to compare the model with several other models. In one study, in which the model and five established benchmark models (used for comparison to evaluate the relative performance of new models) were tested, the new MCM model yielded the most reliable forecasts, especially for the near future.

https://www.sciencedaily.com/releases/2020/06/200629120239.htm

Next-generation battery storage delivers affordable, clean energy to communities in Sierra Leone

Researchers are delivering affordable, clean energy to remote communities in Sierra Leone as part of a pioneering new project. Researchers have already developed pay-per-charge smart battery packs to address the lack of grid electricity in the country. The pay-as-you-go smart battery rental system supplies affordable, clean energy to poor households and enterprises in off-grid communities. The batteries are charged at solar charging stations before being delivered to customers, thereby removing the need for dangerous traditional petrol generators and reducing energy costs by up to 75%. These new battery packs can be swapped in or out of the micro-grid without shutting down the power system and are designed to maximize the life of the battery cells under different applications. They can one day be providing power to a whole village and the next day be swapped out to drive the motor of an electric KeKes (autorickshaw). For households where the cost of connection to the mini-grid is prohibitively high, these packs are easily



carried to the home and are capable of powering multiple devices for long durations.

https://techxplore.com/news/2020-07-next-generation-battery-storage-energy-sierra.html

Shrimp shells to produce electrodes for large storage batteries

A project by Spanish researchers and other collaborators at the Massachusetts Institute of Technology (MIT) suggests the use of chitin from shrimp shells to produce electrodes for vanadium flow batteries. Chitin is a polysaccharide, similar to cellulose, which is found in the exoskeleton of crustaceans and insects. They propose to produce these vanadium flow battery electrodes from chitin, a material from shrimp shells, which, in addition to carbon, contains nitrogen which is incorporated into the structure of the electrode during the production process, improving its performance. Vanadium redox flow batteries, unlike lithium batteries used in the automotive industry, do not provide high energy density, but do provide a large volume of energy storage at low cost, which makes them ideal for storing energy from renewable sources such as solar and wind power, whose energy production is intermittent. The team has proven the benefits of nitrogen in the chemical structure of the electrode, where it facilitates the transfer of electrons between the vanadium ions. These electrodes from shrimp waste could also be applied in supercapacitors, electrochemical devices that provide a very high energy density, and even in desalination processes.

https://phys.org/news/2020-07-shrimp-shells-electrodes-large-storage.html

AI could help improve performance of lithium-ion batteries and fuel cells

A new machine learning algorithm allows researchers to explore possible designs for the microstructure of fuel cells and lithium-ion batteries, before running 3D simulations that help researchers make changes to improve performance. Improvements could include making smartphones charge faster, increasing the time between charges for electric vehicles, and increasing the power of hydrogen fuel cells running data centres. The researchers used a novel machine learning technique called 'deep convolutional generative adversarial networks' (DC-GANs). These algorithms can learn to generate 3D image data of the microstructure based on training data obtained from nanoscale imaging performed synchrotrons. This technique is helping them zoom right in on batteries and cells to see which properties affect overall performance. Developing image-based machine learning technique like this could unlock new ways of analysing images at this scale.

When running 3D simulations to predict cell performance, researchers need a large enough volume of

data to be considered statistically representative of the whole cell. It is currently difficult to obtain large volumes of microstructural image data at the required resolution. However, the authors found they could train their code to generate either much larger data sets that have all the same properties or deliberately generate structures that models suggest would result in better performing batteries.

By constraining their algorithm to produce only results that are currently feasible to manufacture, the researchers hope to apply their technique to manufacturing to design optimized electrodes for next-generation cells.

https://www.sciencedaily.com/releases/2020/06/200625080942.htm

New battery electrolyte may boost the performance of electric vehicles

A team of researchers have demonstrated how their novel electrolyte design boosts the performance of lithium metal batteries, a promising technology for powering electric vehicles, laptops, and other devices. Lithium-ion batteries, used in everything from smartphones to electric cars, have two electrodes – a positively charged cathode containing lithium and a negatively charged anode usually made of graphite. An electrolyte solution allows lithium ions to shuttle back and forth between the anode and the cathode when the battery is used and when it recharges.

A lithium metal battery can hold about twice as much electricity per kilogram as today's conventional lithium-ion battery. Lithium metal batteries do this by replacing the graphite anode with lithium metal, which can store significantly more energy.

The team tested the new electrolyte in a lithium metal battery. The results showed that the experimental battery retained 90% of its initial charge after 420 cycles of charging and discharging. In laboratories, typical lithium metal batteries stop working after about 30 cycles. The researchers also measured how efficiently lithium ions are transferred between the anode and the cathode during charging and discharging, a property known as 'coulombic efficiency'. They also tested the FDMB electrolyte in anode-free lithium metal pouch cells – commercially available batteries with cathodes that supply lithium to the anode.

The U.S. Department of Energy (DOE) is funding a large research consortium called Battery500 to make lithium metal batteries viable, which would allow car manufacturers to build lighter electric vehicles that can drive much longer distances between charges. By improving anodes, electrolytes, and other components, Battery500 aims to nearly triple the amount of electricity that a lithium metal battery can deliver, from about 180 watt-hours per kilogram when the programme started in 2016 to 500 watt-hours per kilogram. A higher energy-to-weight ratio, or 'specific energy', is key to solving the range anxiety that potential electric car buyers often have. EF

https://www.sciencedaily.com/releases/2020/06/200622133016.htm

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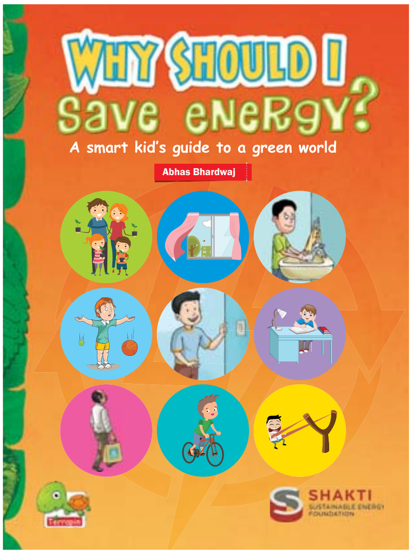

WHY SHOULD I Save eNeRgY?

A smart kid's guide to a green world

Abhas Bhardwaj

• 2020 • 210 x 280 mm • 56 pages
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• Genre: Pictorial-Reference • Price: ₹250.00

Ages: 12+ years

Did you know that energy consumption by humans has increased by at least 30,000 times in the last 5000 years? In Delhi alone, there are over 80,000 trucks that run on the city roads every night. They emit un-burnt fossil fuels from their exhausts. Isn't it terrifying that over 1 million seabirds and 100,000 sea mammals are killed by pollution every year?

Why Should I Save Energy? is a comprehensive book that will introduce children to different forms of energy, history of fossil fuels, great scientists and their inventions, and more importantly, to the problems our planet faces with depletion of natural resources. Filled with eye-opening facts, beautiful pictures, multiple activities, and a quiz that helps reinforce learning; this book is the perfect guide to help you become an energy saver.

Table of Contents

About the Author

Abhas Bhardwaj has studied botany and economics. Currently, he works as a market researcher. He has an avid interest in the environment and likes to share his enthusiasm with young minds. In his inimitable style, he likes to approach serious questions with humour.

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IEEE International Conference on Smart Technologies for Power Energy and Control (STPEC 2020)
September 25–26, 2020
Visvesvaraya National Institute of Technology, Nagpur
Website: http://vnit.ac.in/stpec2020/

2020 IEEE International Power and Renewable Energy Conference
October 30–November 1, 2020
Kollam, Kerala
Website: https://iprecon2020.org/

Renewable Energy India Expo
December 10–12, 2020
Greater Noida
Website: https://renewableenergyindiaexpo.com/

Global RE-Invest
October 14–17, 2020
New Delhi
Website: https://re-invest.in/

International Conference on Recent Trends in Developments of Thermo-fluids and Renewable Energy (TFRE-2020)
September 28–30, 2020
National Institute of Technology, Naharlagun, India
Website: https://www.iitg.ac.in/ceer/tfre2020/

INTERNATIONAL

International Solar Energy Expo & Conference
September 2–4, 2020
Kintex, Goyang-si, South Korea
Website: https://www.exposolar.org/2020/eng/about/sub02.asp

2020 3rd International Joint Conference on Clean Energy and Smart Grid
September 13–15, 2020
Prague, Czech Republic
Website: http://www.ccesg.org/

NEIS 2020 - Conference on Sustainable Energy Supply and Energy Storage Systems
September 14–15, 2020
Hamburg, Germany
Website: https://neis-conference.com/

The Solar Future Nordics
September 23, 2020
Stockholm, Sweden
Website: https://nordics.thesolarfuture.com/

2020 6th International Conference on Environment and Renewable Energy (ICERE 2020)
September 28–30, 2020
Hanoi, Vietnam
Website: http://www.icere.org/

RENEWABLE ENERGY AT A GLANCE

Ministry of New & Renewable Energy			
Programme/Scheme wise Physical Progress in 2020-21 & Cumulative up to June, 2020			
Sector	**FY- 2020-21**		**Cumulative Achievements**
	Target	**Achievements (April-June 2020)**	**(as on 30.6.2020)**
I. GRID-INTERACTIVE POWER (CAPACITIES IN MWp)			
Wind Power	3000.00	85.80	37829.55
Solar Power - Ground Mounted	9000.00	192.66	32305.15
Solar Power - Rooftop	2000.00	301.85	2817.15
Small Hydro Power	100.00	5.00	4688.16
Biomass (Bagasse) Cogeneration	200.00	0.00	9200.50
Biomass (non-bagasse) Cogeneration/Captive Power	50.00	5.00	679.81
Waste to Power	30.00	1.20	148.84
Total	**14380.00**	**591.51**	**87669.16**
II. OFF-GRID/CAPTIVE POWER (CAPACITIES IN MW_{EQ})			
Waste to Energy	10.00	2.41	200.51
SPV Systems	500.00	2.45	980.84
Total	**510.00**	4.86	**1181.45**
III. OTHER RENEWABLE TECHNOLOGIES(Capacity in Nos.)			
Biogas Plants (in Lakhs)	0.60	0.27	50.50

Source: www.mnre.gov.in

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Inside Back Cover	75,000	191,250	360,000	675,000
Inside Front cover	75,000	191,250	360,000	675,000
Inside Full Page	50,000	127,500	240,000	450,000
Inside Half page	30,000	76500	144,000	270,000

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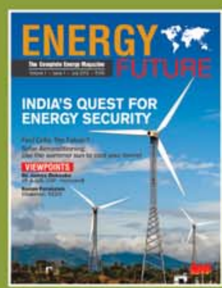

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- Matte paper
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