

# Solar Energy Research Enclave



# Outline

- Introduction
- World Scenario
- Indian Scenario
- SWOT Analysis
- Objectives
- Technology Demonstrator
- Summary



# Energy Source & Utilization (US)

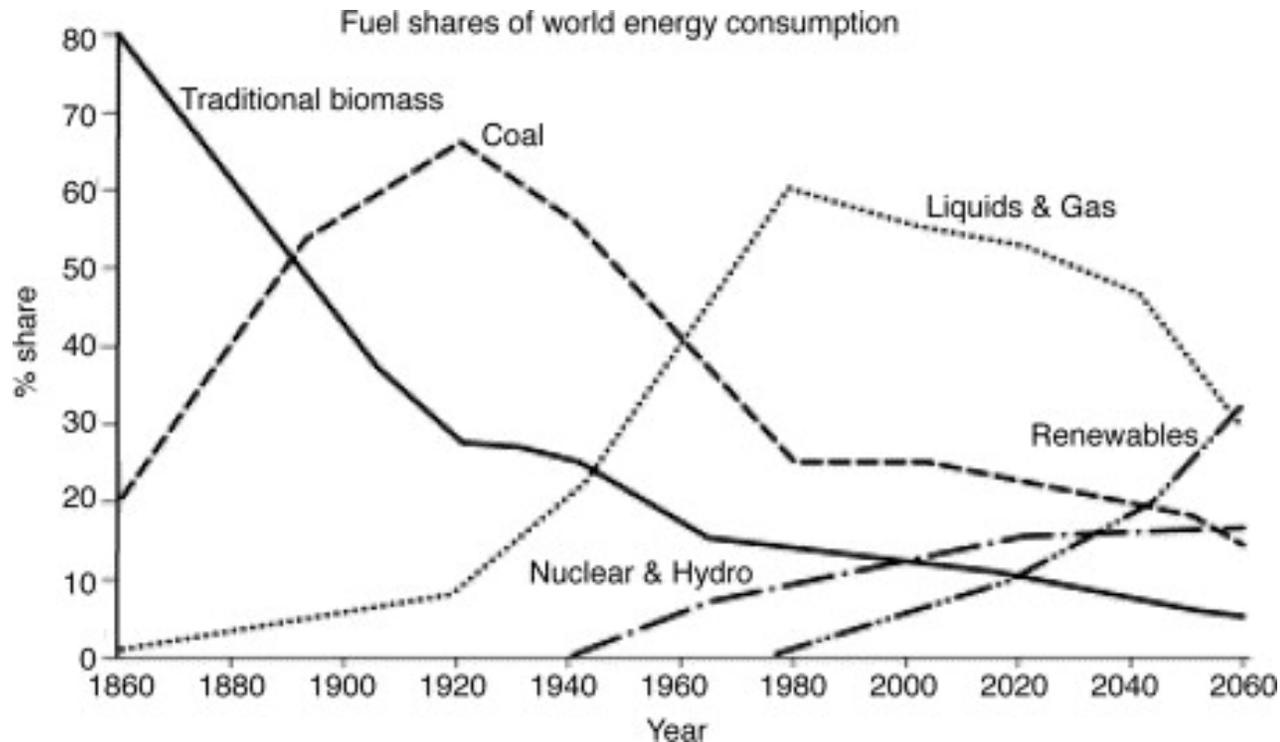
## **SOURCE(%)**

- Hydro (1)
- Wind (0.1)
- Solar (0)
- Geo (0.3)
- Nuclear(9)
- Bio(3)
- Coal (23)
- Natural gas(23)
- Oil (40)

## **USAGE**

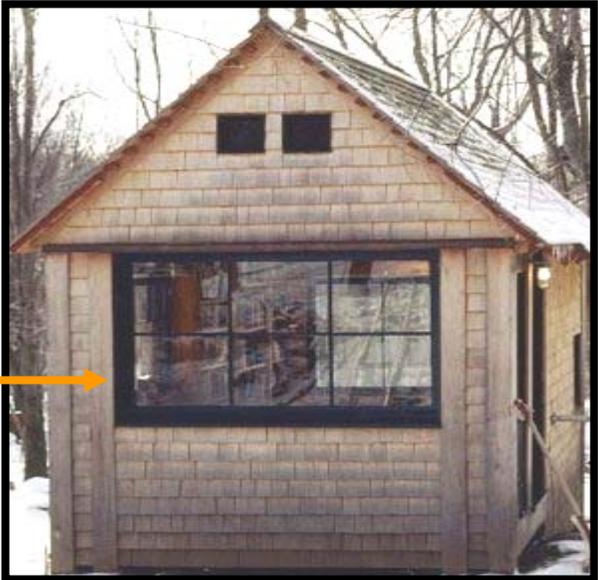
- Residential (11)
- Commercial (9)
- Industrial (24)
- Transport (29)

# Trends towards World Energy Consumption





**DAY**



**NIGHT**



# Solar Energy Usage and Pricing

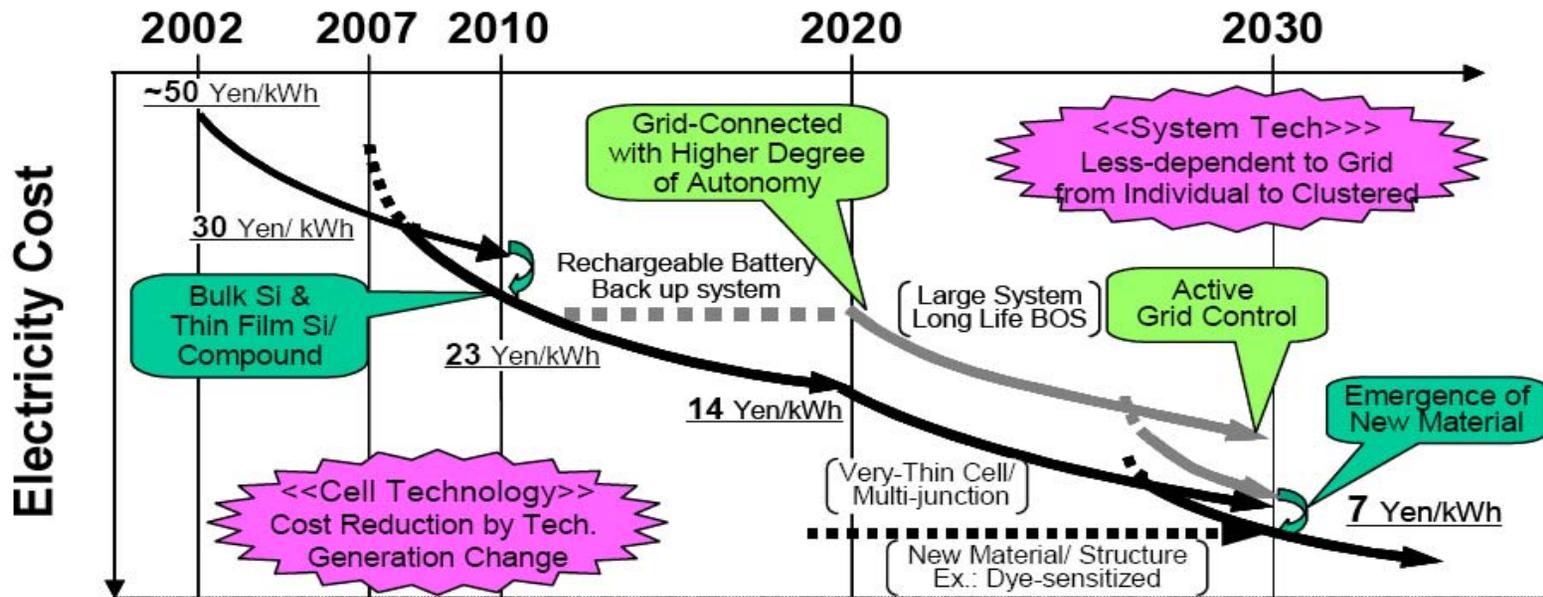
	Solar markets (average of last 5 years)	Solar Price/Competing Energy source
Remote Industrial	17%	0.1-0.5 times
Remote Habitation	22%	0.2-0.8 times
Grid Connected	59%	2-5 times
Consumer Indoor	2%	n/a

**Solar Energy: 30 c per kWh**

**Need to lower cost to 10c per kWh and below**

<http://www.solarbuzz.com/StatsCosts.htm>

# Japanese Road Map



## [PV System Deployment Images] (Examples)

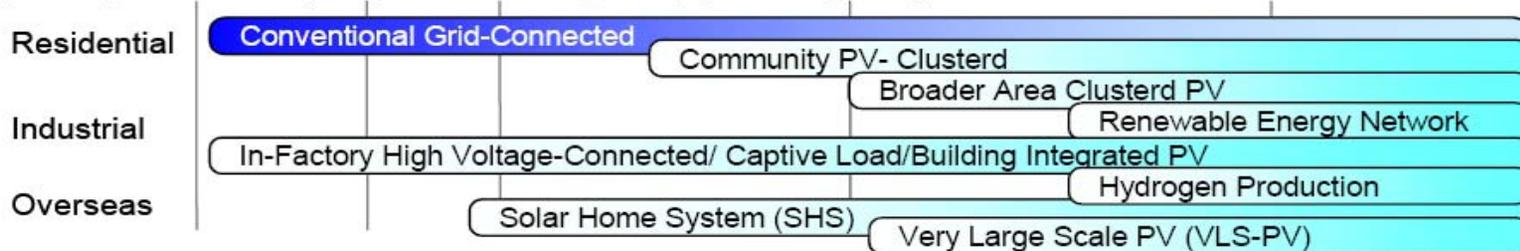


Figure 1. Scenario for improving the economic efficiency of PV power generation

# Energy Source & Utilization (India) 2006

## SOURCE (%)

- Hydro(2)
- Wind(0)
- Solar(0)
- Geo(0)
- Nuclear(1)
- Bio(31)
- Domestic Coal(30)
- Natural gas(6)
- Imported petroleum(23)

## USAGE

- Unaccounted electricity(2)
- Agriculture(6)
- Residential(28)
- Commercial(2)
- Industrial(29)
- Public utilities(.3)
- Transport(10)

# Indian needs

- Our country, therefore, requires solar energy development at different scales such as,
  - small ( $\sim$ W) to large ( $\sim$ MW)
  - grid-connected to islanded
  - supplemented with some energy-storage to no-storage capabilities.
  - hybridization of solar energy with other renewable sources

# National Mission

- On 30th June 2008 the Prime minister of India, Dr. Manmohan Singh, announced the National Plan for Climate Change. This includes a National Solar Mission to “significantly increase the share of solar energy in the total energy resources while recognizing the need to expand the scope of other renewable and non-fossil options such as nuclear energy, wind energy, and biomass”.
- *National Action Plan on Climate Change, Released on 30th June 2008 by Govt. of India*

# Govt. of India Incentive for Grid Interactive PV electricity

- Support for maximum cumulative capacity of 50MWp during the 11<sup>th</sup> plan period.
- Max. cumulative capacity of 10 MWp in any State.
- Any developer can set up grid interactive projects of up to 5 MWp capacity as single or multiple projects.
- Minimum capacity for a project is 1 MWp.
- MNRE will provide financial assistance of Rs.12 per KW hour of energy fed to the grid.

For more information <http://www.mnes.nic.in/>

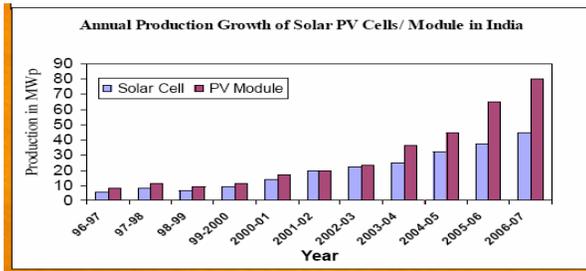
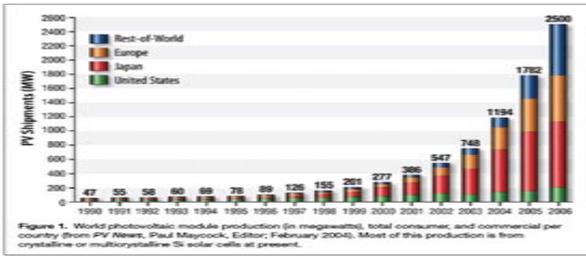
The 1<sup>st</sup> January 2008, the cumulative grid connected PV system capacity in India was measured to be only 2.12 MW.

# PV Power Plants in India

Company	Capacity	Location	Installed by
Tata power company	100 kWp	Lonavala	Tata BP solar
NEDA	100 kWp	Lucknow	Tata BP solar
NEDA	25 kWp	Lucknow	Tata BP solar
PEDA	200 kWp	Punjab	Tata BP solar
PEDA	55 kWp	Chandigarh	Tata BP solar
Green Business Centre	23 kWp	Hydrabad	Tata BP solar
Vikas Soucha	100 kWp	Bangalore	Tata BP solar
Public Utility,	100 kWp	Agatti Island, Lakshadweep	BHEL
APSEB	100 kWp	Hyderabad	BHEL

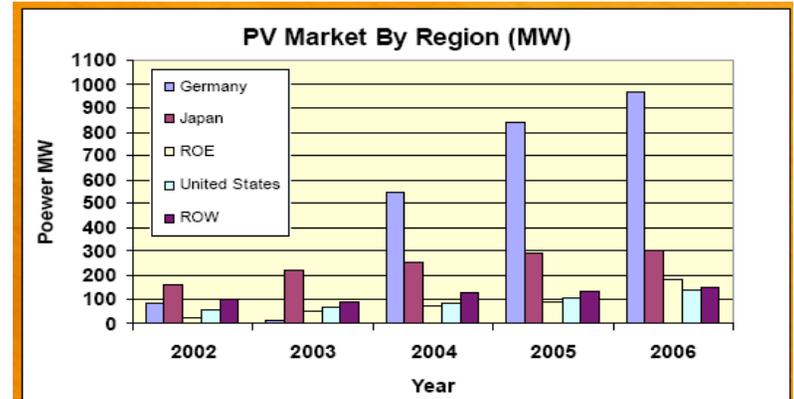
<http://www.pvresources.com/>





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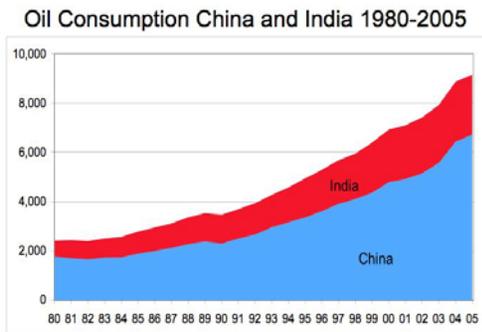
- World PV production
- Indian PV Export



- No national roadmap
- No Large size installation

W

- Increasing Energy requirement
- Reduction of Fossil Fuels



Source: Energy Information Administration and Green Econometrics research

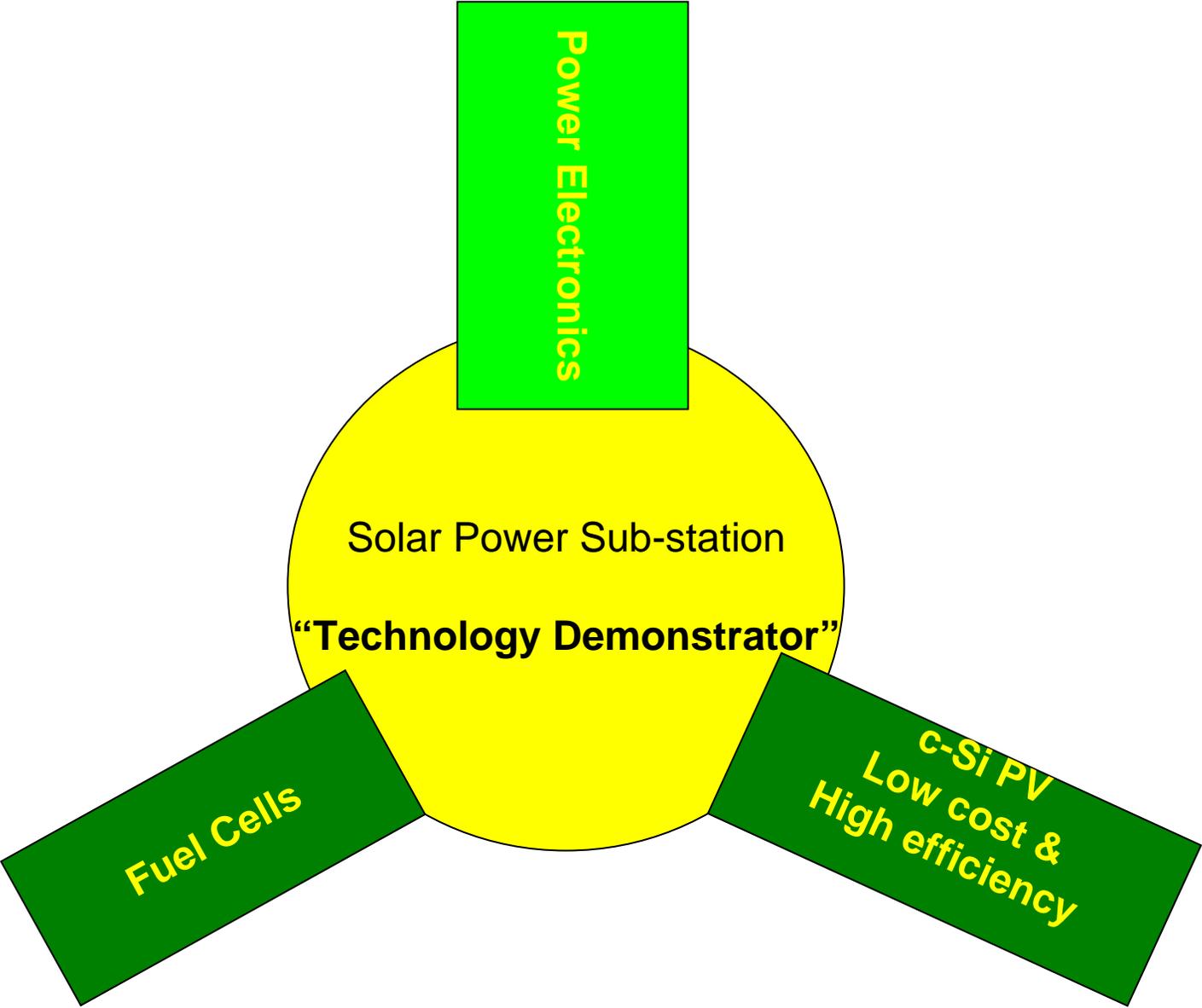
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- Will depend on US, Japan and Europe for efficient technology solutions
- Energy dependence on imports

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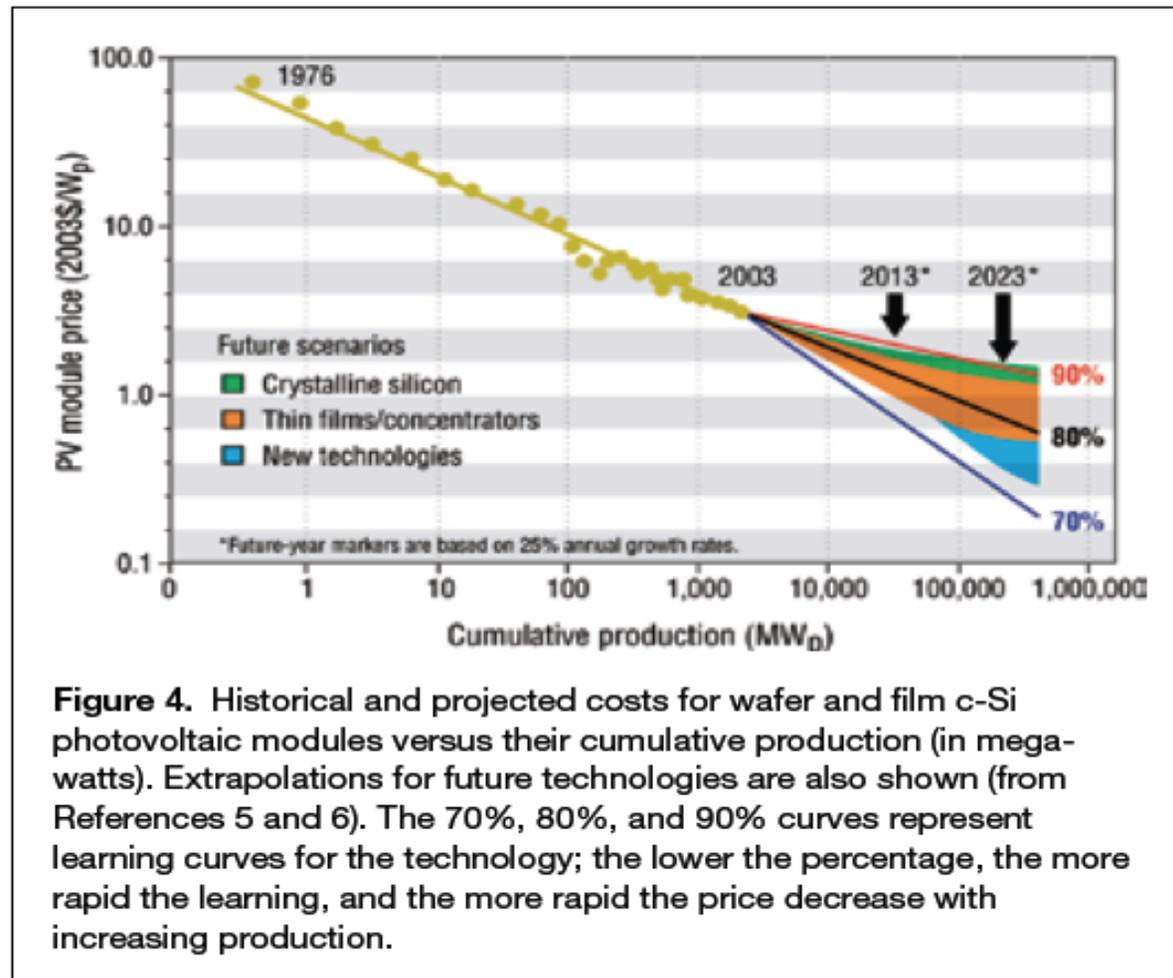
# Objectives

- **500 KW solar power station/research test-bed to be used as supplement to grid power to IITK during day time**
- **Initiate research projects in the area of solar power generation, storage , and distribution to make this a viable solution for future energy requirements**



# Outcomes

- Overall cost of the energy technology decreases with large scale utilization
- This has also encouraged the entrepreneurs to invest in solar energy technologies.



# Contd.

- Test platforms for large scale solar energy utilization technologies.
- Increased awareness of green technologies amongst the public

Engaging faculty and students in long-term solar energy research and development

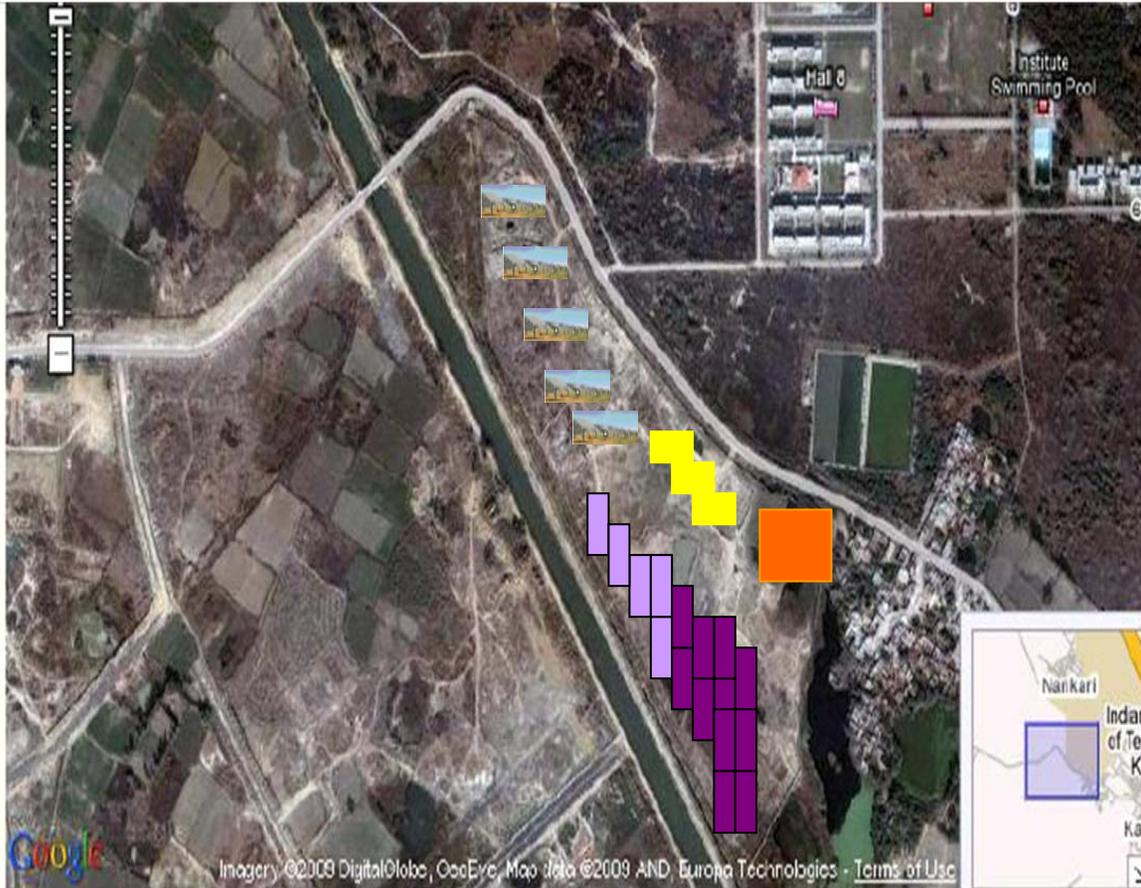
## Proposed Research Programs in three areas:

<b><u>Power Electronics</u></b>	<b><u>Fuel Cells</u></b>	<b><u>Photovoltaics</u></b>
Partha Sarathi Sensarma (EE)	Raj Ganesh Pala (ChE)	Raghubir S. Anand (EE)
Shyama P. Das (EE)	Malay K. Das (ME)	Monica Katiyar (MME)
Santanu K. Mishra (EE)	Sameer Khandekar (ME)	Y. N. Mohapatra (Phy)
	Kantesh Balani (MME)	S. Sundar Kumar Iyer (EE)
	Krishanu Biswas (MME)	Kallol Mandal (MME)
	Deepak Kunzru (ChE)	
	Nitin Kaistha (ChE) Goutam Deo (ChE)	

# Specifics of Technology Demonstrator

# Land required for solar energy capture

- To install photovoltaic panels for 500kWp, an area of 10-12 acres (40000 -48000 m<sup>2</sup>) is needed including service, maintenance, instrumentation, data collection, storage, panel preparation, control room, storage, research test-beds, and security.



- Building
- 1D Concentrator
- 2D Concentrator
- Mono/Multi Silicon
- Thin Film
- Thermal

# Budget & Time line

- **Ist phase (1-3 yrs):**

Estimated cost of a 500kWp solar sub-station and research initiation:

Component	Cost (Crores)	Efficiency (%)
PV- panels (Assuming a mix of technologies to be used and average cost Rs.200/KW <sub>p</sub> )	10	6 - 24
Fuel Cells/Batteries	3	
Power Electronics	2	
Operational cost, maintenance and security	1	
Research initiation for low-cost Si material, high efficiency PV, fuel cells and power electronics	2	
<b>Total</b>	<b>18</b>	

- **IInd phase (4-6 yrs):**

Sustained funding of 4-5 crore per year will be needed for research projects to lower cost of solar energy.

# Strengths of the core group

- Partha Sarathi Sensarma (EE)



- Monica Katiyar (MME)
  - a-Si PV
  - Motorola, Inc



- Raghubir S. Anand (EE)



- Santanu K. Mishra (EE)



- Raj Ganesh Pala (ChE)



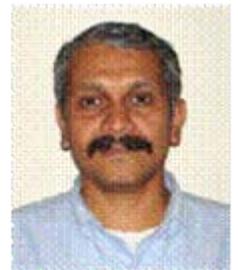
- Malay K. Das (ME)



- Shyama P. Das (EE)



- S. Sundar Kumar Iyer (EE)



# Summary



If approved, a detailed project report will be submitted by the team.

# Indian Experience limited to small PV systems (>1 MWp)

Need for consultants with experience in Large Grid  
Connect PV for:

- ✓ System & engineering design
- ✓ Historical and forecast data for site selection
- ✓ Financial analysis, due diligence & assistance in acquiring finance
- ✓ Developing business model
- ✓ Assessment of CDM benefit
- ✓ Training and capacity building
- ✓ Bench marking and operational excellence
- ✓ Operations and troubleshooting