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India, Renewable Energy

### **India: Expansion of Renewable Energy**

Despite many attempts to eliminate hunger throughout the world, food insecurity continues to grow especially in lower developed countries. The multitude of causes make it difficult to pinpoint one problem and adopt one solution; eliminating hunger involves both analyzing the numerous problems and creating numerous solutions. Food security, as defined by the World Food Programme, involves three components: food availability, food accessibility, and food utilization. All three of these parts need to be fulfilled in order to ensure food security. When considering food utilization, one problem that is often overlooked is pollution, which alters the quality of the food people are eating. This paper will focus on this issue and methods to solve it. My solution combines numerous stakeholders to ensure maximum success when implementing renewable energy sources throughout India, focusing on solar and biomass energy.

India's population, which was 1.324 billion as of 2016, is fairly dispersed between rural and urban areas with 45.7% of the population living in rural and 33.1% in urban areas (World Atlas, 2017). Majority of the rural population is involved in agriculture as 60.4% of the land is cultivated. The average farm size is 2.83 acres making the farms much smaller than the farms in the United States, which has an average size of 434 acres (Business Standard, 2015). This difference in size can be accounted by the fact that many farms in India are owned by families whereas most farms in the United States are commercialized. Despite this difference, India still has many farms for commercial use, being a major exporter for rice, buffalo, cotton, soybean meal, guar gum, corn, and wheat (USDA Foreign Agricultural Service, 2014). The climate throughout India changes significantly between regions; the northern, mountainous states have a continental climate whereas the climate in the rest of the country is hot tropical. The monsoon season, which typically stretches from early June to late August, is crucial for agriculture, however, severe problems such as flooding have arisen (WeatherOnline, n.d.). India has a democracy with Narendra Modi as the current prime minister.

The typical family size is slightly larger than the United States' average (which is at 3 people per household) at around 5 people per household. Typical dwellings differ significantly from urban to rural regions; in 2001, 18% of urban households and 72% of rural households lived in dwellings with mud floors. Overall, 50% of households are considered very poor conditions (Population Reference Bureau, 2008). The World Bank has been working to improve conditions and has made significant progress, however, many continue to live in poor conditions. Today, 1.06 billion people have access to clean water, 300 million people do not have electricity, 1.2 billion people have spotty electricity, and 1.17 billion people have access to telephones (Livemint, 2016). Average jobs differ from urban to rural areas; typical jobs in urban areas include banking, engineering, textiles, or multinational call centers whereas in rural areas, typical jobs include fishing or working in the agriculture industry. The average wage is very low, at \$1.66 an hour, which is why many Indians are forced to live in poor living conditions (Worstall, 2015).

Although there is free and compulsory education for all children till age 14, only 10% have access to higher education, making it difficult for people to move out of the poverty cycle (The Times of India, 2014). Furthermore, many cannot afford proper health care with the out of pocket spending for health care at 71.13% so many look to cultural remedies as a substitution. Overall, the poor sanitation, limited access to health-care, and dependence on cultural remedies have created high disease rates. Most families attain food from local markets and cook using gas stoves or fires. Families often adopt a traditional, vegetarian diet that is focused on lentils, vegetables, fruit and carbs, especially rice and wheat (Arcgis, n.d.). Ensuring that there is enough of these crops for the population is vital to the food security of India.

While there are numerous issues involving food security in India, the issue of pollution affecting food quality involves food utilization thus affecting the overall food security of the country. Pollution allows toxins to enter food in a multitude of ways, including growing food on polluted soil, with polluted water, or in polluted air or consumption of polluted water and/or food by animals (Food and Water Pollution in India, n.d.). India has been making efforts to decrease pollution by increasing renewable energy usage, however, pollution continues to expand due to lack of regulation of these laws. In November 2017, New Delhi's count of harmful PM2.5 particles exceeded 700 on the US Environmental Protection Agency's air quality index, in which the "hazardous to human health -- do not go outside" ratings are between 300-500 (Mangaldas, 2017). Pollution is most severe in New Delhi thus the environment continues to be toxic despite slight improvements. The overall poor air quality has led to over 2.5 million deaths in 2015 (NDTV, 2017). Difficulties arise when considering the correlation between polluted food and illness thus there are no statistics specific to this information, however, studies do show that this problem can lead to harmful long-term effects on the body. Everyone is susceptible to such long-term effects which include gastrointestinal problems, nervous system problems, thyroid dysfunctions, and cancer (Food Pollution Diseases, 2017). Minorities, refugees, and indigenous populations are affected the same way as they are forced to eat contaminated food and face the effects of the significant amounts of pollution. Pollution causes these effects by altering the composition of healthy air; healthy air consists of 78% nitrogen, 21% oxygen, and less than 2% of other gases whereas a polluted environment contains increased amounts of carbon monoxide, nitrogen dioxide, sulfur dioxide, and ammonia (ERS, n.d.). Extreme measures must be taken to solve this problem and renewable energy presents a variety of solutions that can be used to decrease pollution.

India has taken various renewable energy initiatives to fix this problem, however, regulation and full implementation has been difficult. Currently, India's government has been working on large scale projects in solar and wind energy. With the large scope of these projects, India has faced financial and space issues, limiting their ability to keep up these projects (Lowder, 2018). My solution consists of three parts: focusing efforts concerning biomass and solar energy and involving the community through education. Within each part of my solution, there are numerous groups and organizations working together thus enabling a stronger approach to implementing renewable energy and eliminating pollution.

First, biomass energy is produced by burning organic matter in a boiler to produce electricity and heat. The organic matter is extremely accessible as India produces over 600 million tons of agricultural waste each year, however, only 400 million tons are currently being used. Thus, 200 million tons are still

accessible and can be used to producing energy (Yee, 2013). Currently, all renewable energy mechanisms account for a mere 8% of India's power generation, however, various countries have proven that biomass can be extended to provide more energy. Biomass accounts for 16% of Sweden's energy, 20% of Finland's energy, and nearly 50% of Austria's energy. Using biomass would eliminate the large amount of agricultural waste that occupies space, be carbon neutral, and produce methane gas, biodiesel, or other biofuels (Conserve Energy Future, 2017). There are a few complications that have prevented the expansion of biomass in India; collecting, storing, and transporting biomass is very difficult since it needs to be collected and transported from various places and stored in large depots that will keep the biomass dry. Furthermore, these depots must keep the biomass dry, even during monsoon season, making them expensive to build. There have also been protests against biomass as it could potentially lead to deforestation to create more agricultural waste. Addressing these problems involves various groups of people to ensure that the solution is long-term. First, the Indian Renewable Energy Development Agency (IREDA) and the World Resources Institute (WRI) can work together to build the waste bins, using funding previously provided to India from the World Bank. This funding would be sufficient as it is being focused towards a specific cause rather than being dispersed among various renewable energy initiatives. The next part of this plan would be to involve NGOs for education, such as Asha for Education or the Smile Foundation. These organizations reach poor children who often do produce their food through farming options thus educating them on biomass would help to start biomass usage. These areas often do not have access to electricity so this system would not only bring energy to these areas but also ensure minimal pollution. This overall plan of involving the government to produce the bins, NGOs to educate villagers, and citizens to ensure knowledge of these systems, allows maximum success of the implementation of this solution.

Next, solar energy has also been implemented in India, however, a few limitations prevent it from providing sufficient energy. The main benefit with solar energy is that there is an endless supply of energy from the sun, making this a very sustainable option. Implementation of solar panels is environmentally friendly and significantly reduces electricity costs, as well as several other applications. The downsides that have prevented full implementation of solar power is that storage of the energy gathered is necessary since the sun is intermittent, however, storage is expensive. Furthermore, the solar panels require exotic materials to make them, increasing the cost of implementation and creating the possibility of exhausting such materials (Peterson et al., n.d.). Also, the rapidly growing population and already limited space make it difficult to find areas to install solar panels. While here are solar panels being installed, there is not enough to support a whole country on just solar energy. The Indian government is already using a great portion of the funding from the World Bank on solar energy projects so my solution proposes a even more focused investment of the funding. In my solution, this funding would be focused towards working with major food companies, such as DuPont India or ABT Industries, to use or promote solar energy. Currently, Nestle and Amul are hosting renewable energy initiatives with wind and solar energy that already serve as models for the renewable energy movement (Bhave, 2012). Using companies with large farms would help to expand this initiative to the agricultural industry and serve as a model to smaller farms throughout India. Such companies could be encouraged to do so through economic incentives, however, they may be motivated by the fact that they will be saving money through using solar energy instead of nonrenewable resources. Furthermore, such food companies run large farms thus the solar

energy would be used to produce food and agricultural waste which can be used for biomass energy. Starting this transition to solar energy with larger private companies would make it easier to have a large impact even in the initial steps. As private companies transition to using solar energy, smaller farmers may recognize this system and choose to change as well. They could be exposed to this technology through these companies or through education, as mentioned with NGOs and biomass energy.

Finally, education is an important aspect of both of these solutions and is absolutely necessary in order to ensure participation of citizens in the movement towards renewable energy. As the process of shifting from fossil fuels to renewable resources will take time, it is important that India's future is being educated and prepared for the change. By educating children on the pollution in their environment, they can ensure that they continue to improve the environment in the future. Furthermore, educating children can help spread knowledge to their parents thus helping to increase overall participation in the movement. Incorporating education about pollution could be done by requiring a section about this in science classes or requiring a class dedicated to discussing pollution and renewable energy. These programs could be mandatory in official schools and educating children in rural areas would be done through NGOs. This plan does not require much funding as a pollution section is merely being added to the curriculum. This aspect of the solution is important to ensuring that Indians are willing to move forward with a renewable energy initiative. Thus, while the effects of this part of the solution are not immediate, they will have the largest impact in the future.

Currently, Indians live in an environment with an abundance of pollution, causing harmful toxins to enter food. Using a combination of biomass and solar energy, India can shift to a mainly renewable energy based power system. Furthermore, by educating children about pollution and renewable energy, India can ensure that their systems will continue to expand and improve in the future. With this three part solution involving numerous stakeholders in each part, my solution can guarantee maximum success in transitioning to renewable energy. With the increasing percentage of toxins that are entering food and the numerous health issues associated with pollution, it is vital that these solutions are implemented as soon as possible to ensure the health of Indians. Once India takes these necessary actions to build up its fight against pollution, only then can they guarantee food security.

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