

Solar Projects, RPO and REC Trading

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**GLIEMR , Gurgaon
21 February 2012**

Presentation Structure

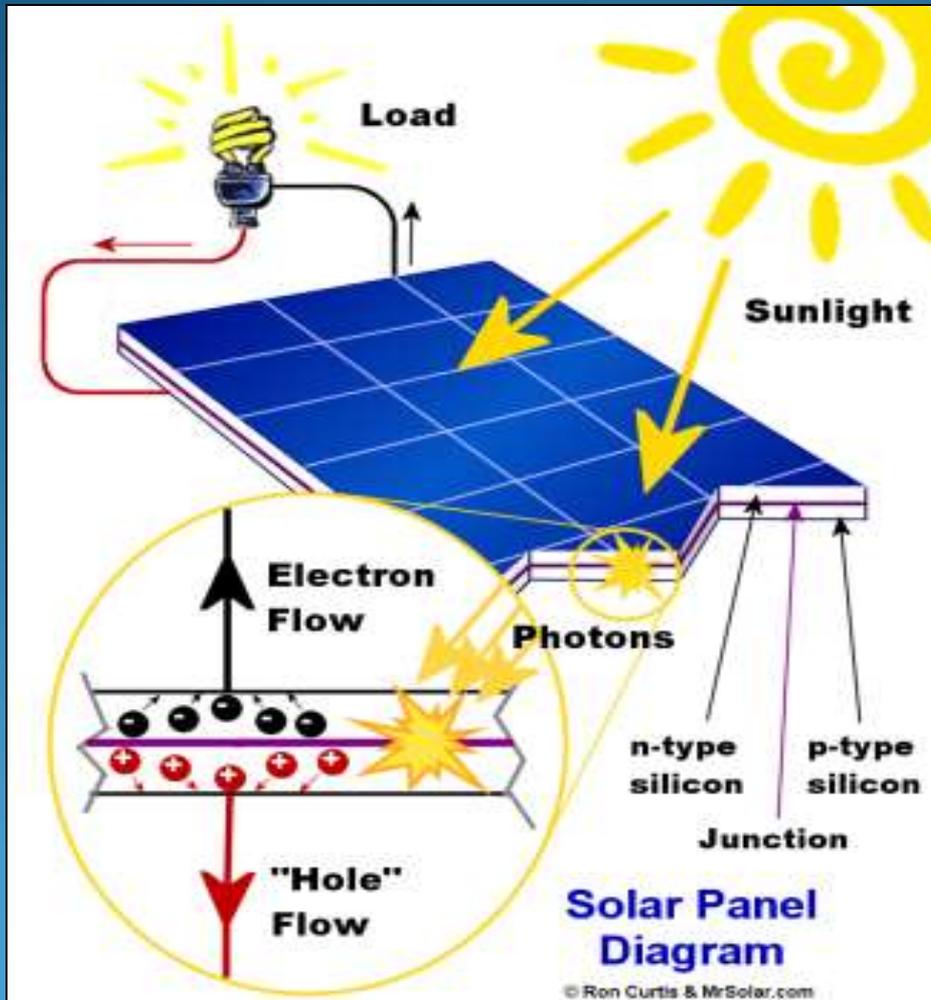
- **Solar Projects (Grid Connected)**
- **Renewable Purchase Obligation**
- **Renewable Energy Certificate**

Solar Projects

- **Solar Photovoltaic (SPV) Power Projects**
- **Solar Concentrated Power (CSP) Projects**
- **What can go wrong with Solar Projects?**

Solar Photovoltaic Power Projects

Solar Photovoltaic Principle

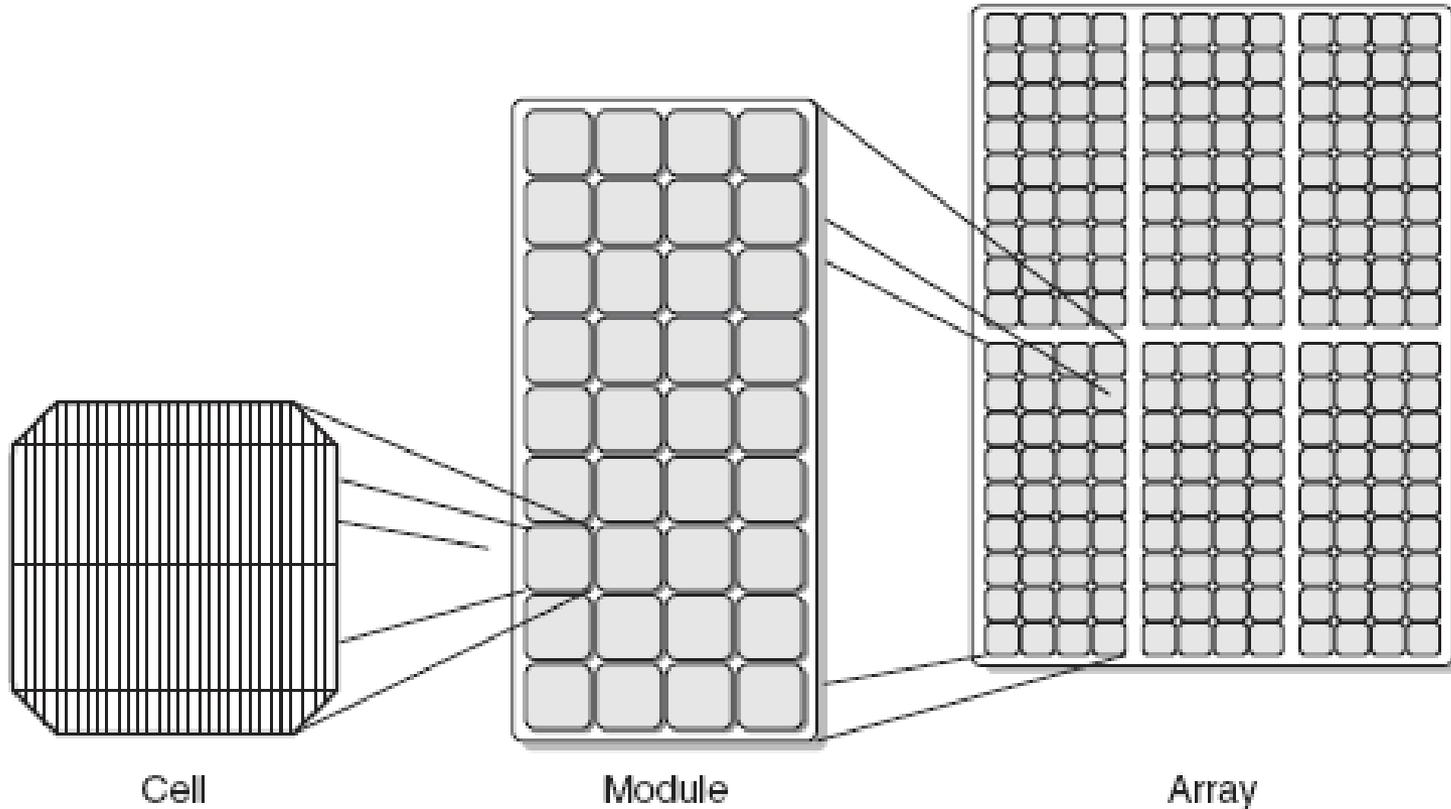


- Crystalline SPV
- Thin film SPV
- Concentrating SPV

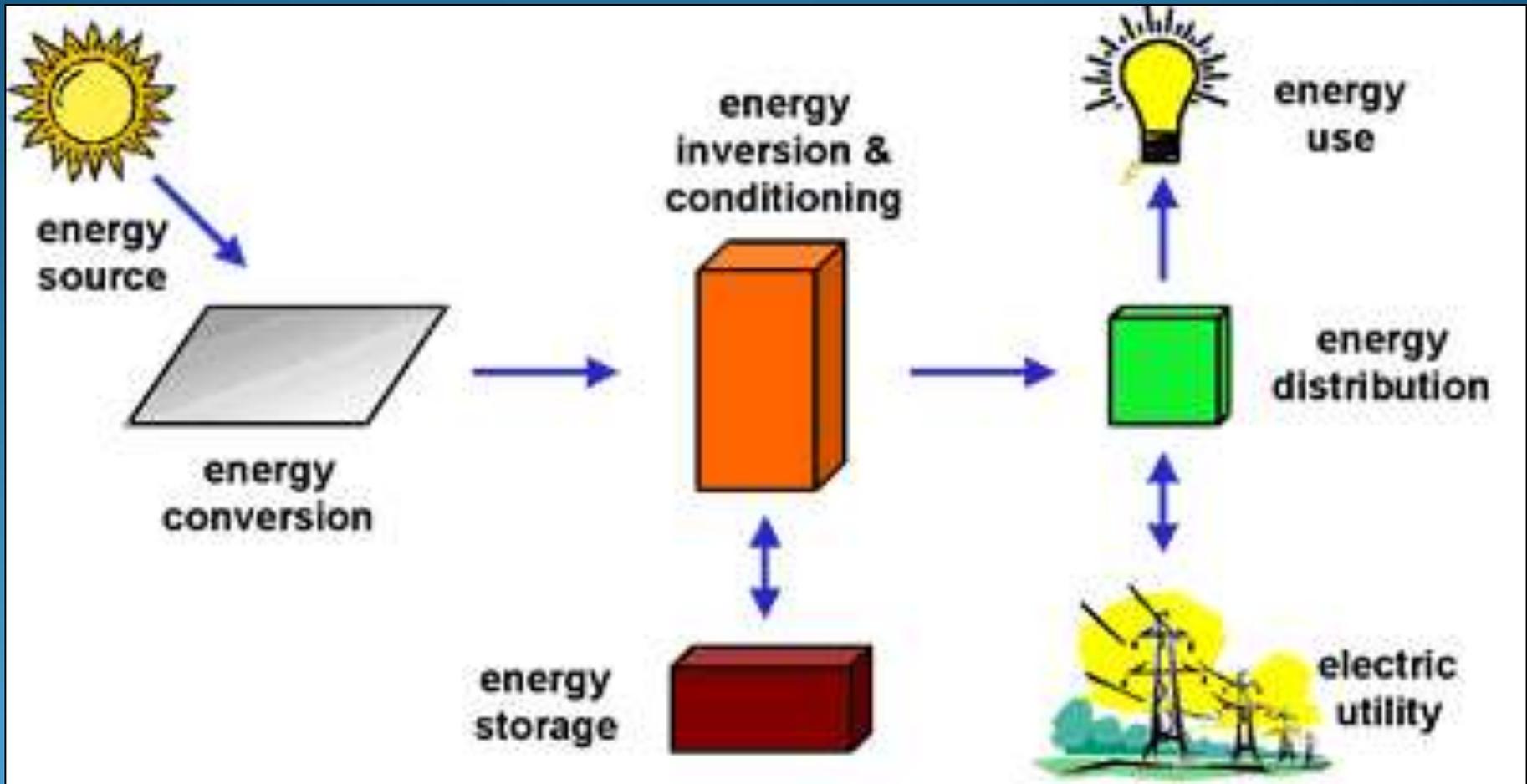
SPV Cells Quality

- **Single-crystal silicon (Mono-crystalline)**
 - **Efficiency - 13% and 17%**
- **Multi-crystal silicon (Poly-crystalline)**
 - **Efficiency - 11% and 15%**
- **Amorphous silicon (Thin film silicon)**
 - **Efficiency - 6% and 8%**
- **Concentrating PV (Si, GaAs, CIS, CIGS, CdTe)**
 - **Efficiency - 25-30%**

Cells, Modules & Arrays



Working of PV Power Generation Systems



SPV (3 MW) Power Plant at Kolar, Karnataka





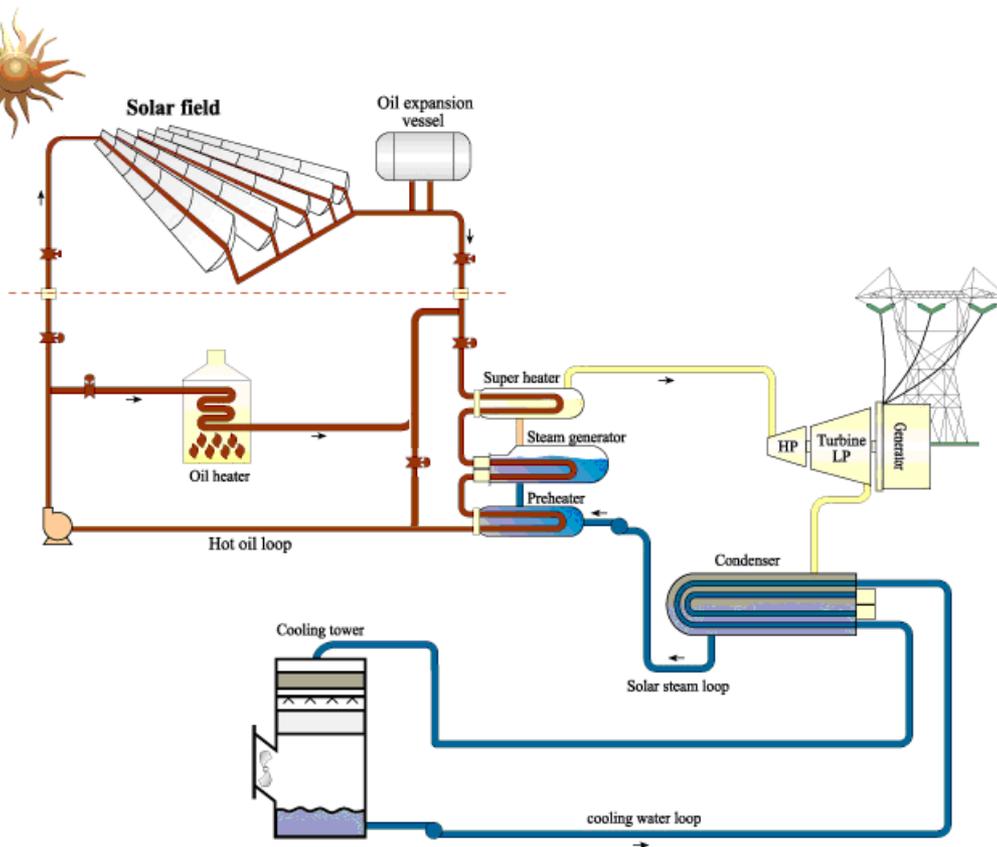
Another View of Kolar SPV Power Project

Solar Concentrated Power Projects

Solar Thermal Technologies

- **Parabolic Trough**
- **Central Receiver/Solar Tower**
- **Parabolic Dish**
- **Compact Linear Fresnel Reflector (CLFR)**

Parabolic Trough



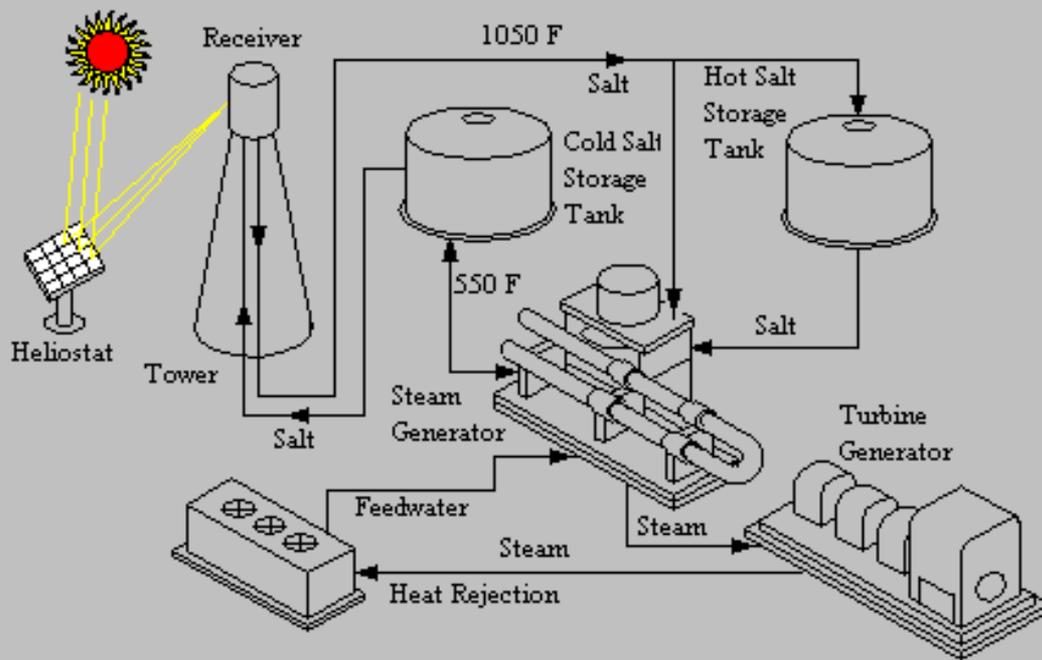
- **Parabolic trough-shaped mirror reflectors**
- **Concentrate sunlight on to receiver tubes**
- **Thermal transfer fluid circulated**
- **Heat exchangers**
- **Superheated steam.**
- **Steam turbine generator**

Spain Andasol 50 MW PTC



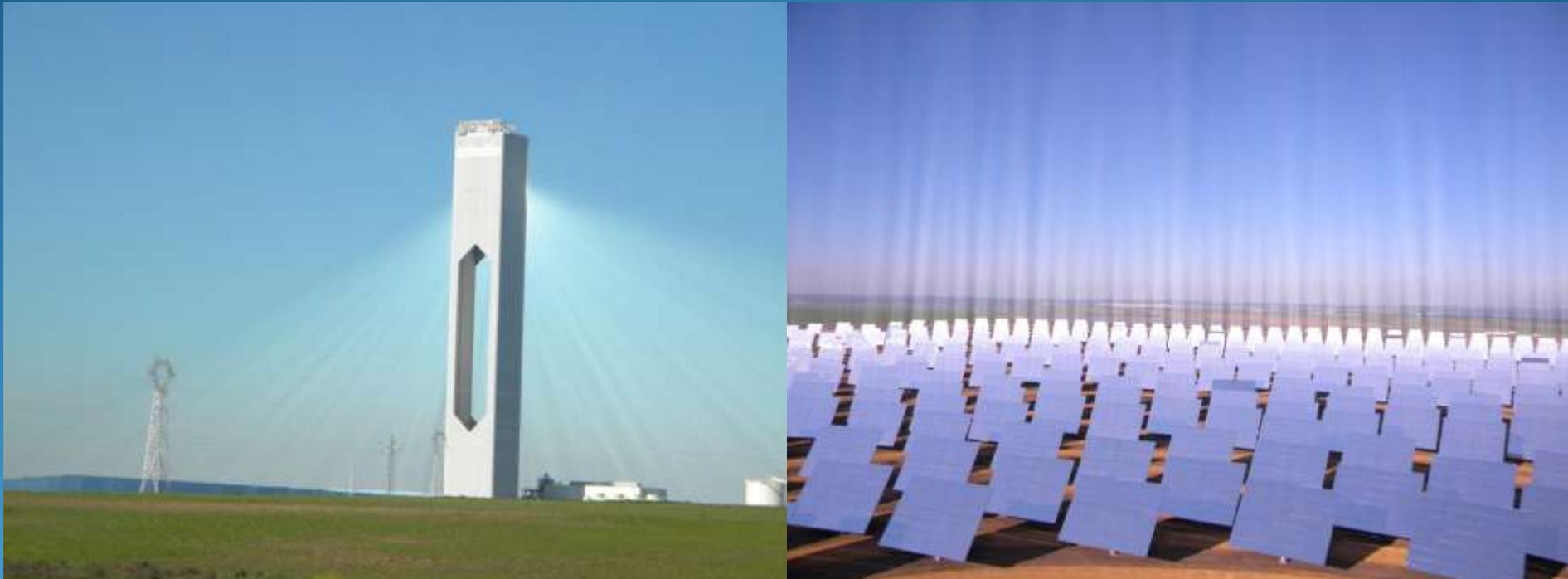
Gaudix Plant , Granada

Central Receiver/Solar Tower



- **An array of heliostats**
- **Central receiver at top of tower**
- **Superheated steam**
- **Steam turbine**

Spain Abengoa 10 MW Solar Tower



Seville Plant

Parabolic Dish Concentrator



- **Parabolic dish-shaped reflector**
- **Receiver at focal point**
- **Steam micro-turbine**
- **or Stirling engine**

US 1.5 MW Dish Power Project



Maricopa Plant Peoria, Arizona

Compact Linear Fresnel Reflector (CLFR)



- Sunlight reflected by series of mirrors
- Concentrate onto receiver tube
- Receiver tube contains water
- Creates saturated steam
- Drives a turbine to generate electricity.

What can go wrong with Solar Projects?

Risk Perception and Mitigation

- Money matters
- Sector's reputation
- Social implications
- Banker's confidence
- Ancillary de-activation

Technical Failures

- **Solar radiation data**
- **Soar photovoltaic vs. CSP (water?)**
- **Solar photovoltaic**
 - **Type of PV cell: crystalline, thin film**
 - **Life, efficiency, de-rating factor**
 - **Tree growth, shading, tall structure**
 - **Dust accumulation**
 - **Thermal stress, decreased adherence**
 - **Short circuit, open circuit**
 - **De-lamination, hot spot**
 - **Glass breakage, wind, hail, vandalism**

Technical Failures

- **Solar thermal (CSP)**
 - **Water supply stoppage, dry spell**
 - **Mirror life**
 - **Thermal receiver life**
 - **Long cloudy, foggy season**
 - **Molten salt, thermi-fluid supply**
 - **Mirror breakage, vandalism**
- **Common to PV & CSP**
 - **Insufficient operational know-how**
 - **Project does not perform as expected**
 - **Delayed/ costly supply of spare parts**
 - **Grid availability/ failure**

Non-Technical Failures

- **Company strength:**
 - **Key personnel, financial solidity, technical ability**
- **Environmental:**
 - **Heavy metal, oil spill, flora-fauna, displacement**
- **Financial:**
 - **Insufficient access: investment, operating capital**
- **Market related:**
 - **Cost rise: labor, spares & Cost fall: electricity**

Non-Technical Failure

- **Operational:**
 - **Unscheduled plant closure, equipment failures**
- **Policy and regulatory:**
 - **Change in policy, tax credit, RPO targets**
- **Political:**
 - **Social unrest, political uprising, mutiny**
- **Natural calamity**
 - **Earthquake (zone I-V), unexpected flood**

Renewable Purchase Obligation

RPO Concept

- **Concept Evolution:**
 - **US SERCs: RPS (renewable portfolio standard)**
 - **India MERC: renewable purchase specification**
 - **India SERCs: renewable purchase obligation**
- **NAPCC recommended:**
 - **Minimum RE share 5% in 2009/10**
 - **Increase 1% per year**
 - **Reach 15% by 2019/20**

RPO Concept

- **The Electricity Act, 2003:**
 - **86(e): promote cogeneration and generation of electricity from renewable sources of energy by providing suitable measures for connectivity with the grid and sale of electricity to any person, and also specify, for purchase of electricity from such sources, a percentage of the total **consumption** of electricity in the area of a distribution license;**

RPO Concept

- **RPO or RPS in states**
 - **Varies: 0.5% to 14%**
 - **Few states: technology-specific RPO**
- **Recently on 20th January 2011:**
 - **Clause 6.4 (1) amended**
 - **Solar specific RPO**
 - **Within the percentage of RE RPO**
 - **Minimum percentage for purchase of solar**
 - **Will go up to 0.25% by 2012/13**
 - **Further up to 3% by 2021/22**

RPO Targets set by SERCs

	State	RE Source	RPS targets for						
			10/11	11/12	12/13	13/14	14/15	15/16	16/17
1	Andhra Pradesh Order Dtd-31.03.09		5%	5%	5%	5%			
2	Assam Draft Notification Dtd 21.06.10		1.40% (0.05%)	2.80% (0.1%)	4.20% (0.15%)	5.60% (0.2%)	7.00% (0.25%)		
3	Bihar Notification Dtd- 16.11.10	Total RE (Solar)	1.5% (0.25%)	2.5% (0.5%)	4% (0.75%)	4.5% (1%)	5% (1.25%)		
4	Chhattisgarh Regulation Dtd-09.11.10	Total RE (Solar)	5% (0.25%)	5.25% (0.25%)	5.50% (0.25%)				
5	Gujarat Notification Dtd- 17.04.10	Total RE (Solar)	5% (0.25%)	6% (0.5%)	7% (1%)				
6	Goa Notification Dtd- 30.11.10	Total RE (Solar)	1% (0.25%)	2% (0.3%)	3% (0.4%)				
7	Haryana Notification Dtd 03.02.11	Total RE (Solar)	1.5% (0.25%)	1.5% (0.5%)	2% (0.75%)	2% (1.0%)	2.5% (1.25%)		
8	Himachal Pradesh Notification Dtd- 26.05.10	Total RE (Solar)	10% (0%)	11.1% (0.1%)	12.1% (0.1%)				
9	Jammu & Kashmir	Total RE	1%	3%	5%				

RPO Targets set by SERCs

	State	RE Source	RPS targets for						
			10/11	11/12	12/13	13/14	14/15	15/16	16/17
	Notification Dtd-11.03.11	(Solar)	(0.02%)	(0.1%)	(0.25%)				
10	Jharkhand Notification Dtd - 21.07.10	Total RE (Solar)	2% (0.25%)	3% (0.5%)	4% (1.0%)				
11	Karnataka Notification Dtd-16.03.11	BESCOM/ NESCOM/ CESE HESCOM/ GESCOM/ Hukkeri		10% (0.25%) 7% (0.25%)					
12	Kerala Notification Dtd-23.11.10	Total RE (Solar)	3% (0.25%)	3.3% (0.25%)	3.63% (0.25%)				
13	Madhya Pradesh Notification Dtd-19.11.10	Total RE (Solar)	0.8%	2.5% (0.4%)	4% (0.6%)	5.5% (0.8%)	7% (1%)		
14	Maharashtra Notification Dtd 07.06.10	Total RE (Solar)	6% (0.25%)	7% (0.25%)	8% (0.25%)	9% (0.5%)	9% (0.5%)	9% (0.5%)	
15	Manipur Notification Dtd-05.05.10	Total RE (Solar)	2% (0.25%)	3% (0.25%)	5% (0.25%)				
16	Mizoram Notification Dtd-05.05.10	Total RE (Solar)	5% (0.25%)	6% (0.25%)	7% (0.25%)				

Contd....

RPO Targets set by SERCs

17	Meghalaya Notification Dtd - 21.12.10	Total RE (Solar)	0.5% (0.2%)	0.75% (0.3%)	1% (0.4%)				
18	Nagaland Draft Notification Dtd 20.10.10	Total RE (Solar)	15% (0.25%)	16% (0.25%)	17% (0.25%)				
19	Orissa Order Dtd - 30.09.10	Total RE	1%	1.30% (0.10)	1.55% (0.15)	1.80% (0.20)	2.05% (0.25)	2.30% (0.30)	
20	Rajasthan Notification Dtd- 23.12.10	Total RE (Additional Solar up to 100 MW)	8.5%	9.5%					
21	Tamil Nadu Notification Dtd- 07.12.10	Total RE	14%						
22	Tripura Draft Notification Dtd 09.11.09	Total RE (Solar)	1% (0.1%)	1% (0.1%)	2% (0.1%)				
23	Uttar Pradesh Regulation Dtd 17.08.10	Total RE (Solar)	4% (0.25%)	5% (0.5%)	6% (1%)				
24	Uttarakhand Notification Dtd- 03.11.10 and Dtd 06.07.10	Total RE (Solar)	4% (0%)	4.525% (0.025%)	5.05% (0.05%)				
25	West Bengal Notification Dtd- 10.08.10	Total RE	2%	3%	4%				

Sample Case: Maharashtra



MAHARASHTRA ENERGY DEVELOPMENT AGENCY

(A Government of Maharashtra Undertaking)



Most Urgent

BP-2008/CR-02/RPS-02/4363

2/8/2008

The Managing Director
Maharashtra State Electricity Distribution Company Limited
5th Floor, Prakashgad
Bandra (East),
Mumbai 400051

Sub: Enforcement for the year 2007-08 towards shortfall in procurement of renewable energy.

Ref: 1) MERC RPS order dtd. 16-08-2006
2) "Operational Framework for Renewable Purchase Specification (RPS) in Maharashtra"- March 2008

Sir,

1. This has reference to Clause nos. 2.10.5 to 2.10.9 of the RPS order dt.16-8-2008 issued by Hon. Commission and Clause no. 4.4 of the Operational Framework for Renewable Purchase Specification (RPS) in Maharashtra – March 2008.
2. As per the above provisions in RPS order and the framework, the MEDA has been given responsibility for enforcement of the order as regards non compliance and penalty thereof vide clause no. 2.10.9 saying "..... *primary responsibility of enforcing and reporting such incidences of non compliance rests with MEDA.....*" Accordingly, the MEDA hereby enforces the provision and the same is being reported to all concerned.
3. In line with the operational framework, the MEDA issued instructions to all the stakeholders to submit data in prescribed formats. After receiving the data as above and compilation of RPS data for FY 2007- 08 is tabulated below based on the data provided by MSLDC and respective distribution licensees in Maharashtra.

Licensees	Energy Input* (MUs)	RPS Obligation (4%)	RE Procured# (MUs)	Shorfall (MUs)	Actual % Achieved
MSEDCL	76451.828873	3058.073155	2658.526562	399.5465929	3.48
TPC	2688.678187	107.5471275	125.0041	-17.4569725	4.65
REL	9207.276798	368.2910719	1.02	367.2710719	0.01
BEST	4608.469043	184.3387617	3.494325	180.8444367	0.08
MPECS	601.020850	24.040834	0	24.040834	0.00
Total	93557.273751	3742.29095	2788.044987	954.245963	

* Energy Input Data obtained from MSLDC

RE Procurement Data received from respective licenses.

4. In line with clause no. 2.10.7 of the RPS order, ".....The Eligible Persons shall be liable to pay at the rate of Rs. 5.00 per unit of shortfall in 2007-08, Further, it is clarified that such charges levied on distribution licensees towards shortfall in renewable energy procurement will not be allowed as 'pass through' expenses in their Annual Revenue Requirement." Accordingly, the penalty for respective licensee is as follows:

Licensees	Shorfall (MUs)	Penalty (Rs in Crores)
MSEDCL	399.5465929	199.773296
REL	367.2710719	183.635536
BEST	180.8444367	90.4222184
MPECS	24.040834	12.020417
Total	954.245963	485.851468

- 5 As per the point no 4.4 "Operational Framework for Renewable Purchase Specification (RPS) in Maharashtra"- March 2008, "..... Agency shall publish Form V based on figure in the Form I and circulate it to all eligible persons. Penalty charges as applicable have to be deposited to the MEDA account within 15 working days."

You are, therefore, requested to deposit the penalty amount of Rs 199.7732960 crores (Rupees One hundred ninety nine crores seventy seven lakhs thirty two thousand nine hundred sixty only) within stipulated time of 15 days from issue of this demand note in the form of demand draft drawn in the favor of Maharashtra Energy Development Agency, payable at Pune.

Thanking you

Yours truly,



(Dr. Sudhir Kumar)
General Manager (R&D)

C.C

The Secretary
Maharashtra Electricity Regulatory Commission,
World Trade Centre, Centre No.1,
13th Floor, Cuffe Parade, Mumbai-400005

The Principal Secretary (Energy),
Govt. of Maharashtra,
Industry, Energy & Labor Dept,
Mantralaya, Mumbai-32

The Managing Director,
TATA Power Company Limited
Bombay House, 24, Horni Mody Street
Fort, Mumbai 400001

Renewable Energy Certificate

Electricity Business Market

- **Tradable consumer items**
 - **Energy: Coal, petroleum, electricity**
 - **Non-Energy: Food grains, metal, Chemicals**
- **Non-energy market**
 - **Price: supply-demand driven**
 - **Decontrolled, free market**
- **Energy market**
 - **Demand >> supply**
 - **Danger of unaffordable price**
 - **Controlled, regulated**
 - **Electricity: Regulatory commission**

Electricity Business

- **Before the EA, 2003:**
 - **Generation: license**
 - **No trading allowed**
 - **Sale only to utility**
 - **or self consumption**
- **After the EA, 2003**
 - **Generation: de-licensed**
 - **Trading allowed**
 - **Sale to any party (mutually fixed price)**
 - **Sale to utility (fixed tariff)**
 - **Sale to energy exchange (flexible price)**

Business Options

- **Sale to utility:**
 - Assured price
 - Assured payment
 - No opportunity cost
 - No risk, No gain
 - Stagnant business
- **Sale to energy exchange**
 - Transparent market
 - Electronic deal, faceless exchange
 - Assured payment: Clearing Bank
 - Avail opportunity cost, standing demand
 - Calculated risk, dynamic market

Renewable Energy Market

- **Different from conventional energy**
- **RE environment friendly**
- **Low carbon transition**
- **Fulfills NAPCC objectives**
- **The EA, 2003 green mandate**
- **Preferential treatment**
- **RPO driven market, enforced**
- **Solar electricity: high cost**
- **Non-solar: comparable to conventional**
- **Sale option-1: to utility at Feed-in-tariff**
- **Sale option-2: to energy exchange, Use REC**

Renewable Energy Certificate

- **RE electricity: two components**
 - **White component: APPC**
 - **Green component: Green tag cost**
 - **APPC (Average Power Purchase Cost):** the weighted average pooled power purchase by distribution licensees (without transmission charges)
- **Green tag cost: Protected by price band**
 - **Forbearance Price:** derived based on the highest difference between cost of generation of RE technologies/RE tariff and the average power purchase cost
 - **Floor Price:** determined keeping in view the basic minimum requirements for ensuring the viability of RE projects

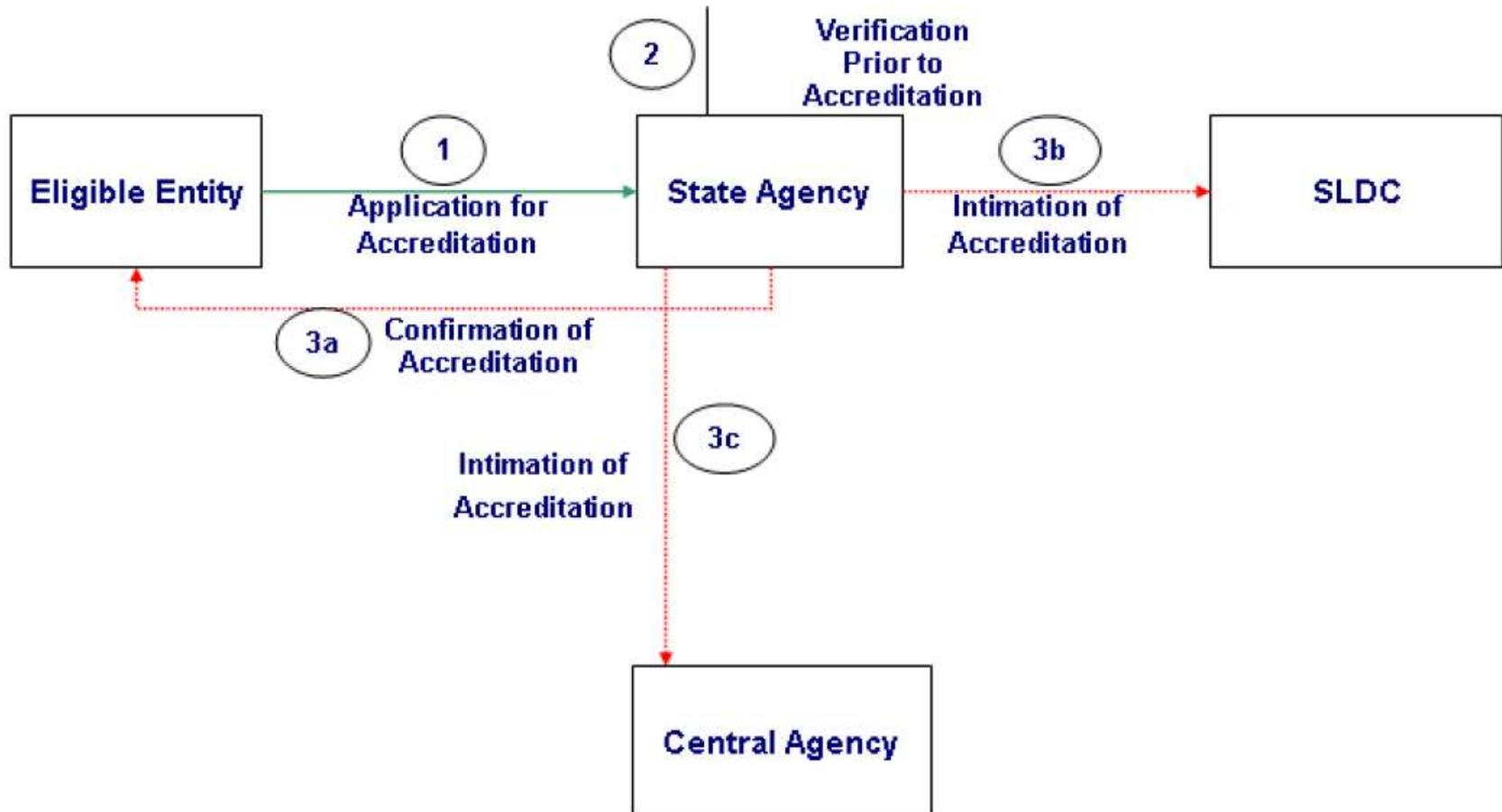
REC Trading

- **CERC order 23 August 2011**
 - **Forbearance price:**
 - **Non-solar Rs. 3.30/unit**
 - **Solar Rs. Rs. 13.40/unit**
 - **Floor price:**
 - **Non-solar Rs. 1.5/unit**
 - **Solar Rs. 9.30/unit**
- **1 REC ~ 1 MWh ~ 1000 units of electricity**
- **Solar REC and Non-solar REC (valid 1 Yr)**
- **REC to be traded on energy exchange within permissible price band like share market**
- **Transparent and faceless trading**
- **White component: exchange contract, money and energy**
- **Green component: exchange only certificate and money**
- **RPO compliance: Deemed to purchase energy; notional**
- **Obligate entity my purchase only REC , no energy**
- **Project accreditation must**

Generator Accreditation

Accreditation

STEP-WISE DESCRIPTION OF THE PROCEDURE



REC Trading on Exchange

- **Only generators to possess REC**
- **Each REC will have Unique Identification Number**
- **Online trading on energy exchange: CERC approved procedure**
- **Bidding session order call period: 13:00 to 15:00 hrs**
- **Order matching & announcement on website : 16:30 hrs**
- **Exchange to inform NLDC for energy transfer: 17:00 hrs**
- **Exchange to inform clearing bank for payments: 17:00 hrs**
 - **Transfer of pay-in: 17:00 hrs**
 - **Transfer of pay-out: 11:00 hrs next bank working day**
- **Exchange to send electronically printable certificate/
invoice to all the successful buyers and sellers: 17.30 hrs**
- **NLDC to extinguish unique number of RECs: 18.00 hrs of
the trade day (no chance of double counting)**
- **Posting information on the website: Market Clearing Price
and Market Clearing Volume: 18.00 hrs**

Trading Report to CERC

Accredited RE Generators (RE Source wise break up) till date

Sr.No.	Source Wise	Capacity(MW)	Units
1	Wind	1085.19	267
2	Solar PV	10.5	2
3	Small Hydro	131	17
4	Others	1.67	1
5	Biomass	547.06	53
6	Bio-fuel cogeneration	618.13	50
	Total	2393.548	390

Registered RE Generators (RE Source wise break up) till date

Sr.No.	Source Wise	Capacity(MW)	Units
1	Wind	924.59	214
2	Small Hydro	87.5	13
3	Others	1.67	1
4	Biomass	446.3	38
5	Bio-fuel cogeneration	605.73	49
	Total	2065.788	315

RECs Issued till date

Sr.No.	Non Solar	Solar	
1	693498	0	

Redemption of REC (till date)

Sr.No.	Non Solar	Solar	
1	609773	0	



Solar power is a great business

**Just keep your eyes and ears
open**