Refresher Training Program
on
"Applications of Solar Technologies in Agriculture and Allied Sectors"
(Under AC & ABC Scheme)

17 to 19 October 2022

PROGRAMME SCHEDULE

Date and Day	Session	Subject/ Topic	Faculty
1	2	3	4
17-10-2022 Monday	10.00 to 10.15	Registration and Inauguration Application of Solar Technologies for Agriculture and allied sectors	Mr. J. Koteswara Rao M.8125544429 jkrao@nimsme.org
	10:15 to 11:00	Innovation and Entrepreneurship	Mr. G. Sudarshan M.No: 9494959108 sudarshan@nimsme.org
	11:00 to 11:45	E-business and Monetization opportunities in Agri Sector	Dr. Dibyendu Choudhury M. 9700422230 dibchoudhury@nimsme.org
	11:45 to 13:00	Road map for Agri start-ups	Mr. Sharath Muthyala M.No : 94917 20486 muthyala.sarath@nimsme.org
18-10-2022 Tuesday	10:00 to 12:00	Application of Solar Technologies in Agriculture sector Experience Sharing: Solar-Hybrid Dehydrator	Mr. Venkat Kumar Tangirala Managing Director of Wind Stream Energy Technologies India Pvt. Ltd., M 998 994 5914 info@windstream.tech
	12:00 to 12:30	Institutional Support and Government Schemes for Agri- Entrepreneurship	Dr. Shreekant Sharma 7894357671 sharma@nimsme.org
	12:30 to 13:30	Role of State and Central Government and Nodal Agencies- PMKUSUM Scheme- guidelines	Shri. Rama Prasad, Project Director, TSREDCO-Hyd M.9949961115
19-10-2022 Wednesday	10:00 to 11:00	Government Initiatives for promoting Solar Technologies in Agriculture and Allied Sectors	Dr L Venkat Reddy Freelancer, Kukatpally Industrial estate, KPHB, Hyderabad adenvironmentappc@gmail.com
	11:00 to 12:00	Promotion of Agro & Food Processing Clusters	K. Surya Prakash Goud, Mobile.No 9908724315 kspg@nimsme.org
	12:00 to 12:45	Prospects of Agri & Food Products Exports	Dr. K. Visweswara Reddy, Mobile.No 9989022344 kvisweswarareddy@nimsme.org
	12:45 to 13:00	Feedback and Valediction	Mr. J. Koteswara Rao M.8125544429 jkrao@nimsme.org

EXECUTIVE SUMMARY

National Institute for MSME organized on-line training programme on **"Applications of Solar Technologies in Agriculture and Allied Sectors" (Under AC & ABC Scheme)**. Energy is the major source for the development of agriculture and industry. Telangana receives very high solar radiation which indicates a very clear potential for solar-based power generation. Hence, solar energy is a highly desirable renewable energy source that has immense potential in the agriculture and agro-processing industry.

The demand for energy in agriculture has increased significantly to meet the needs of growing population and increasing demand for food. For which not only the already available sources of energy are inadequate and have dwindled because their reserves are nearing to depletion. Therefore, along with other aspects of development in the field of agriculture, the field of research and exploration of new sources of energy is also the focus of interest of agro-researchers. Sun is an eternal center of energy, where solar fuel is being converted into solar energy by the fusion process since the birth of the solar system. The use of solar energy is of central importance to meet energy demands. Fortunately, the blessings of Almighty Allah are that solar energy has many features, which can be used directly and indirectly.

For ensuring a sustainable future and addressing the increasingly serious impacts of climate change, especially global warming, developing countries are urgently seeking to switch from traditional energy to renewable energy [1]. Solar energy is abundant, free, and non-polluting; hence, it is considered one of the most competitive choices of all renewable energy choices [2].

The agricultural sector also uses different methods to take advantage of these different features of solar energy for different applications. For example, the thermal properties of solar energy are used to dry foodstuffs, vegetables, crops, and meat, etc., which is a direct use of it. Drying of these goods is done by direct use of solar energy, but it needs a long time which is a waste of time, also it is more likely to be contaminated with dust, malnutrition, food, insects and flies. In addition, unpredictable climate changes, such as wind and rain, can cause serious damage.

In modern times, a variety of solar dryers are used for such direct use of solar energy. For the last few decades, solar energy has been used in various ways after converting it to other forms of energy such as chemical energy and especially electrical energy for various services and research has been given much importance for the improvement of the conversion methods to capture solar energy. The conversion of solar energy into electrical energy "so electrical energy" has greatly increased its use in various spheres of life.

Much research isbeing done in the field of agriculture for use of electrical energy. And its use is sure to not only alleviate energy shortages for a variety of purposes, but is also a cheap, easy, unlimited, and widely available source of energy on the whole earth throughout the year.

The use of this so electrical energy for water pumping, lighting, pesticides spraying, and various types of machinery such as tractors, etc., is being innovated day by day in agriculture. But utilization of solar energy in agriculture in this way is still limited, a lot of awareness and research is required to be beneficiary of this blessing and hope of future energy requirements.

This chapter includes the awareness of solar energy and potential role of solar energy in the development of the agricultural sector and agroindustry. To avail the benefits of solar energy and consume it to perform various agro-affairs through different applications are discussed in this chapter. Moreover, research done so far to improve the agricultural sector through its use in various ways is also covered in this study. This study will provide coordination between energy researchers and farmers to utilize solar energy with its different characteristics.

Renewable energy forms a major Source of energy, of which solar energy, harnessed from the sun, has gained a pivotal position. By converting the power of the sun into electricity, solar energy is clean, and green. It is a long term and non depletable resource with good employment potential, occupying a vivid position in the recent years. The energy demand projections for different sectors presents a varied picture , the energy intensity of GDP for Agriculture is projected to grow with more intensive cultivation.

INTRODUCTION

The demand for energy in agriculture has increased significantly to meet the needs of growing population and increasing demand for food. For which not only the already available sources of energy are inadequate and have dwindled because their reserves are nearing to depletion. Therefore, along with other aspects of development in the field of agriculture, the field of research and exploration of new sources of energy is also the focus of interest of agro-researchers. Sun is an eternal center of energy, where solar fuel is being converted into solar energy by the fusion process since the birth of the solar system. The use of solar energy is of central importance to meet energy demands. Fortunately, the blessings of Almighty Allah are that solar energy has many features, which can be used directly and indirectly.

Solar radiation sustains all forms of life on earth. According to estimates, sun radiates about 1.74 x 1017 W of power to earth. The main features of solar radiation are widespread read distribution, inexhaustible supply and pollution-free source of energy. Solar energy is not available at night, making energy storage an important issue in order to provide the continuous availability of energy. Both wind power and solar power are intermittent energy sources, viz.,an available output must be taken when it is available and either stored for when it can be used, or transported, over transmission lines, to where it can be used.

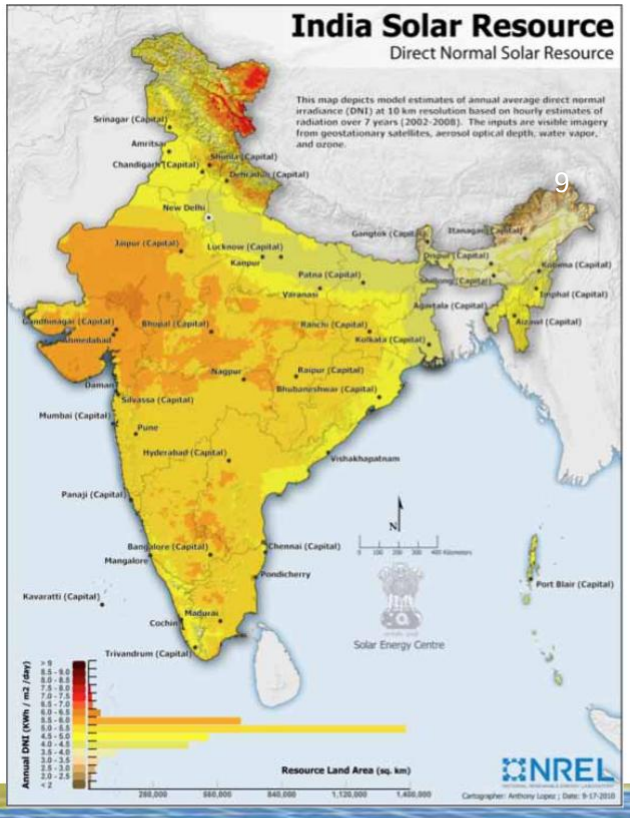
Solar energy is the cleanest and most abundant renewable energy source available. Modern technology can harness this energy for a variety of uses, including generating electricity, providing light or a comfortable interior environment, and heating water for domestic, commercial, or industrial use. Solar energy is a flexible energy technology: solar power plants can be built as distributed generation or as a central-station, utility-scale solar power plant. Some utility-scale solar plants can store the energy they produce for use it after the sun sets. The power from the sun intercepted by the earth is approximately 1.8 x 1011 MW. This makes it one of the most promising unconventional energy sources. Solar energy is available in abundance in most part of our country throughout the year. In India, the annual average daily solar radiation received over the whole of the country is around 1800 J/cm2/day.

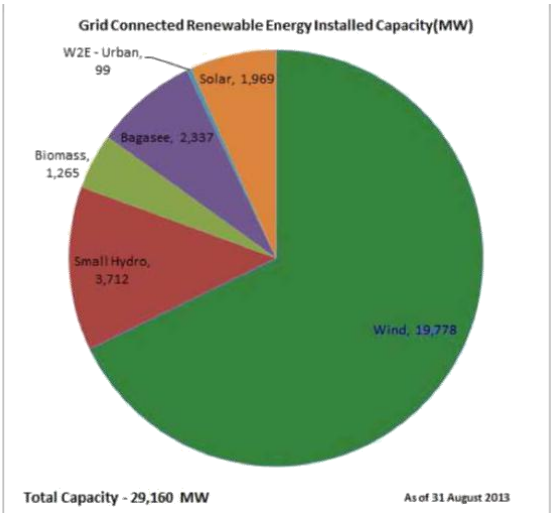
The sun’s radiation provides both heat and light energy from it. The energy harvested from the sun’s radiation for various purposes on the Earth’s surface is termed solar energy which is of two types, solar thermal energy, and solar photovoltaic PV energy. Solar energy, radiant light, and heat from the sun are harnessed using a range of ever-evolving technologies such as solar heating, solar photovoltaics, solar thermal electricity, solar architecture, and artificial photosynthesis.

Most of the energy on the earth is received from the sun. Solar energy creates a circulation of wind and ocean water causing water evaporation and consequent precipitation. Plants use solar energy for photosynthesis and store carbohydrates, protein, fats, oils,
Alcohols, cellulose and lignin. In agricultural systems, energy is available from different sources as human, animal, sun, wind, biomass, coal, fertilizer, seed, agro-chemicals, petroleum products, electricity etc. Widespread use of solar energy for domestic, agricultural, and agro-industrial activities has been practiced and the increasing threat of an acute shortage ofcommercial sources of energy coupled with serious environmental pollution problems has accelerated interest in the scientific exploitation of renewable sources of energy. The energy available from the sun is inexhaustible and environmentally friendly. Solar energy technologies are likely to play an important role in the near future through a variety of thermal applications and decentralized power generation and distribution systems.

Solar technologies are broadly categorized as either passive solar or active solar depending on the way they capture, convert, and distribute solar energy. Active solar techniques include the use of photovoltaic panels and solar thermal collectors to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favourable thermal mass or light-dispersing properties, and designing spaces that naturally circulate air. Active solar technologies increase the supply of energy and are considered supply side technologies, while passive solar technologies reduce the need for alternate resources and are generally considered demand-side technologies.

When considering solar PV in particular, there are two modes of utilization of power. In the off-grid mode, the solar PV panels generate electricity that is stored in battery banks and converted into AC from DC as required with the help of inverters and charge controllers. This is preferable for remote and/ or rural areas. In the on-grid mode, the solar PV panels are connected to the grid with the help of appropriate inverters and charge controllers but without the need for a battery bank. It is to be noted that on-grid systems prerequisite the presence of grid infrastructure without which evacuation of the generated power is not feasible





Need for Solar Energy

With decreasing fossil fuel reserves across the world, increased pollution and global warming resulting in climate change, the need to shift to a cleaner and greener source of energy to meet the demands of a growing population is of foremost importance. Increased use of thermal and nuclear energy poses their own set of risks. Hence, to effectively meet the power requirements, to enhance industrial growth and economic development, solar energy is a viable option when adopted on a large scale. India has a theoretical solar power reception of 600 TW. On an average, India receives 4-7 kWh/ m_2 owing to the 300 plus clear sunshine days available. Despite the fact that commercial solar panel efficiencies are about 10%-15%, it still would be able to meet the demand for the nation if tapped appropriately. In the solar energy sector, some large projects have been proposed already, and 35,000 km_2 area of the Thar Desert has been set aside for solar power projects, sufficient to generate 700 GW to 2,100 GW.

Total Installed Photovoltaic Peak Power Capacity (MWp) by 2018	
Country	**Capacity**
European Union	68,640
Germany	32,509
Italy	16,987
China	8,043
USA	7,665
Japan	6,704
France	3,843
Australia	2,291
India	1,839
UK	1,831

Government Support

The State and Central Governments have announced various schemes and policies to promote the installation and propagation of solar energy among both HT and LT consumers. The National level solar subsidy amounts up to 30% of the total capital cost of the installed solar system which the consumer can avail. Apart from this, several other schemes, such as the one provided by the NABARD allows easier access to solar by rural communities.

Jawaharlal Nehru National Solar Mission (JNNSM) is an important program of the Government of India under Renewable Energy sector aims at establishing India as a global leader in solar energy by creating policy conditions for its diffusion across the country. It is the major initiative to promote ecologically sustainable growth while addressing India's energy security challenge. Phase I of the Mission has a target to achieve 1000 MW of installed capacity, of which the State target is 22MW.

Jawaharlal Nehru National Solar Mission

Application Segment	Target for Phase I (2010-13)	Cumulative Target Phase II (2013-17)	Cumulative Target Phase III (2017-22)
Grid Solar Power including rooftop	1,100	4,000	20,000
Off-grid solar applications	200	1,000	2,000

Source: Ministry of New and Renewable Energy

Telangana State Solar Energy Policy 2015

Tamil Nadu has a very good solar potential with 300 clear sunny days as it receives very high solar radiation. The Government of Telangana is committed to promote renewable energy generation in the State and has come out with **"Telangana State Solar Energy Policy – 2015"** which aims at generating 3000 MW of solar power by 2022 with a vision of developing the State as a world leader in Solar Energy. "Telangana Solar Energy Policy 2016" aims to :

- To achieve energy security
- To reduce carbon emissions
- To project Tamil Nadu as a Solar Hub
- To generate 3000 MW of Solar Energy by 2022
- To achieve grid parity by 2022
- To encourage indigenous solar manufacturing facilities in the State
- To promote Research and Development in the solar energy sector and hybrid systems
- To create skilled man power and employment in a new industry

Telangana State Solar Policy 2015

Phase (2013-2015)	Utility Scale (MW)	Rooftop PV (MW)	REC(MW)	Target (MW)
2013	750	100	150	1000
2014	550	125	325	1000
2015	200	125	675	1000
Total (by 2015)	1500	350	1150	3000

Apart from encouraging indigenous solar manufacturing facilities with incentives, the policy aims at promoting research and development in the sector and hybrid systems, besides creating skilled manpower and jobs. Telangana Energy Development Authority (TEDA) is the nodal agency for guaranteed single window clearances to be made within 30 days so that the plants to be commissioned in less than 12 months.

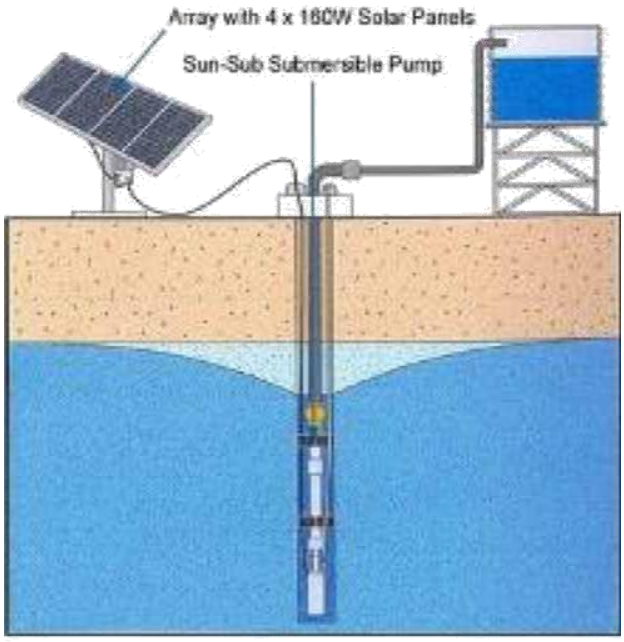
The State promotes the solar energy through promotion of Solar Rooftop Systems (Domestic) – Generation Based Incentive of 2 per unit for first two years, 1 per unit for next two years and 0.5 per unit for subsequent years. Solar Parks is being set up with a capacity of about 50 MW each in 32 districts - Establishment of exclusive Solar Manufacturing Parks to promote solar manufacturing industries in these parks is being setup. Promotion of Rooftops in Government buildings and all street lights and water supply installations in local bodies has been taken up and Installation of Solar Water Heating System for buildings, new houses/ hotels and industries is made mandatory.

Solar in Agriculture

Tamil Nadu is richly endowed with fertile lands and agro climatic zones suitable for a varied agricultural produce. “Vision Telangana 2023” envisages an investment of Rs. 55000 crore in the solar power projects in Telangana. Although many farms would find it difficult to become completely solar powered, natural methods of harnessing solar energy and installing solar panels has been a viable alternative. Drying of various agricultural produce in open sunlight is an age-old practice. Development of various solar devices for thermal applications such as water heating and space heating, drying, cooking and power generation has been the order of the day. Solar cookers, Solar dryers, Solar water heater, photo voltaic systems are commonly used. In solar photo voltaic (SPV) technology the solar radiation falling on a device called solar cells are converted directly into electricity without any environmental pollution. Solar pumping systems are ideal for lifting water for drinking and irrigation without harming the environment. These pumps can be installed in boreholes, tanks, cisterns or rivers etc.

The solar pumps use the solar photovoltaic energy to pump water for agricultural and other purposes. A wide variety of pumps ranging from DC surface to submersible AC pumps are available. They also require a pump controller to adjust for the variation of solar radiation throughout the day. DC surface pumps are designed for high flow rates and low heads. The DC motor driving the surface pump is powered by matching solar arrays to maximize efficiency. AC submersible pumping systems are designed for high head and medium flow applications. Solar PV water pumping systems are used for irrigation and drinking water. The majority of the pumps are fitted with a 200–3,000-watt motor that are powered with 1,800 Wp PV array which can deliver about 140,000 litres of water per day from a total head of 10 metres.

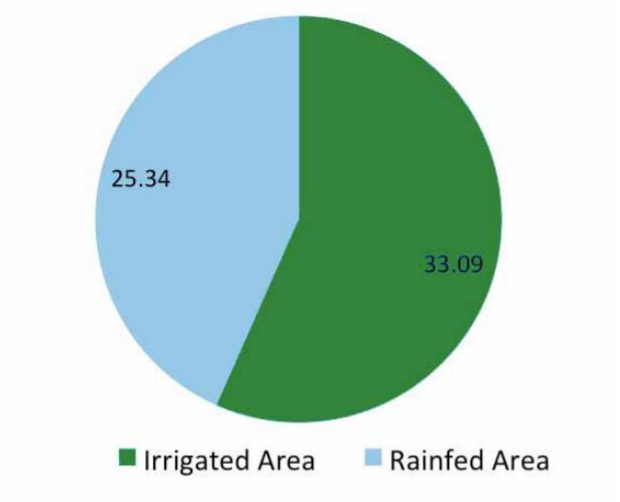
Solar energy is a constant energy and does not rely on the burning of harmful fuels to generate electricity. Solar power is non-polluting and it does not contribute to global warming or greenhouse gas emissions. Solar power allows those in remote locations to live off the grid without having to rely solely on noisy generators. It is part of the solution, to becoming energy self-sufficient. Solar energy is renowned for its versatility – it can be used to power anything from a tiny torch to a satellite in space. However solar energy relies upon enough sunlight reaching the photovoltaic cells – on cloudy days there may not be enough sunshine to produce sufficient electricity and production shuts down completely at night so back-up energy sources are necessary. Solar Energy helps the farmers control energy costs when pumping water or during drought and is profitable alternative to low margin crops. Solar energy for processing plants helps to provide reliable electricity to meet demand at peak processing times and hedge against volatile electricity prices. Solar energy for cold storage helps to offset high electricity loads by producing on-site solar electric power.



Agricultural farming, processing and storage have high and variable energy needs. As a result, unexpected changes in electricity prices can have a costly impact on finance. Providing a consistent energy source at lower fixed rates, has attained utmost importance for ensuring that business has affordable solar electric power. It has become easier and more affordable to use solar power on a farm due to the rapid advancements in technology and the increasing awareness about renewable energy sources.

In this session, Mr. Venkat Kumar Tangiralla, Managing Director, Wind stream Technologies, Hyderabad highlighted on the use of the solar-powered pumps for farming activity in the state. agriculture contributes around 13% to state GDP with 40% of the population involved in Agricultural activities with the cropping intensity of around 1.18. The contribution of food grains is around 3%, vegetables 7%, fruits 12%, and flowers 24% to National produce.

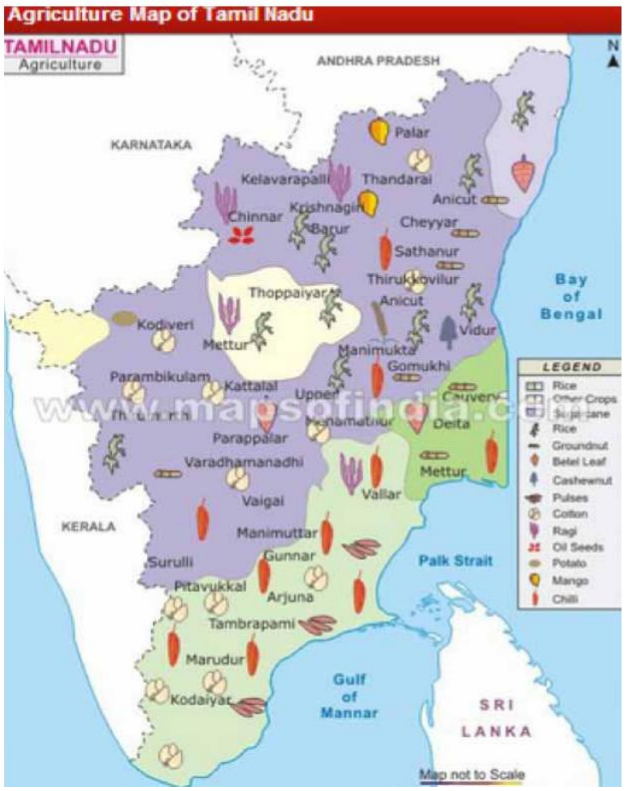
Gross Cropped Area in TN (lakh sq. km)



Agriculture is a primary sector plays a vital role in the economic growth of the state. Factors like erratic and inadequate monsoon rain, low cropping intensity depletion of ground water, deterioration of soil health and yield gaps in majority of the crops have resulted in the reduction of crop yields. Agricultural yield and productivity is interlinked with varied factors, the crux being the technological advancement and the use of modern techniques which interlinks with the power availability to operate the pump sets, motors etc.

The power situation in the state depicts that the installed capacity of conventional energy sources is 10,515.34 MW while the non-con ventional is 8,060 MW. The energy demand is 10,000 MW to 12,300 MW and the average energy availability is 8,500 MW. Considering the growing demand for the electricity, solar energy becomes highly dependable. Solar Water Pumps will directly impact on:

- **Agriculture** through Improving the yield of per unit of land/ water and accelerating innovation and extension mechanism and ensure timely irrigation
- **Water** through Improvement in irrigation practices and reduction of water losses, promoting of efficient use of water by modernization of irrigation systems, improved service delivery, participation of farmers and popularization of micro irrigation Crop Group Historical Yield Trend



Yield gap in major crops

Crop	Potential Yield (Kg/ha)	Average Yield (Kg/ha)	Yield Gap (Kg/ha)
Paddy (I)	6000	5275	(-) 725
Cholam (I)	6000	3008	(-) 2992
Ragi (I)	4750	2527	(-) 2223
Red gram	1500	667	(-) 833
Black gram	1270	389	(-) 881
Groundnut (I)	2850	2481	(-) 369
Sugarcane (I)	146000	109000	(-) 37000
Cotton (I)	730	426	(-) 304

Source : Dept. of Economics, TNAU.2019 : Coimbattore-641003 stands for Irrigated

As per Central Electricity Authority's 2018 General review, there a total number of 20.9 lakh agricultural electric pump has been energized and around 20 % (~2000 MW) of power is consumed annually in the agriculture sector. The current power scenario shows that 21% of the power is utilized by the agriculture sector. The irrigation profile emphasizes that 56% of the lands are irrigated by pump sets while 18% of lands are irrigated through tanks and 26% through canals.

Free supply of power to agriculture plays a major role in agricultural development though certain factors like power cuts, act as an impediment to development. This session further highlighted on the solar water pump system and its component description.

- High-efficiency PV modules generate power
- DCPM optimizes power output at the module level
- Controller performs system-level MPPT and drives pump at variable speed to match input power to required power
- High-efficiency 3-phase AC pump delivers water from source

Solar water pumps create a difference for irrigation farmers by enhancing the customer value proposition through Intermittent grid power which enables to do day time irrigation, opportunity to utilize full land holding and option to grow high profit crop such as cash crop. For the diesel pump users, solar pumps enable diesel abatement, opportunity to utilize full land holding and to increase crop intensity.

Solar pump: Case study

Case studies on the use of the solar pump in Agriculture and its success were also presented in this session.

Solar pump: Case Studies (1)

Farmer Situation:

- Mr. OVR Somasundaram is a renowned agriculturist from Tamil Nadu
- Pioneered the concepts of intercropping of Nutmeg and Cocoa to maximize yield
- One of the most prosperous farmers in Coimbatore

Problem:

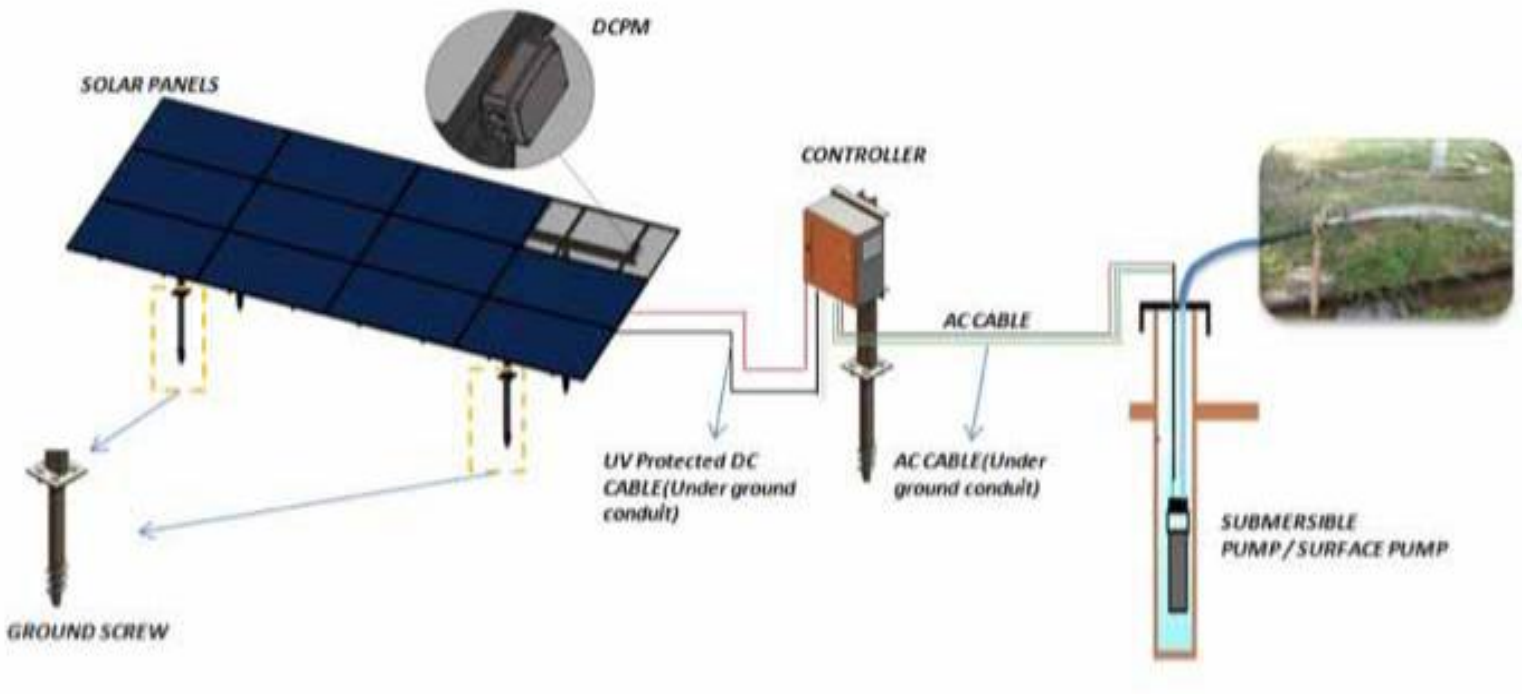
- Intercropping tremendously increases water requirement
- Two open wells supply sufficient water
- Infrequent electricity however, only at night time
- Night-time labour expensive to hire
- Unwilling to use the polluting diesel alternative

Solution:

- SunEdison designed, supplied, installed and commissioned a 10HP water pump in his one of the existing open well
- Did not require any financial assistance, in recognition of the value added
- First TN farmer to install a 10 HP solar pump in TN
- 20 acres of land covered through drip irrigation
- Water delivered 1.2 km away from source
- Reduced night time labour requirement
- Mr. Somasundaram plans to equip all existing electric pumps with solar technology.

OVR Somasundaram, Pollachi

- Depth of water: 30 meters
- Cultivation: 25 Acres (Coconut)
- Type of Irrigation: Drip
- System Size: 10 HP (8.4kW)



Solar pump: Case Studies (2)

Farmer Situation:

- Mr. Srirangan owns five acres of land in Anaimalai village in Coimbatore district
- After retiring from a government job, he chose agriculture to meet his ends.
- 1/4th of land used for coconut plantation.

Problem:

- Intermittent, low-quality power supply
- 3/4th of land free for cattle rearing: restricted by lack of good water supply
- Bore well constructed: diesel pump ineffective for such low depths

Solution:

- Heard about SunEdison solar pumps in 2011
- Arranged for loan from nationalized bank
- SunEdison designed, supplied, installed and commissioned a 5HP solar pump
- Compatible with drip irrigation to optimize water use

Value Add:

- Banana cultivation started on free land
- Tank created to store excess water for cattle rearing
- Mr. Srirangan now earns more than what he used to in his Government Job.

Srirangan, Coimbatore

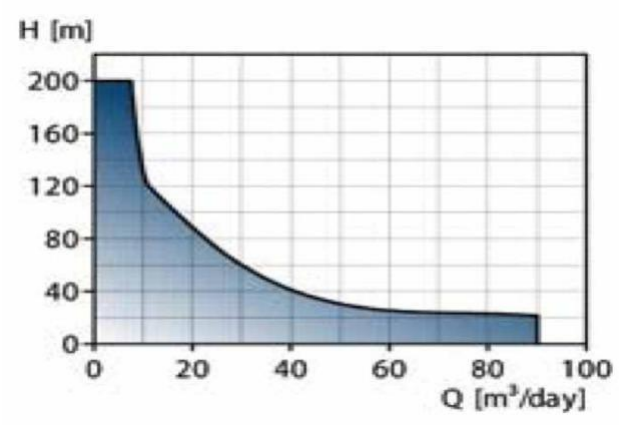
- Depth of water : 150 meters
- Cultivation: 5 Acres
- Type of Irrigation: Flood
- System Size : 5 HP (4.2kW)

this session dealt with the benefits of solar water pumps in agriculture. Solar pumping solution for the agricultural market has dual approaches viz., Supply Side Management and Demand Side Management. Solar pumping solutions could be the right option to support desired /adequate requirements for agriculture needs. Inefficient pumps result in consuming high energy. Power savings through solar pumps have been the wider option and on the demand side, Solar water pumps help farmers through lower Pump Failure rate and less maintenance and higher agricultural yield.

This session highlighted on the earlier techniques used in the solar water pumps and the improvements to the latest techniques.

PRODUCT FEATURES

- Centrifugal or Helical version
- Compatible to Solar, Wind or Combi System
- Simple installation
- Reliable water supply
- Virtually no maintenance
- Expansion possibilities
- Cost-efficient pumping
- Dry-running protection



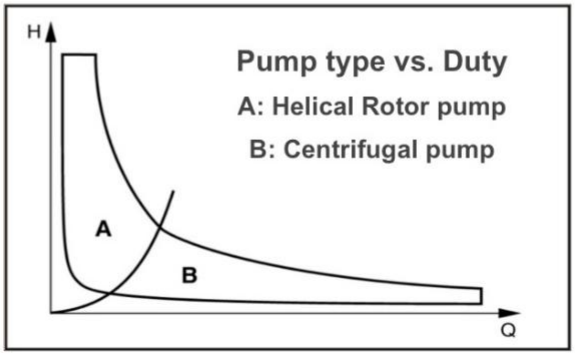
PERFORMANCE RANGE

Flow Q (Max)	90 m^3/day
Head H (Max)	200 m
Liquid Temp. (°C)	0 °C to 40 °C
Voltage Supply	30 – 300 VDC Or 1x90-240V, 50/60Hz
Installation Depth	Max 150 m

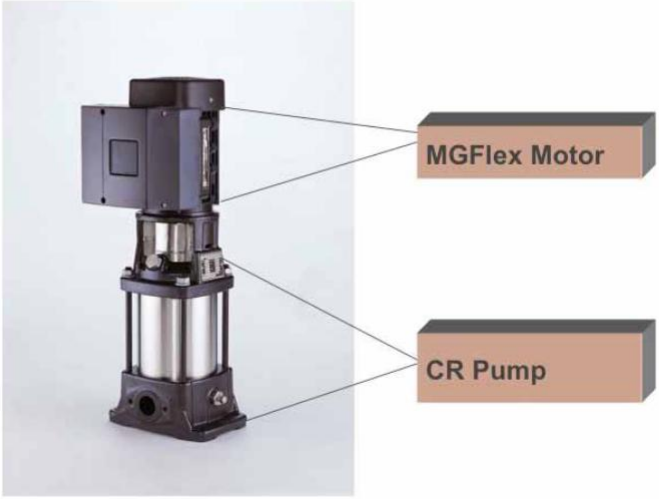
Grundfos Solar Submersible Pump- SQ Flex

Helical Rotor SQFlex
High Head Performance
3” diameter pump end
5 different variants

Centrifugal Rotor SQFlex
High Flow Performance
4” diameter pump end
6 different variants



Grundfos Solar Surface Pump - CRFlex



One-stop product solution
MPPT software
AC/DC compatibility
Connection to solar, generator or grid
Motor protection
Sensor and switches connection

MGflex is an high efficiency
motor Wide Voltage Range
Known-good reliability history

High efficiency hydraulic
Known-good reliability track record
Wide range of material combinations
Easy installation
Various connection solutions

Grundfos Solar Surface Pump - CRFlex

PERFORMANCE RANGE	
Flow (Q) , Max	32 cum/hr
Head (H) Max	150m
Liquid temp, Deg C	0 to 120 Deg C
Power input P1 (Max)	1730W
Current (Max)	8.9A
Speed (Max)	3600 RPM
Voltage Supply	VDC 30 – 300V DC VAC 1x90-240V, 50/60Hz

SP / CR + inverter – higher capacities

Submersible pump with an external inverter

- Flow range: 1.5cum/hr to 180 cum/hr
- Head range: up to 500m
- Motor capacity: 2.2 to 18.5 KW
- Voltage : 3X220V AC (2.2 to 4KW) and 3X415 V AC (5.5 to 18.5KW)
- 150-450 V DC (2.2 to 4KW) and 450-800VDC (5.5 to 18.5KW)

CR (Inline pumps) with an external inverter

- Flow range: 2cum/hr up to100 cum/hr
- Head range: 20 to 220m
- Temperature: up to 120 Deg C
- Motor capacity: 2.2 to 18.5KW , 3X415V AC, 450-800VDC

Certain installations carried out through the solar pumps were highlighted in this session.

Typical Village installation in Maharashtra for drinking water – Pump SQF 2.5-2 below the hand pump

7500 LPD @ 90m, input power -900W

Nellore SQF 8A-5-48000 to 50000 LPD at 80 Feet

Installations

Badami, Karnataka
Application: Irrigation
SQF 3A-10
Flow: 35000 LPD @55m

Karur, Tamil Nadu
Application: Irrigation
SP 3A with 4 KW motor
Flow: 3.5 m3/hr @ 170 m

Sivaganga, TN (Irrigation 180,000 LPD @ 30 M, 4 KW)

Bangladesh: Irrigation Project. SP60-3, 5.5KW, 300,000 LPD @ 20m

In this session, a presentation by J. KoteswaraRao Associate Faculty Member of **ni-msme** highlighted energy conservation and Green Practices for Agriculture through use of the solar power. The Session stressed on the innovative green initiatives available in the Agro-Industries through renewable energy mainly solar energy. Agro-Industries may differ from Large Industries either in scale or in different aspects but energy, is the prime necessity which is not fully available in the rural sector and for SMEs. Rural industries (specifically Micro & Small industries) have the advantage of being small and also getting the energy needs through renewable energies or energy conservation through locally available resources, redesign of the existing systems, in man - machine combination through innovations.

Solar Applications in Cotton to Garment Processing are highly effective since it is possible to promote decentralized solar applications through segmenting the textile process machinery and coupling suitable DC drive systems instead of AC thereby optimizing the power requirements of the process machinery for renewable energy applications to justify internal rate of returns (IRR) and to utilize the locally available renewable energy resources thereby providing sustainable employment round the year. The use of solar energy in various applications commonly used were also presented in this session. The use of solar energy in the garment business and its machinery is highlighted below:

Solar Cotton to Garment Business Unit

Mini Solar Spinning Unit

Solar Powered Power-looms in Tirupur & Auroville, T.N

The use of Solar powered machines used for Agricultural processing and artisans are shown below:

Poultries & Hatcheries

150 Yellow CFL (16 W)

Replaced with Yellow LED's (4 W)

Agriculture & Processing Machineries

Solar Pumping

Solar Fodder Machine

Solar Fruit Grader

Artisan Guilds

Solar Micro Tools

Solar Potter wheel

Energy efficient potter kiln

Other Micro & Small Enterprise Applications identified & conditioned for Green Energy

Dhoop-batti machine

Solar Handicapped Tricycle

Liquid Filler

Auger Filler

Food industries play a key role for development and use of the solar energy in varied activities in the food industries is shown below:

Food Industries

Solar Micro Dal Mill

Solar Food Drier

Vegetable Cutting Machine

Solar Powered Sheds & Buildings

Innovative Solar Cooler

LED Indoor & Outdoor lightings

The presentations highlighted on the concept of utilizing Renewable Energy in the villages for varied applications. Renewable energy concept in villages focusing on the micro level applications through solar power were presented which would serve for energy efficiency and saving power and facing the challenges ahead in the energy sector.

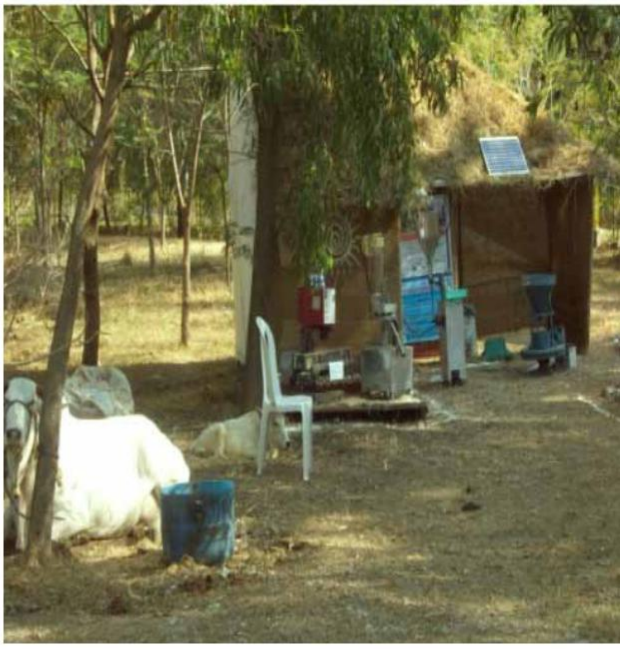
A hut demonstrating solar powered textile unit

A hut demonstrating solar indoor & outdoor LED lighting, solar fan, solar cooler, laptop/ mobile charger etc.

A hut Demonstrating solar micro tool & solar potter wheel for artisan gild

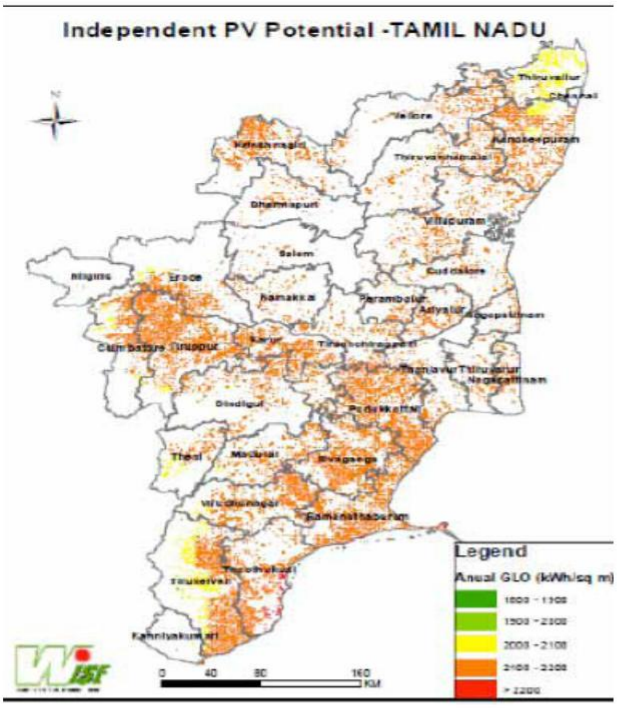
A hut demonstrating biomass based products and charcoal briquettes

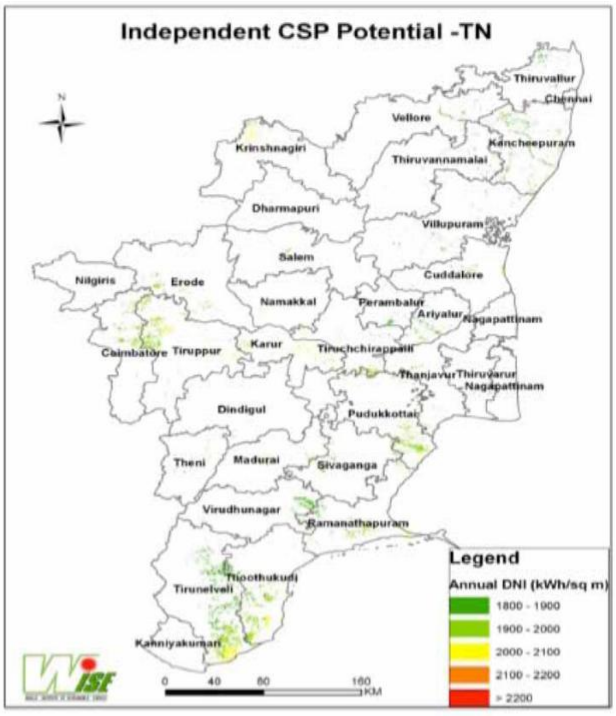
A hut with other rural industry set-ups like solar dal mill, liquid filling machine, auger filling machine & Packaging Machine



Biogas based power back-up system & Panchagavya products like Dhoop-batti machine, mosquito repellent coil machine, cow urine-based phenol etc.

Solar PV potential of each district





No.	District Name	Avg Ann GHI Kwh/sq m	Area Sq km	Potential MW
1	Ariyalur	5.82	73	3650
2	Chennai	5.77	1	70
3	Coimbatore	5.84	172	8576
4	Cuddalore	5.83	61	3047
5	Dharmapuri	5.88	23	1136
6	Dindigul	5.89	73	3647
7	Erode	5.93	127	6354
8	Kancheepuram	5.78	293	14648
9	Kanniyakumari	5.86	1	55
10	Karur	5.97	149	7440
11	Krinshnagiri	5.90	139	6928
12	Madurai	5.88	106	5319
13	Nagapattinam	5.84	37	1828
14	Namakkal	5.96	16	795
15	Nilgiris	5.26	0	16
16	Perambalur	5.78	34	1711
17	Pudukkottai	5.86	465	23226
18	Ramanathapuram	5.88	364	18177
19	Salem	5.92	18	897
20	Sivaganga	5.84	427	21359
21	Thanjavur	5.84	55	2752
22	Theni	5.79	61	3051
23	Thiruvallur	5.73	111	5556
24	Thiruvannamalai	5.79	95	4732
25	Thiruvarur	5.81	23	1167
26	Thoothukudi	5.87	384	19205
27	Tiruchchirappalli	5.88	122	6100
28	Tirunelveli	5.77	746	37310
29	Tiruppur	5.95	491	24554
30	Vellore	5.80	105	5255
31	Villupuram	5.81	111	5571
32	Virudhunagar	5.80	311	15554
		TOTAL	5194	259685

Sr	District Name	Avg Ann DNI kWh/sq m	Area Sq Km	Potential MW
1	Ariyalur	5.18	49	1716
2	Chennai	5.06	1	41
3	Coimbatore	5.41	105	3668
4	Cuddalore	5.22	35	1211
5	Dharmapuri	5.40	5	173
6	Dindigul	5.39	6	224
7	Erode	5.42	53	1865
8	Kancheepuram	5.13	159	5555
9	Kanniyakumari	5.01	0	0
10	Karur	5.49	50	1752
11	Krinshnagiri	5.48	48	1670
12	Madurai	5.31	25	858
13	Nagapattinam	5.23	15	512
14	Namakkal	5.46	4	135
15	Perambalur	5.13	21	725
16	Pudukkottai	5.30	172	6036
17	Ramanathapuram	5.40	124	4347
18	Salem	5.23	8	293
19	Sivaganga	5.24	53	1841
20	Thanjavur	5.23	31	1080
21	Theni	5.29	21	719
22	Thiruvallur	5.03	29	1022
23	Thiruvannamalai	5.09	35	1211
24	Thiruvarur	5.15	10	366
25	Thoothukudi	5.38	248	8664
26	Tiruchchirappalli	5.33	63	2208
27	Tirunelveli	5.28	511	17872
28	Tiruppur	5.44	202	7086
29	Vellore	5.14	39	1364
30	Villupuram	5.16	52	1829
31	Virudhunagar	5.04	71	2483
TOTAL			2244	78525

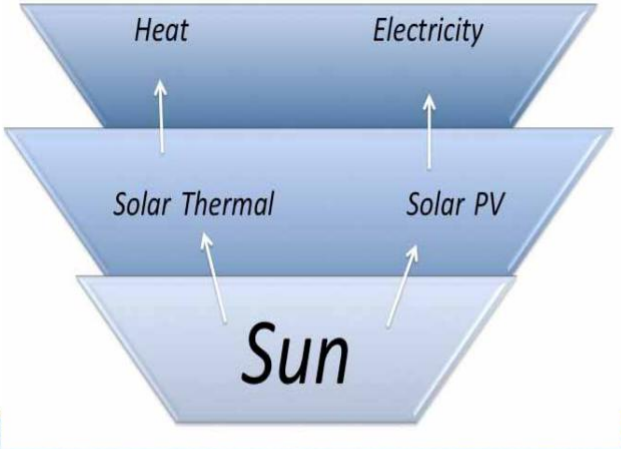
District-wise CSP potential

Solar energy is a highly essential renewable energy source that has immense potential in Agriculture and post-harvest management. The use of solar power as a source of energy in varied agricultural activities was presented by Mr.J. Koteswara Rao, Associate Faculty Member, school of Enterprise Development The Grid interactive power capacity at the National level has stood at 28708.95 MW as of 30.6.13 as shown below:

GRID-INTERACTIVE POWER (CAPACITIES IN MW)	
Wind Power	19,564.95
Small Hydro Power	3,686.25
Biomass Power & Gasification	1,264.80
Bagasse Cogeneration	2,337.42
Waste to Power	96.08
Solar Power	1,759.44
Total	28,708.95

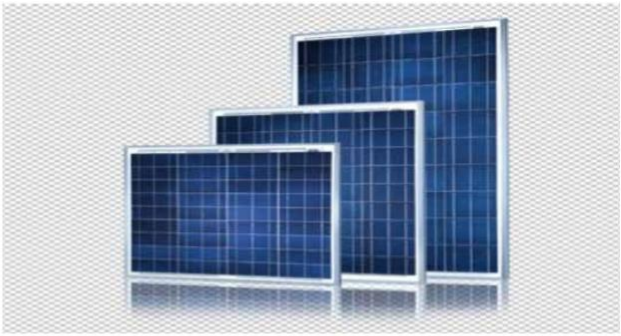
Harnessing solar energy through various modules were highlighted in the presentation.

Harnessing the solar energy



Solar modules

- Available solar module size 5-watt to 300 watts
- One silicon cell- 0.5 volts
- So, 30- 35 cells combined together to charge 15 V battery



Cell type	Efficiency of cell	Land per MW
Mono crystalline silicon	Around 18 – 24 %	3 – 4 acres
Poly/Multi crystalline silicon	Around 14 – 18 %	4 – 5 acres
Thin film (different types)	Amorphous silicon 6–10% Cadmium Telluride 10–11% Copper Indium Gallium Di selenide 12–14%	7.5 – 9 acres

Solar PV home lighting system

Model 1	* 1 light
Model 2	* 2 lights
Model 3	* 1 light & 1 fan
Model 4	* 2 lights & 1 fan
Model 5	* 4 lights

Setup - a solar PV module, battery, inverter, charge controller and DC & AC load.

Simple PV power systems run pumps directly when the sun is shining, so they work hardest in the hot summer months when they are needed most. Generally, batteries are not necessary because the water is stored in tanks or pumped to fields and used in the daytime. Larger pumping systems may include batteries, inverters, and tracking mounts to follow the sun. Some of these solar application models, its components & specification are detailed below:

Solar Pump

Available models

- DC surface pump (high flow rates and low heads)
- AC submersible pump (medium flow rates and high heads)

Tentative cost – 1 lakh/ 1 kW capacity

MNRE subsidy – Rs. 81/ watt

(maximum upto Rs. 50,000/ system)

	AC	DC
SPV rating (W)	75 x 16/24	75 x 12/24
Dimensions, Panel L×W×H (mm)	960×430× 40	960×430× 40
Pump rating (kW)	1.0-1.5	0.75-1.5
Total head (m)	50	10
Discharge (l/ day)	17,625-35,000	70,000-1,35,000

Solar Water Pumping

Solar Panels	Capacity 3 HP	5 HP	7.5 HP	10 HP
	3000 W	5000 W	7500 W	10000 W
Bore well Pumps	• 60,000 litres/day • From 30 m Deep	•1,00,000 litres/day • From 30 m Deep	•1,50,000 litres/day • From 30 m Deep	•2,00,000 litres/day • From 30 m Deep
Controlling System	Switch & Controllers	Switch & Controllers	Switch & Controllers	Switch & Controllers
Approximate Cost	Rs. 3 Lakhs	Rs. 5 Lakhs	Rs. 7.5 Lakhs	Rs. 10 Lakhs
Accessory parts	Cable & Iron rods for supporting the Solar panels			

Solar Street Light

Components

- Two photovoltaic modules of 36 Watts
- A six -meter lamppost for charging.
- A storage battery and an inverter unit.
- Tentative cost – Rs.25,000/- to Rs.35,000/
- MNRE subsidy – 30% of cost subject to Rs. 81/ watt

Spy rating (W)	8
Dimensions of module (mm)	(960-980) ×(430-450) × 40
Dimensions of Lantern (mm)	393 ×310× 100
CFL rating (W)	2 x 20
SMF battery	12V,40Ah

Solar lantern

Components:

- SPV module of 10 Wp capacity,
- rechargeable battery,
- Compact Fluorescent lamp (CFL) of 5 / 7 W and
- electronics (i.e. inverter and charge controller)

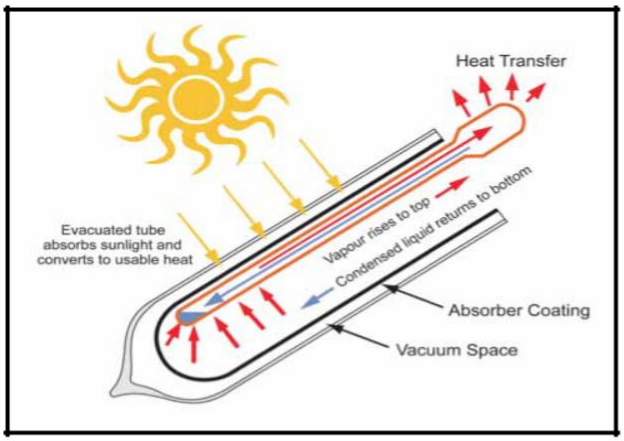
Cost – Rs. 3000 (including solar module 10 Wp)

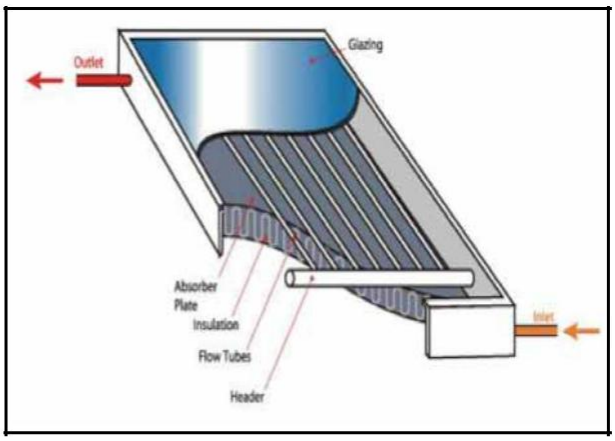
SPV rating (W)	8
Dimensions, Panel Length×Width×Height (mm)	560×260× 60
Dimensions, Lantern Diameter× Height (mm)	240×450
CFL rating (W)	7 and 9
SMF battery	12. 7 Ah

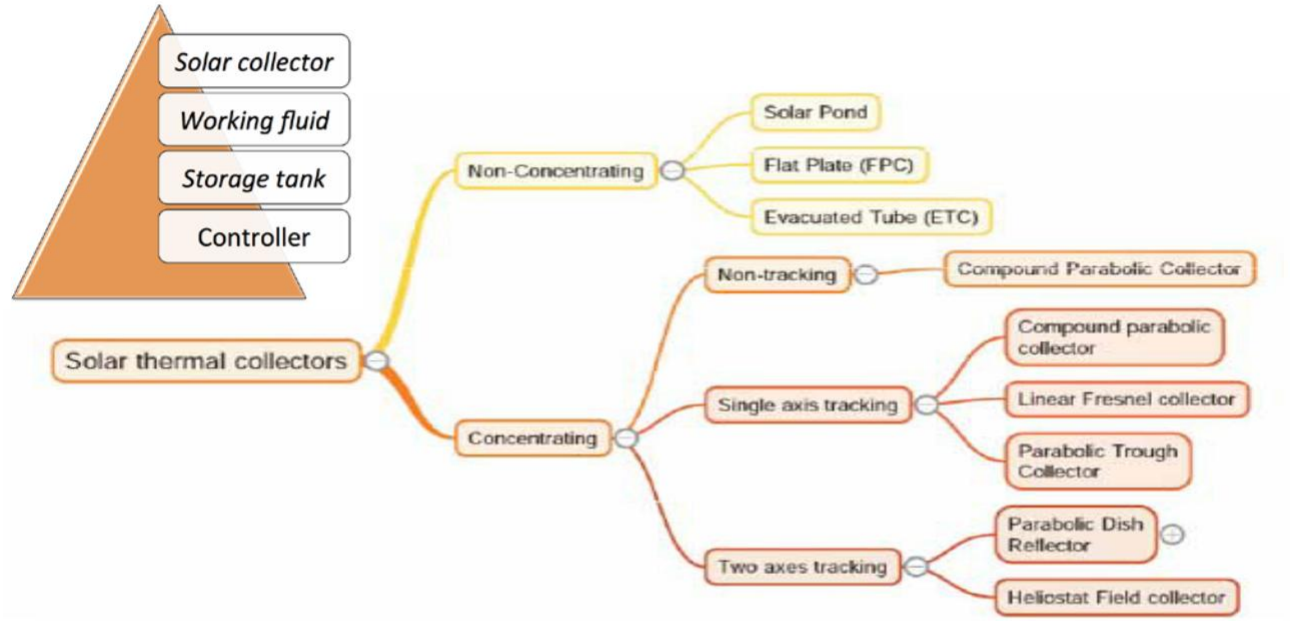
Solar fencing

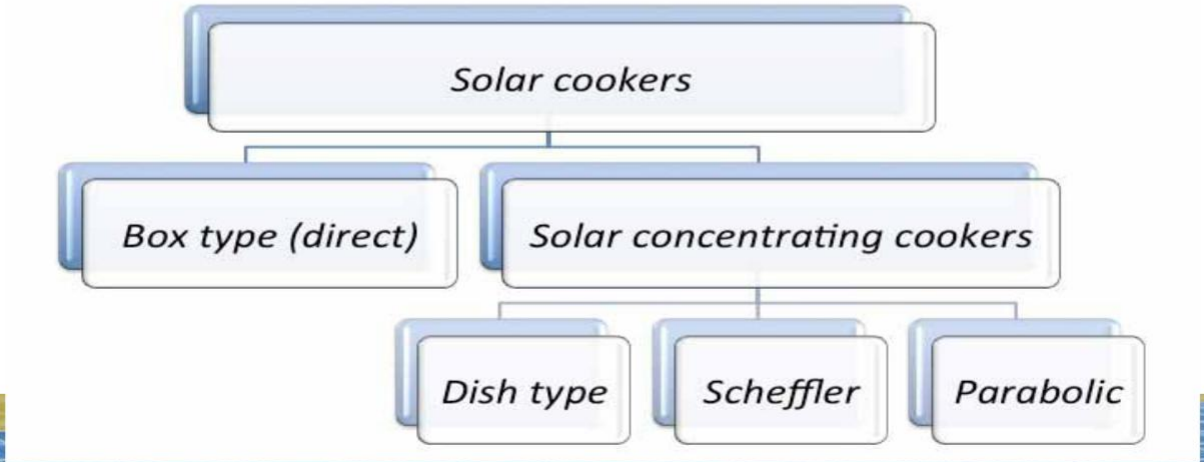
Solar fencing helps to protect the crops from forest animals . Solar fencing includes the solar panel, energiser ,battery ,fencing systems .

Solar thermal applications and its nature of performance were highlighted in this session ushering the importance of harnessing the solar energy. Solar cooker, Solar water heaters, Solar tunnel dryer, Solar distillation and Solar pond etc. are certain application modes of solar energy.


Heat Transfer
Evacuated tube absorbs sunlight and converts to usable heat
Vapour rises to top
Condensed liquid returns to bottom
Absorber Coating
Vacuum Space

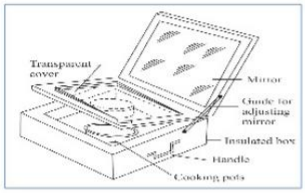

Outlet
Glazing
Absorber Plate
Insulation
Flow Tubes
Header
Inlet


Solar collector
Working fluid
Storage tank
Controller
Solar thermal collectors
Non-Concentrating
Solar Pond
Flat Plate (FPC)
Evacuated Tube (ETC)
Concentrating
Non-tracking
Compound Parabolic Collector
Single axis tracking
Compound parabolic collector
Linear Fresnel collector
Parabolic Trough Collector
Two axes tracking
Parabolic Dish Reflector
Heliostat Field collector


Solar cookers
Box type (direct)
Solar concentrating cookers
Dish type
Scheffler
Parabolic

Box type solar cookers

Overall Dimensions	500 x 500 x 200
Weight (kg)	12
Time taken in cooking (min)	rice, 45-60, vegetables 60-100.
Conversion efficiency (%)	35-40

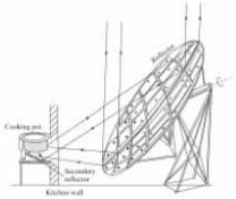


Dish type solar cookers

Shape	Parabolic
Tracking adjustment	Manual
Aperture diameter & focal length	1.4m & 0.28m

Scheffler cookers

Temperature	Attain upto 450°C
Area	8 Sq. m
Life time (in years)	Reflector - 5 Metallic structure - 15



Parabolic concentrating cooker

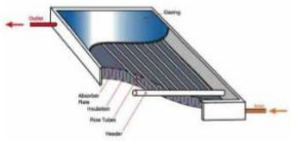
Cost :80 lakhs (1000 people)

Subsidy from MNRE: maximum upto 30%

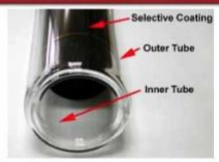
Fuel savings : 20 lakhs/ annum

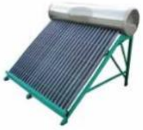
Solar water heaters

1. Flat plate solar water heater



2. Evacuated tube solar water heater





Commercial dairy farms use large amounts of energy to heat water that is used to clean equipment. Heating water accounts for up to 40% of the energy used on a dairy farm. Solar water heating systems may be used to supply all or part of these hot water requirements.

Solar still

Use	To produce distilled water
Capacity	3 liters / day.
Salient Features	No fuel, utilize solar thermal energy. Pollution free. Simple and easy to install.

Designed By Dept of Bio Energy, Tamil Nadu Agricultural University, Coimbatore

Crop Drying Operations

The simplest and least expensive technique is to allow crops to dry naturally in the field, or to spread grain and fruit out in the sun after harvesting. The disadvantage of these methods is that the crops and grain are subject to damage by birds, rodents, wind, and rain, and contamination by windblown dust and dirt. More sophisticated solar dryers can protect grain and fruit, reduce losses, dry faster and more uniformly, and produce a better-quality product than open-air methods.

Solar tunnel dryer

Use	To dry coconut, chili and agro industrial products
Capacity	1 – 1.5 tonnes/day. 5000 nuts/batch for coconut
Salient Features	Clean and hygienic drying. 200µm thick UV stabilized polyethylene as collector material Hot air temperature up to 60°
Cost	Rs. 1,30,000 (60f L * 12f B * 6f H)

Commercialized by TNAU

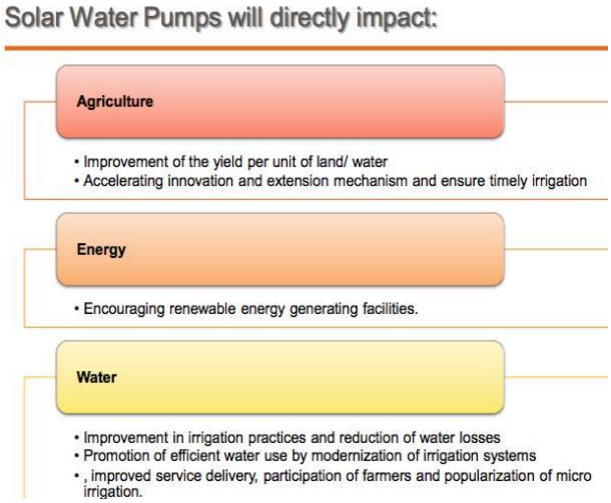
Greenhouse Operations

Commercial greenhouses typically rely on the sun to supply their lighting needs, but they are not designed to use the sun for heating. Instead, they rely on gas or oil heaters to maintain the temperatures necessary to grow plants in the colder months. Solar greenhouses, however, are designed to utilize solar energy for both heating and lighting. A gas or oil heater may serve as a backup heater, or increase carbon dioxide levels to induce higher plant growth.

Livestock Operations

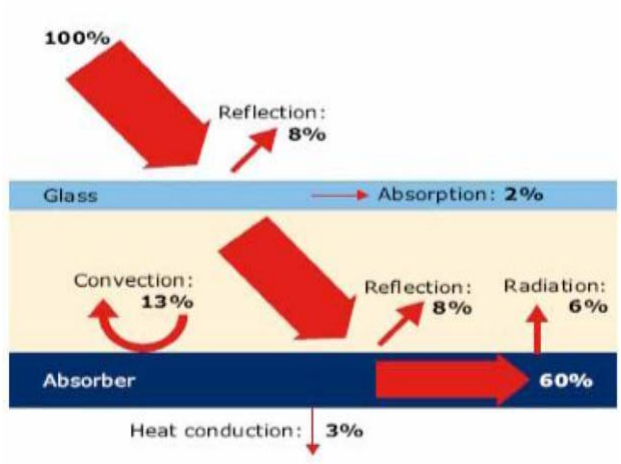
Many pig and poultry farms raise animals in enclosed buildings to control temperature and air quality in an effort to maintain animal health and growth. These facilities need to replace the indoor air regularly to remove moisture, toxic gases, odours, and dust. Heating this air, when necessary, requires large amounts of energy. With proper planning and design, solar air heaters can be incorporated into farm buildings to preheat incoming fresh air.

Solar energy is a huge source of renewable energy and the state is blessed with abundant solar energy with 240 to 320 days of full sunshine in a year with daily radiation of 4 - 7 kWh per m2. Solar energy incident on 1% of our land area at 2% net conversion efficiency can produce 6,00,000 MW of power and this energy is freely available at most places at no cost, pollution free. In this session, the presentation on the use of solar energy for Agro-processing, by a resource person highlighted the use of solar power for aggro-processing It was noted that India spends around 17,80,000 Kl/y or the equivalent of F.O. for meeting 60% of thermal energy used in industries for processing the end product and about 5 million m2 of solar collector for industrial processing and another 5 million m2 for Agro industries could reduce the fuel consumption by 25%.



The solar panel will be installed on the separate South facing support frame of the factory. The Solar panel unit will be formed using aluminium extrusions; high absorption aluminium “V” corrugated absorber, 4mm thick toughened glass, mineral wool insulation of thickness 75mm, silica sealan,t and EPDM rubber. Fresh air zig–zag gedagged below the special “V” corrugated aluminium that the collector will deliver hot air in the range of 60 – 95 ^{o}C depending upon Solar radiation. The insulated metal duct will draw the Solar heated air through a suitable blower with necessary controls and deliver it to the inlet points of the drier.

SOLAR AIR HEATER



The areas of application the solar power are mainly focused on Agriculture, Pharmaceutical, Leather Textiles, Ceramics, Chemical, Industrial Process heat, Minerals Latex rubber/ mattres Paint-shop Laundry drying, Fabricated wet components drying, Heating in Oil and Gas production units, etc. In Agro-processing industries solar energy plays an important role in Tea & Coffee Processing, drying spices like Pepper, Turmeric, Garlic, Chilies, Coriander & Ginger, Grains like Pulses, Oil making units-pre-drying – copra, groundnut, cotton seed, gingelly, etc., Fruits and Vegetables, Fish – salted and dried, Small solar drier with SPV for rural job creation and value addition to product.

The Ministry of Non-Renewable Energy (MNRE) assists the solar energy installations by providing assistance of 30% of the cost of the system subject to a maximum of Rs.2,400 per sq.m of collector area commercial/institutional and industrial areas. Certain case studies on Solar processing were presented during this session showed the utilization of Solar power for Dal processing. India is a major producer and consumer of pulses. There are around 1400 pulse & processing units in the country and it offers employment in rural and sub-urban mass. Due to the space constraint, all pulse mills have shifted from the open yard drying/heating method to the conventional dryer heating method. The preferred fuel for processing pulses is diesel and in some cases coal (or) firewood. A conventional pulse processing unit uses around 15 -20 liter diesel/ hour to produce hot air of temperature around 65deg C. Using a 7.5 kW blower, the hot air is blown through pulses spread in a 1-meter depth open trough (3 m X 3 m) with mesh at the lower side. The consumption of diesel/per day in a typical pulse unit is around 60 - 90 liters. The major advantage of using solar power helps to savings of diesel up to 60 -90 litres/ day depending upon the number of batches/ days. The quality of dal is also improved due to a good level of solar heat aeration. There is an increase of 10% output from the dal than the conventionally heated dal. This creates a premium for the product.

The case study presented in this session highlighted on the Solar Air Heating System installed in Theni District in a Dal Processing Industry for drying purposes which has 123 collectors with an area of 230sq.m. (89Nosx1.860mx1.009) and Solar Air Heating System installed in Thoothukudi District in an Industry for Copra drying process .

297 m_2 Solar air heating system at TI cycles in Ambattur Chennai

135 sq. mt TAFE

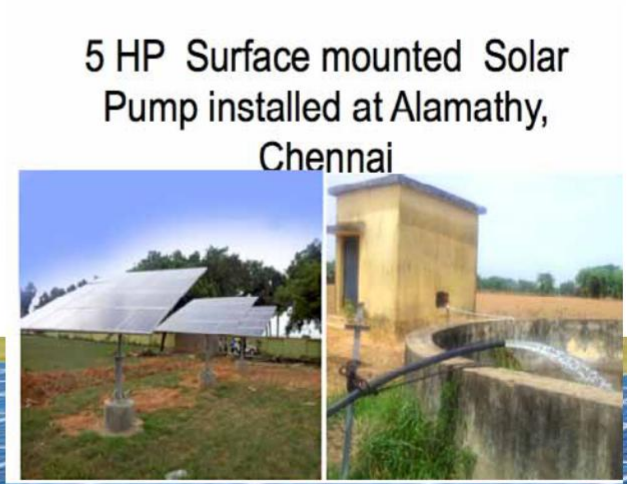
135 sq.m at M/s LARSEN & TOUBRO

135 sq.m at M/s LARSEN & TOUBRO

297 sq.m at Visteon Automotive systems India Pvt Ltd

Duct Connection and automation at Visteon Automotive Systems India Pvt. Ltd

A Solar PV Water Pumping System consists of SPV modules, a Pump controller, AC/DC pump etc., The system does not have any Storage Battery since the power generated is used directly then and there. The SPV array converts the solar energy into electricity which is used for running the motor pump set. The pumping system can draw water from the open well/bore well or stream/pond or canal. The ongoing Solar Pumping System Project in Tamil Nadu has a 5 HP AC submersible pump with a Solar module array of 4800 Wp which is suitable for open/shallow/bore wells of dia 6" with a total maximum dynamic head - 80M and water discharge of 82,000 litres/day from a total head of 50M. The project is taken up with a contribution of 50% from NADP,30% from MNRE, and 20% as a Beneficiary contribution.



5 HP AC Submersible Solar Pump installed at Alamathy, Chennai

10 HP Solar Pump installed at Pollachi, Coimbatore

»» The potential for solar energy in Tamil Nadu for agriculture water pumps and heating and drying applications in post-harvesting is acknowledged by various agencies. The cost-effectiveness of using solar power needs to be emphasized in relation to the consumption of electricity and is not specific to the initial investment.

»» It is recommended that the rollout of a solar water pump scheme needs to be studied with regard to its constraints that would include the water table levels in districts, and the impact of solar water pumps on various crops, crop productivity, enhanced income through cash crop cultivation potential, etc.

»» The contribution of the water pumping scheme to the farmer's net income and also the agricultural productivity needs to be studied anecdotally.

»» The solar water pumping involves advanced and sophisticated technology, the rollout of such a scheme also needs to take into account the service aspects and the down times caused due to malfunctions.

»» The local ecosystem of the districts should be taken into consideration for effective implementation. Cluster-based approach for the implementation of the solar projects needs to be piloted for the grass root level implementation.

»» The technical players and solution providers are to work in an integrated manner.

»» Huge savings that could incur to the electricity board on taking up the solar projects should be enlightened to the people

»» Capacity building and the awareness campaign on the Solar policy of global, needs to be given wide importance in the ensuing period