Agrivoltaics in India and its Potential Growth

A collaboration between

GRAMIN VIKAS TRUST

GVT

Striving for Improved & Sustainable Livelihood

FARMDO GROUP

Farmdo group

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Gramin Vikas Trust (GVT) started its journey in 1992 as a national level non-profit development organization with the support from Krishak Bharati Cooperative Ltd (KRIBHCO), Ministry of Chemical & Fertilizers, GOI and DFID (UK) to create a world where every citizen can live a secure, healthy and fulfilling life and sustain in harmony with nature.

Along with various social, economic and environmental development initiatives, GVT is involved in enabling capacities of rural populace through running various institutes like School of Rural Management, National Livelihood Resource Institute and Krishi Vigyan Kendra.

GVT

Striving for Improved & Sustainable Livelihood

Corporate Profile

Farmdo group

Support agriculture and contribute increase of farm's income

The new ideal style of agriculture for next generations.

Direct sales

"Shoku" no" Eki" (Food) (station)

17 Stores

Chisan marché

16 Stores

Agriculture

Solar sharing

38 Farms

Agriculture-welfare cooperation

50 Person

Renewable energy generation

Solar power plant

197 Plants

Wind power ・Mini hydropower

25 Plants

Overseas

JCM project

8 Plants

UNIDO&JCM project

1 Plants

Increase Farmers Incomes
4,000 farmers sell directly to customers through our stores improving their revenues

Agriculture and Local Development
Jobs for 35 disabled individuals
120 people employed locally

Safe Electricity
Producing enough renewable energy to reduce CO_2 emissions by an equivalent of 30,000 households

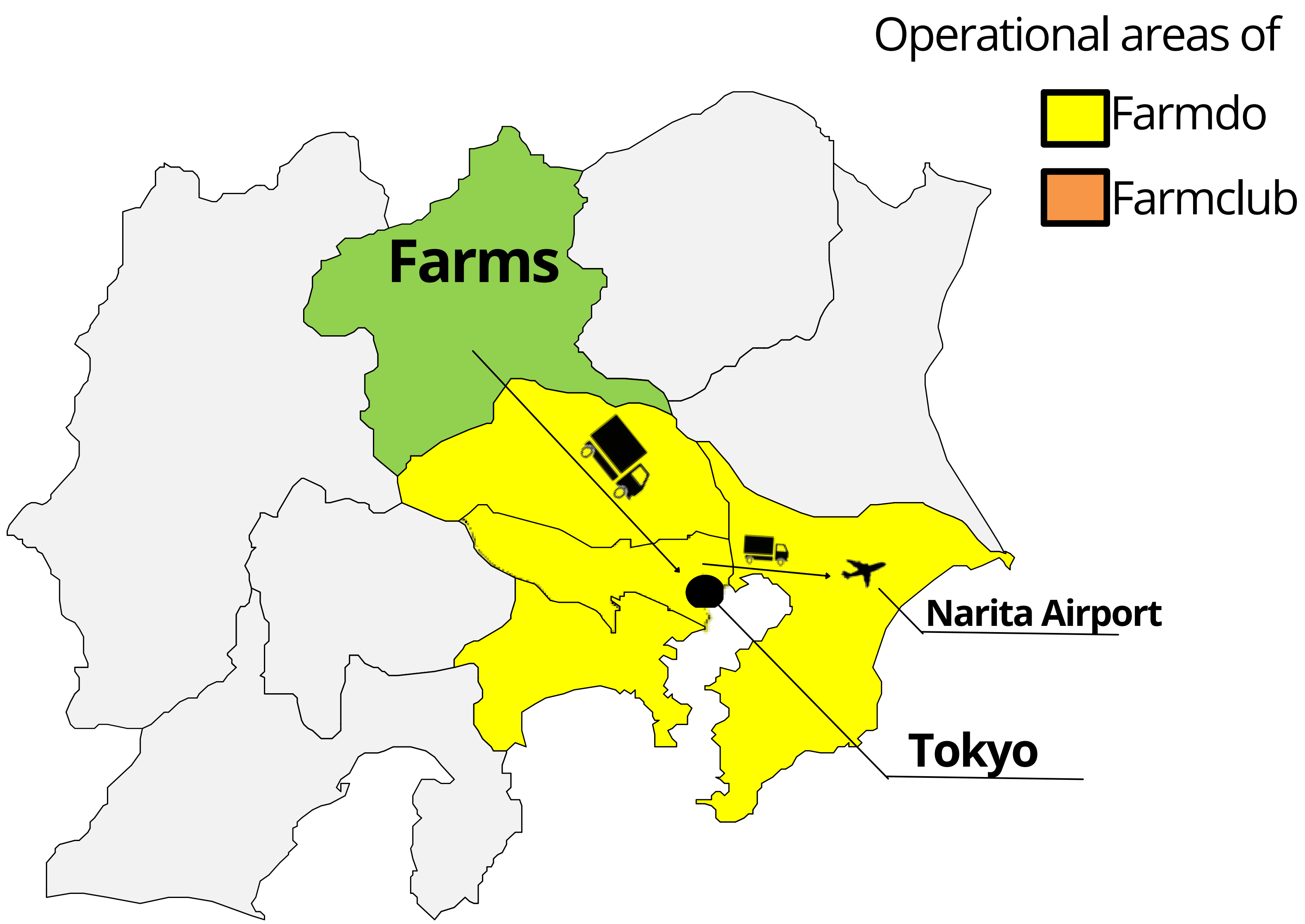
Energizing the Earth
Establishing renewable energy on 500 abandoned farmland locations to help diversify farmers revenues

Activities in Mongolia highlighted at COP25

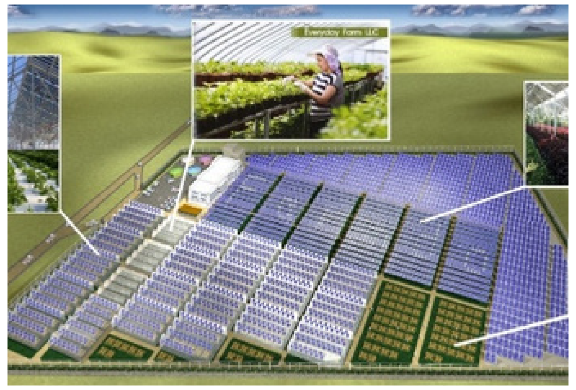
Corporate Profile

Domestic Distribution Network

- 80 Ha of Solar Farms managed in Gunma Pref
- Produce sent to Tokyo area retail stores
- Distribution center established at Narita airport for export and import



International Experience



In Mongolia

- 2 projects
- Fully operational since 2017
- 28 Ha of agriculture land
- Solar farms (greenhouses and open air)
- 12.7 MW DC
- 12,500tCO_2 emission reductions per year

In Chile

- 5 projects
- Expected full operation from Q2 2024
- 30 Ha of agriculture land
- Single Axis tracking technology
- 15 MW DC
- 11,700tCO_2 emission reductions per year

In Kenya

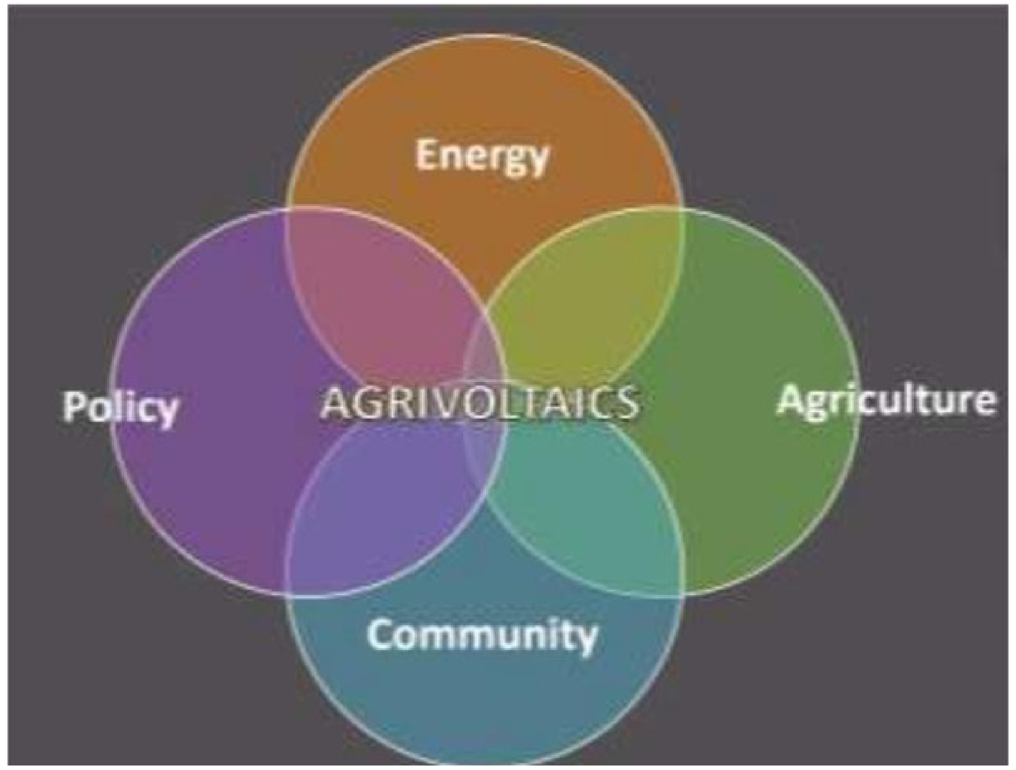
- 1 projects
- Rose farm self-consumption
- 230kw solar and 200kw battery
- Plan development 10 MW solar in local

Agrivoltaics an Introduction

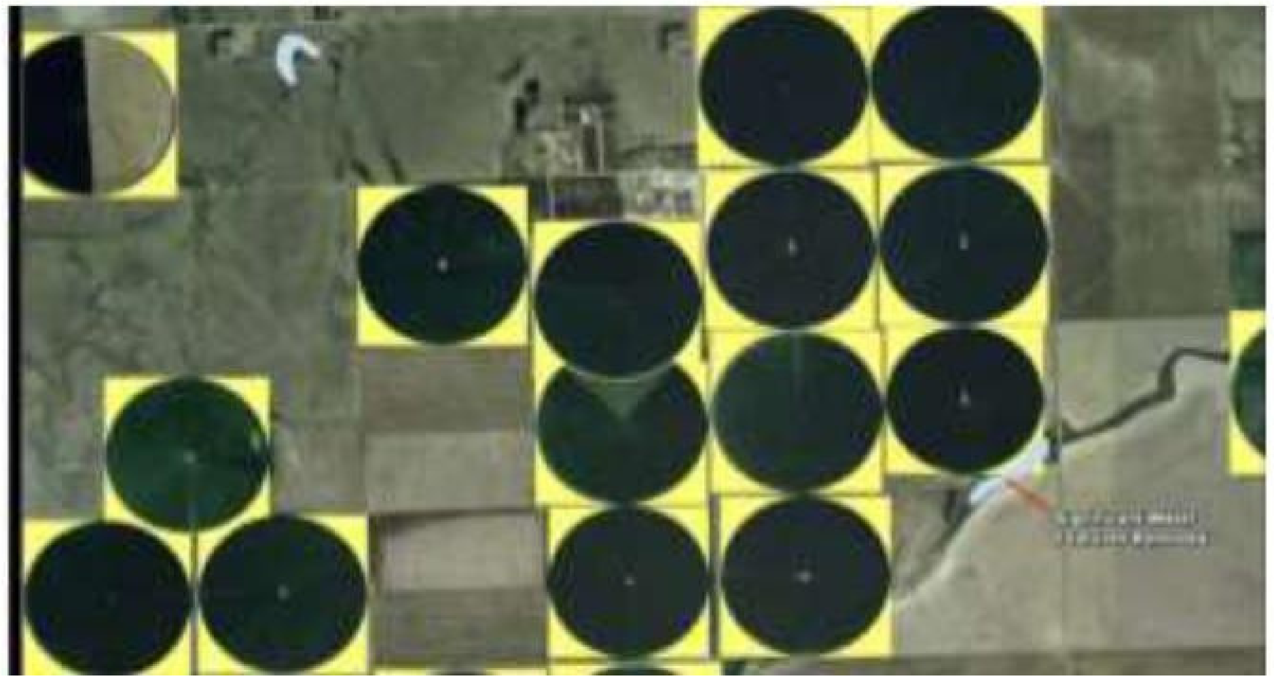
Problems or Questions Leading to Agrivoltaics

Energy Centric	Agriculture Centric	Energy and Agriculture Centric
Pre-designed solar plant	Farms with center-pivot irrigation	Designed with agriculture activities in mind
Maximize land use by growing crops in rows between panels	Maximize land use by building solar in corners	Balances solar and agriculture yield to maximize land use

Components of Agrivoltaics



Agrovoltaics managed agrivoltaic implementation in Himachal, India



Typical large scale farming in multiple countries

Farmdo Group agrivoltaic plant in Gunma, Japan

Agrivoltaics an Introduction

Benefits of Agrivoltaics

Simultaneous use of land for both farming and photovoltaic power production.

Generate a source of employment for the local population and fixed revenues for farmers.

Crops in between array can prevent soil erosion, reducing dust load on PV module.

Shade-tolerant crops can be grown in the dry season, increasing the soil's productivity and fertility.

Agricultural activities can occur throughout the year, increasing the number of cycles to two or more, opening new markets and revenues for farmers.

Micro-climates under PV-module, reducing the temperature, resulting in the optimum g eneration of PV-based electricity

Protection against hail, frost and draught is provided by agrivoltaic system.

Agrivoltaics can supply electricity for water treatment and catchment.

Suitable Crops for Cultivation in India

Onion, Gralic, Chilli, Brocouli, Spinach, Cauliflower, Salad, Field Beans, Legumes, Leafy vegetables, Raddish, Carrot, Green Cabbage.

Grapes, watermelon, muskmelon, strawberries.

Most type of Ornamental and medicinal plants are suitable. Eg: Alovera, Basil, etc.

Agricultural Package of Practice plays an improtant role for most efficient growth of crops and incresing the output of electricity generated by PV modules.

Project Introduction

Goals

- Provide energy security to farmers
- Decentralize renewable energy
- Contribute to achieving 40% non-fossil-fuel sourced power capacity by 2030

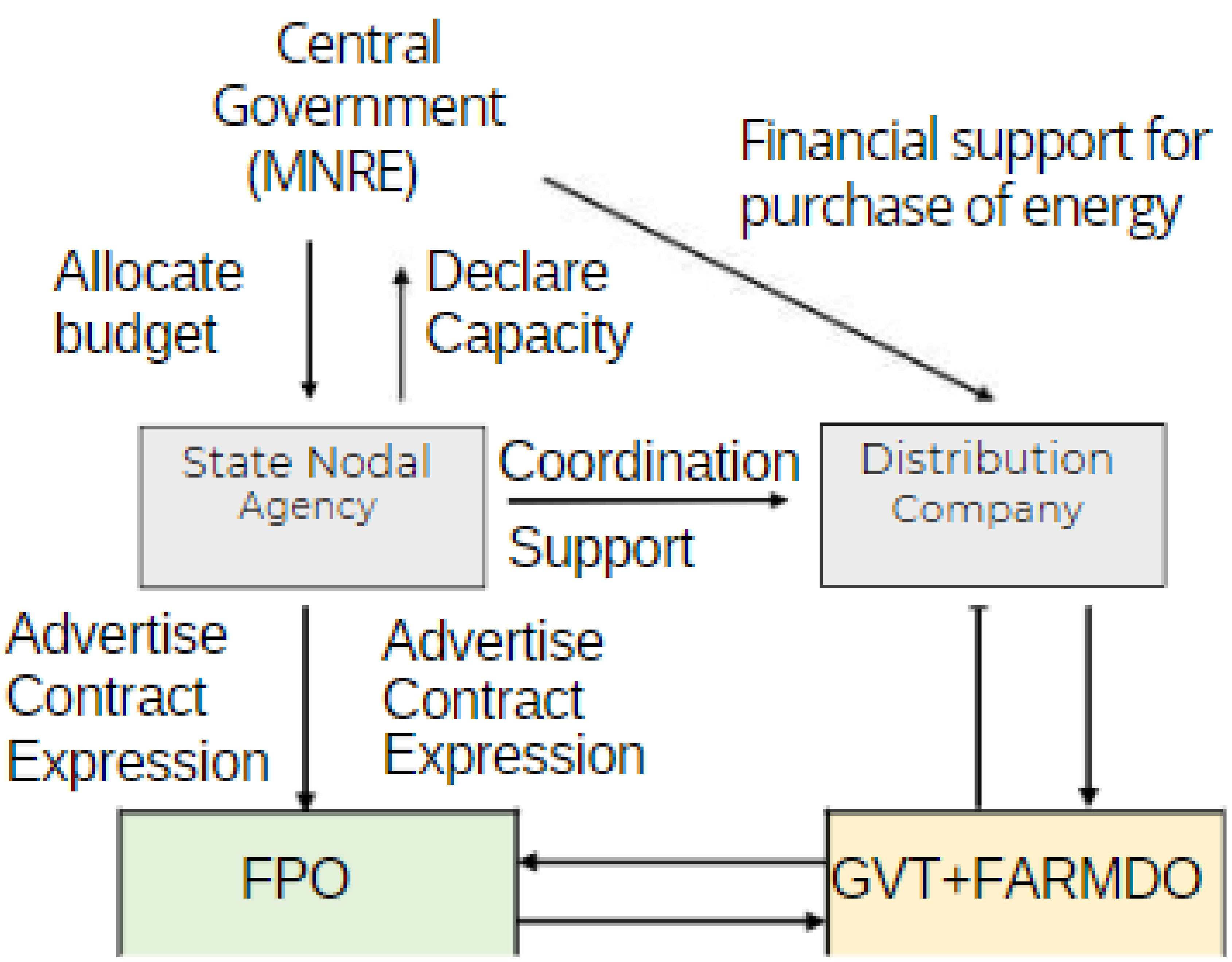
Components

a. Install 10,000 MW grid connected solar PV on agriculture land sized up to 2 MW.
b. Install 1.75 million solar powered irrigation pumps to replace diesel run pumps.
c. Solarize 1 million grid connected solar pumps allowing sales of excess energy to the grid.

Year	2022-23	2023-29
Pilot	1 MW	
Main		10 MW

- The distribution company is obligated to purchase all electricity from Solar PV
- PPA for 25 years at price per kWh set by state

Implementation Structure



Project In Himachal Pradesh

250 kW Solar Plant under KUSUM Scheme

with agriculture implementation

- **Project Outline**

Location	Mandi, Himachal
Status of Land	Already existing solar
Plant Land Area	800 m^2
Solar Panels	250w Polycrystalline
Cultivated Crops	Cabbages, Onions, Garlic, Eggplant, Chilies, strawberries

- Agriculture implementation must consider heavy shading from panels
- Space under panels not available
- Able to reduce O&M costs of solar plant
- through elimination of weeding
- Increase of solar generation through creation of micro-climate reducing temperature of panels

Future Expasion

Project Vision

Introduction of Japanese style Agrivoltaics to India with an energy and agriculture centric approach.

Project Goals

- Engage with farmers
- Demonstrate Farmdo Group and Agrivoltaics knowhow
- Increase resilience of farming in India to climate change

Project Outline

Location
Distribution Company

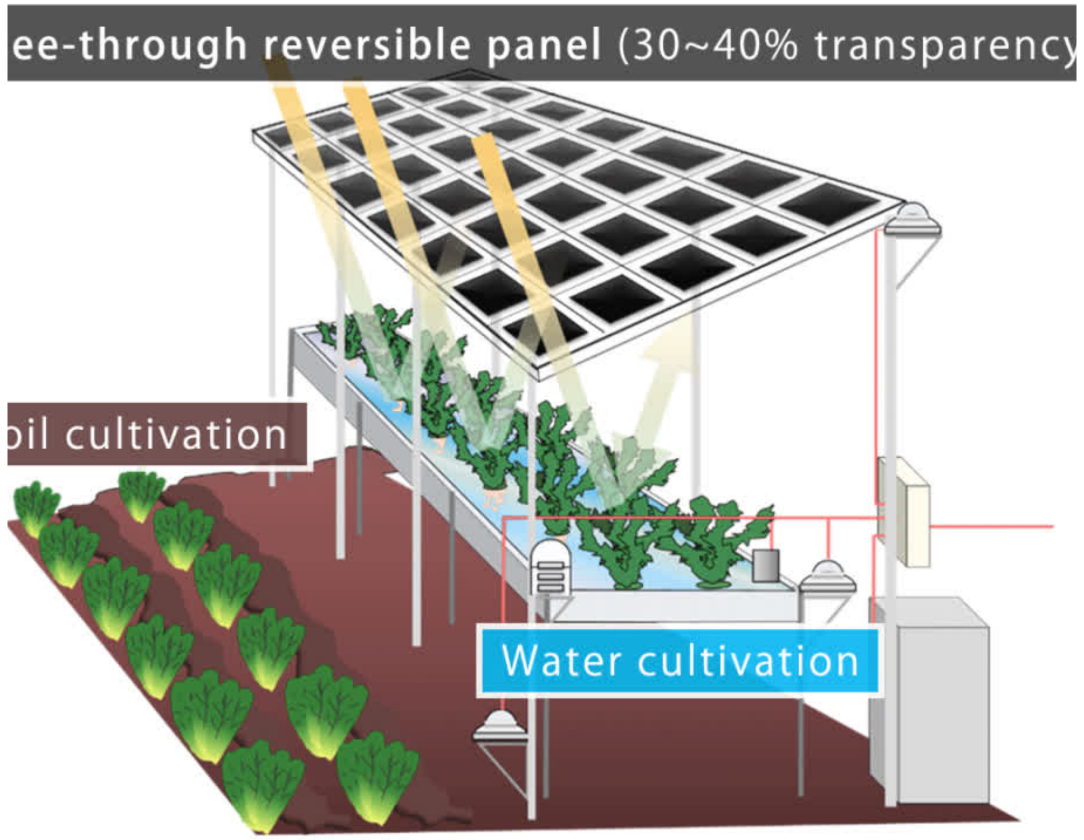
Project Capacity Land Area
Estimated Generation (avg.)
CO2 Emission Reduction (avg.)
PPA tariff

Himachal Pradesh
Himachal Pradesh State Electricity Board Limited
2 MW
2 HA
2,800 MWh per year 2,500 tCO2 per year*
3.98 INR/kWh (0.05 USD)

* Emission reduction based on grid efficiency factor published by Indian Government 2021

Farmdo Group's Solar Farm model

- Bi-facial PV panels
- Increased spacing between cells
- PV panels height 3.5-4.5 meters
- Used in open air, and enclosed systems(greenhouse)
- Compatible with hydroponics, non-soil growing mediums and traditional soil culture agriculture



Solar Farms in Gunma, Japan

Real World Examples

Under construction polyethylene greenhouse incorporating Solar PV roof.

Open air system using white weed barrier sheets to increase reflectivity and reduce OPEX.

Future Expansion

Other GHG (N2O) emission reduction

Granular Fertilizer

- Inefficient, often overused
- Leeches into rivers and ground water
- Undergoes volatilization becoming N2O in the atmosphere

Drip Irrigation with water soluble fertilizer

- Direct application of fertilizer to roots
- Reduces 65% waste of fertilizer
- Conservation of water

Ag-tech to be implemented

- Multispectral cameras and sensors on tractors. Identifying crops nutrient requirement.
- GIS techniques to identify plants transpiration rates affecting change in temperature of panels.
- Image analysis and sensors used to track the live growth of plants helping to understand the ecosystem under PV **panels resulting in further optimisation of agrivoltaics**.
- Study using light sensors, humidity sensors, temperature sensors, AI, and automation to understand plant growth and reaction to changing lighting and environmental conditions can be further carried out for optimization purposes of agrivoltaics.


Thank you