

## Environment Protection through Recycling and Renewables (Indian Context)

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**Abstract**

Large scale migration of people from rural areas (villages) to cities is creating Socio – economic problems in both the places including environmental degradation. Major contribution is from inadequate garbage removal system and indiscrete use of fossil fuels. Typical examples are cities Delhi and Bangalore.

Setting up suitable industries in rural locations will reduce migration of rural population to cities and reduce the environmental pollution there. Besides agro based industries, recycling of used packaging to produce new products has been suggested in this article due to growing consumption of the same, availability of raw material from waste collection, as well as, other pertinent aspects including economic, social and other benefits. Also, by collection and recycling discarded packaging, the volume of garbage and hence environmental pollution will be reduced.

The benefits and necessity of replacing fossil fuels by renewable sources like Solar and biofuels has also been discussed.

The industries will provide “on the job” training to the local population and contribute to skill development. This will be of help in operating and maintaining modern farm machinery and equipment. Also, as part of their social responsibility, the units will contribute to development of the locality by promoting hygiene, education, sports and cultural activities, providing clean drinking water etc.

Mahatma Gandhi’s idea to develop the Indian society was based on his understanding of the rural society and hence based on the village system. Talking about the importance of village, he wrote in 1936, “I would say if the village perishes, India will perish too. It will be no more India” which is more relevant today than it was at his time.

**Keywords:** migration, pollution, garbage, recycling, rural development, renewable energy.

**Introduction**

The world (land, water & air) is being polluted through the years and environment protection agencies are fighting a losing battle. This is particularly relevant for India and some of the other developing countries. With the change in life style, pattern of human habitation and occupation, the quantum of pollution by each person is increasing every day and is naturally a matter of concern. One in two people in this planet is either Chinese or Indian. China has achieved better waste management as compared to India in spite of the higher economic growth. Improving waste management has numerous benefits leading to human wellbeing. Inappropriate waste management system is a significant threat to public health besides hampering growth and other developments including foreign investment and tourism. The present Indian Government has launched an ambitious initiative called the Clean India Campaign

to combat and reverse the effects of pollution [1].

The main pollutants are the solid wastes, municipal sewage and industrial effluent which in turn contaminate the water bodies and restrict the free flow and prevent their natural biological purification. Also, accumulation of solid wastes often generates obnoxious poisonous gases like Methane besides making the land unsuitable for cultivation. The major source of solid wastes, suitable systems for their collection and disposal without harming the environment mainly through reuse & recycling along with those practiced in some of the environmentally conscious countries like Germany (Annexure I) has been discussed here.

**Core to the vision of waste management in India is the use of waste as resources with increased value extraction through recovery, recycling and reuse**

Another major cause of concern is the indiscriminate use of fossil fuels which has polluted the air in most cities and towns beyond

acceptable limits and affecting the health of the population. Also, the disposal of ash from burning coal is a problem and source of land pollution. Harnessing solar energy to meet partial or total electricity and heat requirement in domestic and industrial establishments will reduce this problem substantially.

### Evils of growth in Urban population

The air pollution level in all the major metropolitan cities and towns in India is above the danger level and the ground water is highly contaminated. The per capita waste generation rate has increased from 0.44 Kgs/ day in 2001 to 0.5 Kgs/ day in 2011, fuelled by changing life style and increased purchasing power. There are 53 cities in India which together generate 31.5 million tons/ year (86,000TPD) municipal solid waste (MSW). The total solid waste generation in the country is estimated to be 68.8 million Tons/ year (188,500 TPD). Only 43 million Tons of waste is collected, 11.9 million Tons is treated and the rest is dumped in landfill sites. The collection and disposal system of garbage is mostly primitive. The recent collapse of Delhi's Ghazipur landfill killing 2 persons should be an eye opener. This and similar other landfills are subject to frequent fires and other hazards.

The stench and ugly sight of garbage dumped on the road side, sometimes overflowing from drains or floating on the surface of the rivers is not at all uncommon in India. Also, with clogging of the drains with garbage, there is water logging and flooding of residential areas, roads and even railway tracks in the rainy season disrupting normal life.

Usually in cities and towns, the garbage collectors come to the house every morning, empty the bins into their cart or truck and dump all the garbage from the neighbourhood on an abandoned piece of land (called "landfill"). This causes hazards to humans and animals.



**Garbage dumped in open land.**

People also litter the streets and public places excessively. The street sweeper collects and throws this garbage in to a local dump from where it also goes to a landfill.

The Energy Research Institute (TERI) estimates that by 2047, 1400 Sqkm. land would be required for municipal wastes [2].

The landfill method creates land pollution (and in most cases, ground water contamination). The waste is not sorted for recycling, composting or any other form of environmental treatment. Hazardous toxic wastes lie side by side with organic wastes in the landfill. Quite often, the garbage is dumped in the bank of the neighbouring river. The state of the Yamuna river in Delhi is a testimony to this fact. The river practically doesn't flow at all and expansive white deposits can be seen on the surface which prevents the flow, these are toxic wastes that have reacted with the water. Practically, there is no

living creature in this section of the river. The seriousness of the contamination has been highlighted in a study undertaken by TERI. It shows how industrial effluents and untreated sewage continue to choke the river. In fact, by polluting the ground water and soil, the toxins have entered the food chain through vegetables grown in the banks of the river [3-5].

The city of Bangalore is an example of the evils of urbanisation. Once identified as Garden city and City of lakes, it has become known as "City of burning lakes" and experts fear that it will become uninhabitable by 2025. The illegal dumping of waste mixed with mass of untreated sewage is creating a water crisis which threatens residents' health – and is causing the city's famous lakes to catch fire. On the evening of Thursday 16th February 2017, residents in the south-east part of Bangalore noticed huge plumes of smoke rising into the sky. The smoke was coming from the middle of Bellandur Lake – the biggest lake in the city at a little over 890 acres. Which was on fire [6].

### Burning Bellandur Lake



Long before it began its slow and painful death, Bellandur Lake was part of a clever water and irrigation system devised by the founders of Bangalore in the 1600s. The streams formed at the top of surrounding valleys were dammed into man-made lakes by constructing bunds. Each of these lakes would harvest rainwater from its catchments and the surplus would flow downstream, spilling into the next lake in the cascade via storm water drains. The water bodies in turn served the needs for water of the population. In the 1970s, there were still 285 lakes in the city, making it self-sufficient in its water needs. Today, however, there are just 194 lakes, and the large majority of them are sewage-fed. The rest have been lost to encroachments – by the Bangalore Development Authority, private real estate developers and illegal builders – to cater to the booming housing needs of a city of 10 million.

Bangalore has been subject to unchecked urbanisation in the wake of the IT sector-fuelled economic boom of the late 1990s. The many software companies that sprung up during the dotcom boom attracted hundreds of thousands of skilled IT professionals from across the country, with thousands more people moving from villages and small towns to the city in search of work. According to studies by the Indian Institute of Science (IISc), rapid urbanisation and expansion between 1973 and 2016 caused a 105% increase in paved surfaces and decline of 88% in the city's vegetation, while water bodies declined by 85% between 2000 and 2014. The rise of the IT sector has also created the problem of e-waste in the city. Some garbage collectors, unaware of the necessary safety measures incinerate the e-waste, releasing lead, mercury and other toxins into the air – and dump the rest, allowing pollutants to infiltrate the groundwater [7]. Example of South African cities like Cape Town which have run out of water even for drinking purpose should be relevant.

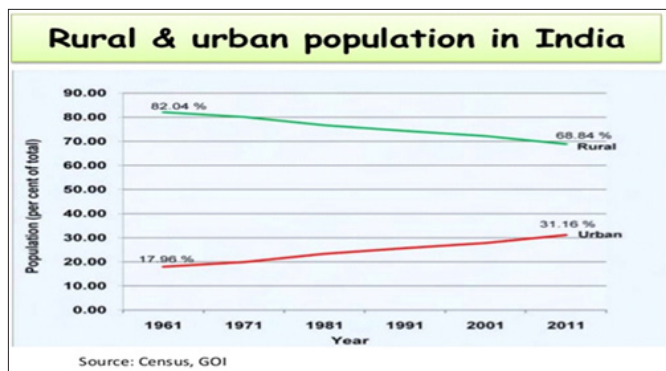
Another important aspect of urban pollution is the indiscriminate and abnormally high quantity of fossil fuels consumed in households, transportation and industries. This has resulted the particulate and carbon dioxide level in the air in most cities to cross the danger limit.

### Causes of migration from rural areas to cities

**Urbanization** is a process whereby populations move from rural to urban area i.e. towns and cities. It is highly influenced by the notion that cities and towns have achieved better economic, political, and social mileages compared to the rural areas. These include social and economic advantages such as better education, health care, sanitation, housing, employment and business opportunities. However, this has had a disastrous consequence both in urban and rural India, as described below:

About 72.2% of India's population (1.35 billion) live in some 638,000 villages and the rest 27.8% in about 5,480 towns and urban agglomerations. In rural areas, agriculture is the chief source of livelihood along with fishing, cottage industries, pottery etc. Due to lack of suitable employment, there is large scale migration of the work force from the rural areas to cities often for lowly paid menial jobs. According to 2011 Census:

- The rural population declined from 72.19% in 2001 to 68.84% in 2011.
- Level of urbanization increased from 27.81% to 31.16% in this period.
- Out of the urban population 48.36 Crores (37.8%) are migrants.



This migration mainly of the male adult population who are often forced to live in inhuman conditions is causing socio-economic problems both in rural & urban areas. Over population in the cities has resulted in undue stress on the amenities and degradation of the environment to an extent that many of them have become unliveable. Also, with reduced earning members, the living condition in the rural areas is deteriorating. The migration of population from rural to urban areas is mainly due to:

- Uncertain & seasonal employment in agricultural sector with low wages.
- Small land holdings making agriculture uneconomic.
- Low productivity due to absence of modern agricultural techniques.
- Lack of alternate avenues of employment.
- Absence of civic amenities.

At present, agriculture accounts for about 50%, industry 21.5% and service the balance 28.5% of the country's work force. The GDP composition as in 2014 is: agriculture 17.9%, industry 24.2% and services 57.9%. Employment of such a large part of the population

in agriculture has become unviable and the emphasis of both the Central and State Governments is on creating alternative employment through manufacturing industries. Most of the industries today, are located close to major cities, ports and other urban centers. As shown in Annexure II and the Map of India Annexure IIA, all the recent start-ups are also following the same pattern of location.

Majority of people move to cities and towns because they view rural areas as places with hardship and backward/primitive lifestyle and this notion has to be reversed by improving the living conditions in rural areas with modern facilities through improved agriculture practice and creation of additional employment through setting up industries. Healthy living with clean environment including better housings, electricity (Solar), running water & flush toilets, cooking gas (Bio), garbage disposal etc. would be the consequence of rural development through increased employment and not the other way around. The Government's policy of providing employment for 100 days to the rural jobless (MNAREGA) and engage them in casual projects like road construction, earth excavation cannot and has not solved the problem of rural unemployment & migration.

### Chinese example

China provides an example of how rural industrialisation can bring about significant change in rural economy and through it in the lives of the rural people as well as, stabilise population movement. Agriculture provided more than 50% of the GDP in 1952 but it fell to 14% in 2004, during which period the rural enterprises known as Township and Village enterprises (TVEs) have contributed remarkably to rural development and economic growth. Their share has grown from none to one third of the GDP. According to the statistics from World bank, the urban population growth rate has come down from 4.9% in 1960 to 2.6% in 2016 [8,9].

Annexure IV gives details of the Start-up investments in India in 2016 which reveals that there has not been any significant investment in the manufacturing sector. Consumer Internet, e-commerce and technology based companies continued to dominate attracting bulk of the investment. Other sectors that have shown positive outlook are Fin-Tech, Edu-Tech and Healthcare. Developed regions (Western states including Maharashtra and Gujarat) have attracted over Rs. 15,000 Crores (US\$ 2.3 billion) which accounts for almost 45% of the total investments in India, followed by Northern and Southern regions of the country. Central and Eastern states continued to lag behind and together account for merely 0.2% of start-up investment. Investment in Agri-Tech is not at all prominent although agriculture is an important part of Indian economy as it is the largest employment source (50% of the workforce) and has a significant place in the overall socio-economic development of the country.

Due to lack of fresh investment in the manufacturing sector, the employment opportunities is getting reduced each year. The International Labour Office (ILO) in its latest publication has predicted that 77% of Indian workforce will face employment vulnerability by 2019, higher than the world level. According to this report, the number of jobless in the country will increase to 18.6 million in 2018 against 18.3 million in 2017. In the last years report, ILO had forecasted that the number of unemployed in the country to be 18 million in 2018 and 17.8 million in 2017. (Annexure V).

## Mahatma Gandhi's vision of rural India

Mahatma Gandhi's idea to develop the Indian society was based on his understanding of the rural society and hence based on the village system. Talking about the importance of village, he wrote in 1936, "I would say if the village perishes, India will perish too. It will be no more India" (Harijan. 29.08.36.) He was aware of the realities of the village life and knew the plight of the villagers. He wrote, "instead of having graceful hamlets dotting the lands, we have dung-heaps. The approach too many villages is not a refreshing experience. Often one would like to shut one's eyes and stuff one's nose, such is the surrounding dirt and offending smell". (Gandhi: Constructive programmes – its meaning and place). His understanding of the plight of the rural people has been extremely well brought out in his writings, identifying his emphasis on removal of rural poverty. It is more relevant today than it was at his time.

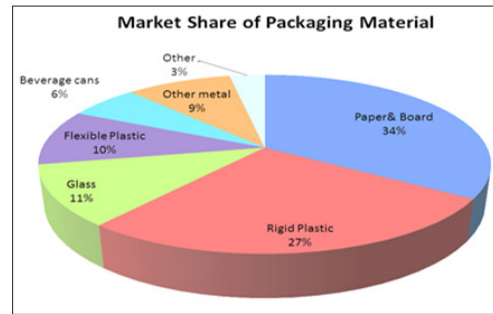
Also, Mahatma Gandhi was probably the first among our leaders to promote rural employment and sustainable development in India. His concept of rural development meant self-reliance with least dependence on outsiders. The Swadeshi Movement was launched through spinning and weaving to promote Khadi. This also provided livelihood to the rural people. The other emphasis was curb on consumption as excessive consumption causes pressure on resources and adds to wastage and pollution. His thought provoking statement "there is enough on this earth to meet the need but not the greed" "has now become an universal slogan for ensuring environmental protection and sustainable development [10].

## Benefits of recycling of wastes

Recycling means that natural resources are used in an efficient way and it contributes to sustainable development. For example, recovered paper, plastics, glass etc. are valuable raw materials that can be reused to create new products. According to Mr. Pete Grogan, nationally recognized authority on resource recycling, who recently earned the Lifetime Achievement Award from the National Recycling Coalition, U.S.A. "Tossing paper into a landfill is not a sustainable practice, It depletes resources, wastes energy, and represents a missed opportunity to participate in the multi-million dollar recycling economic sector."

Reclamation and recycling of material after use is of utmost concern in both developed and developing countries for sustainable development. Recycling one Ton of corrugated containers saves 390 Kwh of energy & 5 Cum of land fill.

With changed life style in India, there has been increased consumption of items of daily use and consumer durables through retail outlets. Even in rural areas these are packed mainly either in paper or plastics cartons, bottles and pouches and delivered in paper and plastics wrappings or carry bags. Also, corrugated board containers are used for bulk transport of most of the material. Nearly 40 million Tons of packaging is consumed in a year. Bulk of these packaging are discarded after use and since, there is no organised waste collection, often end up as garbage and cause land, water and air pollution. Whereas, most of them can be recycled back for reuse and are valuable raw material. The breakup of the different materials is shown below.



Setting up manufacturing units by recycling used packaging in rural locations will solve both the problems of environmental pollution and rural unemployment. Considering the importance of Recyclables as a natural resource, Mr. Ranjit Singh Baxi, President of Bureau of International Recycling has decided the 1st Global Recycling Day to be observed on 18th March 2018. The effectiveness of recycling is evident in a 2009 study by Chintan Environmental & Action Group, where it has been computed that Delhi's recycling efforts saved around 3.6 times more Greenhouse gas than any project receiving "Carbon credit" at that time.

## Rural industrialisation

Industrial development has greater potential in expansion of economic activities and it will eventually help in creation of rural assets along with income generation, development of infrastructure, raising standard of living and per capita income for rural people. Industrialization acts as an instrument both of the creating capacity to absorb excess labour power and of catering for the diversification of the market required at the higher stages of economic development [11-14].

Hence, for sustainable rural development, improved agricultural practices should be supplemented by setting up manufacturing industries preferably related to local raw materials & conditions. The main objective is to provide gainful alternate employment to members of rural families throughout the year and improve their living standard through assured income. However, the three pillars of Sustainable development mentioned below need to be strengthened, integrated & developed for achieving the desired result. These are:

- Economic pillar. Growth for reducing poverty & creating employment.
- Environment pillar. Minimal environmental damage while pursuing development activities.
- Social pillar. Social & geographic inclusion with gender equality.

## Suggestions for rural industries

Besides traditional handicrafts and other cottage industries the other areas of focus have been described below:

- a. Marketing of plants, cut flowers, organic manure and other bi-products.
- b. Adding value to Farm produce

Farmers can increase their income by processing, milling and packing grains, pulses, spices and other farm products to consumer packages for sale at the retail outlets. Also, units can be set up for producing Value-added processed food - which includes products such as processed fruits and vegetables, juices, jams, pickles, squashes, dairy products (ghee, paneer, cheese, and butter), processed poultry,

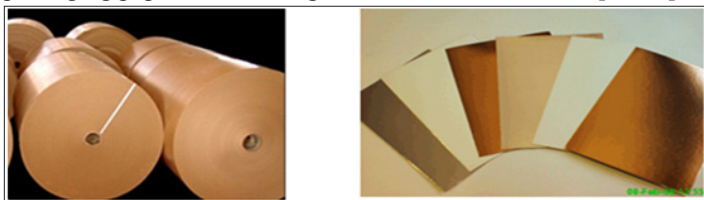
meat and marine products, confectionary, chocolates etc. Also, for producing ready to eat foods like bakery products, chapatis and parothas, snacks, mini-meals, sweets etc. Naturally, these industries will add to the demand for packaging products.

India is the largest producer of milk, fruits, pulses, cashew nuts, coconuts and tea in world and accounts for 10% of the world fruit production. Confederation of Indian Industry has estimated that the food processing sector has potential of attracting US\$ 33 billion (Rs. 2,00,000 Crores ) of investment in next ten years. The Indian domestic food market is expected to grow by nearly 40% of the current market size to US\$ 26.5 billion (Rs. 1,70,000 Crores) by 2025.

### Manufacturing industries based on recycling of wastes

A major part of the packaging waste consist of paper and plastics which, can be converted to new packing material and plants set up in rural areas to recycle the same will provide employment to a large number of persons besides creating clean environment by substantially reducing the quantity of garbage.

Packaging is among the high growth industries in India. Due to lower manufacturing costs, the country is fast becoming a preferred hub for sourcing packaging products by multi – national companies. The over 10,000 corrugated sheet and box making plants are employing over half a million people both directly and indirectly. The industry is converting over 3.5 million tons paper per year in to corrugated boxes. Factories are spread out in all parts of the country, even in the remotest areas. Folding carton (made from multi – ply board) market size is estimated at 2.2 million Tons. The consumption of packaging paper is increasing at a CAGR of over 10 % [15-17].



**Kraft Paper Rolls**

**Paper Board Sheets**

Presently, about 7 million tons of paper is being consumed in India for packaging, of which only 33% is being collected and recycled. In developed countries like Germany, more than 70% of the paper used is collected and either recycled there or exported (Annexure VI). The reason for lower collection in India is due to the lower quantities available in rural areas, the collection from there is not economical. Setting up small and medium size paper mills in rural areas will create employment both in the manufacturing plant as well as in collection of waste paper.

For example, a 50 Tons/ day mill producing packaging paper and board will employ 125 persons (115 direct and 10 for casual and contractual jobs). Besides at least another 25 persons will be engaged in sourcing raw materials and fuels as well as, supporting services like canteen, transport etc. The raw material will be collected within a lead of 50 Kms at about 1 Kg per month from individual households and substantial quantities from shops and establishments.



**Manual sorting and collection**



**Mixed waste Paper**

India's burgeoning middleclass is driving the demand for plastic and plastic products and today the sector is one of the fastest growing in the Indian economy. In terms of polymers, India's consumption is quite low at only 4 kilograms per person, but things are changing and it is expected that by the end of the decade it will increase to 20 kilograms.

The Indian plastics market has now grown to become one of the leading sectors in the country's economy, consisting of over 30,000 firms and employing more than 4 million people. India is also one of the world's top exporters of plastics products. The industry manufactures and exports a variety of raw materials, laminates, electronic accessories, medical ware, and consumer goods. These plastic products are exported to more than 150 countries, mainly in Europe, Africa and Asia. The plastics industry in India also provides plastic materials to several other industries like automotive, consumer packaging, and electronics. Over the last few decades, the demand for and usage of plastics in several industries has increased tremendously. Over the last 5 years, the Indian plastic industry has grown by 13% annually. A similar growth rate is expected to continue in 2018-19, and the size of the industry is expected to reach around USD 25 billion (160,000Crores) by then [18,19]. 15,342 Tons of plastics waste is produced in India every day of which 60% is recycled.

According to Federation of Indian Chamber of Commerce & Industry (FICCI), the plastics recycling industry in India employs over 1.6 million people and has more than 7500 recycling units. In HDPE bottle-to-bottle recycling the process of used-material sorting and separation must meet highest demands. For example, food-quality packaging is being generated from HDPE milk bottles. It must be guaranteed that different types of plastics and contaminant materials are reliably separated. Since, the garbage collectors are paid by weight, there is no incentive for them to sort out the waste. "Central Pollution Control Board in India has estimated the generation of plastic waste in the country as 15,342 Tons per year, out of which, 9,205 Tons are recycled and leaving 6,137 Tons uncollected and littered."



**Discarded Plastic Items**

Plastic waste disposal has been of a global concern since 1990. The main source of plastic wastes is mostly domestic wastes

(about 70%), trade and industry (less than 20%), agriculture and construction (3-5%), and even transport (up to 6%). Most plastics are not bio-degradable through corrosion and decomposition, so it is difficult to dispose them. Also, burning plastic waste releases harmful toxic emissions into the atmosphere. Therefore, plastic recycling is considered to be the most environmental friendly and beneficial process [20].



**Collected Plastic Waste**

Owing to their low cost, low weight, ease of manufacture, availability of raw materials and flexibility of use, plastics have displaced many conventional materials in the majority of their uses. The increasing demand for sustainable and durable products in various end-user industries is driving demand for various plastics globally.

The growth of major end use industries (mainly packaging and construction) and versatile properties of plastics including better heat and pressure resistance make them more applicable in various industries. For example: The Indian plastic pipe market is forecast to grow at a CAGR of 10.4% from 2016 to 2021. The major growth drivers for this market are the growth of government infrastructural spending, increasing residential and commercial construction, industrial production, irrigation sector, and replacement of aging pipelines. PET bottles and containers (made from PET resin or Polyester) are commonly used for carbonated beverage and water bottles. PET provides very good alcohol and essential oil barrier properties, generally good chemical resistance and a high degree of impact resistance and tensile strength.

With the availability of basic paper and plastic materials, downstream plants for producing consumer products will be set up creating further employment. Some packaging products from recycled paper and plastic wastes have been described at the end of this article. (Annexure VII& VIIA). Addition of earning members in the community will increase the demand for services and facilities like health care, retail outlets, restaurants, tailoring, repair shops etc. and create further employment.



**PE 1 BOTTLE FOR Areated mineral water and soft drinks**

## Renewable energy

All countries even the petroleum rich ones are going in for substantial energy generation from alternate renewable sources, mainly due to:

1. Increasing energy needs with depleting fossil fuel reserves.
2. Environmental concerns with need to reduce carbon pollution.

## Both are critical for long term survival of human beings

Since it is abundantly available in most locations and other advantages, Solar is the most favoured. This is particularly relevant for India, as due to indiscriminate use of fossil fuels in households, transportation and industries, the atmospheric pollution in the metropolitan and other larger cities have reached well above the danger level. Also, the country is spending billions of Rupees in import of coal and oil.

The International Renewable Energy Agency (IRENA\*) estimates the total renewable energy generation capacity in all countries in the world (on2016), as 2006, 202 MW. Sweden meets over 55% of it's energy requirement from renewable sources. Availability of different renewable energies are shown in Annexure VIII and that of solar is far in excess of the other sources. 30 days of sunshine striking the Earth have the energy equivalent of the total of all the planet's fossil fuels, both used and unused. According to IRENA, the total solar energy generation in the world is 295,664 MW with China leading (77,434MW) followed by Japan (41,600MW) and Germany (40,998MW).

## Harnessing Solar Energy in India

Solar power generation is growing very fast in India and it has quadrupled from 2650 MW on May 2014 to 10,000 MW on March 2017 (4 GW was added in 2016 the highest in any year). Highlighting the importance India gives to solar power, Prime Minister Narendra Modi said at the COP21 climate conference in Paris in 2016 “ The world must turn to (the) sun to power the future. As the developing world lifts billions of people in to prosperity, our hope for a sustainable planet rests on a bold global initiative.” Hence, due to it's obvious advantages, particularly for manufacturing industries using heat and electricity, harnessing solar energy is a most viable option [21,22].

Solar energy is mostly harnessed through Photovoltaic (PV) and Concentrated Solar Power (CSP) routes. While, electricity is directly generated in the PV system, the heat energy from the CSP collector is to be converted to hot air, hot water, hot oil or steam for use.

PV solar panels are now a common sight in residential, commercial and industrial complexes including railway stations in India. Normally 10 Sq mtrs. shade free area is required for 1 kW peak ( 4.5 kWh/ day) solar panels.



**Figure 1: Roof Top mounted and Fixed Tilt Ground mounted PV Panels.**

A reference of solar PV electricity is at Murugan Textiles in Tamil Nadu, where a 2 MW capacity system supplied by Tata Power Solar is in operation saving 2567 Tons Co<sub>2</sub> generation per year. The panels (700 kW + 2x 650 kW) are installed over 18,850 Sqmtrs. roof area. (The solar generation is operating in parallel with wind generators and the plant is operating totally on renewable energy). The main benefit is the reduction in Global warming (@ 1 kWh solar energy = 1 Kg of Carbon dioxide) and land pollution. A typical Solar electricity generation system is shown In Annexure IX.

There are several types of solar thermal (CSP) collectors, each suitable for particular temperature, generating requirement etc. The CSP systems suitable for industrial applications are the Linear Fresnel lens (Figure – 2) and for higher temperatures, the Parabolic trough (Figure – 3). Water or Thermic fluids are heated in the Absorber tubes in the collectors and the heated fluid is used for producing steam or other heating applications.

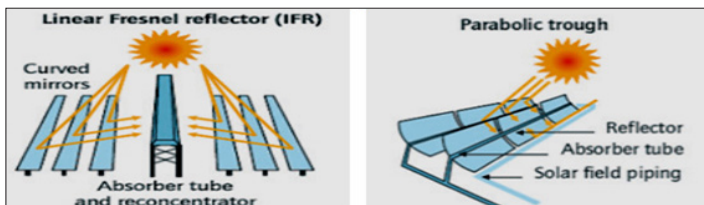


Figure :2

Figure:3

Solar thermal systems are being widely used in India in industries as well for domestic use, hotels and community cooking in religious places etc. for producing hot water and steam. As an example, Godavari Fertilizer & Chemicals is producing 120 CuM per day hot water from solar source. However, while there are a number of instances of use of solar energy in different industries (Diary, textile, Paint, Pharma, Engineering, Hospitality & Food etc.), there is not many references of use of the same in paper mills and paper, plastics and other conversion units. The main hindrance for continuous operating plants is the availability of solar energy for only 8 to 9 hours in a day for about 300 days in a year. Hence, for utilisation in continuously operating plants, it has to be integrated (Hybrid) with other permanent sources like grid power and/ or captive generation to supplement the same. Also, the high cost of solar thermal systems is a pertinent factor in restricting industries in investing in solar steam and other thermal applications. In spite of the limitations, use of solar energy in paper mills and allied industries is technically as well as economically viable and also desirable. Hybridisation with solar energy reduces dependency on purchased electricity and fuels (bio – mass and fossil) by around 15 to 30% in plants operating round the clock and to a much larger extent in single shift operating plants. One example is the installation at B.S. Paper mills, Ludhiana where 9 CuM hot water for boiler is produced per day through solar heat generation saving corresponding quantity fire wood (Annexure X). This is very relevant as the cost of electricity and fuels have increased several folds in recent years with limited availability due to poor performance of the generating and distributing companies. What is much more relevant is that there is corresponding reduction in Carbon dioxide generation.

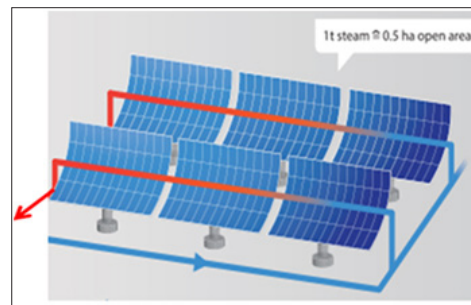


Figure 5: Steam generation in solar concentrators

In locations with good solar radiation, Solar concentrators require about 0.6 hectare (1.5acre) solar field to generate 1 MW peak (Thermal) capacity, corresponding to about 1.5 Tons/ hr. Peak (2500 Tons/ year steam generation).

The largest solar process heat application till recently has been at Hangzhou, China, with 13,000 Sqmtrs. of collectors installed on the roof of a textile factory to provide hot water for the dyeing process. Solar thermal systems are being widely used in India in industries as well for domestic use, hotels and community cooking in religious places etc. for producing hot water and steam. As an example, Godavari Fertilizer & Chemicals is producing 120 CuM per day hot water from solar source.

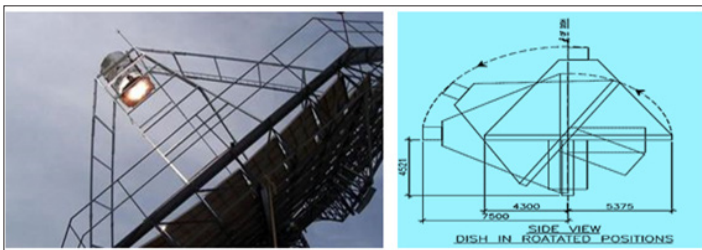
#### Feasibility of utilisation in industries

Solar energy can be effectively and profitably utilised in industries to supplement purchased electricity and fuel. Surplus open land as well as roof tops and even water tanks and effluent lagoons can be used for installing the solar panels.

**Electricity:** 100 kW (peak) solar PV panels would require 1000 square meter open area and generate about 450 kWh electricity per day. From details available from Solar Mango, a leading solar consultancy firm, investment in the installation will be between Rs.50 to 55lacs. The annual electricity generation will be 135,000 kWh(450 kWh/ day for 300 days) and even @ Rs.5.50 per unit the savings in cost of electricity will be Rs.7.45 lacs. Hence, the investment will be paid back within seven years and much earlier, at places with higher cost of electricity as well as, taking into account incentives and tax benefits whereas, the life of solar panels is over twenty years. There is also the possibility of earnings through trading Carbon credits and Renewable Energy Certificates.

**Hot water:** Producing 100 CuM per day hot water through solar heating will reduce fuel (Paddy husk) consumption by 600 Tons in a year. As a result of UNDP's partnership with MNRE and supported by Global Environment Facility, the installation of solar water heating system in India has increased by 20% each year. In addition, this partnership has also resulted in saving 3.57 million kWh electricity and corresponding reduction of greenhouse gas emission of 1.66 million Ton Carbon dioxide.

**Steam:** Hybrid solar and bio mass or fossil fuel steam generation is very common now. A Fresnel parabolic reflector with point focus that delivers at temperatures from 80 to 400°C "ARUN" supplied by M/s Clique Solar, has been installed in several industries, ranging from diary to automobile (Figure – 6).



**Figure 6:** ARUN Solar Concentrator. 160 Sq.mtr.

This includes the solar steam installation at ITC Maurya Sheraton, New Delhi to generate about 830 Kgs per day steam. India’s Center for Study of Science, Technology and Policy (CSTEP) is building a 3MW, CSP – Bio mass Hybrid power plant in Barun, Bihar. Parabolic trough technology with direct steam generation (DSG) has been selected for this plant in which solar and bio– mass will each contribute 50 % towards power generation.

Also, industries in general can benefit by using solar energy for : producing hot air for space heating and cooling, repair shop, lighting and ventilation ( with battery storage ), water pumping, charging of battery operated fork lifts, vehicles and equipment, effluent treatment, drying of rejects etc. Besides cost saving, this will reduce air and land pollution.

### Renewable energy from biofuels

Fuels that have been extracted from crops are known as biofuels. In India, most of the biofuels are bi-products (wastes) from food crops.



These are grown annually and in some cases seasonally and are renewable sources of energy. Burning biofuels result in much lower quantity carbon dioxide and toxin (Sulphur compounds) generation compared to fossil fuels. Besides the environmental benefits, it is highly suitable for use in industries in rural locations due to local availability hence, lower cost. Also, a major benefit is reduced air pollution as substantially lower or negligible transport distance is involved. The main crops grown annually and the corresponding biofuels are:

#### Availability of Bio-fuels in India.(Million Tons/ year)

Main crop	Total annual prodn.	Bio fuel	Ratio
Rice	104.4	Husk 31.3	0.3
Coarse serials	40.0	Husk 72.0	1.8
Sugar cane	339.0	Tops 1.0	0.12

\*crops like Maize, Soyabean, Tapioca, Bajra, Groundnut, Jowar, Maize, Groundnut, Arhar, Castor seed, Gram and til consist the major shares of residues.

The reduction in pollution through change over to biofuels has been indicated in Annexure XI.

Bio crops and bi-products like Mollases are also being converted to Ethanol and other products to replace fossil fuels.

### Conclusion

**Clean environment** is essential for socio-economic development of the country with the objective of creating wealth: human, material and social as these complement each other and contribute to the overall growth and success. This can mainly be achieved through geographic and social dispersal of economic activities with minimum degradation of natural resources. Setting of industries in rural locations including by recycling packaging and other wastes using nonpolluting energy sources will significantly contribute to this objective.

Industries in India as part of their Corporate Social Responsibility (CSR) have been maintaining places of worship, schools, healthcare units and other facilities not only for the benefit of the employees but also the local population. They are also training the local youth and developing their skills hence, employability and contributing to the social life by promoting sports and cultural activities. Setting up industries in the rural areas will significantly improve the rural economy and quality of life. Also by reducing the overpopulation in the cities the degradation of the civic amenities and environment (air, land and water) there will be reversed.

It is necessary that industries set up in rural areas should participate seriously in the Prime minister’s “Clean India” concept and try to maintain not only their campus and residential complexes clean and green but also the villages and other habitations in their neighbourhood.

This would include ensuring that public places like health centers, schools, offices, streets, parks and playgrounds are free from litters, and the water bodies are not filled up with garbage. For achieving this, implementation of suitable garbage collection and disposal system is required with participation of the local bodies. Also, construction and maintaining public toilets with running water (solar/ hand pumps where no electricity is available ) is an important activity. The users may pay a token amount and it can be self-financing. Another area is tree plantation.

Use of green energy particularly **Solar** to reduce carbon dioxide generation will be a major contribution. In this context the Prime Minister.Narendra Modi’s statement at the COP21 climate conference in Paris in 2016 “The world must turn to (the) sun to power the future.” is quite relevant. Industries should not only use solar energy in the plant and complexes where ever practicable but also motivate people of the locality to go in for harnessing solar power. This will include solar lighting, ventilation, water pumping, producing steam and hot water for cooking as well as other use.

The village Mawlynnong in Meghalaya, which has become an International Tourist Destination as the Cleanest Village should be an example.





Views from Mawlynnong



Garbage bins

Trash bins at Railway Station

Clean environment is also essential for economic development of the country through tourism and investment in commerce and industry. Naturally, nobody would think of visiting a country again or have long term plans about it, if his first experience has not been very pleasant. Hence, for socio-economic benefit of the country, the Government must encourage setting up industries in rural areas through support and incentives. However, it has to be ensured that the industries fulfil their social responsibility for environmental protection and ensure that their operation does not in any way harm the environment.

#### \*Bureau of International Recycling (BIR)

The only global recycling industry association representing 800 companies and 35 affiliated national associations. President: Mr. Ranjit Singh Baxi\*\*\*, Head office: Brussels, Belgium. [www.bir.org/](http://www.bir.org/)

#### \*IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organization dedicated to renewable energy. [www.irena.org](http://www.irena.org)

#### IEA-ETSAP

The Energy Technology Systems Analysis Programme (ETSAP) is an Implementing Agreement of the International Energy Agency (IEA), [www.etsap.org](http://www.etsap.org)

#### Annexure i .waste disposal and recycling in Germany

Germany produces 30 million tons of garbage annually and the country has been very successful in it's fight against growing garbage heaps. The manufacturers and retailer s have to pay a "Green Dot "fee on products, the more the packaging the higher the fee. This has reduced the garbage by about a million tons per year. However, major success of the programme is the proper sorting and processing of the garbage. It has implemented the EU policy on packaging through its Ordinance on the Avoidance and Recovery of Packaging Waste . Furthermore the Ordinance also rules out incineration for energy recovery as an option.

#### Return of bottles and cans

When you purchase something like Coke or beer in a bottle or can, you pay the advertised price plus a deposit (Pf and) which is refunded when you return the empty bottles and cans. This results in zero litter, minimum environmental impact and saving in cost by the municipalities.

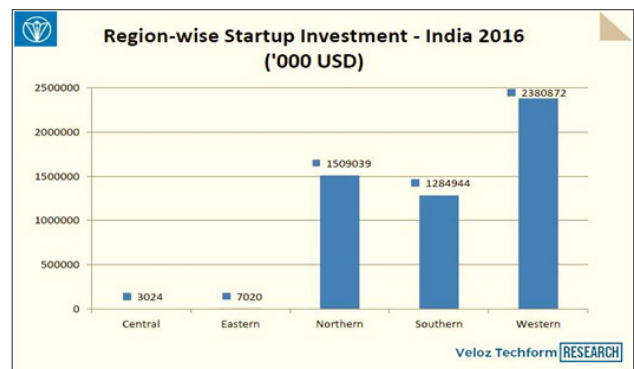
#### Garbage Bins of Different Colours

Bins of different colours are provided in residential buildings and public places for different wastes like glass, paper, plastics which are collected on designated days in the week.

\*XXXXX For the **hazardous waste**, which includes fluorescent tubes, batteries and acids, cans of paint still containing paint, thinners, adhesives, corrosives, disinfectants, insecticides and so forth, a notice is issued by the local town council on when and where the truck collecting this kind of waste will be available.

Batteries can be disposed of separately in a bin provided in the local shopping area. Another useful feature of the waste disposal system in most cities is the Recycling of\*, an outlying area with containers to which one can transport and deposit heavy garbage like old furniture, electrical appliances etc.

#### Annexure II



#### Annexure- Iia, Map Of India With Start-Ups In 2016

As an eagle eye view of the Investments in Start-Ups' pan-India, shows that very few centres are the hub of all Strat-Up activity and surprisingly the Eastern and Central regions are nowhere on this

map. The Western States of India Including Maharashtra and Gujarat continue to attract maximum investments followed by Northern and Southern regions of the country. Consumer Internet and e-Commerce comprise over 71% of the Start-up investments.

**Annexure III, Rural Development Programme in China & India**

The programmes and policy strategies adopted by the Chinese government include:

- Promoting Self-reliance aimed at putting people at the centre to increase the effectiveness of the assistance from the government and international partners.
- Establishment of the ‘People’s Communes’ as the basic unit of self-reliance.
- Skill Acquisition and Technology Development aimed at building up the skill base of villagers, particularly the women. In some villages, women have been trained to repair and maintain hand-pumps and other equipment. Also, some have been trained as masons and artisans.
- Creation of Rural Assets Institutional structures are created at the village level to enable the people to prioritize their needs and decide how best to manage common resources such as water storage, water use, irrigation systems, soil conservation and forestry management.

The rural development strategies in India are based on the following schemes, and are contained in the ‘National Rural Employment Act of 2005 and subsequent amendments:

- Integrated Rural Development Programme (IRDP): The objective is to assist the rural poor with subsidy and bank credit for productive employment opportunities including training of Rural Youths for self-employment, development of women for Self-Employment etc.
- Wage Employment Programmes: To provide employment opportunities during lean agricultural seasons and also assist farmers during periods of floods, droughts and other natural calamities.
- Employment Assurance Scheme (EAS) and Food for Work Programme: to provide employment to the youths in the form of manual works during lean agricultural seasons. (now MNAREGA).
- National Bank for Agriculture and Rural Development (NABARD) provides credit facilities for the development of crafts, agriculture, small scale industries, village industries, rural crafts, cottage industries, and other related operations.

**Effectiveness of rural development programme implementation in china and India**

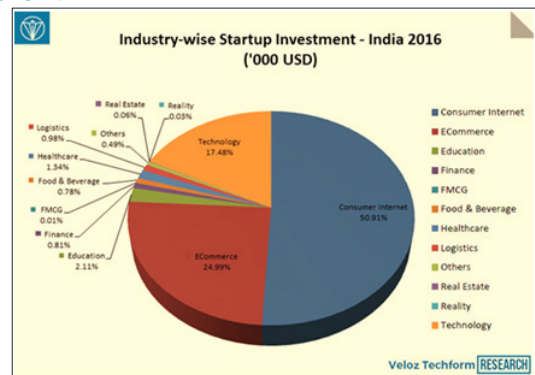
The central policy strategy approach in China is aimed at putting people at the centre of development. The assets created at the rural areas have increased income generation to households and ensured more water for drinking, irrigation, higher agricultural productivity, rural employment and incomes (including household saving), greater resilience to droughts and the ability to appropriately manage the natural resources. Formation of Farmers’ and Women’s Federations have reduced unnecessary expenditure on social customs like weddings, promoted the education of girls, anti-liquor campaigns, and modern farming. More people, especially women have benefited significantly from this policy strategy.

The rural development approach in India is multi-dimensional with the rural and urban economies integrated into the overall national

economy and policy objectives in their best interests. As a result, rural development strategies are strictly anchored on a defined population.

However, any programme of development without involvement of the affected rural people in it’s implementation is incomplete. The major hindrance to success of rural development programmes in India has been bureaucratic bottlenecks and budgetary constraints. The mindset that rural development is a routine bureaucratic exercise & not a people’s movement needs to be changed with the approach that people are not the objects but agents of development.

**Annexure IV**



**Annexure V, Employment Statistics from International Labour Office.( ILO )**

Country/region	Unemployment rate, 2007-19 (percentages)			Unemployment, 2017-19 (millions)			
	2007-16	2017	2018	2017	2018	2019	
<b>Asia and the Pacific</b>		<b>4.2</b>	<b>4.2</b>	<b>4.2</b>	<b>82.9</b>	<b>83.6</b>	<b>84.6</b>
Eastern Asia		4.5	4.5	4.6	41.8	41.8	42.0
China		4.7	4.7	4.8	37.4	37.6	37.8
Japan		2.8	2.6	2.6	1.9	1.8	1.7
Korea, Republic of		3.8	3.7	3.7	1.0	1.0	1.0
South-Eastern Asia and the Pacific		3.4	3.4	3.5	11.7	12.0	12.4
Australia		5.7	5.6	5.4	0.7	0.7	0.7
Indonesia		4.3	4.4	4.6	5.4	5.7	5.9
Southern Asia		4.1	4.1	4.1	29.5	29.7	30.2
India		3.5	3.5	3.5	18.3	18.6	18.9

**Annexure VI, Paper consumption & Recycling in different Countries.**

**Table 1: RCP consumption usage and recovery – Select countries and regions 2012**

Country / Region	Consumption (million tonnes)	Usage	Recovery (million tonnes)	Recovery rate
China	76.4	72%	48.9	46%
Western Europe	45.9	52%	54.3	73%
North America	32.0	36%	50.8	65%
Japan	17.4	64%	21.6	78%
Indonesia	6.3	61%	3.8	56%
India	5.7	55%	3.3	27%
Mexico	4.9	9.9	3.9	51%
Brazil	4.4	41%	4.4	43%
Thailand	3.8	77%	2.8	60%

Africa	2.7	57%	2.8	32%
Turkey	2.6	85%	2.5	45%
Middle East	2.5	75%	2.9	36%
Worldwide	237.5	57%	237.3	57%

Source: derived from RISI 2012 Outlook for Global Recovered Paper Markets

### Annexure VII, Paper Packaging, Mostly Commonly Used Comprise

a. Corrugated boxes made from Kraft paper have continued to dominate the Indian paper packaging. Use of good quality corrugated boxes is preferred highly in every sector, whether it is pharmaceuticals, electronics or anything else. It is believed that if corrugated boxes cannot stand with the transportation risks, no other form of packaging material can. Even, corrugated shipping cartons are used for transport of other packaging like pouches, cans, bottles, folding cartons etc. to manufacturers of different products and to the whole sellers & retailers after being filled in.



b. Carry bags and packets made from Kraft paper used by most retail outlets for packaging groceries and most other consumables as well as food and snacks. With restrictions imposed on use of polyethylene bags in most states, use of paper bags has increased substantially. Also, Kraft paper is being used for wrapping textile products, books and other goods and laundries in shops before delivery. Kraft papers with high strength properties are used for sacks for packing cement, tea, fertilizer and many other items.



c. Folding cartons made from multi-ply boards are used for packaging almost all consumer goods like food & provisions, pharmaceuticals & cosmetics, garments, electrical items and other consumer durables. Packaging coming in contact with food, hygiene and health care products come under specifications (ISO22,000&Reference:9)



d. Rigid boxes made from gery board are used for packing foot wear, readymade garments, handicrafts, stationary and several other items. It is preferred where rigidity is required like inner boxes and

displays. Also, used for partitions, book covers and as raw material for textile cones, tubes and other industrial products.

### e. laminated ( aseptic ) packing for liquids

Laminated i.e. aseptic packages are made by laminating paper and board with polyethylene and aluminum foil. This multilayered construction enables the carton to protect the contents from various factors responsible for spoilage, thereby preserving the freshness and value. Laminated cartons are used to store liquids such as milk and pure orange juice, for up to a year. The most famous laminated cartons are manufactured by Tetra Pak. In Sweden, over 130 billion Tetra Paks are manufactured each year.



Presently the Indian Aseptic Liquid Packaging Market is growing at 17 to 18% per annum, and the market is expected to double up in the next five years to approximately 20 billion packs per annum..

The company Lucart of France has received the 6th European Paper Recycling Award for 2017 due to developing and implementing an innovative technology for paper recycling along with Tetra-Pak. The process involves separation of cellulose fibers in beverage cartons from polyethylene and aluminum parts without use of substances that are harmful to humans and the environment. The polyethylene and aluminum are converted to a material called AL.PE.

### Annexure VIIa, Moulded Products from Recycled Plastics

Bottles and containers used for milk, shampoo, laundry detergent and household cleaners are lightweight and tough – but they usually are made from a different type of plastic than beverage bottles. When they are recycled they make new bottles and containers furniture, playground equipment, recycling bins and many more items.

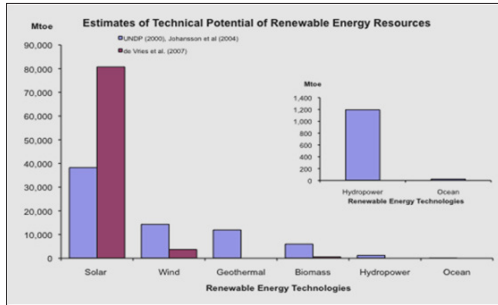


### Some other Plastic Products

When they are recycled plastic bags and wraps can be made into plastic lumber that is used to make park benches, backyard decks and fences – even playground equipment. They also can be recycled into new plastic bags – and then recycled again.

Plastic Storage Tanks are used to store water and other liquids in residences, offices and factories. They are used in chemical industries

to store chemicals as they are non-corrosive in nature.

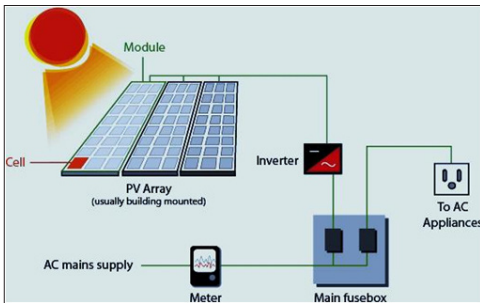


### Annexure IX, Boiler feed water heating at B.S.paper mills, Ludhiana.

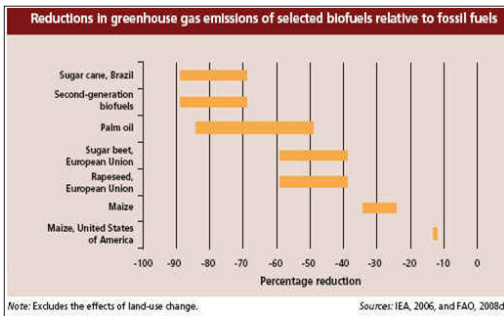


Type of Installation: Scheffler Dishes. Configuration: 160 m<sup>2</sup> (16 m<sup>2</sup> x 10 No's) Supplier: Taylor made Solar Solutions Pvt. Ltd. [www.tss.india.com](http://www.tss.india.com)

### Annexure X, PV Electricity Generation.



### Annexure XI



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