Climate Change Adaptation Initiatives of Public Health Engineering Department in the field of Water Supply and Sanitation Sector

There are two main programmes/missions undertaken by the Public Health Engineering Department, they are "Jal Jeevan Mission (JJM)" and "Swachh Bharat Mission – Grameen (SBM-G)". The main goals of JJM is coverage of 100% provision of Functional Household Tap Connections (FHTC) in rural areas by 2024. SBM-G aims to achieve Open Defecation Free (ODF) Plus Model status in all the villages by sustaining open defecation free status with proper solid and liquid waste management while being visibly clean.

The contributions of the above two missions towards managing a sustainable environment can be briefly described as below:

Under JJM programme, the provision of functional household tap connections entails the necessity of a continuous supply of water. Thus various steps have been taken up for source sustainability such as protection of watershed areas, plantation of trees, digging of contour trenches and such similar methods as ground water recharge mechanisms. Apart from the physical aspects, numerous awareness programmes and trainings have been conducted at Block levels educating about the importance of protection of the forests and the environment at large.

Under the SBM-G programme, the first and foremost priority is ensuring that every citizen in the villages have an access to toilet. This is facilitated by providing Individual Household Latrine (IHHL) as well as Community Sanitary Complexes (CSC). Till date, 49973 nos. of IHHL and CSC's have been constructed in 353 villages under this mission. And under Swachh Bharat Kosh (SBK) 68828 nos. of IHHL have been constructed. In addition, a massive drive has been undertaken to ensure conversion of all single pit toilets to twin pits which will aid in a continuous cycle of alternating between the use of the pits with minimum management requirement. By this time of filling up of the alternate pit, the sludge will have been digested and converted to manure.

Further, those households using septic tanks are provided with soak pits. Grey water management is also undertaken through construction of individual soak pits, community soak pits (1632 nos. in 383 villages) and re-using for kitchen gardens. Regarding faecal sludge management, it is planned to construct Faecal Sludge Treatment Plant in each District such that there will be a better and improved management besides those mentioned above. In the solid waste management sector, works are in progress to construct segregation sheds, community compost pits (700 nos. in 423 villages) for biodegradables and Plastic Waste Management Units have been set up at 7 Districts in 8 Blocks and works are ongoing for its operation.

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Impact of Climate Change on Livestock and its Adaptation and Mitigation

Animal Husbandry & Veterinary Department, Govt. of Mizoram

The increasing demand for livestock products offer market opportunities and income for small, marginal and landless farmers, livestock production globally faces increasing pressure because of negative environmental implications particularly because of greenhouse gas (GHG) emission. The climate change effect livestock production systems both directly and indirectly. Direct effects include changes on growth, milk production, reproduction, metabolic activity and disease occurences. The indirect impacts of climate change on livestock are reducing water and pasture availability and other feed resources.

Impact on livestock production

Global warming causes heat stress in animals and affect production performances of farm animals, reduce feed intake, Feed Conversion Ratio, thereby affecting its growth and carcass weight, milk production and quality in dairy animals and egg production in poultry birds.

Impact on reproduction

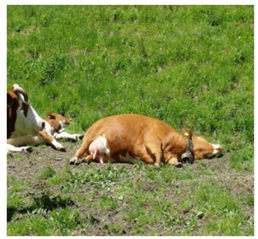
Heat stress in cattle and pig affect oestrus behaviour, oocyte growth and quality, impairment of embryo, pregnancy rate in females and low sperm concentration and quality in breeding male.

Impact on pasture and feed availability for livestock

Climate change may cause environmental stress such as drought which may affect forage production for grazing and hay making. Quantity and quality of food will be affected due to an increase in atmospheric CO2 level and temperature which will have an impact in the growth and yield of forages.

Impact on animal health and diseases occurrences

Global warming is likely to affect the health of animals directly and indirectly. Direct effects include temperature related illness causing physiological disturbances and death during extreme weather events. Indirect impacts include effect of climate on microbial populations, prevalence of infectious diseases, emerging and re-emerging infectious diseases, example SARS, swine influenza virus, Nipah, highly pathegonic Avian influenza etc, distribution of vector borne, water borne diseases, food borne diseases due to climate related flood, heavy rainfall, humidity and increase in temperature.



Effect of heat stress

Prevalence of infectious disease in animal (ASF)

Adaptation measures

Nutritional Interventions to sustain livestock production

- Feeding more concentrate at the expense of fibrous ingredients increases ration energy density and reduces heat.
- Feeding high quality forages and balanced ration
- The use of fates in diet could lower the heat load because of high energy density
- Use of antioxidants such as Vitamin E, vitamin A, selenium maintains oxidants balance resulting in improved milk quantity and health
- Frequency of feeding to 3 times daily during hot climate.

Ideal shelter design for different livestock

- Modification of floor design, cost of construction, ease of cleaning, proper ventilation, drainage, adequate lining
- Use of weatherproof or insulated materials for housing of animal shelter from adverse climate condition.

(Contd... on pg2)

Diversification of livestocks and crops

Diversification of livestock and crop varieties as in Agroforestry (establishing trees alongside crops and pastures in a mix) as a land management approach can help maintain the balance between agricultural, environmental protection and carbon sequestration to offset emissions. It also can increase tolerance to drought and heat wave in extreme climatic condition thereby improving quality of air, soil water and biodiversity. It can also improve nutrient cycle while keeping check pests and diseases.

Strategies to improve livestock breeding/Genetic resources

- Genetically develop more heat resilient breed to adapt to climate change scenario. For example: upgradation of indigenous breed with other exotic breeds.
- Introduction of genetically heat and disease resistant local breeds of animal. Example: Zovawk, Zobawng
- Use of technologies such as Artificial Insemination (AI). Implementation of embryo transfer, administration of bovine somatotroph insulin like growth factor (BST-IGF-I) for enhancing reproduction during heat stress.

Farmers perception and adaptive capacity

Understanding farmers perception using open ended survey question group discussion and including them in rural policy development. This can increase better chance of accomplishing food security and environmental conservation objectives.

Future adaptation to disease onslaught due to climate changes

- Improve surveillance and response capacity involving veterinarians, animal health workers, farmers and modern technologies.
- Forecasting and prediction of disease
- Support eradication and control of priority diseases by using a combination of vaccination, treatment, culling, use of insecticides to control multiple vectors.

Design of shelter due to climate change

Modern Housing system due to climate change

Mitigation measures

Livestock manure releases CH_4, N_2O and CO_2 gases through respiration, the latter is not counted as a net source of CO_2 emissions because they are a part of the global biological system cycle. Technical options for mitigating impact of livestock on climate change are:

- **Carbon sequestration:** It can be achieved through decreasing deforestation rates, reversing of deforestation by replanting, targeting for higher yielding crops with climate change adapted varieties.
- **Enteric fermentation (by way of nutritional intervention)**: It is a source of methane emission that can be reduced through improvement of animal nutrition through practices such as increasing dietary fat content, providing higher quality forage, supplements and the use of antimethanogens (lipids, saponins, tanins and ionospheres to suppress methane emissions)
- **Manure management:** Most methane from manure management are related to storage and anaerobic treatment. Although manure deposited on pasture can produce nitrous oxide emissions, the mitigation measures are often difficult to apply because of the manure dispersion on pasture, therefore most mitigation practices involving shortening storage duration, improving timing and application of manure, use of anaerobic digesters, covering the storage can reduce methane emissions while producing biogas.
- **Fertilizer management:** Fertilizer application on food crops increases nitrous oxide (N_2O) emissions, therefore, mitigation measures such as increasing nitrogen use efficiency is necessary. Plant breeding and genetic modifications using organic fertilizers, regular soil testing using technologically advanced fertilizers and combining legumes with grasses in pasture areas may decrease greenhouse gas emissions in feed production.

Installation of Bio Gas to reduce from emission of gas (methane

An eco friendly Culture (Sericulture)

Sericulture is the science which deals with the rearing of silkworm for the production of the silk. Sericulture and silk industry has a long history of thousands of year as a conventional trade of India. India is the second largest producer of the silk producing countries. Sericulture industry supports jobs, economic development and health and begins with cultivation of foodplant trees with their manifold uses, including production of leaves as food for silkworms.

Sericulture culminates in the production of high-quality silk thread as well as high- protein food for humans and animals. It depends, in turn, on one of the most versatile plants known, with additional benefits ranging from enhancing human health to soil conservation. Sericulture represents a rare end-to-end sustainable industry with minimal ecological impact when care is taken with supply chain management. Silk itself is a naturally versatile polymer, known as poly-fibroin, with the versatility of plastic and the advantage of biodegradability.

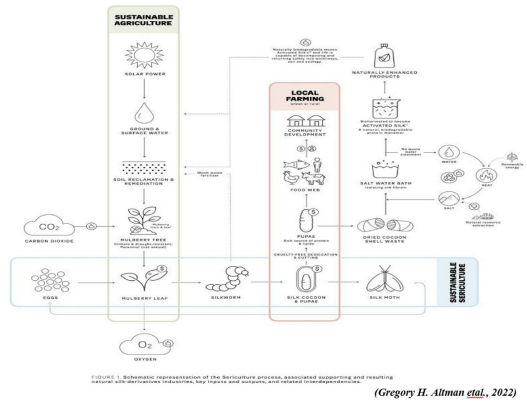


FIGURE 1. Schematic representation of the Sericulture process, associated supporting and resulting natural silk-derivatives industries, key inputs and outputs, and related interdependencies.

(Gregory H. Altman etal., 2022)

Silkworm pupae as a nutrition source

Sericulture activity byproduct pupae contain protein with many essential amino acids that satisfy generally accepted dietary requirements (Van Huis et al., 2013). For humans, consuming only 105 g (dry weight) of silkworm pupae would provide approximately 58 g of protein, which satisfies the recommended daily dietary allowance of protein for adults. In addition, silkworm pupae possess high levels of n-3 fatty acids that are important for normal metabolism and have been linked to beneficial effects on cardiovascular disease, cancer and inflammatory disease, as well as certain brain and cognitive functions, and may be used as a source of medicinal oil (Tomotake et al., 2010).

Worldwide, sericulture produces over 57,000 tons of pupal "byproduct" rich in valuable protein and lipids each year, about equal to the annual production of similarly nutritious beans in many smaller countries. The FAO reports that silkworms are one of "the most promising species for industrial feed production". In general, insect farming is much more efficient than vertebrate farming in terms of feed conversion to protein, in biomass production as well as in space and water use. Insect farming produces negligible greenhouse gasses.

Silkworm meal has already been shown to be a valuable feed protein supplement in a variety of agricultural systems, including cattle, pigs, chickens, rabbits and fish. Global movement away from such mammal and bird sources of protein and towards fish, mollusks and arthropods such as silkworms would not only alleviate major sources of greenhouse gasses but would also reduce agricultural sources of potential viral transmission across vertebrate species to humans (Ma et al., 2018).

In pursuance of higher income generation for the farmers and for in-depth research for promotion of Sericulture byproduct Mizoram University (A Central University), Tanhril, Mizoram and Sericulture Department, Mizoram signed an MoU to work together for development of Eri pupae for consumption of the Armies and their trained dogs under a project initiated by Defence Research and Development Organization (DRDO), Ministry of Defence Govt. of India, Indian Institute of Technology (IIT), Guwahati.

Climate Hazard Assessment and Mapping of Mizoram for the period 2031 to 2080

State Climate Change Cell, MISTIC

(Detail report will soon be avaible after November 2023)

As the climate continues to change, it is essential to conduct risk assessments to evaluate the potential impacts and vulnerabilities associated with future climate scenarios. The risk assessment process involves analyzing the potential hazards, exposure, and vulnerability of various systems and sectors to identify and prioritize potential risks.

Projected climate change scenario

Climatic parameters such as temperature, rainfall, storms, cyclones, etc., are projected to be more severe and frequent in the coming years and decades. Projected climate data are derived from 15 CORDEX model simulations. The ensemble of these models is employed to project future climate conditions. the data is re-gridded to a resolution of 0.25° x 0.25°, which matches the resolution of the observed IMD data. The projections cover the period from 2031 to 2080, specifically focusing on the 2050s-time frame. Two representative concentration pathway (RCP) scenarios, namely RCP 4.5 and RCP 8.5, are considered to represent different greenhouse gas concentration trajectories.

Parameters	Projections	Resolution
Monthly Rainfall	CMIP5 - 15 CORDEX model ensemble (2031-2080) · RCP 4.5 scenario -2050s · RCP 8.5 scenario-2050s	0.25° x 0.25°

Projected Monthly rainfall data over the 50 years period are compared with 6 months aggregate by using the Standard Precipitation Index, the probability of occurrence of wet and dry events varies considerably across the eight districts. The frequency of severe to extremely wet months over the study time periods are both considered for calculating the probability of severe to extreme events.

District	No. of moderately wet events	No. of severely wet events	No. of extreme wet events	Probability of occurrence of severe to extreme wet events	Rank
Aizawl	64	22	5	0.045378151	5
Champhai	47	21	6	0.045378151	5
Kolasib	65	16	3	0.031932773	8
Lawngtlai	16	7	28	0.058823529	2
Lunglei	42	16	13	0.048739496	4
Mamit	58	28	12	0.067226891	1
Saiha	15	6	29	0.058823529	2
Serchhip	48	16	5	0.035294118	7

Types of occurrences of wet events in the state Mizoram (2031-2080) under RCP 4.5 scenario

District	No. of moderately Dry events	No. of severely dry events	No. of extreme dry events	Probability of occurrence of severe to extreme dry events	Rank
Aizawl	31	24	29	0.08907563	1
Champhai	22	24	28	0.087394958	2
Kolasib	33	25	24	0.082352941	4
Lawngtlai	36	5	1	0.010084034	8
Lunglei	26	14	21	0.058823529	6
Mamit	44	37	14	0.085714286	3
Saiha	35	9	0	0.01512605	7
Serchhip	29	19	26	0.075630252	5

Types of occurrences of dry events in the state Mizoram (2031-2080) under RCP 4.5 scenario

District	No. of moderately wet events	No. of severely wet events	No. of extreme wet events	Probability of occurrence of severe to extreme wet events	Rank
Aizawl	67	31	2	0.055462185	2
Champhai	44	22	8	0.050420168	4
Kolasib	63	27	3	0.050420168	4
Lawngtlai	9	4	26	0.050420168	4
Lunglei	40	17	13	0.050420168	4
Mamit	55	36	10	0.077310924	1
Saiha	7	6	26	0.053781513	3
Serchhip	52	20	4	0.040336134	8

Types of occurrences of wet events in the state Mizoram (2031-2080) under RCP 8.5 scenario

District	No. of moderately Dry events	No. of severely dry events	No. of extreme dry events	Probability of occurrence of severe to extreme dry events	Rank
Aizawl	34	28	23	0.085714286	1
Champhai	34	20	24	0.07394958	2
Kolasib	52	21	22	0.072268908	3
Lawngtlai	30	7	4	0.018487395	7
Lunglei	30	9	23	0.053781513	6
Mamit	66	27	9	0.060504202	5
Saiha	28	5	5	0.016806723	8
Serchhip	41	18	22	0.067226891	4

Types of occurrences of dry events in the state Mizoram (2031-2080) under RCP 8.5 scenario

Climate Change and Mitigation Strategies under Horticulture Department

Since the world's surface air temperature increased an average of 1.10 Celsius due to burning of fossil fuels and deforestation, creating a negative impact in most agriculture/horticulture crops and its production. The horticulture department can play a significant role in addressing climate change through mitigation strategies. Here are some approaches they can consider.

- **Promote Sustainable Farming Practices:** Encourage farmers to adopt sustainable horticultural practices that reduce greenhouse gas emissions. This includes efficient water management, organic farming techniques, and reduced chemical pesticide use.
- **Climate-Resilient Crop Varieties:** Research and promoting the cultivation of climate-resilient crop varieties that can withstand changing weather patterns can reduce the need for inputs like irrigation and pesticides.
- **Afforestation and Agroforestry:** Advocate for and support afforestation and agroforestry projects, which help sequester carbon dioxide and improve soil health.
- **Energy-Efficient Technologies:** Promote the use of energy-efficient technologies in horticultural operations, such as solar-powered irrigation systems and energy-efficient cold storage facilities.
- **Reducing Food Waste:** Implement strategies to reduce food waste in the horticulture supply chain, as food waste generates methane, a potent greenhouse gas, when it decomposes in landfills.
- **Carbon Farming:** Explore carbon farming techniques like cover cropping, crop rotation, and reduced tillage, which can enhance soil carbon sequestration.
- **Education and Outreach:** Conduct awareness campaigns and training programs for farmers to educate them about the impacts of climate change and mitigation strategies.
- **Research and Innovation:** Invest in research and development to identify and develop climate-smart horticultural practices and and technologies
- **Policy Advocacy:** Advocate for policies that support climate-friendly horticultural practices, such as incentives for renewable energy adoption and carbon pricing mechanisms.
- **Collaboration:** Collaborate with other government departments, agricultural organizations, and international agencies to share knowledge and resources for effective climate change mitigation.

Apart from these, The Department of Horticulture, Government of Mizoram has taken various steps of mitigation strategies against the negative impact of climate change such as area expansion of fruits and vegetables and plantation of bamboo.

- **Planting of Fruits and Vegetables :** In order to mitigate the negative impact of climate change, the department implement area expansion of fruits and vegetables under MIDH 2022-2023, the department covers 923 Ha under fruits and 368 Ha under vegetables. Planting and covering of this many areas is believed to have positive impact on climate change.

- **Bamboo Plantation :** In order to mitigate global warming and soil erosion, plantation of Bamboo is carried out in an area of 351 Ha. under SEDP 2019-2021, 1053 Ha is covered under Family oriented SEDP. It may also be pointed out that a total of 1274 Ha. of new bamboo plantation was completed during 2021-2022 under Bamboo Development project in Mizoram under NEC funding covering 6 districts. Planting of this many bamboo is expected to have a positive impact on climate change.

Rooftop Solar - Renewable and sustainable energy

Zoram Energy Development Agency (ZEDA)

What is Rooftop Solar?

- ZEDA is currently implementing Rooftop Solar Scheme Phase II under the CFA (subsidy) of the Ministry of New & Renewable Energy (MNRE).
- It generates electricity using Solar module/ Solar Plate
- Rooftop solar can be installed on rooftops or any convenient places at home which is connected with the existing electric line.
- It is useful in reducing electric bill.
- ZEDA is currently working on 1MW rooftop Solar Phase- II.

Installation of rooftop solar

- For installing 1kWp, 64sq ft area is required. This comes with three module and likewise 3kWp comes with nine module, 5kWp with fifteen module and so on.
- The module should be kept in the area which will receive maximum amount of sunlight in a day.
- In a day, 1kWp will generate 4-5kWh when kept in an area that receives a good amount of sunlight.

What will be its effect on electricity bill?

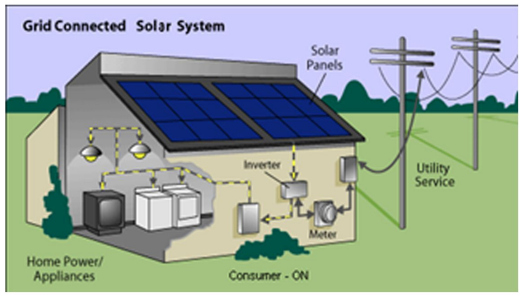
- The leftover energy generated by the rooftop solar used by the beneficiary is then exported to the power and electricity department.
- The leftover amount of solar energy generated that is used by the beneficiary exported to P&E Department and the amount of energy consumed (import) by P&E beneficiary in a month are recorded by Net Meter.
- The amount of import and export energy is then adjusted every month in the electric bill. If the export is more than import then the beneficiary need to pay only the fixed charge. The amount of export is to be adjusted in the next month's bill where it is added to the amount of energy generated by the solar.
- Since the solar export and P&E department import is a unit adjustment, it is not affected by high electric bill.
- Since electric bill is increased every year, the rooftop solar will prove to be more valuable.

Maintenance

- Operation and maintenance for five years is done for the beneficiaries of Rooftop Solar.

Example:

- The amount of energy generated by a beneficiary using 5kWp capacity Rooftop receiving good amount of sunlight can be calculated as follows:
- 1kWp Solar rooftop can generate 4kWh of electricity per day, so 5kWp can generate 20 kWh of electricity. In a month, 5kWp can generate 600kWh. At the present rate electricity of Rs. 4480/- can be generated in a month.
- Suppose every month you pay between Rs 4000/- and Rs 4500/- and install rooftop solar of 5kWp then you only need to pay the fixed charge.
- When the import and eport are adjusted and there is energy leftover then that will be purchased by P&E Department every financial year. The energy is purchased according to the Average Power Purchase Cost (APPC). The rate used as of now is Rs 4.64/- per unit.



Roof Top Solar (RTS) chu enge?

- Rooftop solar hi Central Government, Ministry of New & Renewable Energy (MNRE) hnuaiah, CFA(subsidy)awmin ZEDA in Rooftop Solar scheme Phase-II hmangin a kalpui mek ani.
- Solar Module/Solar Plate hmanga Electric siamna ani.
- Mahni inchung awl leh hmun remchangah Rooftop Solar hi dahin, electric line nen a thlun zawm tur a ni.
- Electric Bill chawi tlem nan a tangkai hle ani.
- Tunah hian 1MW rooftop Solar Phase – II Scheme ZEDA ah thawh mek a ni.

Phek leh lamah chhunzawmna

Hmun hma ngai zat leh a dah dan

- 1kWp dah nan 64sqft a mamawh a, chu chuan Module pathum (3) a keng tel ani. Chutiangzeli, 3kWp in Module pakua(9), 5kWp in sawmpanga(15) etc.
- Module hi chhim chhawng, nisa hmu rei thei ang bera dah tur a ni.
- 1kWp hian nikhatah 4-5kWh a tharchhuak thei a ni, nisa hmu rei thei ang bera dah hian.

Electric Bill a nghawng a neih dan

- RTS in Energy a thar chhuah te hi, a la tu (Beneficiary) in a hman bak te P&E department ah a thawn chhuak ang.
- Thla khat chhunga Solar in a thar chhuah hman bang P&E Dept a a thawnchhuah (export) leh P&E Dept energy Beneficiary in a hman (Import) te hi Net Meter in a record vek a ni.
- Export leh Import Energy te hi thla tin Bill siam dawnah adjust tur ani a. Export hi a tam zawk chuan Beneficiary in fixed charge bak a chawi a ngailo. Export tam zawk na hi thla leh Bill a adjust tur in a thla leh a solar thar chhuah nen belh tur ani.
- Solar Export leh P&E Dept atanga import te hi unit adjustment anit avangin, kumtin a electric bill sangin a ti buai ve lo ani.
- Electric Bill kumtina a san avangin Rooftop hlutna a zual zel dawn tihna ani.

A enkawl zui dan

Rooftop Solar hmangtu te hi kum nga (5) Operation & Maintenance tihsak anni.

For Example:

Beneficiary in 5kWp capcity Rooftop lo la ta se, ni sat that thla ina hnuai ami ang hian rooftop thar chhuah a chhut theih ang.

Solar Rooftop 1kWp in nikhatah 4kWh a siam chhuak thei a. chuvangin 5kWp in nikhatah 20kwh a siam chhuak thei a, thla khatah 5kWp in 600kWh a siam chhuak thei ani.

Tuna a rate ang chuan Rs.4480/- thla khata thar chhuak ang ani.

Thla tina Rs.4000/- atang Rs.4500/- vel bill chawi thin lo nita se, rooftop 5kWp I lak chuan fixed charged bak chawi tur I nei dawnlo ani.

I import kha export nena adjust anih hnuah a chuang la awm chu financial year ah P&E Department in a lei let sak dawn ani. A leina rate hi Average Power Purchase Cost(APPC) anga lei phawt tur ani a, hei hi tuna rate hman ah chuan Rs.4.64/- per unit ani.

Environment Impacts of 10MWp Grid connected SPV Power Plant, Thenzawl

Power & Electricity Dept., Govt. of Mizoram


Pu R. Lalzirliana, Power Minister, Engineer-in-Chief P&E and Department officials visited the proposed site of 10 MW Thenzawl Solar plant on Dt. 29.09.2023

Renewable energy projects are cleaner energy generation options in comparison to other technologies. The zero dependence on fossil fuels makes it a preferred choice in comparison to non-renewable energy.

It is evident that the CO_2 emissions from solar power are much lower than that of coal or natural gas based energy generation. A major motivation of focus and investments in deploying solar power projects is to contain and reduce greenhouse gas and other toxic emissions conventionally associated with energy projects.

Solar energy is renewable by nature, which makes it an eco-friendly source of energy that can address our power needs without any harmful repercussions like the emission of greenhouse gases. Govt. of Mizoram has intended to set-up 10MWp Grid-connected SPV Power Plant at Thenzawl. The proposed solar power plant site is located at the hill top of Vantawng Khawhmun Ram, Thenzawl, Serchhip District. Mizoram. The site is located at 23014'11.09"N; 92045'50.35"E. There is an ample space for installation of 10MWp Solar Power Plant on the hill top of Vantawng Khawhmun Ram, Thenzawl. Thenzawl is about 90Kms from Aizawl City. The proposed place is at about 3.6 Kms from Thenzawl to Lunglei World Bank Road. The proposed power plant is expected to generate 17.489 Million Units per annum. Moreover, as greenhouse gas emissions from human activities increase, they build up in the atmosphere and warm the climate, the project is expected to reduce Greenhouse gas of about 13,991 tons per year.

Therefore, the above solar project will be play an important role in reducing greenhouse gas emissions and mitigating climate change which is critical to protecting humans, wildlife and ecosystems.