

Chief Editor

Dr. A. Singaraj, M.A., M.Phil., Ph.D.

Editor

Mrs.M.Josephin Immaculate Ruba

EDITORIAL ADVISORS

1. Prof. Dr.Said I.Shalaby, MD,Ph.D.
Professor & Vice President
Tropical Medicine,
Hepatology & Gastroenterology, NRC,
Academy of Scientific Research and Technology,
Cairo, Egypt.
2. Dr. Mussie T. Tessema,
Associate Professor,
Department of Business Administration,
Winona State University, MN,
United States of America,
3. Dr. Mengsteab Tesfayohannes,
Associate Professor,
Department of Management,
Sigmund Weis School of Business,
Susquehanna University,
Selinsgrove, PENN,
United States of America,
4. Dr. Ahmed Sebihi
Associate Professor
Islamic Culture and Social Sciences (ICSS),
Department of General Education (DGE),
Gulf Medical University (GMU),
UAE.
5. Dr. Anne Maduka,
Assistant Professor,
Department of Economics,
Anambra State University,
Igbariam Campus,
Nigeria.
6. Dr. D.K. Awasthi, M.Sc., Ph.D.
Associate Professor
Department of Chemistry,
Sri J.N.P.G. College,
Charbagh, Lucknow,
Uttar Pradesh. India
7. Dr. Tirtharaj Bhoi, M.A, Ph.D,
Assistant Professor,
School of Social Science,
University of Jammu,
Jammu, Jammu & Kashmir, India.
8. Dr. Pradeep Kumar Choudhury,
Assistant Professor,
Institute for Studies in Industrial Development,
An ICSSR Research Institute,
New Delhi- 110070, India.
9. Dr. Gyanendra Awasthi, M.Sc., Ph.D., NET
Associate Professor & HOD
Department of Biochemistry,
Dolphin (PG) Institute of Biomedical & Natural
Sciences,
Dehradun, Uttarakhand, India.
10. Dr. C. Satapathy,
Director,
Amity Humanity Foundation,
Amity Business School, Bhubaneswar,
Orissa, India.



ISSN (Online): 2455-7838

SJIF Impact Factor (2017): 5.705

EPRA International Journal of

Research & Development (IJRD)

Monthly Peer Reviewed & Indexed
International Online Journal

Volume: 3, Issue:10, October 2018



Published By :
EPRA Journals

CC License





ANALYSIS OF RENEWABLE ENERGY IMPACT IN INDIA, 2011-15

Akshay Krishnan

Research Associate, International Centre for Technological Innovations, Kerala, India

ABSTRACT

Renewable energy is one of the major sources of energy right now. Therefore, it is not surprising that its implications on other sectors are far-reaching. We study the effect of renewable energy in a few particular areas in the period 2011-2015. We cover electricity access, pollution, health & healthcare sector and finally economy. Lack of renewable energy sources for electricity production not only caused pollution, but also reduced the utilization level of electricity. Renewable energy also has the potential to provide for a reliable source of energy in the healthcare industry by providing for a constant and safe electricity access model, along with reduced cost of service. Apart from this, need for more investment in the renewable energy sector is realized in order to bring about possible changes in the economy such increase in high technology exports, reduction in energy imports etc. For a boost in this sector, active participation is required at the local, national and international level. People need to understand the importance of usage of renewable energy technology. Government needs to reform policies and release mandates to boost renewable energy production in the country. Finally, there are various international organizations that presently support projects in this field. More platforms are needed to spread awareness for individuals and agencies interested in pursuing such projects, who seek this support.

KEYWORDS: *Renewable Energy, Electrification, Solar*

1. INTRODUCTION

Renewable energy (excluding hydro) accounts for over 8 percent of global electricity generation. But more importantly, they contributed to over 50 percent growth in power generation in 2017 (bp.com, 2018). Thus, renewable energy is not only a supplementary, but rather a major source of energy. They provide better living conditions to millions and are also a major sector for employment generation. An estimated 24.4 million jobs would be created worldwide by 2030 in the renewable energy industry (I.R.E.N.A, 2016). Another major reason to adopt renewable energy is its environmental impact. While all sources of energy have some impact on the environment, renewable energy has a significantly lower impact than any other.

Seeing the advantages that renewable energy poses, it is high time to identify the effects that lack of renewable energy causes and the possible measures that can be taken in order to tackle this issue at a global scale. Trends are studied during

the five-year period of 2011 to 2015. Various factors such as electricity access, health and healthcare, pollution and economy are considered to provide a suitable solution.

2. RESEARCH METHODOLOGY

The research is based on a study conducted at the International Center for Technological Innovations (ICTI). World Bank indicators are the main source of data used for this study. Multiple factors are assessed ranging from electricity access to healthcare. Based on the results, recommendations are provided which can be implemented on a basic household level as well as national and international levels.

3. RESULTS AND DISCUSSIONS

3.1. Electricity Access

Of the total energy consumption, approximately 40 percent is used to produce electricity which makes it the most important part of a person's environmental footprint (US EPA, 2018). Despite this fact, electricity is not abundantly available in most areas. According to (World Bank, 2018), 88 percent of Indian population had electricity access in 2015. This is a significant growth from 67.6 percent in 2011. Urban electricity access reached an all-time high of 97.5 percent in 2015 whereas the rural electricity access also showed a bump of over 49 percent during the five year period to reach 83.2 percent (World Bank, 2018). Another point to be noted is that over 879 million people live in rural areas by 2015 (World Bank, 2018). Estimated population of India during this period was approximately 1.282 billion. Thus, nearly 70 percent of Indian population is rural. This means significant electrification projects are being executed in India. The credit for this growth goes to the 758,930 million, allocated under the *Deen Dayal Upadhyaya Gram Jyoti Yo- jana* (DDUGJY) taken up by the government in 2015 (Bhaskar, 2018) which is intended to provide electricity access to all villages in India.

It is interesting to note that out of total electricity production, only about 5 percent is from renewable energy sources (excluding hydro). But surprisingly, over 36 percent of the electricity consumption is from renewable energy sources (World Bank, 2018). We can see the changes in trend during the period 2011-15 from figure 1.

We can see that the utilization of electricity produced from renewable sources is much higher than regular electricity. Thus, implementation of renewable energy products and sources is a viable way to increase electricity access.

Now, electricity access has multiple aspects. Traditionally, rural electrification is all about connecting households to the electric grid (Barnes, 2007). But quality of electricity access is a major necessity in satisfaction of the consumer. In a survey conducted between November 2014 and May 2015 in six of the most populous states in India,

it was found that average electricity access is only about 12 hours a day (Aklin et al., 2016). Therefore, even though connecting households to the grid, or perhaps to off-grid systems, is a necessary first step toward domestic electricity access, but the benefits of rural electrification depend to a large extent on the quality of the service available (Ganesan et al., 2018).

3.2 Pollution

Efficient usage of electricity reduces both amount of fuel needed to generate electricity, as well as the amount of greenhouse gases and other pollutants emitted (US EPA, 2018). Providing universal access to electricity is considered conflicting with efforts to mitigate climate change. But it is to be noted that household electricity access has contributed to only 3-4 percent of national emission growth in the past three decades (Pachauri, 2014). Thus, various other factors contribute largely to pollution.

It can be seen from figure 2 that electricity production from oil sources and fossil fuels has been continuously declining. But there is still significant presence of such sources. Fossil fuel power plants burn carbon fuels such coal, oil or gas to generate steam that drives large turbines to produce electricity. However, by burning carbon fuels they produce large amounts carbon dioxide. They can also produce other pollutants, such as sulfurous oxides, which cause acid rain. Thus, it is of utmost importance to reduce the usage of fossil fuel and shift to alternative sources for electricity production (world-nuclear.org, 2018). A study conducted by World Health Organization (WHO) and International Energy Agency (IEA), and published by (Moore and Gould, 2018) shows that India is the 9th worst country in terms of pollution. Apart from the fact that electricity power plants produce pollution, most of them also require land clearing in order to establish the plants (EIA, 2018). All these factors together signify the need to move to an alternative source of electricity i.e. renewable energy, in order to mitigate pollution.

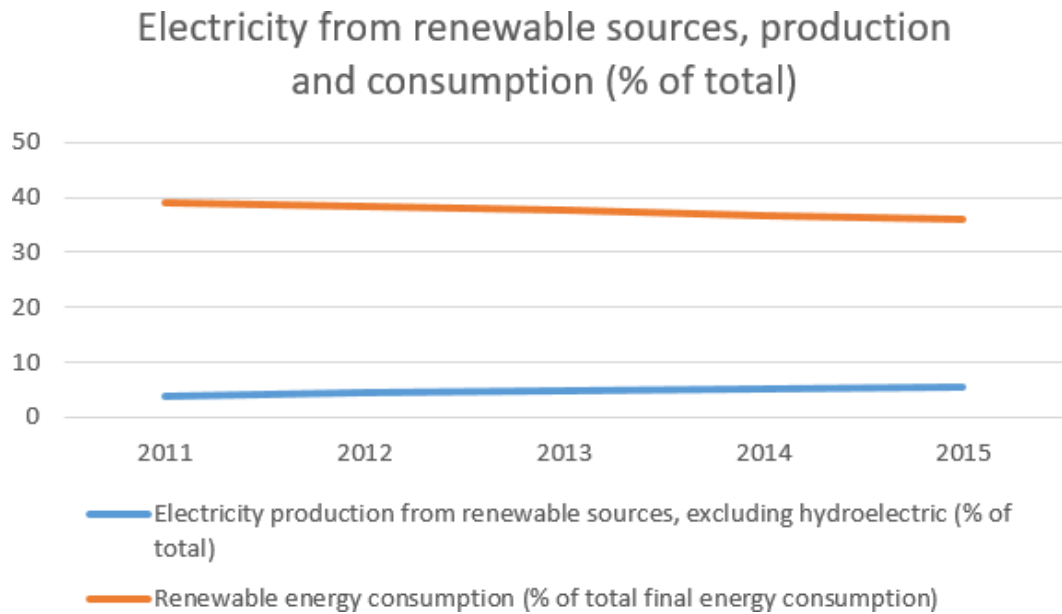


Figure 1: Production vs Consumption, electricity production from renewable sources; Source: World Bank, 2018)

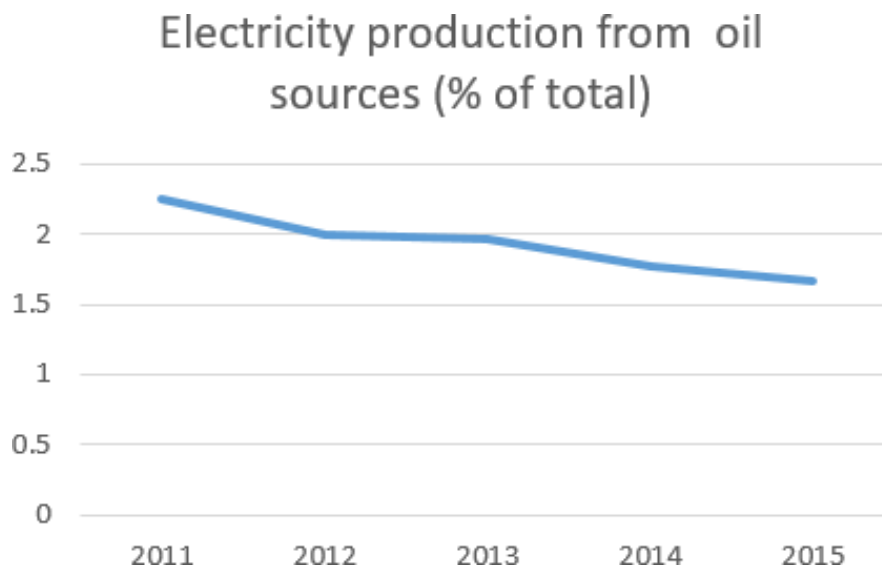


Figure 2: Electricity production from oil sources (% of total) Source: (World Bank, 2018)

3.3 Health & Healthcare access

Health and Healthcare are closely interlinked. These are two sectors in which renewable energy involvement can play a major role. Inefficient and unsafe sources of energy possess major implications on an individual’s health. In a research conducted in Africa, three main health problems were found due to energy consumption in developing countries. First was the lack of modern energy sources, which caused indoor pollution. Second was the increasing urbanization, which further caused clean energy sources to become unaffordable. Lastly, global warming and desertification of certain areas caused depletion of

traditional energy sources (Youssef et al., 2015). With regard to healthcare, energy or its lack thereof can play a major role. Infant mortality statistics in India during the years 2011-2015 are provided in fig. 3. Though the numbers are coming down, compared to the developed OECD countries where the average value is 655, India with an average infant mortality rate of over 3900 still has a long way to go (World Bank, 2018). One of the main reasons for a poor healthcare industry is lack of energy. States like Chhattisgarh, Odisha, and Uttarakhand etc. consist of a number of hospitals without electricity, thus undermining the ability of health workers to perform their functions (Bajpai,

2014). “*In India, nearly half of all health facilities, serving an estimated 580 million people, lack electricity*”. For critical and urgent cases, such as childbirth, staff has to work in the dark or in low lighting (Provost, 2013). Unreliable electricity access causes problems such as vaccine spoilage, interruptions in the use of essential medical and diagnostic devices, and lack of even the most basic lighting and communications for maternal delivery and emergency procedures. Disease patterns are changing and more energy is required for diagnosis and treatment for non-communicable diseases such as breast cancer, cervical cancer etc. (WHO, 2018).

Intervention of renewable energy is one way to tackle these issues. Healthcare services in many countries are transitioning to 100% renewable energy (Noharm-global.org, 2018) suggests that this transition may be due to the following reasons:

Renewable energy protects patients and communities from fossil fuel pollution and climate change. It can save health facilities’ money by providing a fixed cost for a long-term energy supply. Onsite renewable energy can help maintain power during extreme weather. From a study conducted in rural areas of Chhattisgarh, it was found that healthcare facilities with solar power treated over 50 percent more out-patients every month. 98 % of the staff also reported lower disruptions and 80 % reported savings in electricity costs (World economic forum, 2018). Apart from this, there are new technologies in the field of renewable energy which may be highly useful in providing a reliable healthcare facility. A couple of new technologies are discussed below:

1. Vaccine Refrigerator

A majority of healthcare centers store vaccines at a wrong temperature. Others failed to rotate stock and stored expired vaccines with non-expired ones (McColloster and Martin-de-Nicolas, 2014). A solution to this is a direct drive vaccine refrigerator. This system uses solar energy to freeze water, and uses the cold from that ice bank to keep the refrigerator active during night or cloudy season (who.int, 2015). The schematic for this system is shown in fig. 4.

2. Solar Suitcase

In various situations, healthcare facilities have deplorable conditions. There are no reliable sources of power which leads deliveries in near darkness and situations in which critically ill patients had to wait for hours for life-saving proce-

dures (We Care Solar, n.d). This was the motivation behind solar suitcase. Solar suitcase is a solar powered box that houses medical lighting, mobile communication and essential medical devices. This provides a safe and reliable means of facilitating emergency procedures.

More such innovations need to come up in order to provide for a self-sustainable and efficient model in the health and healthcare industry.

3.4 Economy

Renewable energy is one of the cheapest forms of energy sources. But apart from this, there are various quantifiable economic benefits associated with RE. The RE industry accounts for over 10 million jobs around the globe. Apart from this, it can provide electricity to economically backward regions. To quantify the economic benefit of this factor, energy for phone charging, cooking etc. using kerosene consumes over 50 % of household incomes in Africa (Richardson, 2018). Thus, economy is more affected by renewable energy than we generally assume.

We can see the employment statistics in a few sectors to assess the effects renewable energy can make on that sector. Considering agricultural sector, India has a large percentage of its population employed in this sector. As of 2015, over 44 percent of total employment was in agriculture. Despite this fact, only about 16 percent of GDP was constituted by the agriculture, fisheries and forestry industry (value added). This shows a lack of enough resources to convert the raw materials into useful products. According to (Alexandratos et.al 2012), energy requirements will reduce in subsequent years. This is due to better technologies, better energy management systems etc. The expected trend can be seen from figure 5. However, availability of fuel sources will also be declining.

Another problem is that a large amount of food is left unconsumed due to lack of reliable storage or processing facility. “*Reducing post-harvest losses by investing in dryers, cooling equipment, storage facilities etc. is well understood. But access to heat and electricity is needed to heat the drying air, power the fans, run the refrigeration plants etc.*”(Sims et al., 2015). This is where so-

Mortality rate, infant (per 100,000 live births)

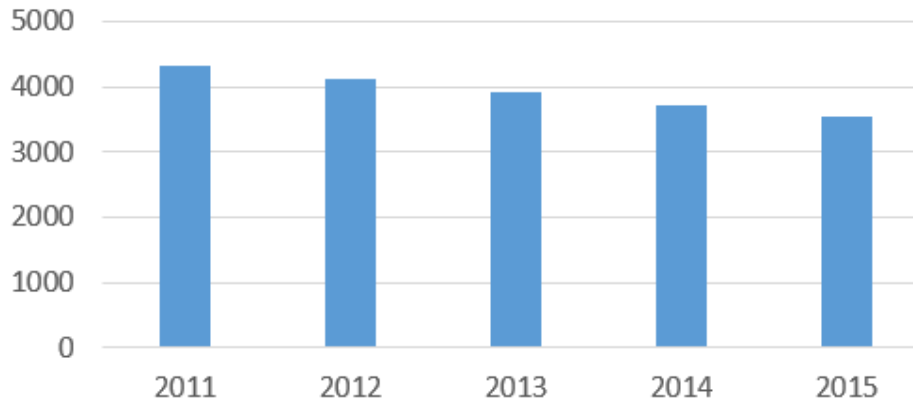


Figure 3: Infant mortality rate statistics Source: (World Bank (2018))

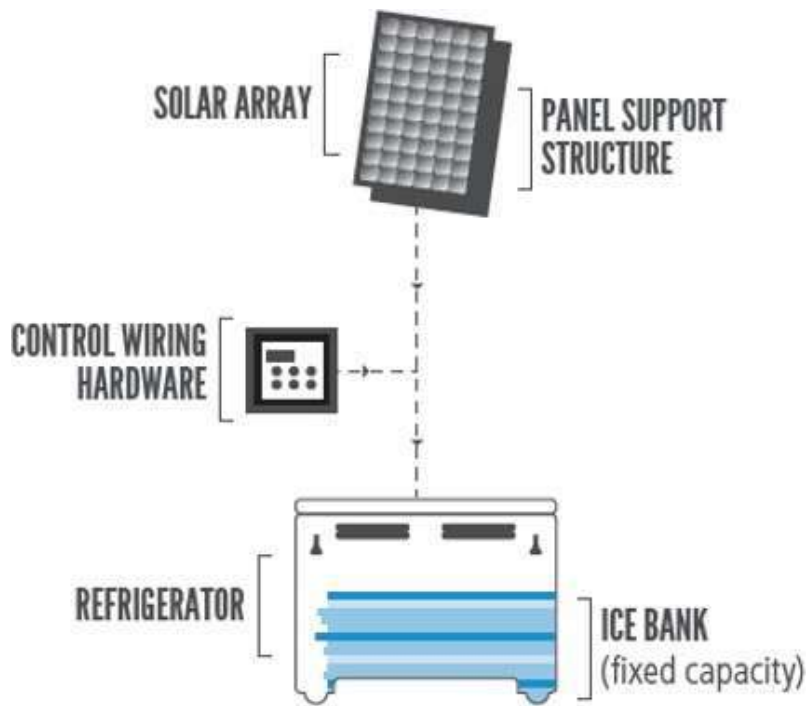


Figure 4: Solar direct-drive refrigerator for vaccine storage WHO (2015)

This is where solar processing and storage technologies come into play. Technologies like solar driers, solar refrigerators have started becoming more and more popular. Solar processing technologies solve two major problems. First, how to generate energy for a growing global population? And secondly, how to feed the constantly expanding world population? (Eswara and Ramakrishnarao, 2012). Thus, technological advancements in this field are the only way to solve this ever-growing worry.

Another notable statistic is the percentage of high technology exports. High-technology exports are products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery (Index mundi, 2018). From figure 6, it can be seen that high technology exports in India have almost been constant in the past few years. Energy systems are a large part of high technology product, and they also form a large part of national economy. Thus, investments in energy technologies can lead to a

growth in the national economy. This can also help reduce the energy import in the country

which is over 34 % of the total energy consumption (World Bank, 2018)



Figure 5: Energy consumption in agriculture, forestry and fisheries: actual data in 2012 and projections to 2030. (Data based on UNSD Energy Statistics Database 2015 and FAO Food Consumption projections to 2030)



Figure 6: High technology exports as percentage of manufactured exports Source: (World Bank, 2018)

Renewable energy valuation reached an all-time high of 331 billion in 2015 (William, J., 2018). With this sector taking up such a large share of global economy, it is high time that more investments are made to promote its growth in India as well. En-ergy technologies can play a huge role in improving Indian economic status and propelling India to become a developed nation soon.

4. CONCLUSIONS AND RECOMMENDATIONS

The paper mainly focused on identifying the problems that are currently existing in a few sectors in India and how intervention of Renewable Energy can be a method to tackle those problems. We considered electricity access, pollution, health & healthcare, and economy. Each sector had problems pertinent to that sector, and we looked at methods to face each of them. Majority of

electricity access is from non-renewable sources which consequently led to lack of energy in certain areas, as well as pollution. This energy source also showed a lower level of utilization than renewable sources. The healthcare sector in rural area showed lack of a reliable source of electricity which led to a large number of deaths and unsafe medical procedures. Furthermore, usage of non-renewable energy sources caused a large economic burden on the nation. A significant amount of energy has to be imported into the country, and also a major income source, i.e. high technology export is limited due to lack in R&D and investments.

To tackle these issues, action needs to be taken at a local, national and international level. More renewable energy appliances need to be purchased, not only to assist in mitigation of climate change, but also to provide a reliable technology, and to provide a cost-efficient model in the long term. At the national level, government needs to make policy reforms to promote usage of renewable energy products. Subsidies and grants should be provided to take up more renewable energy projects. More investment needs to be made at the national level for R&D in renewable energy sector to transition into an energy efficient nation. Healthcare sector needs to transition into a 100% energy independent sector with more utilization of products such as vaccine storage, solar suitcase etc.

At the international level, people need to be made aware of the multitude of schemes that exist. Numerous agencies are involved in funding renewable energy projects for developing countries such as India. Enthusiasts should be provided with a common portal to access knowledge about the presence of such organization. A few organizations investing in renewable energy projects in India are provided in table 1.

Table 1: International organizations funding renewable energy projects

S.No	Name of Organization
1	Asian Development Bank
2	CleanStart
3	Energizing Development (EnDev)
4	Giz - Hera Basic Energy Supply
5	Global Alliance for Clean Cookstoves (GACC)
6	Global Lighting and Energy Access Partnership (Global LEAP)
7	IRENA - Abu Dhabi Fund for Development (ADFD)
8	Lighting a Billion Lives
9	Lighting Asia
10	The OPEC Fund for International Development (OFID)
11	Readiness for Investment in Sustainable Energy (RISE)
12	Renewable Energy and Energy Efficiency Partnership (REEEP)
13	Sustainable Energy for All Initiative (SE4All)
14	Alliance for Rural Electrification (ARE)
15	Alliance of CSOs for Clean Energy Access (ACCESS)
16	Climate Technology Centre and Network (CTCN)
17	Consultative Group to Assist the Poor (CGAP)
18	ENERGIA International
19	Energy Access Practitioner Network
20	Energy for All Partnership (E4ALL)
21	Global Network on Energy for Sustainable Development (GNESD)
22	International Network for Sustainable Energy (INFORSE)
23	Small-Scale Sustainable Infrastructure Development Fund (S3IDF)

This data should be an impetus to take up more projects in the renewable energy field and to ultimately achieve a clean energy nation.

REFERENCES

1. bp.com. (2018). *Statistical review of world energy*. [online] Available at: <https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/renewable-energy.html> [Accessed 24 Sep. 2018].
2. I.R.E.N.A. (2016). *Renewable Energy and Jobs - Annual Review*
3. US EPA. (2018). *Learn about Energy and its Impact on the Environment | US EPA*. [online] Available at: <https://www.epa.gov/energy/learn-about-energy-and-its-impact-environment> [Accessed 2 Oct. 2018].
4. World Bank (2018). "DataBank Indicators". Available at: <https://data.worldbank.org/indicator> [Accessed 25th Sep. 2018].
5. Bhaskar, U. (2018). *Narendra Modi highlights success of rural electrification*. [online] <http://www.sPolitics/1Lxa2DmgHmGyeW8wX8BqjP/Narendra-Modi-highlights-success-of-rural-electrification.html.livemint.com/>. Available at: <https://www.livemint.com/>
6. Barnes, DF (2007), *The Challenge of Rural Electrification: Strategies for Developing Countries*, RFF Press, Washington, DC.
7. Aklin, M., Cheng, C., Urpelainen, J., Ganesan, K. and Jain, A. (2016). *Factors affecting household satisfaction with electricity supply in rural India*. *Nature Energy*, 1(11).
8. Ganesan, K., Jain, A. and Urpeleinen, J. (2018). *Rural electrification in India: Focus on service quality*. [online] *Ideas For India*. Available at: <http://www.ideasforindia.in/topics/macro-economics/rural-electrification-in-india-focus-on-service-quality.html>.
9. Pachauri, S. (2014). *Household electricity access a trivial contributor to CO2 emissions growth in India*. *Nature Climate Change*, 4(12), pp.1073-1076
10. World-nuclear.org. (2018). *Electricity generation - what are the options? - World Nuclear Association*. [online] Available at: <http://www.world-nuclear.org/nuclear-basics/electricity-generation-what-are-the-options.aspx> [Accessed 17 Sep. 2018].
11. Moore, D. and Gould, S. (2018). *The best and worst countries in the world when it comes to air pollution and electricity use*. [online] *Business Insider*. Available at: <https://bit.ly/2OuQpCG> [Accessed 18 Sep. 2018].
12. EIA (2018). *Electricity and the Environment - Energy Explained, Your Guide To Understanding Energy - Energy Information Administration*. [online] Available at: https://www.eia.gov/energyexplained/index.php?page=electricity_environment [Accessed 18 Sep. 2018].
13. Youssef, A., Lannes, L., Rault, C., & Soucat, A. (2015). *Energy consumption and health outcomes in Africa*. *The Journal of Energy and Development*, 41(1/2), 175-200. Retrieved from <http://www.jstor.org/stable/90005936>
14. Bajpai, V. (2014). "The Challenges Confronting Public Hospitals in India, Their Origins, and Possible Solutions," *Advances in Public Health*, vol. 2014, Article ID 898502, 27 pages. <https://doi.org/10.1155/2014/898502>.
15. Provoost, C. (2013). *Energy poverty deprives 1 billion of adequate healthcare*. [online] *The Guardian*. Available at: <https://www.theguardian.com/global-development/2013/mar/07/energy-poverty-deprives-billion-adequate-healthcare> [Accessed 24 Sep. 2018].
16. WHO, (2018). *Energy access and resilience*. [online] Available at: <http://www.who.int/sustainable-development/health-sector/health-risks/energy-access/en/> [Accessed 25 Sep. 2018].
17. Noharm-global.org. (2018). *Health care leaders transitioning to 100% renewable energy | Health Care Without Harm*. [online] Available at: <https://noharm-global.org/articles/news/global/health-care-leaders-transitioning-100-renewable-energy> [Accessed 27 Sep. 2018].
18. World Economic Forum. (2018). *what renewable energy can do for healthcare in India*. [online] Available at: <https://www.weforum.org/agenda/2017/10/solar-power-can-reshape-our-health-future/> [Accessed 27 Sep. 2018].
19. McColloster, P. and Martin-de-Nicolas, A. (2014). *Vaccine refrigeration*. *Human Vaccines & Immunotherapeutics*, 10(4), pp.1126-1128.
20. who.int. (2015). *Direct-drive solar vaccine refrigerators— a new choice for vaccine storage*. [online] Available at: <https://bit.ly/2OIpd3D> [Accessed 27 Sep. 2018].
21. WHO (2015). *Solar Direct-Drive Refrigerator*. [image].
22. We Care Solar. (n.d.). *We Care Solar - The Power to Save Lives*. [online] Available at: <https://wecaresolar.org/> [Accessed 4 Oct. 2018].
23. Richardson, J. (2018). *Renewable Energy Has More Economic Benefits Than You Know | CleanTechnica*. [online] cleantechnica.com. Available at: <https://bit.ly/2Iid13x> [Accessed 28 Sep. 2018].
24. Alexandratos N. and Bruinsma J. 2012. *World agriculture towards 2030/2050: the 2012 revision*. ESA working paper No. 12-03. Rome: FAO. Available online at <http://www.fao.org/docrep/016/ap106e/ap106e.pdf>
25. Sims, R., Flammini, A., Puri, M. and Bracco, S. (2015). *Opportunities For Agri-Food Chains To Become Energy-Smart*. [ebook] FAO, p.34. Available at: <http://www.fao.org/3/a-i5125e.pdf>.
26. Esvara, A. and Ramakrishnarao, M. (2012). *Solar energy in food processing—a critical appraisal*. *Journal of Food Science and Technology*, 50(2), pp.209-227.
27. Index Mundi. (2018). *India - High technology exports*. [online] Available at: <https://www.indexmundi.com/facts/india/high-technology-exports>.
28. William, J. (2018). *Renewable Resources: The Impact of Green Energy on the Economy*. [online] *business.com*. Available at: <https://www.business.com/articles/the-impact-of-green-energy-on-the-economy/> [Accessed 29 Sep. 2018].