Trends and Way Forward in the State Electricity Sectors, 2018

An Experience Sharing Workshop

3rd and 4th September 2018
Hyderabad

Prayas (Energy Group)

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Estimating agricultural electricity consumption and T&D losses – Some experiences from Andhra Pradesh and Telangana

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www.pmger.org

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Electricity and agriculture

Between 2004 and 2014 (Before bifurcation)

- Gross area irrigated under wells increased from 23.75 lakh hectares to 38.57 lakh hectares
- No of agriculture services increased from 20,04,054 to 30,54,716
- Electricity consumption in agriculture sector increased from MU 11,703 MU to 21,096 MU
- Subsidy to agriculture services increased from Rs. 664.70 crore to Rs. 4,300.92 crore
- The issue is how far estimates of electricity consumption in agriculture sector are reliable

Electricity consumption (MU)

Year	Electricity purchased	Unmetered consumption *	Agriculture**	T&D losses **
2002	37,321	19,675 (53%)	10,301 (52%)	9,374 (48%)
2003	39,842	19,801 (50%)	11,236 (57%)	8,565 (43%)
2004	41,281	19,875 (48%)	11,703 (59%)	8,172 (41%)
2005	46,259	21,868 (47%)	13,218 (60%)	8,650 (40%)

* % of Electricity purchased

** % of unmetered consumption

Overestimation of agriculture consumption

- In the year 2006-07, No. of wells according to DISCOMs were 22,96,996. No. of wells according to MI Census were 22,00,361. Out of this, 2,33,987 wells were out of use.
- In 2013-14, according to DISCOMs there were about 14 lakh agriculture services in residual AP. According to MI Census there were 9,88,185 wells and about 15% of them were not in use.
- According to GeoTagging programme of agriculture services taken up in AP in 2016, there were 15,04,565 services. Out of these information of 14,73,797 services was updated. Out of them, 1,50,816 services were found to be non-functional.
- DISCOMs not adhering to No. of hours of electricity supply to agriculture services.

ISI Methodology

- In 2003, APERC introduced a sample methodology developed by Indian Statistical Institute (ISI), Hyderabad. Under this meters were installed on sample DTRs feeding agriculture load. Under this, 20,300 DTRs were metered. Agriculture consumption arrived with the help of these DTR meters was applied to all DTRs feeding agriculture.
- This sampling methodology was not implemented properly. In 2003-04, Valid data represented less than 50% of the sampled DTRs. In 2016-17 ARR filings, APSPDCL stated that only 14% of the meters provided valid data.
- Even after a decade of introduction of the ISI methodology, it is difficult to say how far the four DISCOMs have followed it. In their ARR each DISCOM presents data related to agriculture consumption differently. They do not specify the number of DTRs from which valid data were collected.
- The way ISI methodology was implemented raised doubts about the reliability of agriculture consumption estimates.

Alternative 1: Feeder segregation

- Segregation of agriculture feeders are expected to lead to better load management and increased power supply to households and small industries in rural areas along with improved estimation of electricity consumption in agriculture sector.
- In 2010 a pilot was initiated for village level segregation of agriculture feeder in one mandal of each district.
- UDAY envisages complete feeder segregation by March 2018 in both the states.
- In Telangana, 330 agriculture feeders are segregated out of 4,139 by June 2018.
- In AP, 109 agriculture feeders were segregated out of 1291 feeders under APEPDCL by March 2017 and in the case of APSPDCL it was 4696

Alternative 2: DTR metering

- DTR metering provides more accurate picture compared to feeder metering as it is nearer to consumers and technical losses between feeder and DTR will not come in to picture.
- At present only sample DTRs are provided with meters.
- Under UDAY, TSDISCOMs are obliged to meter all DTRs including DTRs serving agriculture services by June 2017 and APDISCOMs have to achieve this metering by 30th September, 2017.
- DISCOMs contend that UDAY MoU specifies an action plan regarding DTR metering in urban area only and there is no specification regarding the metering of agriculture DTRs.

Alternative 3:
Metering all agriculture services

- Metering all agricultural services will be an ideal alternative to compute electricity consumption. Given the costs involved in metering and billing this alternative was not considered.
- The introduction of smart meters with facility for remote reading of meters addresses this difficulty.
- APERC approved APDISCOMs' proposals to replace 1 lakh existing pump sets with energy efficient pump sets. These EE pump sets come with smart control panels with facility for remote reading of meters.
- APERC as a part of approval stipulated that quarterly reports on performance have to be placed on the websites. But this is not being done.
- States like West Bengal are reported to have installed smart meters at all agriculture services.

Concluding …

- Reluctance on the part of DISCOMs

- Merely installing meters on pump-sets, DTs and feeders is not enough. It has to be seen that these meters are working, meter readings are accurate and both are validated by third party audits.

- Placing energy audit data in the public domain in an easily accessible format.

THE POLITICAL ECONOMY OF AGRICULTURAL ELECTRICITY SUBSIDY

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Workshop on *Trends and Way Forward in the State Electricity Sectors*
Organised by Prayas Energy Group, 03-04 September 2018, Hyderabad.

Conventional Wisdom:
Agricultural supply and subsidy is a key source of discoms' financial stress.

- Cost of supply to agriculture may be high
  - *Seasonal load*
  - *High transmission loss*
  - *High O&M expenses*
- But does it affect discoms' revenue?
  - *Cross-subsidy + state govt. subventions*
  - *Delay in subsidy disbursement*
  - *Partial subsidy disbursement*

Agricultural Electricity Subsidy: Winners and Losers

- Who pays for the costs?
  - *Cross-subsidy from C&I consumers*
    - Even from domestic consumers in few cases
  - *State govt. subsidies*
    - Electricity duties as double cross-subsidisation
- Do farmers gain from the subsidy?
  - *Pump-priming livelihood activity*
  - *Skewed benefit allocation: Larger farmers gain more!*
  - *An input subsidy to keep food prices low: Passed on to food consumers*
  - *Better irrigation facility is often corelated with higher agri input costs*
- Do discoms hate agricultural subsidy?
  - *Overestimation of consumption to cover losses*
  - *Justification for poor quality of supply and service*

Farmers' Demand

- Water is what matters
  - *Demand for explicit subsidy*
  - *Willingness to pay for better quality supply*
  - *Demand for a passthrough in MSP*

- Can farmers pay for electricity?
  - *Low inflation in food procurement price*
  - *Declining income margin in high yielding states*
  - *Surplus (large) farmers need subsidy as much as the subsistence farmers*
  - *Complexity of DBT*
    - Draft amendments to tariff policy

Conventional Solutions

- Feeder separation and rationing
- Energy efficient pumps and high voltage distribution system
- Separate solar feeders and solar irrigation pumps
- Metered supply and getting the price right

Limited focus on discom finance and quality of supply.

Need for a Holistic Approach

- Real Challenges:
  - *Overutilization of water and energy: Depleting water tables*
  - *Increasing agri input costs, driven by over irrigation*
  - *Potential decline in cross-subsidising load and states' ability to subsidise*

- A holistic approach to water-energy-food challenges
  - *Need to acknowledge the scarcity value of interlinked resources and the costs of their use and understand how they feature in farm-level decision making and village economies*
  - *Policy bundling*
  - *Alignment of interests and agencies*
  - *Multi-level interventions*
    - Consideration of regional dynamics

POWER PURCHASE FROM 1200 MW TEESTA-III HYDRO ELECTRIC PROJECT, SIKKIM

Er. Padamjit Singh, Advisor - AIPEF

Electricity sector experience sharing workshop

Hyderabad, September 3-4, 2018

OUTLINE OF PROJECT

TYPE & CAPACITY	Run of river with limited storage, rating 1200 MW with 10% continuous overload, total 1320 MW
HYDRAULICS	High Head, 788 meter, rated discharge 175 cumec @ 1200 MW, 6 units of 200 MW each, with Pelton wheel turbine.
RESERVOIR CAPACITY	Live storage 3.33 million cubic meter with peaking capability of 5.29 hours @ 1200 MW.
DESIGN ENERGY	5214 GWh
TRANSMISSION	400 kV double circuit line with Quad Moose conductor from Teesta-III to PGCIL Kishanganj (North Bihar)

EXECUTION OF PROJECT

(1) Project awarded by Sikkim Government to Athena Projects Private Limited in Feb-2005 without competitive bidding. SPV, Teesta Urja Limited (TUL) formed in Mar-2005.

(2) Techno-Economic clearance by C.E.A. on 12-May-2006 for project with hard cost Rs.5102 crore, interest and finance charges Rs.603 crore, total cost Rs.5705 crore. Commissioning schedule 60 months from zero date of Oct-2006, target commissioning date 31-Oct-2011.

(3) Implementation agreement between Sikkim Government and TUL – July-2005, giving free power of 12% for 15 years and 15% for next 20 years to home State i.e. Sikkim.

(4) PTC India to purchase entire power of Teesta-III and sell 70% i.e. 840 MW to Punjab (340 MW), Haryana 200 MW, UP 200 MW, Rajasthan 100 MW. Power Sale Agreements signed in Sep-2006.

(5) **TIME OVER RUN**: Claimed COD of project 28-Feb-2017 against the scheduled date as 31-oct-2011, delay of 65 months.

(6) **COST OVERRUN**: Capital cost claimed as Rs.13800 crore against C.E.A. approved Rs.5705 crore. Soft cost increased from Rs.603 crore (CEA T.E.C.) to Rs.6046 crore, an increase of 10 times. Soft cost of project more than the originally total approved cost of Rs.5705 crore.

(7) **TARIFF**: At the time of finalizing power sale agreement with Northern States, PTC indicated a tariff of about Rs.2.5 per unit. At the time of signing common loan agreement with banks, TUL submitted tariff calculations indicating levelised tariff of Rs.1.92 per unit over 35 years.

In the tariff petition before CERC submitted in Dec-2016, TUL claimed annual fixed charges of Rs.3028 crore, which works out to Rs.6.60 per unit. CERC issued on 23-May-2017 provisional tariff order based on 85% of capital cost, which is Rs.4.71 per unit.

ISSUES RELATING TO TARIFF

TUL claimed cost escalation on account of floods, earthquake, civil agitation (Gorkhaland Stir), delay in forest clearance and collapse of Road Bridge, disrupting transportation and communication.

Dispute on COD

PPA condition for COD of **EACH** unit is 24 hours operation at rated capacity whereas IEGC Regulations specified 12 hours.

For COD of project as per PPA, **ALL** units should run at 100% capacity for 8 hours whereas IEGC specifies 12 hours.

Actually, the COD of project (all six units operating at 200 MW and project at 1200 MW) not achieved at all since Transmission Line to Kishanganj still incomplete. Project can not generate beyond 800 MW due to transmission constraint.

TRANSMISSION

CTU entrusted 400 KV Teesta-III – Kishanganj Line to be constructed by TUL. The 206 KM line completed only up to Rangpo (35 Km) and from Rangpo to Binaguri (Siliguri), the existing line can not carry more than 1700 MW.

Existing capacity is Teesta-V, NHPC, 510 MW, 4 IPPs of 100 MW each and balance capacity on line is only 800 MW which becomes the limit for 1200 MW Teesta-III Project.

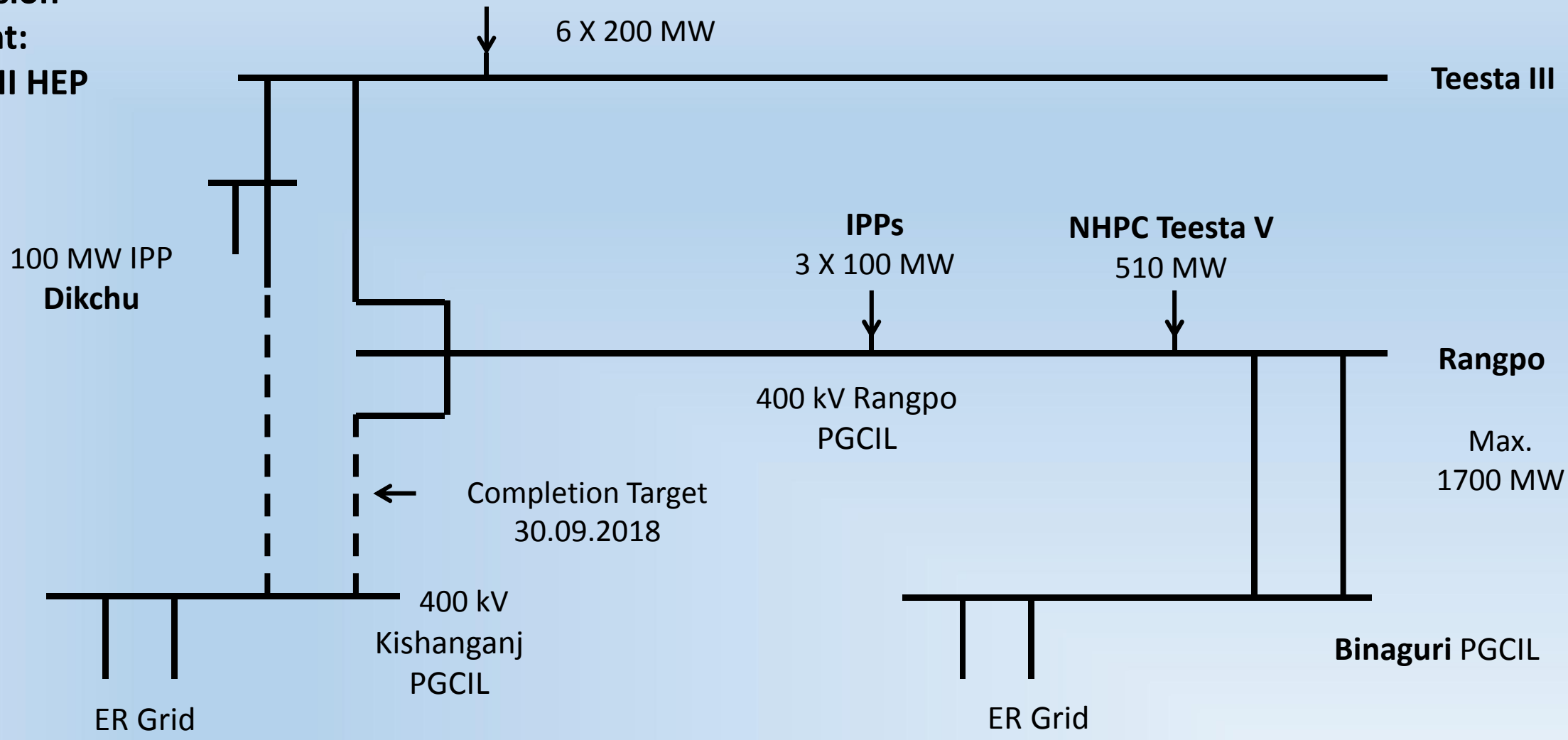
As per Govt. of India Policy, the transmission line was given to a joint venture of TUL and PGCIL with TUL holding 74% equity.

Whereas, the generation project developer TUL was also executing the transmission line, TUL failed to coordinate the line with project. While COD of project has been claimed as 28-Feb-17, the transmission line would not be ready before 30-Sep-18. (see next slide)

Because the 1200 MW project can not operate beyond 800 MW, the PPAs with 4 Northern States for 840 MW out of 1200 MW have not been implemented. The entire power from Teesta-III was sold through STOA in Power Exchange.

During Monsoon of 2017 and again in 2018 while water inflows were sufficient to generate 1320 MW, the station was restricted to 800 MW resulting in 500 MW spillage loss round the clock during Monsoon of 2017 and again in 2018 resulting in an estimated energy loss of 2400 MU.

Transmission Constraint: TEESTA- III HEP



If all the hydro power stations connected to Rangpo operate at 100%, the power flow on Rangpo-Binaguri line would be **2110 MW**
(1200 MW (Teesta III) + 510 MW (Teesta V) + 400 MW (4 IPP stations of 100 MW))
while loading limit is **1700 MW**

PRESENT POSITION

Since the transmission line to Kishanganj is still incomplete, the project is unable to operate at 1200 MW and due to this, COD of project is still not achieved. The entire energy from Feb-2017 up to date becomes infirm energy.

FUNCTION OF ENERGY STORAGE

While initially project was envisaged as having ROR with limited storage feature, in present context of 175 GW renewable energy target, the storage feature has become important. This project has a storage energy of 6000 MWh. The battery storage available has a capital cost of 230 US $ per kWh. A storage capability of 6000 MWh is equivalent to a storage battery of capital cost Rs.9660 crore.

LESSONS AND WAY FORWARD -1

- AIPEF role
  - To contest the cost escalations before APTEL and CERC for ensuring reasonable tariff of Rs 2-3 per unit against Rs.6.60 claimed
  - To activate State DISOCMs for pro-active participation in tariff and regulatory matters.

LESSONS

- Govt. of India Policy of PPP (Public Private Participation) has failed and needs review.
- Cost plus approach leads to inflate capital cost based on excuses, force majeure events
- Awarding hydro projects to private players having no experience be avoided .
- Monitoring and coordination function of Govt. of India has failed in this case. (WRT mismatch between generation and transmission). Role may be assigned to CEA
- DISCOMs to establish/ strengthen dedicated group for dealing regulatory and tariff matters pro-actively and to defend the interest of consumers
- Priority be given for immediately taking up on new hydro projects of storage type or ROR with daily storage facility.
- Merchant mode sale is possible, thought without windfall profits (see next slide)

TEESTA-III ENERGY SALE TO POWER EXCHANGE			
Month	MU	Rs. Crore	Rs. per unit
Mar-17	176.75	46.75	2.64
Apr-17	159.11	43.56	2.74
May-17	429.40	128.39	2.99
Jun-17	524.62	136.54	2.60
Jul-17	627.99	154.84	2.74
Aug-17	509.69	161.09	3.16
Sep-17	514.88	208.78	4.05
Oct-17	439.91	183.84	4.18
Nov-17	264.44	108.46	4.10
Dec-17	195.80	74.98	3.83
Jan-18	142.88	60.97	4.27
Feb-18	118.76	49.92	4.20
Mar-18	150.46	70.83	4.71
Apr-18	190.86	88.53	4.64
May-18	333.95	165.98	4.97

LESSONS AND WAY FORWARD -2

WAY FORWARD

- TUL to complete and commission the 400 kV line to Kishanganj thereby enabling the project to operate at 100% capacity.
- The COD of the project operating at 1200 MW be demonstrated and COD be declared thereafter.
- Matter presently before APTEL be referred back to CERC for re-determination of tariff.

Resource Planning and Power Procurement by Distribution Companies

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Importance of Long Term Planning by Discoms

- In India, great concern about retail tariffs for electricity, but little attention to components of cost
- Cost of generation = 70-80% of tariff
- Long Term Power Procurement Practices have significant effect on cost of supply
  - ➢ Little attention to these practices
- Declining PLFs due to excess capacity
  - Indicator of shortcomings in power procurement practices.
- Future challenges even greater:
  - Increasing amounts of Renewable Energy (RE)
    - Greater uncertainty and need for higher level of balancing services
  - Additional uncertainty due to EVs, storage, smart homes.
- *Urgent need to improve power procurement practices*

CEER
Centre for Energy, Environment & Resources

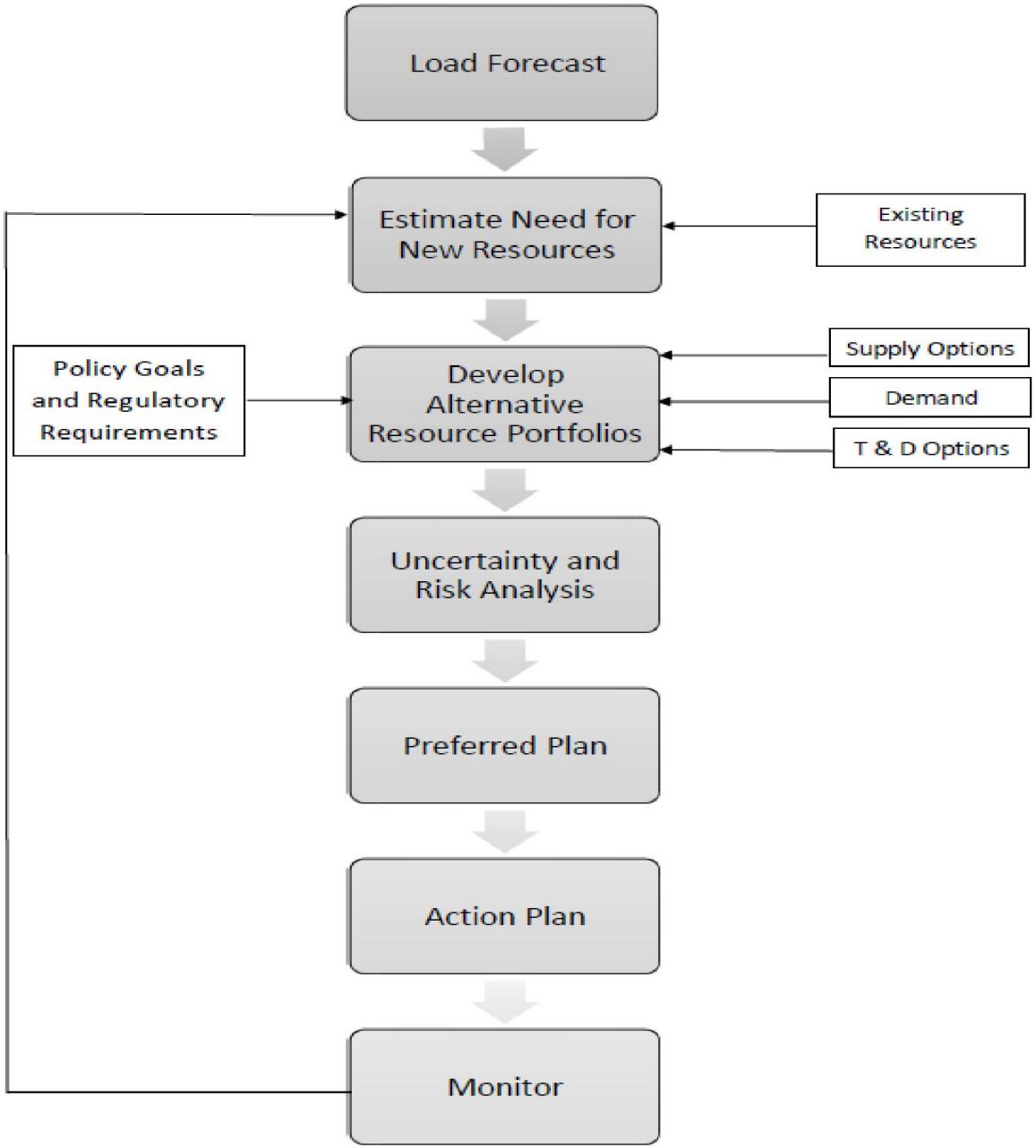
CEER Study

- Analysis of current practice of power procurement at discom level
- Review of international best practices
- Recommendations of steps for improving long term resource planning

Need to Move to Resource Planning

- Resource Planning incorporates power procurement but covers broader range of activities.
- Plan by discom to meet forecasted peak and energy demand over the plan period
  - Using mix of supply, demand and T&D options
  - Cost effective
  - With minimum risk
  - Meets environmental and policy goals
- Planning horizon = 10-20 years
- Output = Action Plan

Steps in Resource Planning



State Experience - Punjab

- Organization and processes for Resource Planning (RP) absent
  - Responsibility for RP in PSPCL not clear.
  - Divided between several entities

- Decision to add 3 IPPs seems to have come from State Govt.
  - No detailed analysis done to estimate need for new generation
  - Inconsistent objectives:
    - Want to reduce costs but yet adding in-state generation which is expensive compared to pit-head plants
    - No thought given to handling of risks due to changes in load growth.

- State Govt pushed capacity additions without any RP process.
  - PSPCL and PSERC followed Govt directive without questioning its appropriateness.

State Experience - Delhi

- State & Central Govts and DERC had some role in pushing discoms to procure more power, particularly in preparation for CWG
- Over-estimation of expected growth in load, particularly industrial load.
- One positive development
  - Demand-side measures being explored to manage load
  - To create packages of round-the-clock (RTC) power that can be sold to reduce burden of excess capacity.

State Experience - UP

- Focus on adding generation capacity
  - Political considerations made the load forecasts higher than reasonable.
    - In 2009, estimated need of 32,000 MW of additional capacity to match national per capita consumption
    - Current peak load only ~20,000 MW (2017-18)

- State government set capacity addition targets and signed MoUs
  - No questioning by UPERC of need for capacity additions
  - MoU route allowed UPPCL to ignore costs
    - For example, during approval of PPAs for Bajaj plants (5x2x45MW), UPPCL reluctant to verify capital costs despite several directives from UPERC.
    - Bajaj plants cost = Rs 7.63 per kWh (2016-17); twice UPPCL's average procurement cost.

- Encouraging signs
  - UPPCL recognizing challenge of implementing Saubhagya scheme and trying to reduce power purchase costs
  - Enlisting help from IIT Kanpur to manage supply resources.

State of Long-Term Planning in Indian Discoms

- Long-term resource planning not part of sector vocabulary.
  - Resource planning poorly understood, if at all.
  - Little appreciation of value of resource planning
- Considerable interference by state governments
- Power procurement bundled with tariff filing
  - Almost no attention to long-term issues in power procurement.
- Regulatory scrutiny of individual supply additions
  - No holistic view of requirements and planned additions
- Diffused responsibility
  - Multiple cells for interlinked activities

Shortcomings in Discoms' Planning

- Poor quality of load forecast
- Inadequate analytical backup for capacity additions
  - State Government intervention and directives
- Lack of integrated consideration of all options to meet load.
- Insufficient attention to resource mix
- Uncertainty and risk management ignored
- Environmental impacts not considered.

Issues and Questions

- Effective resource planning essential in the future
  - Greater uncertainty
  - Impact of RE on grid operations
- How to increase awareness of need and benefits of resource planning?
- Currently, almost all PPAs are for round-the-clock (RTC) power
  - How to have more seasonal and peaking power contracts?
- How to rapidly increase the HR capacity in discoms and SERCs for resource planning?
  - Training in modelling and other best practices around resource planning.

Some Recommendations

- Mandate regulators to require resource planning.
- Develop regulatory framework for resource planning
  - Periodic, separate proceeding for resource planning; not with tariff review
  - Develop specifications for resource planning
    - Process to be used
    - Planning horizon (~20 years)
    - Frequency of updates (suggest every two years)
    - RE integration studies
    - Public participation
- Develop road map for gradually adopting international best practices in resource planning.

Quality of supply and service

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As per government reports, grid has reached all the villages and 87% of the rural households have been connected. Universal access to grid power can be expected within a few years. Quality of supply and service, especially to the small and rural consumers is indeed the next challenge.

Current situation in Maharashtra:

- **Repairs material shortage:** Today, in cities as also in rural areas, repair materials including cables; fuses; kitkats; poles; transformers are in absolute short supply. We have witnessed two such cases in CGRF. One consumer was without power for 7.5 months for want of cable (100 meters) and subsequently was ordered compensation of 2.75 lakhs as per SOP norms by CGRF. In another case a rural farmer was without power for 3.5 months for 50 meters cable shortage and wrong BU in bill; finally he bought the cable and then supply was restored. The case is pending before the CGRF. In several complaints about transformer failures, it is observed that the matter is not attended till consumers contribute money for transformer repairs. Even today, several thousand consumers, many of them in urban areas, are on waiting list for electrical meters areas since last six months.
- **Absence of meter reading:** Many of the rural consumers, especially agricultural, complain about average billing for months together in spite of meter being installed, not to mention any thing about the unmetered consumers. They do not get the bill corrected even if they fight up to IGRF; CGRF.
- **Supply reliability:** There are three main supply reliability indices i) System Average Interruption Frequency Index (SAIFI); (ii) System Average Interruption Duration Index (SAIDI); and (iii) Customer Average Interruption Duration Index (CAIDI). In spite of the regulatory mandate, these are not published every month. As of today, indices published on MSEDCL website are of March 2018 and the table says "*The indices are computed based on the data provided by the field offices which is subjected to subsequent corrections, if any.*" March 2018 indices show that for entire Maharashtra indices are SAIFI 3.61; SAIDI 223.76; CAIDI 62 and the total number of affected consumers is 3,18,35,468. This indicates poor quality of supply.
- **Standards of performance (SOP), implementation issues**: Till date, display boards informing consumers about their rights under the standards of performance have not been put up in any of MSEDCL's consumer centres or offices across the state. Only Pune zone has such display boards, but that is also because of continuous pressure and follow-up by consumer activists. Further, the display boards that do exist still show information as per the standards of performance regulations of 2005 and they have not be updated to reflect the new norms as per the 2014 regulations. Most officials do not follow schedule of charges and ask consumers to do everything by giving 1.3 % supervision charges.

The Maharashtra experience highlights the challenges on the road to reliable good quality supply and service. It also underlines the fact that as a first step towards improving supply and service quality, it is essential to implement the existing provisions in this regard. For this purpose, both the regulator and the distribution company need to be held accountable. In this context, the role of the civil society and consumer organisations becomes very crucial.

MAHARASHTRA STATE ELECTRICITY DISTRIBUSTION CO. LTD.

Circle wise Reliability Indices (SAIFI/SAIDI/CAIDI) Excluding AG Feeders For the Month MAR-18

Sr. No.	CIRCLE NAME/ZONE NAME	Total No of Consumers Data Received	Total No of Affected Consumers	No. of Intr.	Duration of Intr.	Total Intr.	Total Duration	SAIFI	SAIDI	CAIDI
1	AKOLA CIRCLE	122388	212210	95	8524	212210	30478763	1.73	249.03	143.63
2	BULDHANA CIRCLE	140069	224054	133	8295	224054	19838826	1.6	141.64	88.54
3	WASHIM CIRCLE	52301	63025	40	3911	63025	10889937	1.21	208.22	172.79
	AKOLA ZONE	**314758**	**499289**	**268**	**20730**	**499289**	**61207526**	**1.59**	**194.46**	**122.59**
4	AMARAVATI CIRCLE	243763	384839	163	13557	384839	47835455	1.58	196.24	124.3
5	YAVATMAL CIRCLE	157913	447133	181	13391	447133	33498905	2.83	212.14	74.92
	AMARAVATI ZONE	**401676**	**831972**	**344**	**26948**	**831972**	**81334360**	**2.07**	**202.49**	**97.76**
6	AURANGABAD (U) CIRCLE	160472	817596	254	8693	817596	36074758	5.09	224.8	44.12
7	AURANGABAD CIRCLE	69956	187493	152	8156	187493	18120893	2.68	259.03	96.65
8	JALNA CIRCLE	9284	8634	12	1213	8634	1388982	0.93	149.61	160.87
	AURANGABAD ZONE	**239712**	**1013723**	**418**	**18062**	**1013723**	**55584633**	**4.23**	**231.88**	**54.83**
9	BARAMATI CIRCLE	134751	308518	158	10153	308518	22365937	2.29	165.98	72.49
10	SATARA CIRCLE	467597	1612034	433	17886	1612034	96884829	3.45	207.2	60.1
11	SOLAPUR CIRCLE	248216	909260	409	17975	909260	43156808	3.66	173.87	47.46
	BARAMATI ZONE	**850564**	**2829812**	**1000**	**46014**	**2829812**	**162407574**	**3.33**	**190.94**	**57.39**
12	THANE (U) CIRCLE	372226	827152	225	6251	827152	69483316	2.22	186.67	84
13	WASHI CIRCLE	313447	815257	181	8856	815257	63631441	2.6	203.01	78.05
	BHANDUP (U) ZONE	**685673**	**1642409**	**406**	**15107**	**1642409**	**133114757**	**2.4**	**194.14**	**81.05**
14	CHANDRAPUR CIRCLE	170125	860129	249	9037	860129	39792752	5.06	233.9	46.26
15	GADCHIROLI CIRCLE	149855	396589	148	8476	396589	32479733	2.65	216.74	81.9
	CHANDRAPUR ZONE	**319980**	**1256718**	**397**	**17513**	**1256718**	**72272485**	**3.93**	**225.87**	**57.51**
16	BHANDARA CIRCLE	127572	290397	118	6764	290397	30296351	2.28	237.48	104.33
17	GONDIA CIRCLE	133501	248437	78	6473	248437	26236670	1.86	196.53	105.61
	GONDIA ZONE	**261073**	**538834**	**196**	**13237**	**538834**	**56533021**	**2.06**	**216.54**	**104.92**
18	DHULE CIRCLE	63711	101358	52	2351	101358	6900417	1.59	108.31	68.08
19	JALGAON CIRCLE	275483	1363267	718	26050	1363267	63382018	4.95	230.08	46.49
20	NANDURBAR CIRCLE	50108	106241	76	4168	106241	6211101	2.12	123.95	58.46
	JALGAON ZONE	**389302**	**1570866**	**846**	**32569**	**1570866**	**76493536**	**4.04**	**196.49**	**48.7**
21	KALYAN CIRCLE - I	506211	3125509	311	9651	3125509	161641051	6.17	319.32	51.72
22	KALYAN CIRCLE - II	276004	1431699	151	7335	1431699	93307533	5.19	338.07	65.17
23	PALGHAR (MINI) CIRCLE	101484	406961	143	6894	406961	37428676	4.01	368.81	91.97
24	PEN CIRCLE	254554	629650	134	10065	629650	82786847	2.47	325.22	131.48
25	VASAI CIRCLE	583695	4605760	329	12517	4605760	172725418	7.89	295.92	37.5
	KALYAN ZONE	**1721948**	**10199579**	**1068**	**46462**	**10199579**	**547889525**	**5.92**	**318.18**	**53.72**
26	RATNAGIRI CIRCLE	253295	556077	140	8106	556077	51831780	2.2	204.63	93.21
27	SINDUDURG CIRCLE	120181	864245	169	3649	864245	16029412	7.19	133.38	18.55
	KOKAN ZONE,RATNAGIRI	**373476**	**1420322**	**309**	**11755**	**1420322**	**67861192**	**3.8**	**181.7**	**47.78**
28	KOLHAPUR CIRCLE	726802	2733821	1006	39746	2733821	165143923	3.76	227.22	60.41
29	SANGLI CIRCLE	368358	1229254	523	20975	1229254	88348223	3.34	239.84	71.87
	KOLHAPUR ZONE	**1095160**	**3963075**	**1529**	**60721**	**3963075**	**253492146**	**3.62**	**231.47**	**63.96**
30	BEED CIRCLE	36105	56436	23	2193	56436	5428780	1.56	150.36	96.19
31	LATUR CIRCLE	30245	47037	27	1087	47037	3062091	1.56	101.24	65.1
32	OSMANBAD CIRCLE	34259	246163	82	1527	246163	7177766	7.19	209.51	29.16
	LATUR ZONE, LATUR	**100609**	**349636**	**132**	**4807**	**349636**	**15668637**	**3.48**	**155.74**	**44.81**
33	NAGPUR (R) CIRCLE	109097	190965	101	4719	190965	12294286	1.75	112.69	64.38
34	NAGPUR (U) CIRCLE	88236	180463	150	3551	180463	6668836	2.05	75.58	36.95
35	WARDHA CIRCLE	91115	196153	91	6323	196153	19344418	2.15	212.31	98.62
	NAGPUR ZONE	**288448**	**567581**	**342**	**14593**	**567581**	**38307540**	**1.97**	**132.81**	**67.49**
36	HINGOLI CIRCLE	17542	19553	18	3492	19553	4106292	1.11	234.08	210.01
37	NANDED CIRCLE	49517	75551	35	2930	75551	8683175	1.53	175.36	114.93
38	PARBHANI CIRCLE	46319	125426	77	10089	125426	18652746	2.71	402.7	148.72
	NANDED ZONE	**113378**	**220530**	**130**	**16511**	**220530**	**31442213**	**1.95**	**277.32**	**142.58**
39	A' NAGAR CIRCLE	149527	252891	130	11565	252891	42004363	1.69	280.91	166.1
40	MALEGAON CIRCLE	64614	298497	225	6622	298497	14500666	4.62	224.42	48.58
41	NASIK (U) CIRCLE	250220	448417	135	8915	448417	48804297	1.79	195.05	108.84
	NASIK ZONE	**464361**	**999805**	**490**	**27102**	**999805**	**105309326**	**2.15**	**226.78**	**105.33**
42	GANESHKHIND (U) CIRCLE	459884	1345684	268	14706	1345684	74837203	2.93	162.73	55.61
43	PUNE (R) CIRCLE	153102	526360	127	5286	526360	34858873	3.44	227.68	66.23
44	RASTAPETH (U) CIRCLE	588502	2059273	434	14029	2059273	105316832	3.5	178.96	51.14
	PUNE ZONE	**1201488**	**3931317**	**829**	**34021**	**3931317**	**215012908**	**3.27**	**178.96**	**54.69**
STATE TOTAL :-		**8821606**	**31835468**	**8704**	**406152**	**31835468**	**1973931379**	**3.61**	**223.76**	**62**

The indices are computed based on the data provided by the field offices which is subjected to subsequent corrections if any

Quality of Supply and Service

Introductory presentation for break-out discussion

Prayas (Energy Group)

Trends and Way Forward in the State Electricity Sectors, 2018

An Experience Sharing Workshop

3rd September, 2018

Hyderabad

Access: Connections challenge mostly addressed

- Household electrification challenge within sight:
  - 100% village electrification , > 90% households with connections
  - Around 13 states >95% electrified, non-electrified households concentrated in few states
    - Uttar Pradesh, Meghalaya, Assam, Jharkhand alone account for almost 70% of non-electrified households in India
- However, village electrification/ connections need to translate to sustained use of electricity
  - Procedural hassles in obtaining or modification of connections persist
  - Investment, effort needed to ensure reliable, affordable power supply and quality service
  - Imperative that quality of supply and service is focussed on

But, several challenges persist beyond connections

Possible metering and billing issues

No/ faulty meter, wrong/average reading , incorrect billing, delay

Low supply reliability

Load Shedding, frequent/ long interruptions, DT failure

Low affordability

Inadequate subsidy, high tariffs for small commercial/industrial

Increase in consumer arrears

Disconnection

Possibility of Hooking

Buildup of trust deficit

Switch to costly supply alternatives

Reduction in productive activities

Difficulty in bill payment

Poor paying capacity

Low demand for electricity

↑ in AT&C losses, ↓ investment efforts by DISCOMs

Electrification efforts may not yield results

What are the existing measures to ensure QoS?

- Sections 57, 58, 59 of the Electricity Act pertain to Standards of Performance (SoP)
- All SERCs have SoP Regulations
- SoP reporting
- QoS compensation payment
- SERC directives
- Measures for monitoring
- Harnessing technology to ensure metering and billing

Accountability for Supply and Service Quality needs focus

- Does not get as much attention as tariff in regulatory processes
- Repeated directives but low compliance
- Lack of reliable, disaggregated data provided on a consistent basis
  - National Power Portal good initiative but more efforts needed
  - SoP compliance reports not audited, very little independent monitoring
- Complaint handling and compensation processes inaccessible/ cumbersome
  - Low awareness of available facilities
  - Compensation rarely done and many cases decided in favour of utility
- Many issues with metering and billing but no special focus by ERCs

Break-out topics

Group 1:

QoS issues for newly electrified households

Group 2:

Metering and billing issues

Group 3:

Implementation of SoP parameters and possibility of automatic compensation

Group 4:

Strengthening of complaint handling system

Group discussion could be based on:

- What are the major barriers?
- What should be done, by whom, to address the problem?
- What is the role of CSOs?

One hour time to discuss, 10 minute presentation by each group

Break-Out Groups

Group 1	Group 2	Group 3	Group 4
• Ashwini Swain	• Alok Shukla	• Anoop Singh	• Vivek Velankar
• Bharat Jairaj	• Archana M.V	• Ashok Pendse	• Ashutosh Behera
• D. Narasimha Reddy	• Bose Jacob	• D. Ramanaiah Setty	• B S Udupa
• Jaigopal Soni	• Yawanti Kumar Bolia	• Gobardhan Pujari	• Divakar Babu
• M Venugopala Rao	• Kanika Balani	• Padamjit Singh	• Daljit Singh
• Arundhati Muthu	• M Thimma Reddy	• Nagendra Murthy	• Elisha George
• Usha Ramachandra	• Manoj Kumar Mishra	• Parth Bhatia	• K.N.Venkatgiri Rao
• Nandikesh Sivalingam	• Nandakumar N.	• Subhas Chandra Banerjee	• Nand Kashyap
• Uttara Narayanan	• Vinuta Gopal	• D V Ramana	• P.C.Chouhan
• Pradyut Choudhury	• S. Gandhi	• Rajkiran B	• Vishnu Rao
• S Chandramouli	• Prabhakar BN	• Pratap Hogade	• Udai Singh Mehta
• Rama Shankar Awasthi	• Piyush Sharma	• Raghu K	• Rachel Pearlin
• Pulikkodan Rajesh	• Rajendra Reddy K	• Ranga Rao	• Prateek Aggarwal
• Ashwini	• Sreedhar Reddy	• Sreekumar	• Ann
• Manabika	• Shantanu	• Mokshda	• Shiv
	• Maria		

Maharashtra Veej Grahak Sanghatana

Brief Note - Regulatory Effectiveness - Experience in Maharashtra

(A) Way Positive -

After enactment of ERC/E Act, transparent approach was started, Regulations were framed, consumer interest is being considered, CRs and Consumer Organizations are being heard. Forums are established for consumers' grievances to fight & get justice.

Some positive decisions, We have experienced in Maharashtra, are as below,

(1) **TDL Charges (Y 2003)** - TDL Charges in 11 districts withdrawn by MERC due to low T&D Loss Percentage. Around 40 Lakh consumers were benefited by @ 360 Cr. Rs. in one year.

(2) **Single Phasing Scheme (Y 2005)** - The scheme was disallowed by MERC. Burden of Rs. 900 Cr. in the ARR was reduced.

(3) **Infrastructure Cost & Meter Cost Refund (Y 2007)** - Infrastructure Cost & Meter Cost recovery from the prospective consumers was disallowed by MERC in Y 2006. After struggle of 2 years it was implemented from Y 2008.

(4) **Reliance SLC Refund (Y 2009)** - Reliance had charged higher SLC than allowable. After MERC orders, Reliance refunded @ Rs. 12 Cr. to its @ 64000 consumers.

(5) **Load Shedding Protocol -** In the power shortage period from FY 2006-07 to FY 2011-12, Load Shedding protocol was determined by MERC & implemented by MSEDCL.

(6) **Commercial Activities allowed in Residences (Y 2012) -** Small commercial activities in residences (such as Kirana, Xerox, Tea stall etc.) are allowed to the Residential Consumers having consumption below 300 Units per month. It is helping to @ 1.5 Lakh consumers & benefit @ 80 Cr. Rs. per annum.

(7) **MYT Order 2016 -** Industrial Power tariff was properly controlled.

(8) **Power Purchase Cost** - Power Purchase Cost is properly controlled within last 3/4 years.

(9) **Agricultural Consumption** - Agricultural Consumption and Distribution Losses were properly analyzed & determined from Y 2000 up to Y 2006.

(B) Way Negative -

First decade was better. Deterioration started from Y 2009. Major important issues are ignored. As a result Maharashtra Tariff is much higher than all adjoining States from Y 2012. Impact - proportionate growth and development of the State not achieved.

Some negative/ignored fields, as per our experience, are as below,

(1) **ARR -** ARR is not properly being determined. Many inefficiencies are being allowed such as O&M expenses, interest, capital expenditure etc.

(2) **Third Party Verification -** Third Party Verification particularly in case of Capital Expenditure, Assets, Accounts, Balance Sheets, Audit Compliances & Agricultural Consumption is must in the interest of consumers. Still it is being avoided.

(3) **Non compliance of directions -** Non compliance of the provisions of Act, provisions of regulations & various directions is a major issue, may be 40-50% work load of the Commission. Still no serious cognizance and no strong action against utilities.

(4) **Consumer Services/Quality of Supply** - These important issues are not seriously handled by regulator.

(5) **CSS -** As per Tariff Policy "Cross Subsidy Surcharge" should not be onerous to eliminate the competition. But now the CSS is being determined in such a manner that there should be no OA consumers & no competition.

(6) **No Accountability -** "Yet Regulators and Discoms are not discharging their duties as bound by Act, in a sense they have not been held accountable" as observed by Shunglu Committees in its Report Y 2011.

(7) **Utilities -** Unbundled into separate companies in Y 2005. But still no change in the functioning. Attitude is still like a government owned board.

(8) **Government -** No serious desire of reforms. No control on own companies.

(9) **Regulators** - Regulators are not in fact (really) independent.

(10) **Agricultural Consumption** - As per Shunglu Committee Observations "Majority of the States overstate Agricultural Consumption in order to manipulate their distribution losses and to hide lower collection efficiency".

In Maharashtra MSEDCL claims Agricultural Consumption 30% and Distribution Losses 15%. In fact (on the basis of evidences) Agricultural Consumption is 15% and Distribution Losses are 30%. This manipulation of 15% amounts to Rs. 9300 Cr., which is nothing but theft & corruption & which makes huge impact on the Tariff.

Still this issue is not properly decided by the Regulator.

(C) Way Forward/Solutions -

(1) **Consumer Awareness** - Still too low 1% to 2%. All the consumer associations should work hard. We must achieve Awareness more than 10%.

(2) **One Worker, One Block -** Consumers Organizations should have One active worker in each Block/Tahsil. Initially We can start with One Worker One District. Consumer organization should arrange training camps in each district, also up to block/tahsil level.

(3) **Continuous Pressure -** Continuous Pressure through CGR Forums, through various litigations or through various agitations is necessary and must.

(4) **Battle up to APTEL** - Battle up to Commission/Regulator level is not sufficient. Consumer Organizations should expand their battle level up to minimum APTEL. And on the issues like distribution losses (in fact theft & corruption) up to Supreme Court.

Dt. 3rd September 2018

Pratap Hogade
President, MVGS

Improving effectiveness of regulatory processes

Prayas (Energy Group)

Trends and Way Forward in the State Electricity Sectors, 2018

An Experience Sharing Workshop
3rd and 4th September, 2018
Hyderabad

Electricity Regulatory Commissions (ERC):
Important institution to protect the public interest

- ERC – vast mandate and significant authority
  - Licensing, approval of power purchase, tariff determination, service quality
  - Quasi-judicial body, subordinate legislation (regulations),powers of civil court

- Two aspects of making the institution effective
  - Substantive
  - Procedural

Critical ‘substantive’ aspects

- Power purchase planning
- Quality of supply and service (SoP / Supply Code / CGRF)
- Estimation of AG sales and ensuring timely subsidy
- Preparing sector for the uncertain future

Critical ‘process’ aspects

- Appointment of Chairperson and members
- Overdependence on consultants
- Shrinking ‘public hearings’
- Appointment of consumer representatives (S 94 (3))
- Participation of consumer groups in Technical Validation Sessions / Meetings
- Quality of orders and making data / information public
- Holding utilities accountable for ‘directives’
- Appeals before APTEL
- Functioning of SAC
- Implications of CERC orders / process

Future of the DISCOM

Introductory Presentation for Break-Out Discussions
Prayas (Energy Group)

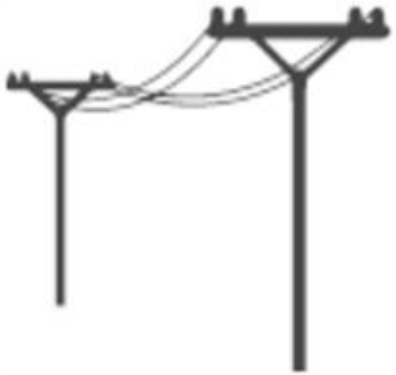
Trends and Way Forward in the State Electricity Sectors, 2018

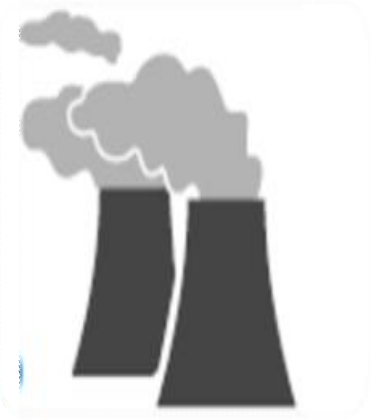
An Experience Sharing Workshop

3rd and 4th September, 2018

Hyderabad

Utility Business Model at Crossroads





Renewable energy boom

- ↓Solar PV, wind price
- Policy push for RE – 175 GW
- Target could possibly be revised
- Increasing viability of storage options
- Move to solarise agriculture as well.

Uncertainty in Demand

- ↑ in open access, captive sales with cheaper supply options
- Imminently possible for large consumers to reduce dependence on grid.

Power Procurement

- Inefficiency of cost plus plants, rise in discovered tariffs
- Backing down issues
- Coal, gas: ↑ prices, issues with availability, quality

Need to understand key trends and implications

Key Trends: Sustained surplus in base power

- India tripled its coal power plant capacity in past decade : 71 GW → 192 GW
- ~ 40 GW → stressed assets – increased burden on economy, financial sector
- Significant surplus power : > 100 BU
- Surplus power not sold but backed down/ lying idle→ inc. fixed cost burden

State DISCOM 2015-16	Backing down reported (MW)	Backing down as % of contracted capacity	Fixed-cost payments due to backing down (Rs. crore)	Fixed-cost payments for backing down as a % of fixed cost payments to generators	Fixed-cost payments for backing down as a percentage of agricultural subsidies
Rajasthan	1798	14%	1051	16%	59%
Punjab	3457	27%	3006	33%	51%
Maharashtra*	4231	19%	2828	21%	59%
Madhya Pradesh	2444	17%	2177	28%	40%
Gujarat	5525	30%	3823	36%	104%

*Data for 2016-17 for Maharashtra

Key Trends: Increasing costs and Rising Tariffs

Average cost of supply

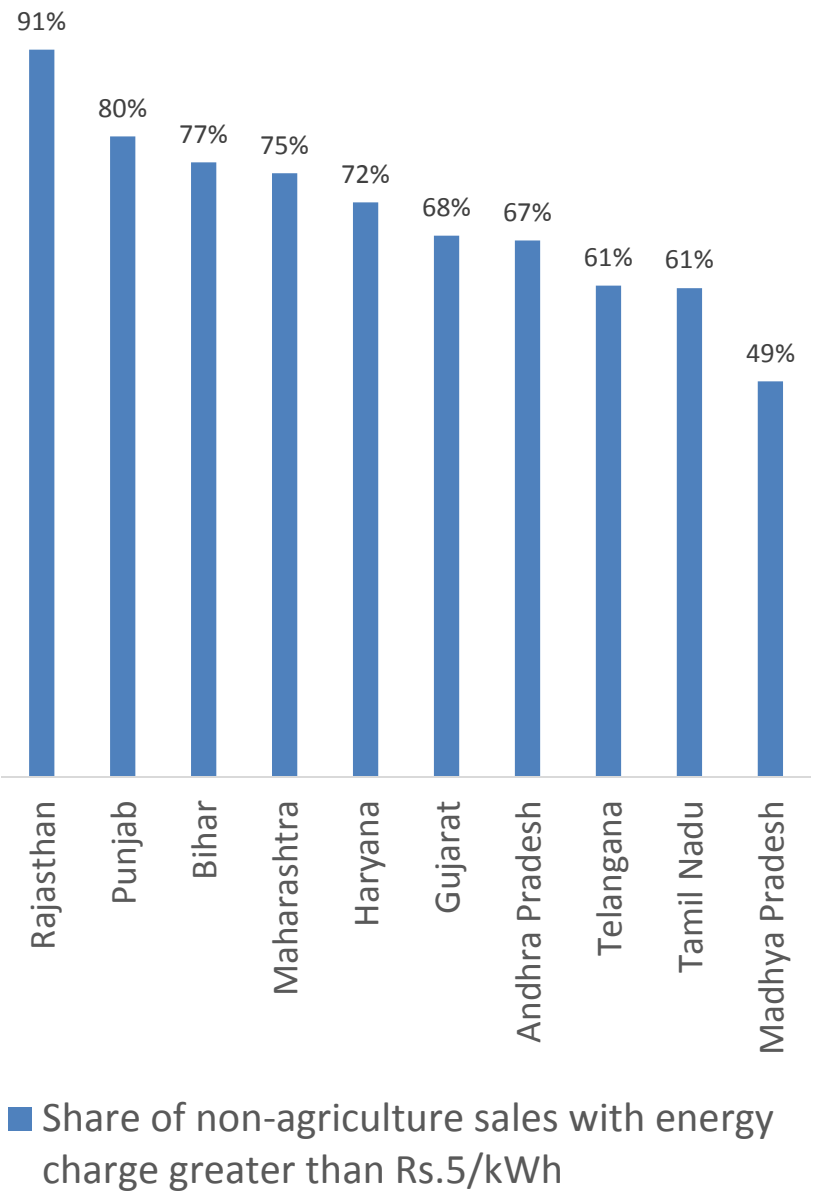
- Average cost of supply in FY 18 – **Rs.7/unit**
- Cost of supply increasing at an average rate of **6% per annum** (3-5 yr CAGR)

Tariffs

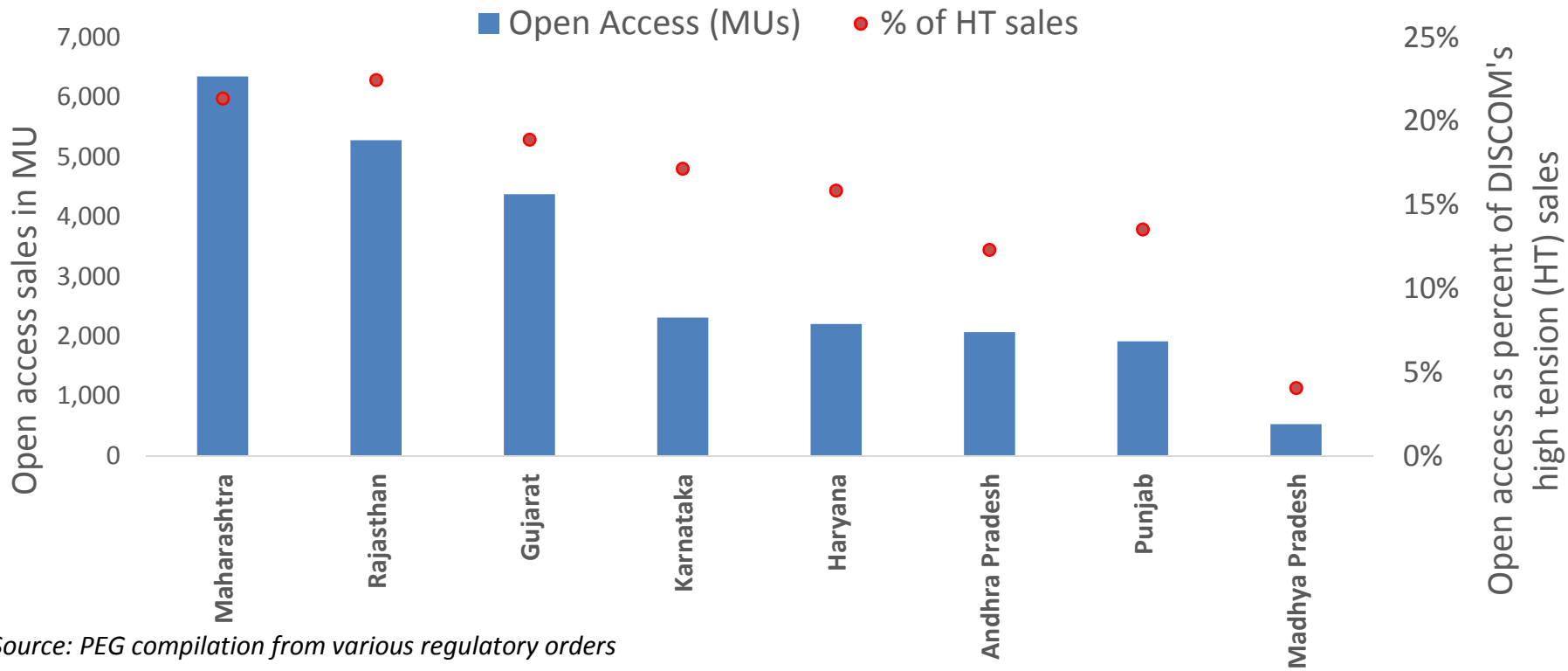
- Cross subsidy significant for HT,LT industrial, commercial consumers **> 130% of ABR**
- Average tariffs for cross-subsiding consumers **~ Rs. 9/ unit**

Power from Alternate Sources

- Cost of RE power **< Rs. 5/unit**
- **> 70% of non-agri. sales** with energy charges > Rs. 5/unit
- Short/medium term power **< Rs. 4 unit**



Key Trends: Rise of Open Access (OA)

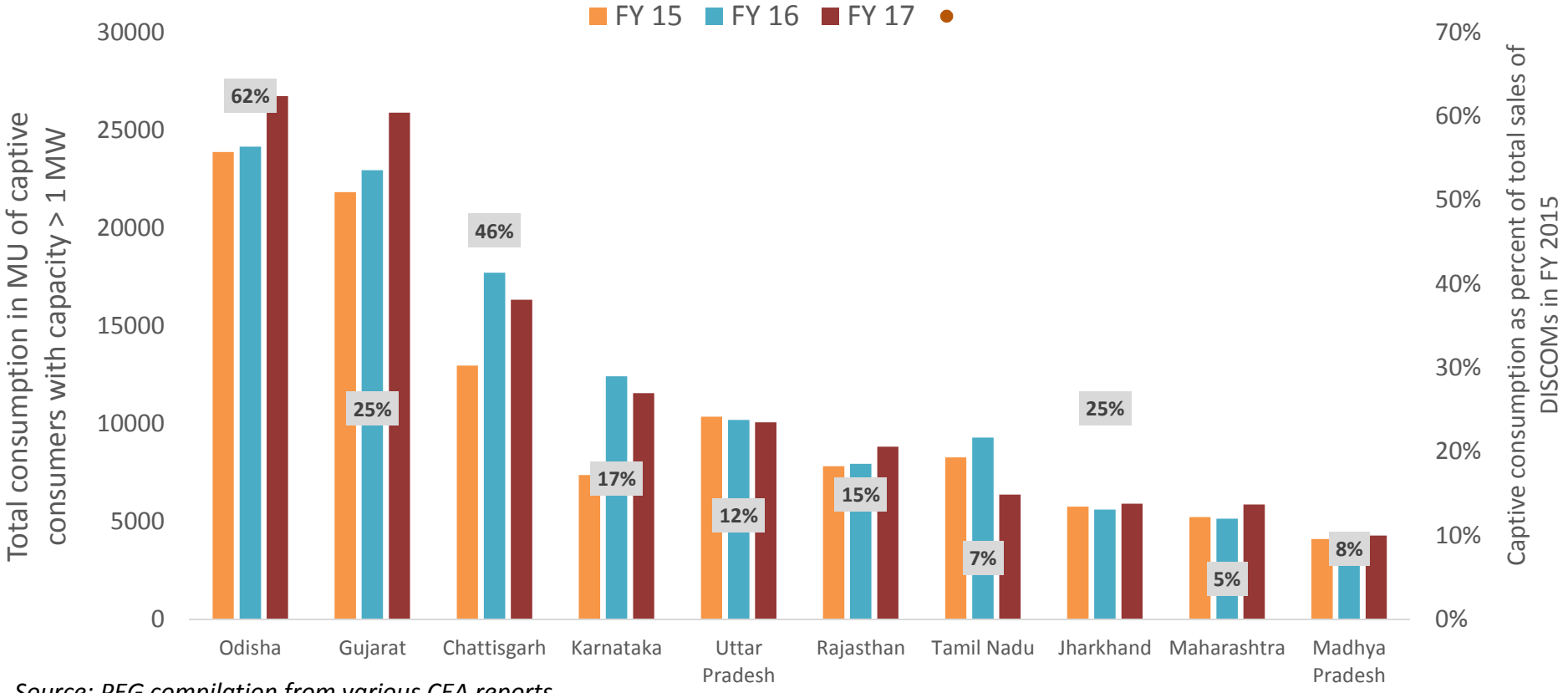


Source: PEG compilation from various regulatory orders

Estimates for FY17 for all states except Rajasthan (FY 16) and Madhya Pradesh (Sept 2015 to August 2016

- >90% of open access is short term with durations > 1 day
- Makes power procurement planning challenging for DISCOMs
- In Maharashtra, Rajasthan and Gujarat , OA as high as 20% of DISCOM HT sales
- Efforts need to be made for these consumers to go for good

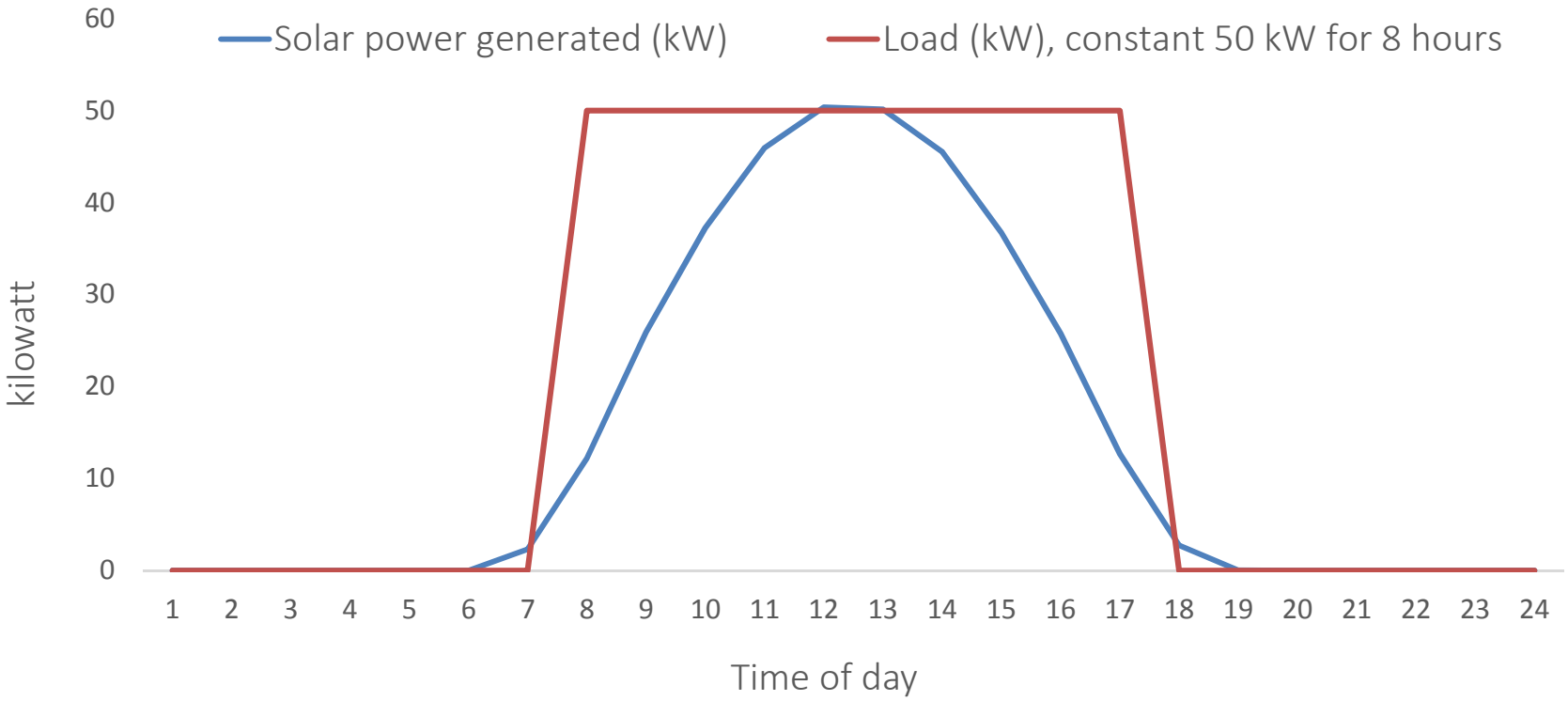
Key trends: Proliferation of captive use



Source: PEG compilation from various CEA reports

- Captive consumption from own generation already 20% to 30% of total sales
- FY 14 to FY 15 saw 9% ↑ in Odisha, 12% in Chhattisgarh, and 34% in Karnataka
- Captive rules amendments to encourage serious players not just CSS evaders
  - Treatment of subsidiaries
  - Preference shares and treatment of group captive

Key Trends : Increasing Viability of kW scale solar PV systems



- Generation cost for such system @ Rs. 5/kWh
- Even without net metering, a consumer with day-time load of 50 kW will save Rs. 2/unit with migration
- In the face of policy/regulatory hurdles to obtain power from DISCOM, consumers will also find solar + storage options viable @ Rs. 7.6/kWh.

Traditional methods to curb migration ineffective

- Increasing fixed cost while keeping total tariffs the same
  - Possible reduction in energy charges → can reduce sales migration
  - Counter-intuitive results : ↑ in Fixed cost burden → makes RE captive more lucrative
  - Results from states for a typical 1 MW industrial consumer
    - 100% increase in fixed charges results in only a 10% to 15% reduction in energy charge
    - Fixed charges increase to about 50 to 60 lakhs per year
    - This is equivalent to 10% to 15% of total capital cost for 1 MW solar plant

- Increase in additional surcharge, cross subsidy surcharge
  - Both charges are levied on open access consumers
  - Move can drive more and more consumers to group captive/ captive options
  - Some success of this approach in states like TN but not sure if it can be sustained.

- Reduction in industrial tariffs
  - Rebates and subsidies given by Punjab, Maharashtra , Haryana, and others
  - Maharashtra : FY 15 to FY 16 →HT consumer subsidy ↓ tariff by 16% but open access ↑ by 29%
  - Sustainability of such a measure with current cross subsidy, strained state finances?

Key Trends: Solar Power for Agriculture

- Launch of KUSUM (Kisan Urja Suraksha Evam Utthaan Mahaabhiyan) Scheme
  - 60% central + state govt, 30% loans, 10% farmers contribution

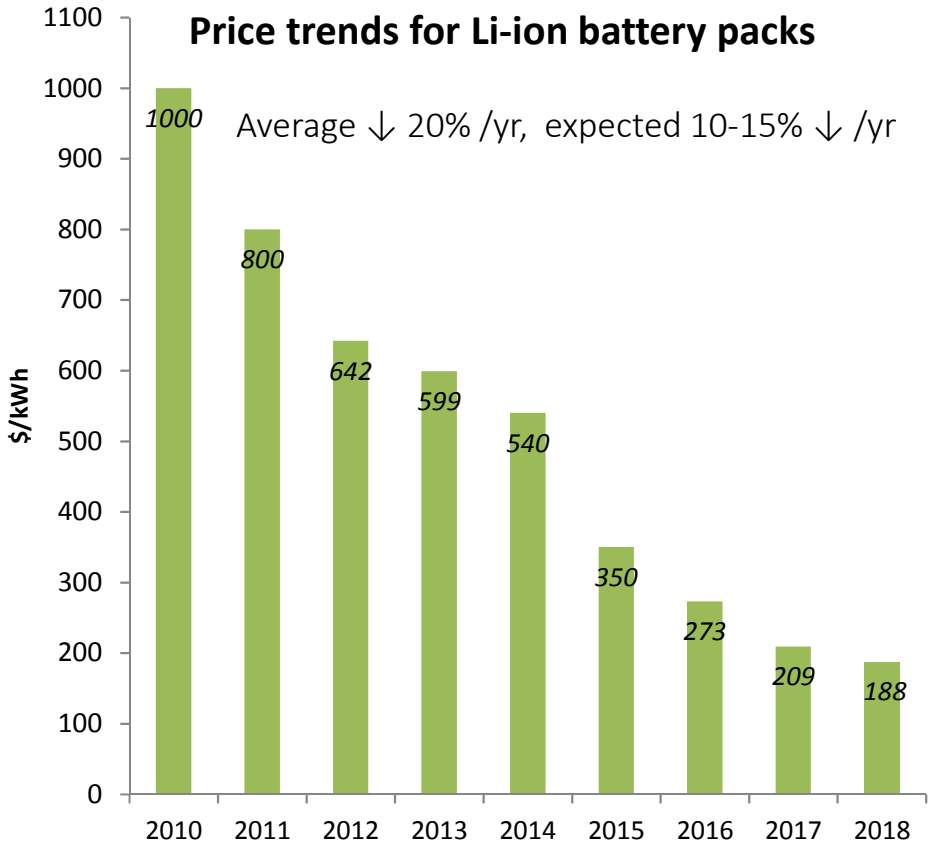
Planned Works	Target
Grid-connected solar power plants up to 2 MW (Mh model)	10 GW
Standalone off-grid solar pumps	17.5 lakh pumps
Solarisation of existing grid-connected agriculture pumps	10 lakh pumps
Solarisation of govt. tube-wells and lift irrigation projects	50,000 projects

- Significant progress in many states
  - Projects being implemented in Maharashtra, Gujarat, Rajasthan, Chattisgarh, Tamilnadu, Karnataka and Andhra Pradesh
  - Maharashtra model can result in significant savings
    - Feeder level solar plants to provide day-time supply to farmers
    - Pilots initiated for > 1500 MW and tenders to be less than Rs. 3.25/unit
    - Programme implementation at minimal cost and no subsidy support

- Can impact 10% to 30% of agricultural sales in medium term

Key trends: Increasing viability of storage

- Rapid fall in price of Lithium-ion battery pack
  - Push due to economies of scale, larger average pack sizes, energy density improvements
- Applications can influence
  - RE/system level balancing
  - Transmission planning, Capacity addition
  - Behind the meter applications
- Can fundamentally change the business of the utility
  - RE+ Storage options
  - Transmission, power purchase planning

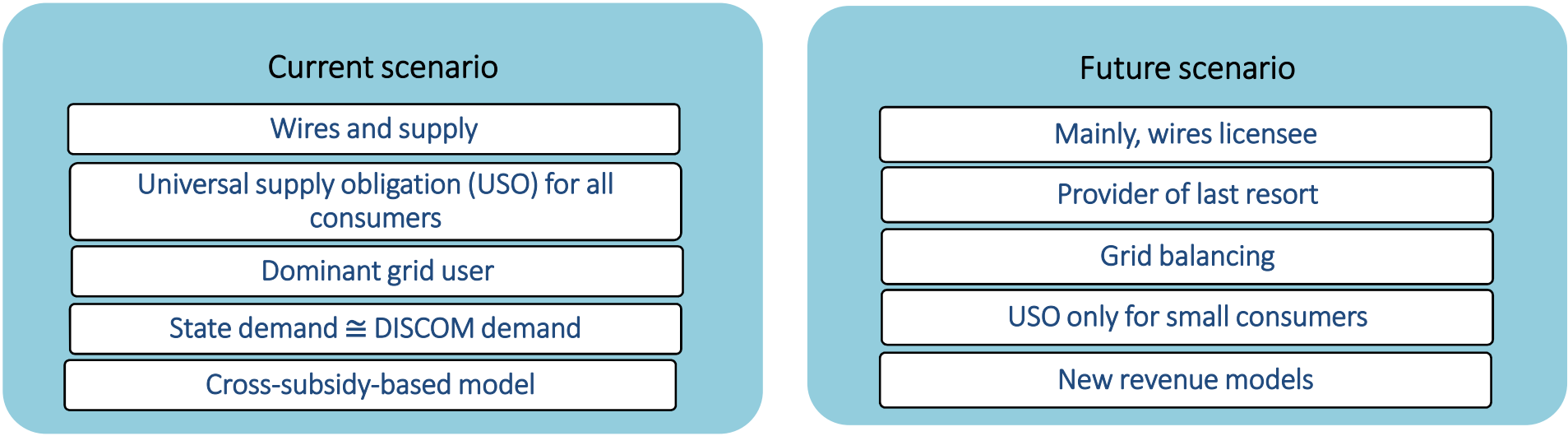


Source: BNEF

Recent Utility scale RE +Storage prices (2017)

Details of RE+ Storage Project	Price
Xcel Energy – Colorado Utility , 100 bids received, contract from 2022	Median bid : Rs.1.5- Rs. 2.5 /Kwh
20 year PPA between Tucson Electric and NextEra Energy	Price fixed at Rs. 2.9/kWh

The (inevitable) changing role of the DISCOM



- Transition will take place even without Electricity Act Amendment due to emerging trends
- 'Cost-plus' tariff determination → little room for efficiency improvement
- Current cross – subsidy based tariff design → incentivizes migration
- Loss of cross subsidy→ Impact on small consumer tariffs and supply quality
- Long-term base-load power procurement with demand uncertainty, RE, surplus power→ risk of stranded capacity

Possibility of with high losses, significant stranded assets and expensive , poor quality supply

Can the transition be less 'painful'?

Points for Discussion

- What are the major elements and implications of the transition?
- How to ensure that the transition does not harm, or rather can benefit the small consumers in the long run?
- What should be the appropriate reactions by different actors to manage the transition, be it DISCOMs, Regulators, Governments, Industry and CSOs?
- Specifically, what can CSOs do to ensure a fair transition?

Thank you

Shared handouts by participants

All Bengal Electricity Consumers' Association

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Registration No. S/71702 of 92-93
Phone : 2237-9908, Email : allbengalelectricityconsumersa@gmail.com

Dated 3rd September, 2018

In this experience sharing workshop during 3rd & 4th September, 2018, organized by Prayas (Energy Group), Pune, on Trends and Way Forward in the State Electricity Sectors our organization All Bengal Electricity Consumers' Association being a participant in the workshop share our views in the workshop.

1. Electricity is an important ingredient on the way of development in our country and necessary ingredients of our life.

2. Indian development as well as development of the states of India depends on electrification (electricity to all) and uninterrupted supply and in low price is essential.

   In this respect Generation, Transmission and Distribution of Electricity at a cheaper cost and Rural Electrification and all out electrification is required. It is learnt that the complete and all out electrification is not done in our country. The Role of Govt. both in the State and in the Central for providing Electricity to all at a cheaper Cost is necessary. The policy of the Govt. and the Electricity Act 2003 has brought a change in the field of electricity. Abolishing earlier electricity Acts the New Electricity Act 2003 is in vogue. The basic difference of Electricity Act 2003 with that of earlier Acts is that the Act 2003 has changed the Electricity industry to run on commercial principle and abolishing the Government control over electricity industry. Emphasis is given on more and more privatization.

   Problems faced in Electricity sector both in the states and in the central is due to the electricity Act 2003. We think that there should be a thorough discussion on Electricity Act 2003 and its impact on the Electricity Consumers and the Licensee and generator of Electricity.

   At present Electricity is generated through (i) Thermal Generating Station (ii) Hydel Generating Sector (iii) Non Conventional Generation of Electricity. It is no doubt that the thermal generation is costly. Hydel generation is comparatively cheaper. Another important point may be mentioned here that the generating company does not produce the full installed capacity of the industry. The PLF is low i.e., 60% to 80%. It is an All India feature. The State Regulatory Commission in West Bengal has fixed the PLF 65% to 80% depending on the licensee. The Central Electricity Regulatory Commission also made a norm for generation. But the PLF of the Generating Company is very high i.e., 90% to 95%.

   But, all the state regulatory commissions are violating the norm. Everybody understand that if CERC norm maintained by State Regulatory Commission and generators then power crisis will be minimized and cost of electricity will be less. Then why the ERC of the states and state govts. are not persuing the central ERC norm in this regard. Because if it is maintained then the profit of the licensee may decrease. Thereby the State ERC, State Govt. & Licensees — a caucus always try to low the PLF norm as a result of which the licensee gets ~~a vew amount~~ incentives.

   As in the workshop some specific items have decided so it is now furnished here in our discussion item wise.

1. Power Procurement :-

   In West Bengal Power Generation is mainly for Thermal Power and a few Hydel Power and very few Non Conventional Sources of Power. (WBERC directed to purchase 8% of power from non conventional sources.)

   (i) West Bengal Power Development Company Limited, a State Government undertaking unit produces / generate power through the Kolaghat T.P.S., Bakreswar T.P.S., Bandel T.P.S., Santaldihi T.P.S. and Sagardighi T.P.S.

a) Kolaghat T.P.S. generates 7726.32 MU

b) Bakreswar T.P.S. generates 7358.00 MU

c) Bandel T.P.S. generates 2870.00 MU

d) Santaldihi T.P.S. generates 3504 MU

e) Sagardighi T.P.S. generates 4204 MU

Total generation = 25662.32 MU

2. West Bengal State Electricity Distribution Company Limited, a State Government undertaking Unit produces / generates power through hydel project.

i) WBSEDCL has two main hydel power station - (a) Rammam produces 236.50 MU and (b) Jaldhaka produces 165.20 MU

ii) WBSEDCL generates power from 10 small Micro Hyde generating stations and produces 172.63 MU.I

iii) Besides the above two hydel power projects the WBSEDCL has pump storage project at Purulia and produces 1318 MU.

Total generation = 1892.33 MU

3. Power purchase of the West Bengal State Electricity Distribution Company Limited are as follows :—

i) From WBPDCL power purchase = 27910 MU

ii) From DPL power purchase = 174 MU

iii) From DPSCL power purchase = 65.37 MU

iv) From DVC power purchase = 324.16 MU

v) From CESC power purchase = 48 MU

vi) From Govt of Sikkim power purchse = 0.10 MU

Total power purchase = 28521.63 MU

4. Total generation and power purchase of WBSEDCL = 30413.96 MU

5. The CESC Ltd. a private Concern generates power through its Budge Budge, Titagarh and Southern Thermal Power Stations.

Besides generation from its own generating stations, CESC Ltd. purchase power from several sources.

6. Generation of CESC Ltd. from its own generation.

i) Budge Budge = 5590 MU (2016-17)

ii) Titagarh = 1685 MU (2016-17)

iii) Southern = 950 MU (2016-17)

Total generation = 8225 MU (2016-17)

7. Power Purchase of CESC Ltd. :-

i) From WBSEDCL power purchase = 685 MU

ii) From Haldia Energy Ltd. power purchase = 2971 MU

iii) Co-generation power purchase = 84 MU

iv) From other sources power purchase = 266 MU

Total power purchase = 4006 MU

8. i) **Total generation of CESC Ltd. = 8225 MU**

ii) **Total power purchase of CESC Ltd. = 4006 MU**

Total power procurement = 12231 MU

Besides non conventional power procurement is also available from solar system, wind system and bio-gas.

ATC Loss, Agricultural consumption and Govt, Subsidy :-

The State Govt. and Licensees are saying that CESC's ATC Loss is more than 20% and WBSEDCL 29%. And all over India as far as our knowledge goes ATC Loss is 30%. Because —

i) Corruption of the Licensees

ii) Captive Coal are being sold outside and not using the same to produce electricity.

iii) Licensees linked with coal mafia.

iv) Using low grade coal by the licensee, low grade transmission wire and even not maintaining that also, transformer meter are not being supplied by the licensees and rest of the meters are of low standards. Big industrial houses and various govt. establishment are not paying the bill / bills in time and theft of electricity by big industrial houses to protect the vote banks of parliamentary political parties. They are allowing the theft of electricity. In this regard licensee, political party and the administration — a peculiar caucus is working under the umbrella of the state and central govt. We are demanding that ATC Loss should not be more than 4% to 5% and it can be easily achieved.

v) ATC Loss was fixed by the State Commission in the Tariff Regulation and in the Tariff Order from time to time.

Commission directed to reduce the ATC loss by 4% to 8%, distribution loss by 17.50% in WBSEDCL and 14.3% in CESC Ltd.

vi) For Agricultural Consumption of Electricity no specific data is provided in the Tariff Order by the Commission, our experience says after Domestic Consumption Agricultural Consumption is in the 2nd rank in number but not in quantity. Agricultural Consumption of Electricity in West Bengal is very low.

Just now it is 15 lacs consumers out of 1 crore 80 lacs. Because in West Bengal Agricultural Tariff is very high than the other states of India. It is just Rs. 4.71 paise an average per unit. A very negligible subsidy is provided by State Govt. We are demanding that 50% by state govt. and 30% by the central govt. should be subsidized for the developments of Agricultural in West Bengal and other states.

30% / 20%

vii) On Govt. subsidy we think that the Govt. subsidy is not the solution of the problems of tariff hike. Moreover if the subsidy is given then our most urgent and welfare works of the Government will be hampered. So we do not support govt. subsidy, but for the time being to give some relief to the consumer from tariff shock government subsidy may be necessary. But to reduce the cost, profit and improve the efficiency of the licensee, low tariff will solve the problem and if it is done then there will be no need of government subsidy. In West Bengal the govt. subsidy is the lowest of all other states who give subsidy to their consumers.

In West Bengal the consumers under CESC Ltd. supply do not get subsidy.

The consumers of WBSEDCL specially domestic (urban and rural), life line consumers consuming upto 300 units get subsidy and Agricultural consumers consuming upto 300 units get Govt. Subsidy.

Quality of Supply and Services :-

1. In case of WBEDCL the quality of supply and services is very bad. Load Shadding, Low Voltage supply is a regular phenomenon for which agitation of the affected electricity consumers is also a regular feature. Fault Repair and remove of tree from the supply line due to storm takes much more time than that of time fixed by the Commission in the Regulation. The net result is the sufferings of the electricity consumers.

2. The supply of CESC Ltd. is within the compact area of urban and city where fault repair should be prompt and time bound. But in this case also CESC failed to take prompt action and complete the work within reasonable time. Load Shedding and Low voltage in CESC supply area is lesser than that of the WBSEDCL area.

But the service can not be said better and up to the mark. Considering the urban area supply and under ground cable system. The ASKI Consultant appointed by the State Commission in 2001-02 opined that the T & D Loss in such an urban area should be low. Loss of energy should be low and better supply should be ensured here.

Improving effectiveness of Regulatory Process :-

1. a) Regulatory process is not effective to Regulate the Licensee in many respects. In fact the Regulatory Commission is nothing but a Rubber Stamp.

The Licensee does not abide by the Regulation framed by the Commission and the direction given to the Licensee. Mention may be made here that the Commission directed the Licensee to reduce tariff one rupee in the next proposal and ATC Loss reduce by 4% to 8% but the licensee did not act accordingly. Moreover, there is a unholyrelation of the commission with the Licensee and the commission takes steps so that the licensees get benefit. It may be mentioned here that the capacity of PLF of CESC Ltd. Plants are 90 % to 94% but the commission fixed the PLF norm in the Terms of Tariff Regulation 80%. The actual distribution loss where 12% in CESC, the Commission fixed it 14% distribution loss.

b) As per Electricity Act 2003 tariff is to be declared within 120 days but the commission declared the tariff of CESC Ltd. and WBSEDCL after the laps of one year and five months and for such a delay the commission did not give any explanation.

c) Our organisation raised a point of 40% reduction of Coal price 7% reduction of GST and 2% reduction of technical and commercial loss the result of which there is a reduction of cost amounting to Rs. 8539.14 Crore. This amount should be refunded to the consumers. But the commission did nothing on this issue. To combat reduction of 40% Coal price commission gave a data of coal price of 2009-10 and 2017-18 and said how the coal price is increased. The commission did not give any answer whether coal price in 2016-17 was reduced or not.

d) In many state there is a public hearing system in the commission but in West Bengal the public hearing system was withdrawn. This reflects the status of transparency in the works of the commission.

Future of distribution licensee :-

1. i) There is a very very bright future of the distribution company and generating company and in turn the transmission company has also bright future. In this connection we may refer here that in West Bengal new company Haldia Energy Limited and Rajarhat New Town Electric Supply Company has started there business. In West Bengal CESC Ltd. owned by Goenka at the Cost of Rs. 6 Crore and now their capital from the electricity business has enhanced to Rs. 6000 Crore. CESC is a profit earning concern and gains profit Rs. 500 Crore on an average, in addition CESC Ltd. get 16.5% return on equity.

ii) Due to introduction of the Electricity Act 2003 the SEB has divided into three Govt. Companies and each one is getting 16.5% R.O.E. and over and above they also gain profit from Electricity Sector.

In the conclusion we are to say that the Return on Equity and Profit of the Licensees are gradually increasing year by year but the Tariff of Electricity is continuously increasing and it increases from Rs. 1 per unit to Rs. 7.10 per unit and for this consumers are in the hardship to meet up the electricity charges. The quality of supply and services is not improving. The role of the Regulator is not so much effective. All are due to the evil effect of the electricity Act 2003. It is necessary to be a workshop on the electricity act 2003 and the Consumers' awareness and consolidation are necessary.

Dt. 03.09.2018

Submitted by

Sd/-

(Pradyot Chowdhury)
General Secretary
ABECA

DC Solar Microrgrid At Abu Road

A Joint Effort between Mrida Renergy & Samta Power

Overview

- Mission
- Motivation
- Technology
- Business Model
- Abu Road Grid
- The Way Forward

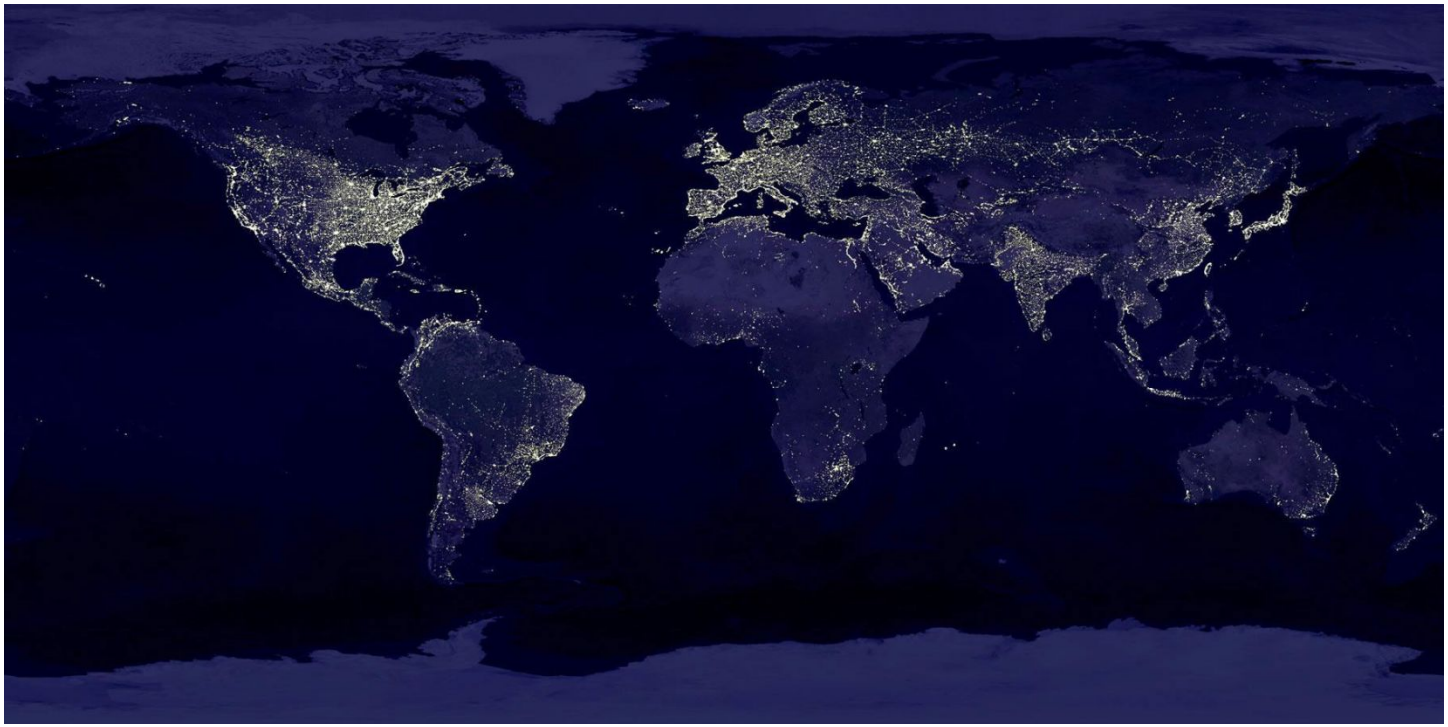
Mission

Mrida Renergy looks to setup DC Solar Microgrids in the remotest areas of India that are

financially viable, and
create **sustainable businesses** with
strong **social orientation**

Motivation

Rural electrification is a 1.1 billion-person issue



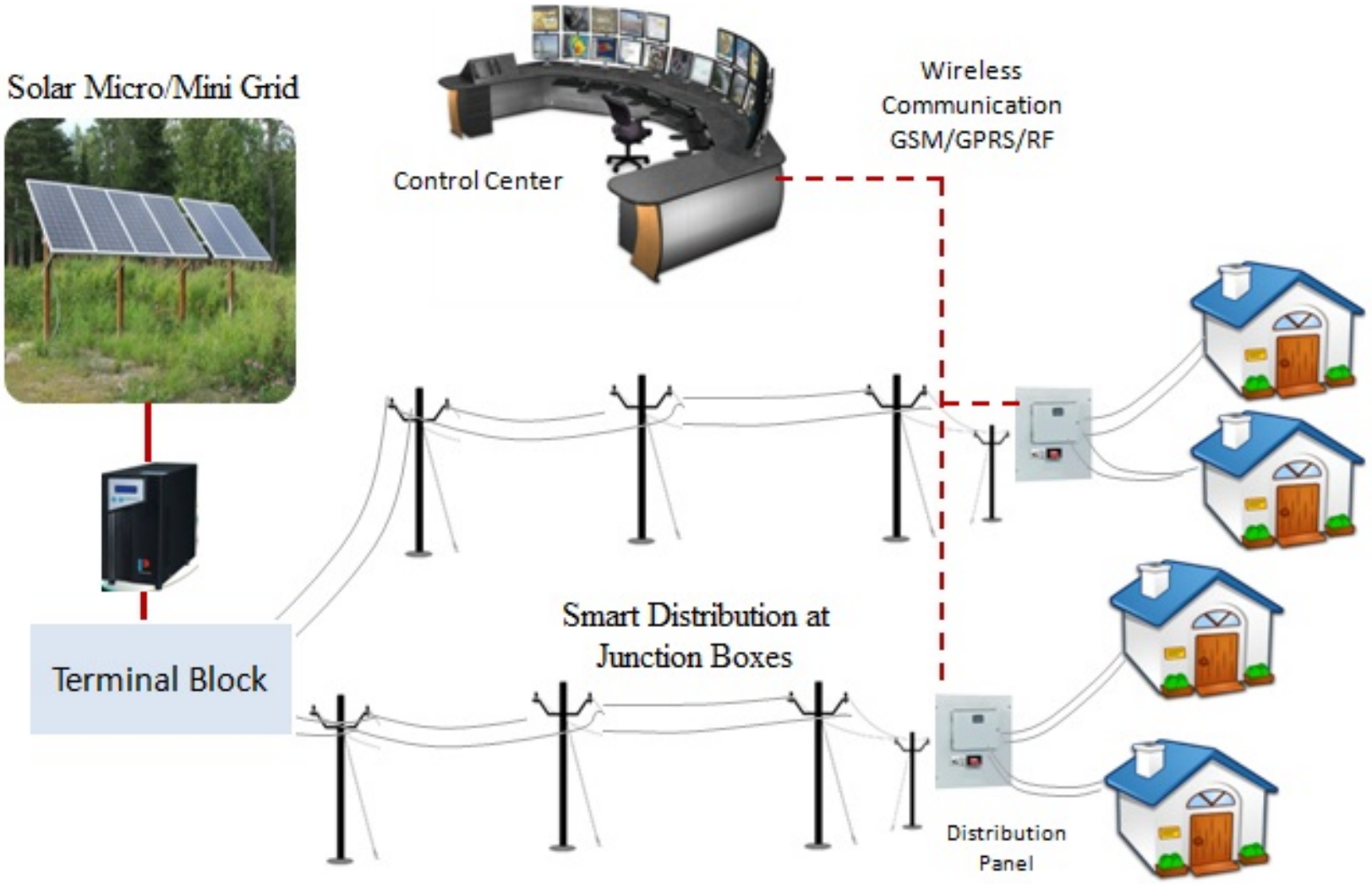
Globally, **1.3 billion people lack access to electricity; 84% live in rural areas.**
289 Million in India

Technology

Mrida is focused in implementing DC Solar Microgrids of 240 Watt Capacity

- Microgrid between 20-30 homes
- 2 LED Lights and 1 Mobile Charging point per household
- 10 hours Backup
- Low Power loss due to wiring within 150 meters diameter
- Proposed Centralized monitoring through mobiles and server

Future Technological Innovatio



Technology

DC Micro grids will lower costs and improve service with an integrated energy solution

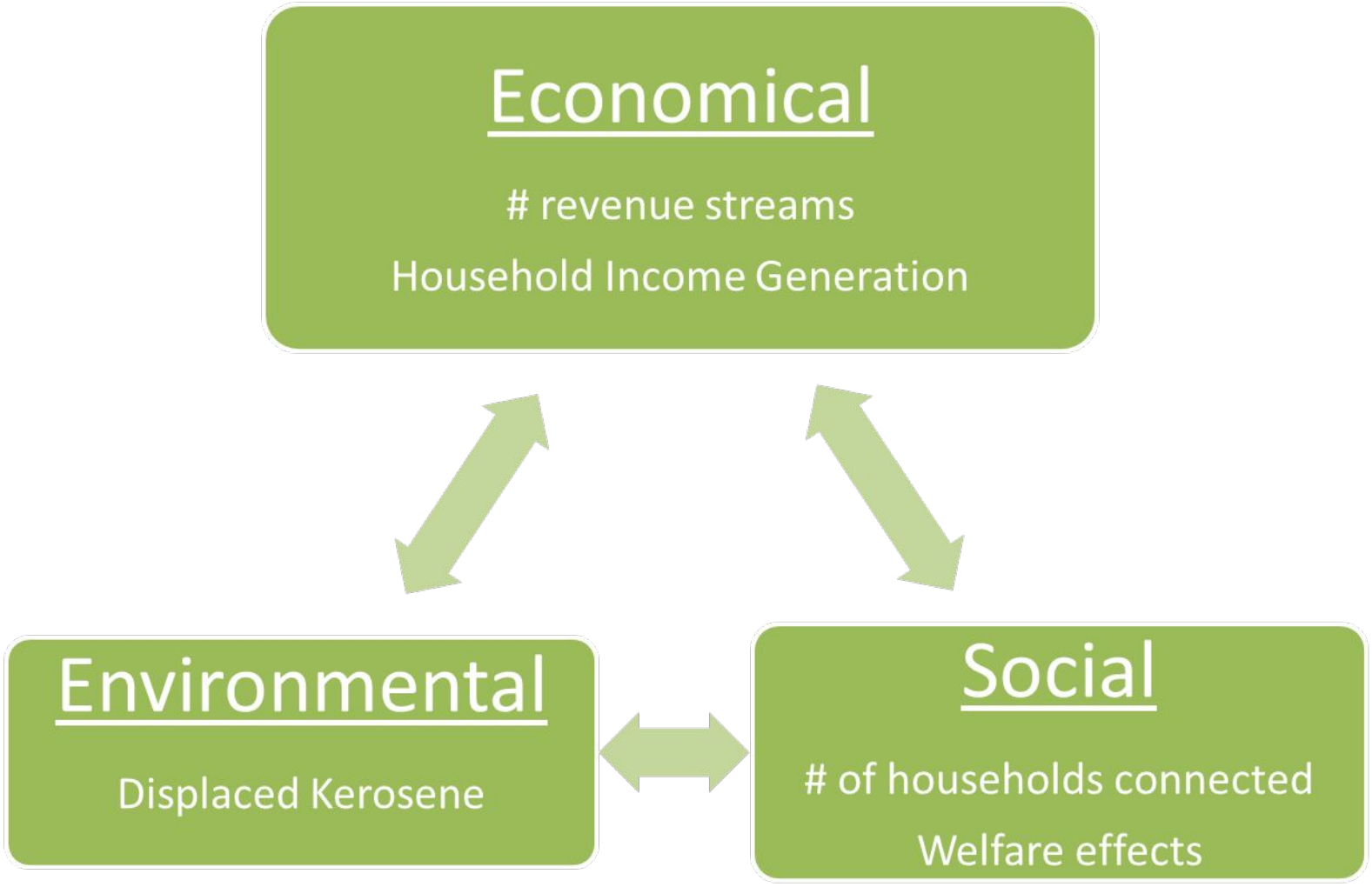
- Reliable
- Inexpensive
- Complementary

Business Model

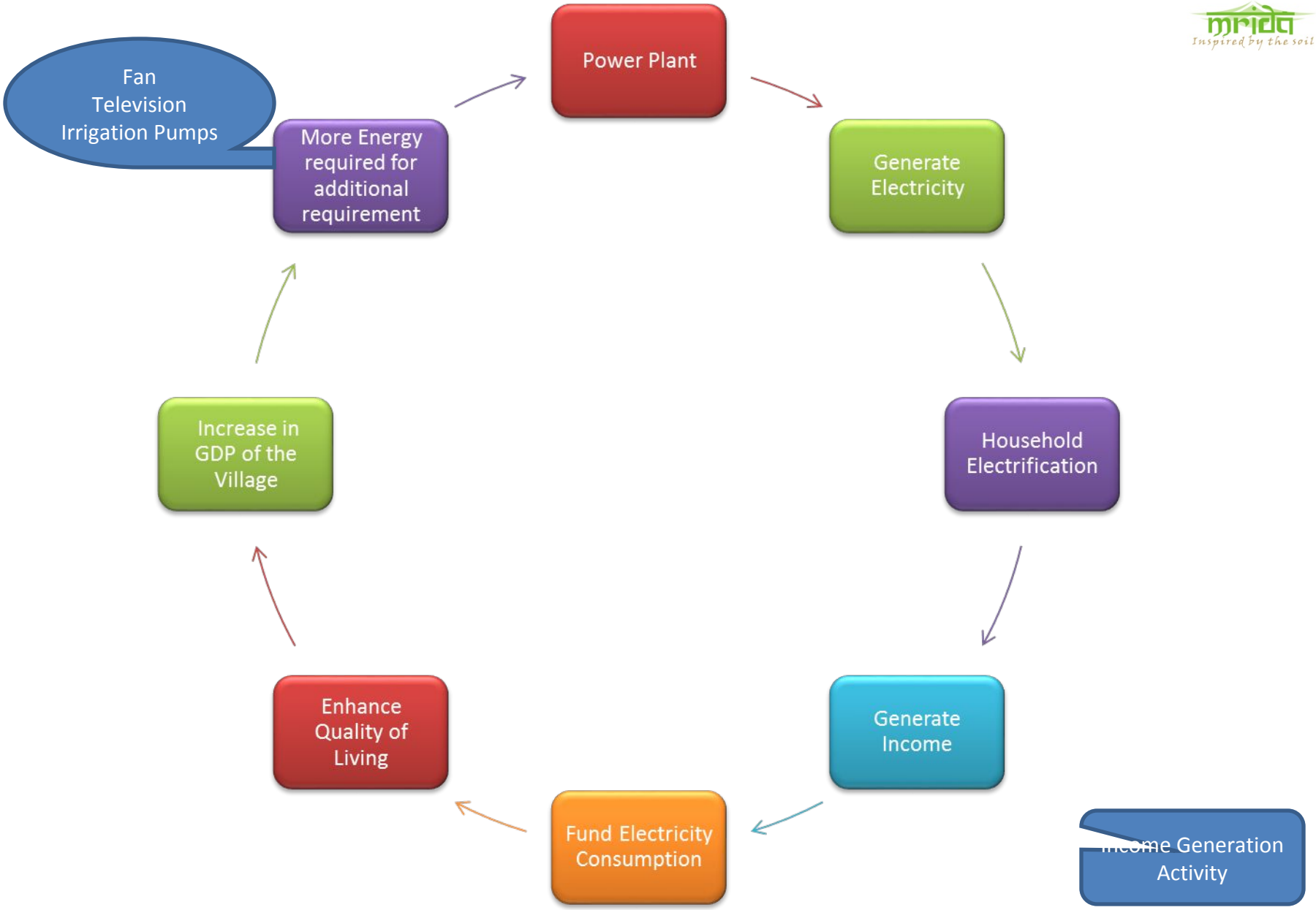
Electricity is an asset that increases ability to pay

- Setup cost would range between 85K -100K INR
- VLE and SHG based Model
- 30% Self Financing from the Owner, 70% through Bank/Institution
- 2.5 years of repayment time for the Owner
- 5 years of system Warranty

Triple Bottom Line effects



Virtuous Circles – Renewable Energy



Abu Road Installation

in Association with Samta Power

240 Watt DC Solar Microgrid- 20 Households

Removal from Darkness – Escape from oil

SimpleTechnology - at Abu Road

- 240 Watt Solar Panels
- 2 Watt LED Bulbs – 2 Nos. per household
- 100 Ah Battery – 2 Nos.
- Automatic charge Controller – Switches on light after sunset and switches off on sunrise
- 1 Mobile Charging point per household
- Copper wiring

The Way Forward with Samta Power

- Identify Sirohi District for atleast 20 more Microgrids
- Identify VLE in each Village
- Start income generation activities for each village
- Identify Philaudi Area for 10 more Microgrids
- Try innovative technologies for Microgrids

Thanks you

2018 Kerala Floods

- SEVERE FLOODING – AUG 2018 – UNUSUAL RAINFALL(> 250 %)
- WORST FLOODING IN KERALA IN NEARLY A CENTURY (1924)
- 15 LAKH PEOPLE WERE EVACUATED,
- ALL 14 DISTRICTS OF THE STATE WERE PLACED ON RED ALERT.
- THE INDIAN GOVERNMENT HAD DECLARED IT A LEVEL 3 CALAMITY. (“CALAMITY OF A SEVERE NATURE“)

- THIRTY-FIVE OUT OF THE FIFTY-FOUR DAMS WERE OPENED FOR THE FIRST TIME IN HISTORY.

- ALL FIVE OVERFLOW GATES OF THE IDUKKI DAM WERE OPENED AT THE SAME TIME, FOR THE FIRST TIME IN 26 YEARS.

- HEAVY RAINS IN WAYANAD AND IDUKKI HAVE CAUSED SEVERE LANDSLIDES AND HAVE LEFT THE HILLY DISTRICTS ISOLATED.

Kerala before (L) & after (R) flood

RESCUE

- THE FISHERMEN FROM ALL COASTAL DISTRICTS OF KERALA (4,537 FISH WORKERS,669 FB)
- 40 HELICOPTERS, 31 AIRCRAFT, 182 TEAMS FOR RESCUE, 18 MEDICAL TEAMS OF DEFENSE FORCES, 58 TEAMS OF NDRF AND 7 COMPANIES OF CENTRAL ARMED POLICE FORCES WERE PRESSED INTO SERVICE ALONG WITH OVER 500 BOATS AND NECESSARY RESCUE.
- > 3,274 RELIEF CAMPS, 1,247,496 PEOPLE


Heroes of
Kerala floods

GENERATING STATIONS

- Severe damage to
  - 5 Major Hydro Stations &
  - 7 SHEPs in the State
- Estimated damage
  Rs 48.77 Cr

TRANSMISSON

- 50 Substations are affected
  - 22 Stations Submerged - Control Systems seriously affected
  - 10 Power Transformers were drowned
- 10 major transmission corridors were interrupted

DISTRIBUTION

- Massive flood have hit the Distribution infra badly
- 284 Electrical Sections in six Districts shattered
- Around 1000 Distribution Transformers drowned
- Feeding from 16,158 Distribution Transformers affected
- Service to 25.60 Lakh consumers were disrupted

- 3500 km Distribution lines to be reconstructed
- 30,000 poles damaged

- Energy meters damaged
  - Single Phase 5 Lakh
  - Three Phase 1 Lakh
- 3 Lakh ELCBs required for resuming supply
- Severe damage to Section Offices functioned in submerged buildings and IT infrastructure therein

Financial Impact (Preliminary Assessment)

Department of Power

- Cost for reconstruction — Rs 351.59 Crore
  - Distribution Lines & Transformers — Rs 252.55 Crore
  - Transmission Lines & Substations — Rs 50.27 Crore
  - Generating Stations — Rs 48.77 Crore
- Loss of Revenue — Rs 472.10 Crore
  - 821 MU @ Rs 5.75 per kWH
- **Total loss** — **Rs 823.69 Cr**

EARLIER INCIDENTS – CHARAMOODU DISASTER 2010 & OCKHI – 2017 NOV

ACTION PLAN – MISSION RECONNECT

MISSION RECONNECT

Director Board Members review status regularly

State Level, Circle Level & Section Level Task force are put to task

Goal

- Restore all disrupted networks by 31.08.2018

  Restoration may be delayed in

  - areas where water does not recede &
  - Areas which lost road access.

MATERIAL MANAGEMENT

- Special Delegation provided for procurement
- Material diverted from DDUGJY/IPDS stock
- Materials received from external sources
  - Distribution Transformers
    - 125 DTR received from TANGEDCO (240 DTR offered)
    - 100 DTR received from Karnataka (Hubli & Gulbarga)
  - Energy Meters – 40,000 Single Phase from TANGEDCO
  - Mobile DTR reconditioning units from PGCIL
  - PSC Poles (Additional Order already placed)
    - 8 m - 47,132
    - 9 m – 15,336
  - ACSR Weasel – 543 km Additional Order already placed

HR

- 120 plus Officers & Staff from APSPDCL deployed to Trissur & Alappuzha Districts
- Officers, Staff & Contractors from other areas deployed
- Service of Pensioners & Voluntary Organisations used
- Service offered by
  - Contract Workers
  - Wiring Contractors
  - Electrical Traders Association

SPECIAL RELIEF

- Out of turn priority given to restore supply for
  - Hospitals (Government & Private)
  - Pumping Stations for Drinking Water
  - Other Emergencies
- KSEB will bear the cost for replacing streetlights, wherever material supply is ensured by LSGD
- Free mobile charging facility at KSEB offices & Public places till normalcy is restored
- Will restrain from disconnection for want of payment in affected areas till normalcy is restored

- Essential supply to houses which were de-electrified due to flooding.
- Require assistance from
  - Electrical Inspectorate
  - Wiremen's & Traders Associations
  - Students of technical schools

RESTORATION STATUS AS ON 01-9-2018 12 HRS

- GENERATION RESTORED AT IDAMALAYAR POWER HOUSE (2X37.5MW) & PORINGALKUTHU PLBE(1X16MW)
- 9/10 EHT TRANSMISSION CORRIDORS RESTORED
- 48/50 SUBSTATIONS RESTORED (BALANCE TWO SUBSTATIONS EXPECTED TO BE CHARGED WITHIN TWO DAYS)
- 2/5 GENERATING STATIONS –LARGE HYDEL RESTORED, 6/10 SMALL HYDEL RESTORED.

- 15946/16158 DISTRIBUTION TRANSFORMERS CHARGED(98.69%)
- 25.57/ 25.60 LAKHS SERVICE CONNECTIONS RESTORED (99.88%)
- 673 NOS. SINGLE POINT CONNECTION EFFECTED IN PREMISES WITH FAULTY INSTALLATIONS
- AS PER AVAILABLE RECORDS, NO KWA PUMP HOUSES PENDING RESTORATION OF SUPPLY BY KSEBL

GENERATING STATIONS

Station	Expected By	Remarks
Lower Periyar	15.09.2018	By KSEB Ltd
Poringalkuthu	April 2019	With assistance from NHPC
Panniyar	February 2019	With assistance from NHPC
Ranni – Perunadu SHEP	February 2019	With assistance from NHPC
Vellathooval SHEP	August 2019	With assistance from NHPC
Adyanpara SHEP	August 2019	With assistance from NHPC
Madupetty SHEP	February 2019	By KSEB Ltd

SOURCES OF FUNDS

- Assistance from Govt of Kerala
- Assistance from Govt of India
- Own fund of KSEB Ltd

KSEB is ready to restore normalcy

mobilising own resources

WE SHALL OVER COME

Creating Innovative Solutions for a Sustainable Future

"Exploring Opportunities for Energy Access and Clean Drinking Water through Smart Mini-Grid (SMG), and Solar Water Pumping System for Irrigation"



Prepared for Rajasthan, India

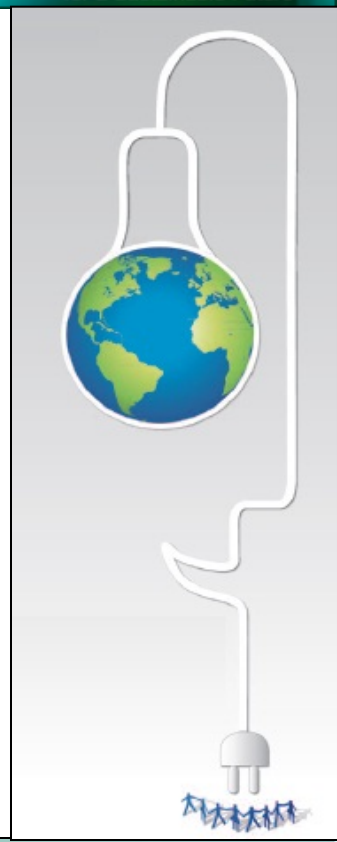
EETD Division
TERI, IHC Complex, New Delhi

October 28, 2013

Outlines

Creating Innovative Solutions for a Sustainable Future

- ✓ Objective and Study Area;
- ✓ Scope of Work;
- ✓ Stakeholders Consultation;
- ✓ Shortlisted Sites;
- ✓ Proposed Technical Configurations;
- ✓ Cost Estimation;
- ✓ Conclusion and Way Forward.



Objective and Study Area

Creating Innovative Solutions for a Sustainable Future

"Pilot demonstration of the Renewable Energy (RE) based Smart Mini-Grid (SMG) Systems for providing Community Electricity and Safe Drinking Water Supply, and Solar Water Pumping Systems for Integrated Irrigation in the selected locations in Rajasthan, India"

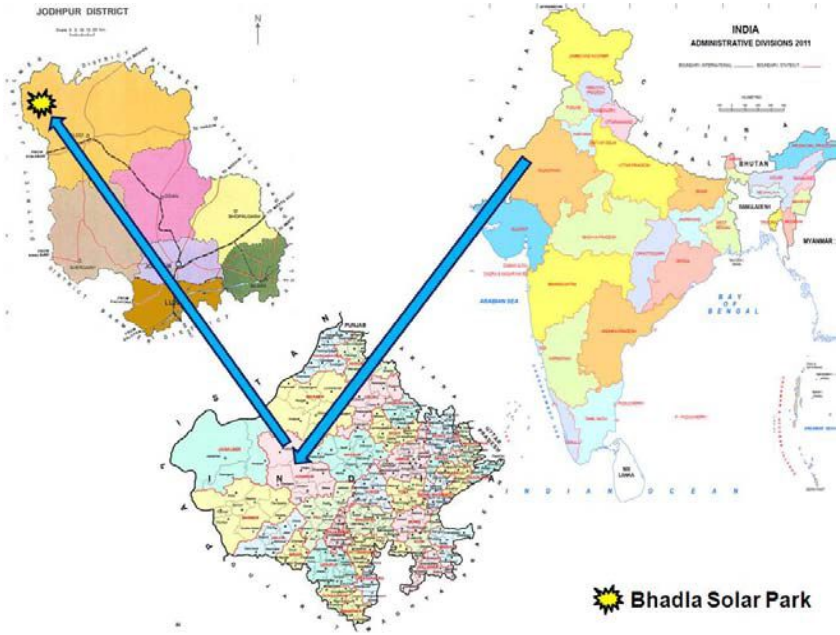
Scope of Work

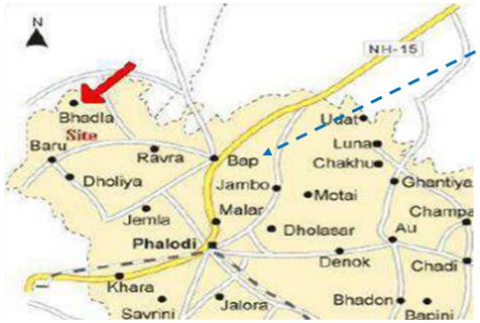
Creating Innovative Solutions for a Sustainable Future

In order to achieve the objective, the study has been segregated into two phases:

✓Phase I: Scoping studies and preliminary designs of Renewable Energy based SMGs, and Solar Water Pumps for identified sites near "Bhadla Solar Park", Jodhpur District in Rajasthan;

✓Phase II: Pilot demonstration of SMGs, and Solar Water Pumps at shortlisted sites based on the scoping studies, and preliminary designs.





Scope of Work: Phase I

Creating Innovative Solutions for a Sustainable Future

The following tasks will be carried-out/conducted under Phase I:

✓Task I: Site visit and selection of sites in the identified clusters for implementation of SMGs, and Solar Water Pumps;

✓Task II: Load Profiling and Load Categorization;

✓Task III: Renewable Energy Resource Profiling;

✓Task IV: Technology optimization and design of Smart Mini-Grid Systems, and Solar Water Pumps;

✓Task V: Estimate the entire cost and the institutional arrangement for implementation of SMGs, and Solar Water Pumps at each site.

Scope of Work: Phase II

Creating Innovative Solutions for a Sustainable Future

Based on the scoping study and preliminary design, SMGs, and Solar Water Pumps will be implemented in the shortlisted site(s). The broad scope of work of TERI in Phase II will be:

✓Preparing the EOI/bid for short-listing of technology-supplier(s) and installer(s);

✓Evaluating the EOIs with local implementation partner(s);

✓Help the technology providers in developing the algorithm and control strategies for the Smart Control;

✓Monitoring the installation and commissioning of the SMGs, and Solar Water Pumps;

✓Assessing the performance of the SMGs for specified months from the date of commissioning of SMGs, and Solar Water Pumps;

✓Providing required training/know-how to local implementation partner(s) on design, install, operate, and manage the SMGs, and Solar Water Pumps.

Stakeholders Consultation/Meetings

Creating Innovative Solutions for a Sustainable Future

Sr. No.	Time Period	Activities	Location	Remarks
1	Sept. 12, 2013	Interactions with Rajasthan Renewable Energy Corporation Limited (RRECL), Department of Horticulture, Government of Rajasthan (GoR)/Rajasthan Horticulture Development Society (RHDS), and Asian Development Bank (ADB).	Jaipur, Rajasthan, India.	Meeting with Director – RRECL, Principle Secretary – RHDS and Energy Access Specialist (Consultant) – ADB to discuss for Smart Mini-Grids (SMGs), Clean Drinking Water, and Solar Water Pumps for Irrigation.
2	Sept. 13, 2013	Meeting with Samta Power (NGO/Local Partner).	Jodhpur, Rajasthan, India.	Discussions with Director – Samta Power for the identification of the probable sites for the implementations of SMGs, Drinking Water and Solar Water Pumps for Irrigation near-by Solar Bhadla Park, Jodhpur.
3	Sept. 13, 2013	Meeting with Department of Horticulture, Jodhpur.	Jodhpur, Rajasthan, India.	Discussions with Deputy Director – Horticulture, Jodhpur for the identification of the probable sites for the implementations of Solar Water Pumps for Irrigation near-by Solar Bhadla Park.
4	Sept. 13, 2013	Visit to BAP – Phalodi Area, jointly with Samta Power.	BAP, Jodhpur, Rajasthan, India.	To shortlist probable hamlets for the implementation of Smart Mini-Grid Systems for Remote Village Electrification, Drinking Water, and Solar Water Pumping Systems for Irrigation.
5	Sept. 13, 2013	Interactions with Sarpanch, Village Communities at BAP – Phalodi Area.	BAP, Jodhpur, Rajasthan, India.	To understand the local energy and community needs.

Stakeholders' Consultation/Meetings (Contd.)

Creating Innovative Solutions for a Sustainable Future

Sr. No.	Time Period	Activities	Location	Remarks
6	Sept. 14, 2013	Visit to Salt Manufacturing Area of BAP – Phalodi, jointly with Samta Power.	BAP, Jodhpur, Rajasthan, India.	To explore the possibilities for Solar Water Pump Projects.
7	Sept. 14, 2013	Visit to Balesar Area, jointly with Samta Power.	Balesar, Jodhpur, Rajasthan, India.	To explore the possibilities for Solar Water Pumps for Irrigation and Electrification of Dhanis/Hamlets in the Balesar Area.
8	Sept. 15, 2013	Meeting with Department of Horticulture, Jodhpur and Samta Power.	Jodhpur, Rajasthan, India.	To explore the possibilities for Solar Water Pumps for Irrigation and Electrification of Dhanis/Hamlets in the Baru Gram Panchayat Area.
9	Oct. 10, 2013	Meeting with Department of Horticulture – Jodhpur, RRECL – Jodhpur, and Samta Power.	Jodhpur, Rajasthan, India.	Discussions to finalize probable hamlets for the implementation of Smart Mini-Grid Systems for Remote Village Electrification, Drinking Water, and Solar Water Pumping Systems for Irrigation in BAP– Phalodi Area (70 Kms. from Bhadla Solar Park), and Baru Gram Panchayat Area (12 Kms. from Bhadla Solar Park).
10	Oct. 11, 2013	Visit to Baru Gram Panchayat Area – BAP Block, jointly with Horticulture – Jodhpur, and Samta Power.	Jodhpur, Rajasthan, India.	Visit to existing Solar Water Pump installations on the way to Baru, Advanced Irrigation Technologies such as, Drip Irrigation, Shed-Net etc.

Stakeholders' Consultation/Meetings (Contd.)

Creating Innovative Solutions for a Sustainable Future

Sr. No.	Time Period	Activities	Location	Remarks
11	Oct. 12, 2013	Interactions with Sarpanch, Village Communities at Baru Gram Panchayat Area.	Baru, Jodhpur, Rajasthan, India.	Conducting community meeting to understand the village level requirements such as, energy needs, institutional arrangements, socio-economic profile of the village etc. as per the need of developing and implementing Smart Mini-Grids, Clean Safe Drinking Water, and Solar Water Pumps for Irrigation.
12	Oct. 12-13, 2013	Interactions with Sarpanch, Village Communities, and Samta Power at Baru Gram Panchayat Area.	Baru, Jodhpur, Rajasthan, India.	Finalize 3-4 probable sites (namely, Heer Singh ki Dhani, Aakhali ki Dhani, Nathu Ram ki Dhani, Alkhoo Khan ki Dhani, and Arjun Pura) for the implementation of Smart Mini-Grid Systems, Clean Drinking Water, and Solar Water Pumps for Irrigation in Baru village along-with the collection of water samples for Drinking Water Quality Analysis.
13	Oct. 14-15, 2013	Visit to BAP – Phalodi Area and interactions with Sarpanch, Village Communities, and Samta Power.	BAP, Jodhpur, Rajasthan, India.	Finalize 2-3 probable sites (namely, Bhato ki Dhani, Goyalo ki Dhani, Barsingho ki Dhani, and Bishnoi ki Dhani) for the implementation of Smart Mini-Grid Systems, and Clean Drinking Water in BAP area along-with the collection of water samples for Drinking Water Quality Analysis.

Stakeholders' Consultation/Meetings (Contd.)

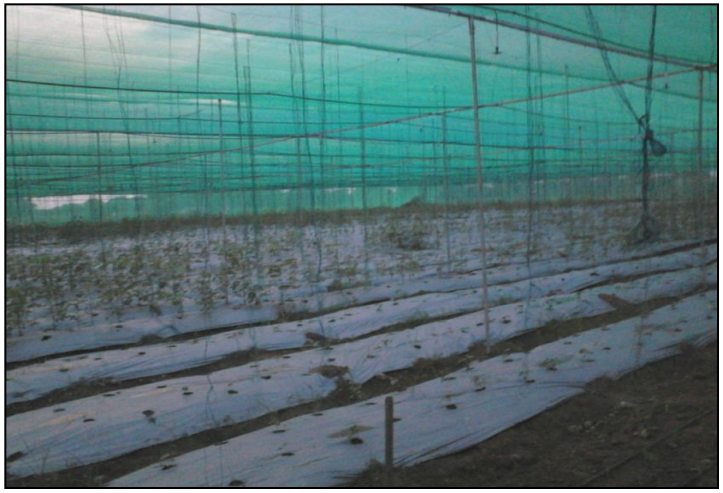
Creating Innovative Solutions for a Sustainable Future

Sr. No.	Time Period	Activities	Location	Remarks
14	Oct. 16, 2013	Meeting with Department of Horticulture – Jodhpur.	Jodhpur, Rajasthan, India.	Discussions with Deputy Director – Horticulture, Jodhpur and finalize the sites for Solar Water Pumping for Irrigation, along-with the collection of Soil, Water, Crop Reports etc. for selected region of Jodhpur district.
15	Oct. 16, 2013	Meeting with Samta Power.	Jodhpur, Rajasthan, India.	Finalization of Technical Configuration, Cost of all the sites (for both Smart Mini-Grids and Water Pumping for Irrigation) along-with the meeting with few local implementation partners (namely, Punchline Energy etc.).
16				

Integrated Irrigation Techniques

Creating Innovative Solutions for a Sustainable Future

Shade-Net/Green-House Farming @ 26.6122 DD N, 72.9973 DD E, Elevation: 868 meters.



Solar PV AC Water Pump @ 26.4246 DD N, 73.0399 DD E, Elevation: 957 meters.

Solar PV DC Water Pump @ 26.5129 DD N, 73.0443 DD E, Elevation: 1012 meters.

Drip Irrigation with Solar Pump @ 26.4246 DD N, 73.0399 DD E, Elevation: 957 meters.

Shortlisted Project Sites

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Sr. No.	Name of the Hamlet	No. of House-Hold (HH)	Population (Beneficiaries)	Caste	Services	Remarks
1	Heer Singh ki Dhani, Baru, BAP Block	25	125	Rajput	SMG 1: Home Lighting, Community Energy Needs (Atta Chakki, TV, RO Water Plant, and Refrigerator); Solar Water Pumps for Irrigation: 2 Nos.	@ 12 Kms. from Bhadla Solar Park, Jodhpur.
2	a) Aakhali ki Dhani, Baru, BAP Block; b) Lal Singh ki Dhani, Baru, BAP Block.	11 10	54 40	Rajput		
Total (1+2a,b)*		**46 HHs**	**219**	*Heer Singh ki Dhani, Aakhali ki Dhani, and Lal Singh ki Dhani will form one cluster.		
3	Nathu Ram ki Dhani, Baru, BAP Block	27	200	Meghwal (S/C), Rajput	SMG 2: Home Lighting, Community Energy Needs (Atta Chakki, TV, RO Water Plant, and Refrigerator).	@ 11 Kms. from Bhadla Solar Park, Jodhpur.
4	Alkhoo Khan ki Dhani, Baru, BAP Block	13	78	Muslim		
Total (3+4)*		**40 HHs**	**278**	*Nathu Ram ki Dhani and Alkhoo Khan ki Dhani will form one cluster.		

Shortlisted Project Sites (Contd.)

Creating Innovative Solutions for a Sustainable Future

Sr. No.	Name of the Hamlet	No. of House-Hold	Population (Beneficiaries)	Caste	Services	Remarks
5	Arjun Pura,	(HH)	210	Rajput	SMG 3: Home Lighting,	@ 10 Kms.
	Baru, BAP Block				Community Energy Needs (Atta Chakki, TV, RO Water Plant, and Refrigerator); Solar Water Pumps for Irrigation: 1 No.	from Bhadla Solar Park, Jodhpur.
6	Bhato ki Dhani, Naya Gaon, BAP Block	30	200	Rajput	SMG 4: Home Lighting, Community Energy Needs (Atta Chakki, TV, RO Water Plant, and Refrigerator).	@ 8-10 Kms. from BAP on NH-15, and @ 70 Kms. from Bhadla Solar Park, Jodhpur.
7	Barsingho ki Dhani, Badi Sid, BAP Block	12	80	Rajput		
8	Goyalo ki Dhani, Badi Sid, BAP Block	14	70	Rajput		
Total (6+7+8)*		**56 HHs**	**350**	*Bhato ki Dhani, Barsingho ki Dhani, and Goyalo ki Dhani will form one cluster.		

Shortlisted Project Sites (Contd.)

Creating Innovative Solutions for a Sustainable Future

Sr. No.	Name of the Hamlet	No. of House-Hold	Population (Beneficiaries)	Caste	Services	Remarks
9	Bishnoi ki Dhani,	(HH)	270	Rajput	SMG 5: Home	@ 15 Kms. from
	Badi Sid (Ranjit Nagar), BAP Block				Lighting, Community Energy Needs (Atta Chakki, TV, RO Water Plant, and Refrigerator).	BAP on NH-15, and @ 75 Kms. from Bhadla Solar Park, Jodhpur.

Village Demography @ Nathu Ram ki Dhani, Baru

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Government School: 27.4279 DD N, 71.8639 DD E,
Elevation: 658 meters.

Village Demography @ Bhato ki Dhani, BAP

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Village Demography @ Bishnoi ki Dhani, BAP

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Stakeholders Meeting @ Baru, Jodhpur

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Stakeholders: Sarpanch, Village Committee, Local NGO, and Implementation Partners.

Stakeholders Meeting @ BAP, Jodhpur

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Stakeholders: Sarpanch, Village Committee, Local NGO, and Implementation Partners.

Village Cluster @ Baru: Heer Singh ki Dhani, Aakhali ki Dhani, and Lal Singh ki Dhani

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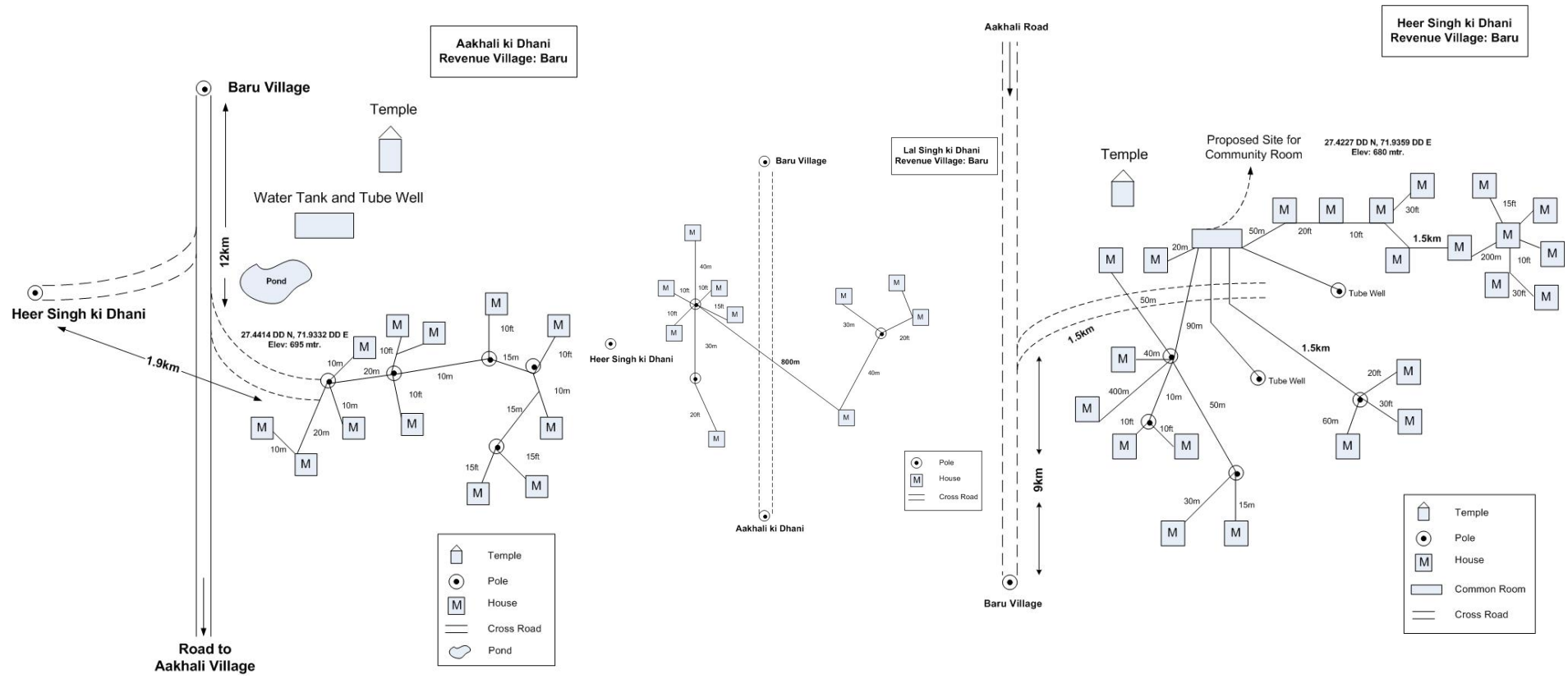
Home Lighting, Community Energy Needs (Atta Chakki, TV, RO Water Plant, and Refrigerator), Street Lights, Basic Sanitation, Education, and Solar Water Pumps for Irrigation.



Geographic Info (Lat/Long): 27.4227 DD N, 71.9359 DD E, Elevation: 680 meters.

SMG 1 @ Baru: Heer Singh ki Dhani, Aakhali ki Dhani, and Lal Singh ki Dhani

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Basic Load							
Load Type	Wattage	Hours of operation	Numbers of such load	Number of HH	Total Wattage	Total Watt-hour	Operation Time
CFL-1	10	5	3	25	750	3750	6PM-11PM
Fan-1	50	4	2	25	2500	10000	12PM-3PM
CFL-2	10	5	2	11	220	1100	6PM-11PM
Fan-2	50	4	1	11	550	2200	12PM-3PM
Community Centre Load							
TV	100	4	1	1	100	400	6PM-10PM
Atta-Chakki	1500	5	1	1	1500	7500	10AM-3PM
Refrigerator	200	24	1	1	200	4800	12AM-12PM
RO-Water	2200	5	1	1	2200	11000	10AM-3PM

Costing				
Components	Numbers	Rating	Cost (INR, approx.)	
Hybrid Inverter	2	5kVA	3,50,000	
Battery Bank	2	48V, 150Ah	1,60,000	
PV inverter	2	5kVA	2,00,000	
Distribution Line				
Pole Structure				

Dhani Name	Heer Singh ki Dhani, Aakhali ki Dhani, and Lal Singh ki Dhani
Number of House holds	36
Number of Solar Water Pump Proposed	2
Number of tube-well	2

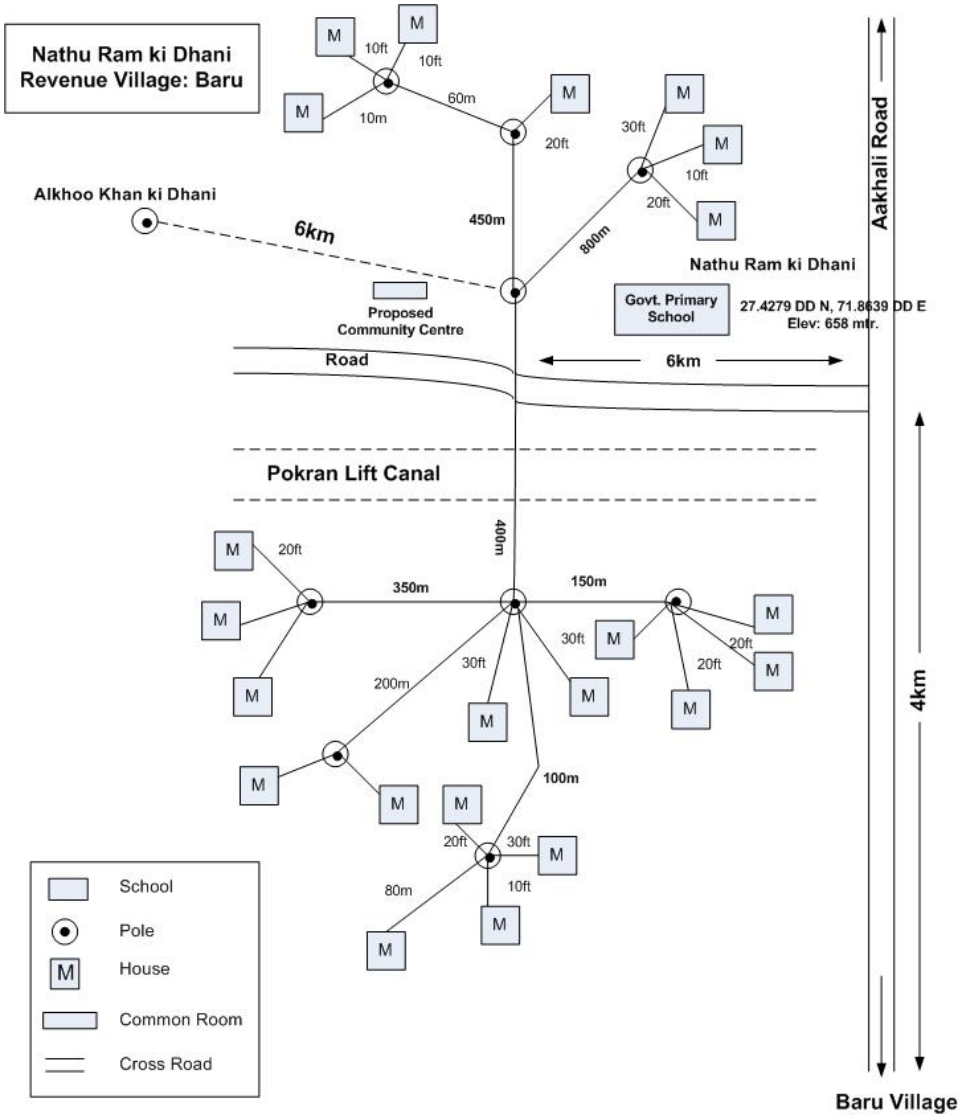
Parameters	
Peak Power (kW)	6950
Day Time Energy Requirement(Wh)	33100
Night Time load requirement(Wh)	7250
Number of autonomy days	1
Night time energy requirement for 1 day of autonomy (kWh)	7250
Inverter Efficiency %	0.95
Battery Efficiency	0.85
System Losses %	0.1
DOD of battery	0.7
Battery Ah	282.0572674
Peak Sun-Hours	5
Solar PV loss	0.15
PV for day time load (kWp)	9109.047128

Village Cluster @ Baru: Nathu Ram ki Dhani, and Alkhoo Khan ki Dhani

Creating Innovative Solutions for a Sustainable Future

Home Lighting, Community Energy Needs (Atta Chakki, TV, RO Water Plant, and Refrigerator), Street Lights, Basic Sanitation, Education, and Solar Water Pumps for Irrigation.

Geographic Info (Lat/Long): 27.4279 DD N, 71.8639 DD E, Elevation: 658 meters.



SMG 2 @ Baru: Nathu Ram ki Dhani, and Alkhoo Khan ki Dhani

Creating Innovative Solutions for a Sustainable Future

Basic Load							
Load Type	Wattage	Hours of operation	Numbers of such load	Number of HH	Total Wattage	Total Watt-hour	Operation Time
CFL-1	10	5	3	30	900	4500	6PM-11PM
Fan-1	50	4	2	30	3000	12000	12PM-3PM
CFL-2	10	5	2	10	200	1000	6PM-11PM
Fan-2	50	4	1	10	500	2000	12PM-3PM
Community Centre Load							
TV	100	4	1	1	100	400	6PM-10PM
Atta-Chakki	1500	5	1	1	1500	7500	10AM-3PM
Refrigerator	200	24	1	1	200	4800	12AM-12PM
RO-Water	2200	5	1	1	2200	11000	10AM-3PM

Costing				
Components	**Numbers**	**Rating**	**Cost (INR, approx.)**	
Hybrid Inverter	2	5kVA	3,50,000	
Battery Bank	2	48V, 150Ah	1,60,000	
PV inverter	2	5kVA	2,00,000	
Distribution Line				
Pole Structure				

Dhani Name	**Nathu Ram ki Dhani, and Alkhoo Khan ki Dhani**
Number of House holds	40
Number of Solar Water Pump Proposed	
Number of tube-well	

Parameters	
Peak Power (kW)	7400
Day Time Energy Requirement(Wh)	34900
Night Time load requirement(Wh)	7900
Number of autonomy days	1
Night time energy requirement for 1 day of autonomy (kWh)	7900
Inverter Efficiency %	0.95
Battery Efficiency	0.85
System Losses %	0.1
DOD of battery	0.7
Battery Ah	307.3451603
Peak Sun-Hours	5
Solar PV loss	0.15
PV for day time load	

Village Cluster @ BAP: Bhato ki Dhani, Barsingho ki Dhani, and Goyalo ki Dhani

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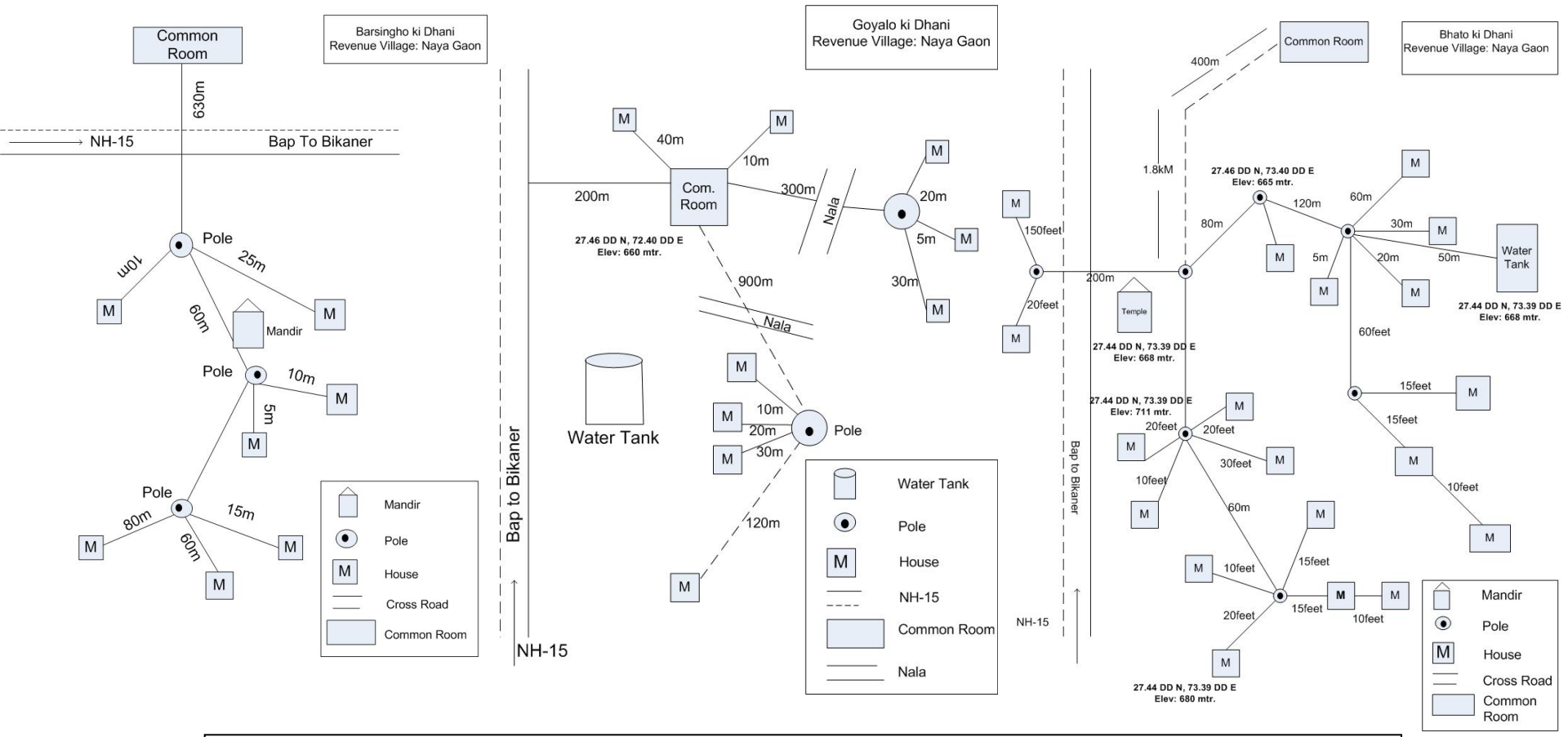
Home Lighting, Community Energy Needs (Atta Chakki, TV, RO Water Plant, and Refrigerator), Street Lights, Basic Sanitation, and Education.



Geographic Info (Lat/Long): 27.46 DD N, 72.40 DD E; Elevation: 660 meters.

SMG 4 @ BAP: Bhato ki Dhani, Barsingho ki Dhani, and Goyalo ki Dhani

Creating Innovative Solutions for a Sustainable Future

Basic Load							
Load Type	Wattage	Hours of operation	Numbers of such load	Number of HH	Total Wattage	Total Watt-hour	Operation Time
CFL-1	10	5	3	30	900	4500	6PM-11PM
Fan-1	50	4	2	30	3000	12000	12PM-3PM
CFL-2	10	5	2	10	200	1000	6PM-11PM
Fan-2	50	4	1	10	500	2000	12PM-3PM
Community Centre Load							
TV	100	4	1	1	100	400	6PM-10PM
Atta-Chakki	1500	5	1	1	1500	7500	10AM-3PM
Refrigerator	200	24	1	1	200	4800	12AM-12PM
RO Water	2200	5	1	1	2200	11000	10AM-3PM
Street Lights	10	5	10	1	100	500	6PM-10PM

Dhani Name	Goyalo ki Dhani, Bhato ki Dhani, and Barsingho ki Dhani
Number of Households	40
Number of Solar Water Pump Proposed	
Number of tube-well	

Parameters	
Peak Power (kW)	7400
Day Time Energy Requirement(Wh)	35400
Night Time load requirement(Wh)	7900
Number of autonomy days	1
Night time energy requirement for 1 day of autonomy (kWh)	7900
Inverter Efficiency %	0.95
Battery Efficiency	0.85
System Losses %	0.1
DOD of battery	0.7
Battery Ah	307.3451603
Peak Sun-Hours	5
Solar PV loss	0.15
PV for day time load (kWp)	9742.002064

Costing				
Components	Numbers	Rating	Cost (INR, approx.)	
Hybrid Inverter	2	5kVA	3,50,000	
Battery Bank	2	48V, 150Ah	1,60,000	
PV inverter	2	5kVA	2,00,000	
Distribution Line				
Pole Structure				

Village Clusters: Arjun Pura @ Baru, and Bishnoi ki Dhani, Ranjit Nagar @ BAP Block

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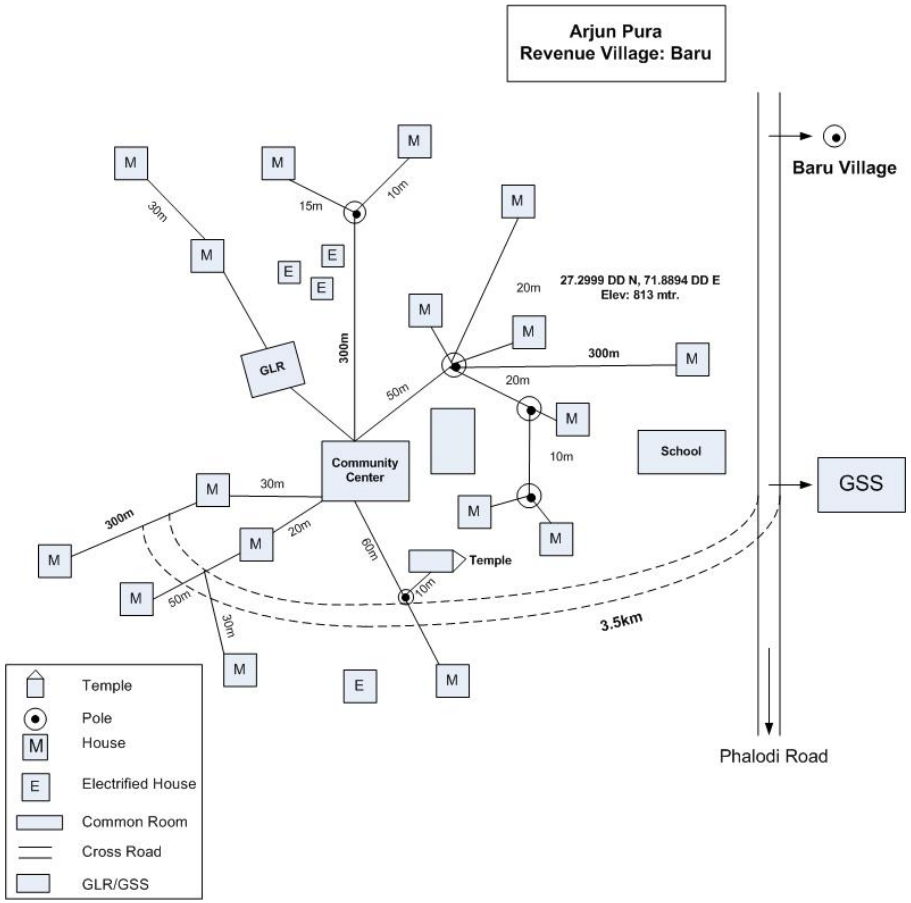
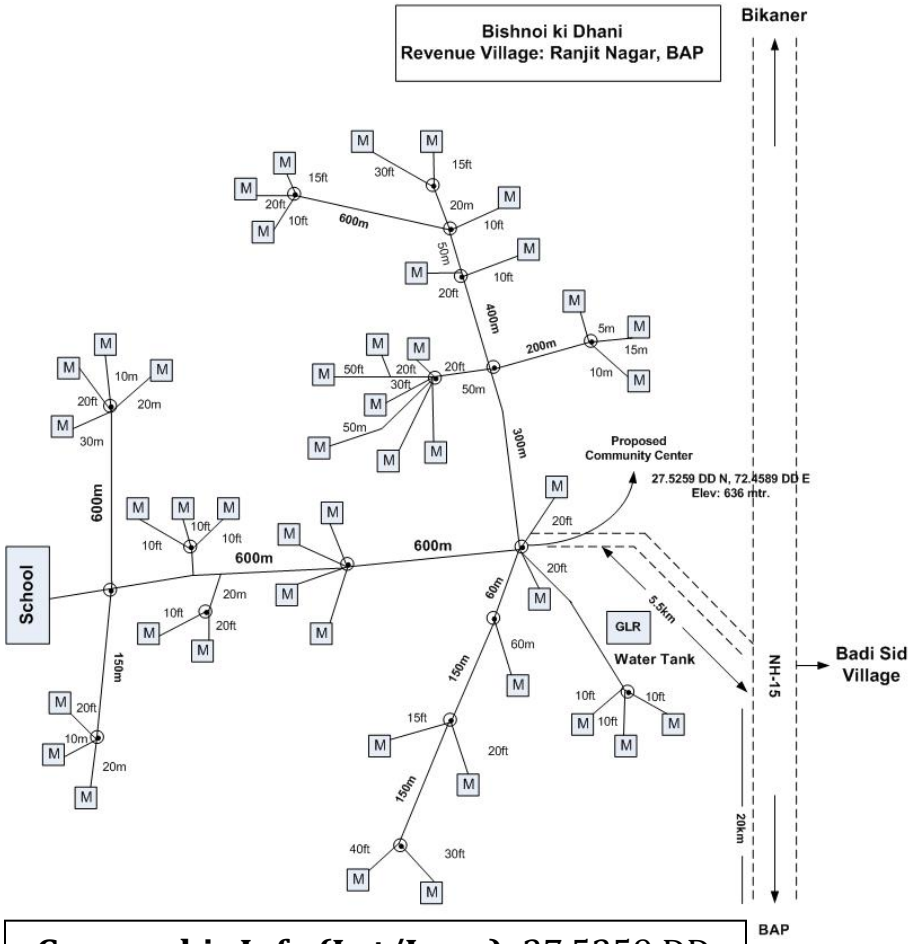
Home Lighting, Community Energy Needs (Atta Chakki, TV, RO Water Plant, and Refrigerator), Street Lights, Basic Sanitation, Education, and Solar Water Pumps for Irrigation.





Geographic Info (Lat/Long): 27.2999 DD N, 71.8894 DD E, Elevation: 813 meter.

Geographic Info (Lat/Long): 27.5259 DD N, 72.4589 DD E, Elevation: 636 meters.

SMG 3 & 5: Arjun Pura @ Baru, and Bishnoi ki Dhani, Ranjit Nagar @ BAP Block

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Basic Load							
Load Type	Wattage	Hours of operation	Numbers of such load	Number of HH	Total Wattage	Total Watt-hour	Operation Time
CFL-1	10	5	3	35	1050	5250	6PM-11PM
Fan-1	50	4	2	35	3500	14000	12PM-3PM
CFL-2	10	5	2	10	200	1000	6PM-11PM
Fan-2	50	4	1	10	500	2000	12PM-3PM
Community Centre Load							
TV	100	4	1	1	100	400	6PM-10PM
Atta-Chakki	1500	5	1	1	1500	7500	10AM-3PM
Refrigerator	200	24	1	1	200	4800	12AM-12PM
RO-Water	2200	5	1	1	2200	11000	10AM-3PM

Dhani Name	Arjun Pura/Bishnoi ki Dhani
Number of House holds	45
Number of Solar Water Pump Proposed	
Number of tube-well	

Parameters	
Peak Power (kW)	7900
Day Time Energy Requirement(Wh)	36900
Night Time load requirement(Wh)	8650
Number of autonomy days	1
Night time energy requirement for 1 day of autonomy (kWh)	8650
Inverter Efficiency %	0.95
Battery Efficiency	0.85
System Losses %	0.1
DOD of battery	0.7
Battery Ah	336.5234983
Peak Sun-Hours	5
Solar PV loss	0.15
PV for day time load (kWp)	10154.79876

Costing				
Components	Numbers	Rating	Cost (INR, approx.)	
Hybrid Inverter	2	5kVA	3,50,000	
Battery Bank	2	48V,150Ah	1,60,000	
PV inverter	2	5kVA	2,00,000	
Distribution Line				
Pole Structure				

Technical Configuration for Smart Mini-Grids

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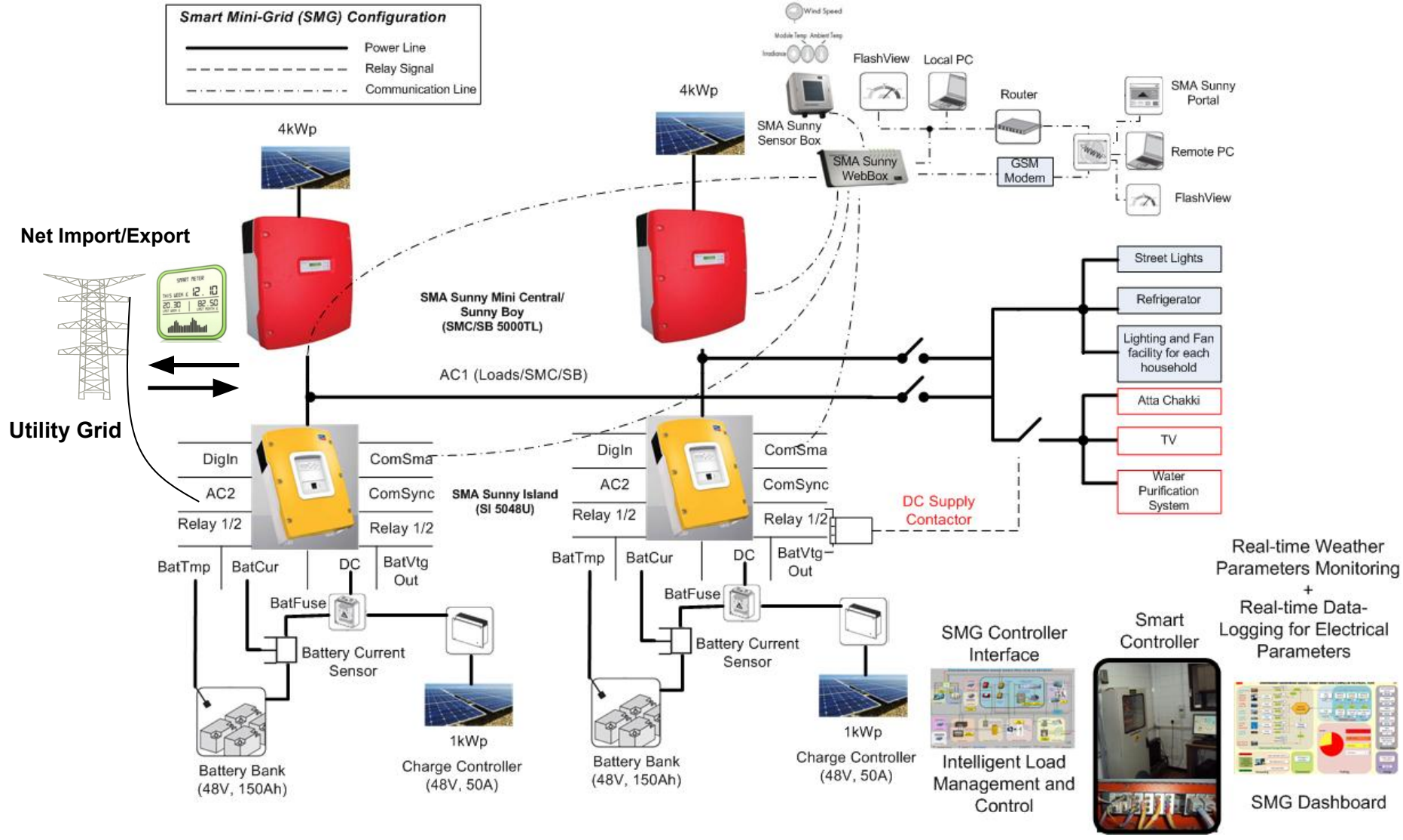

Remote Monitoring and Control for SMGs

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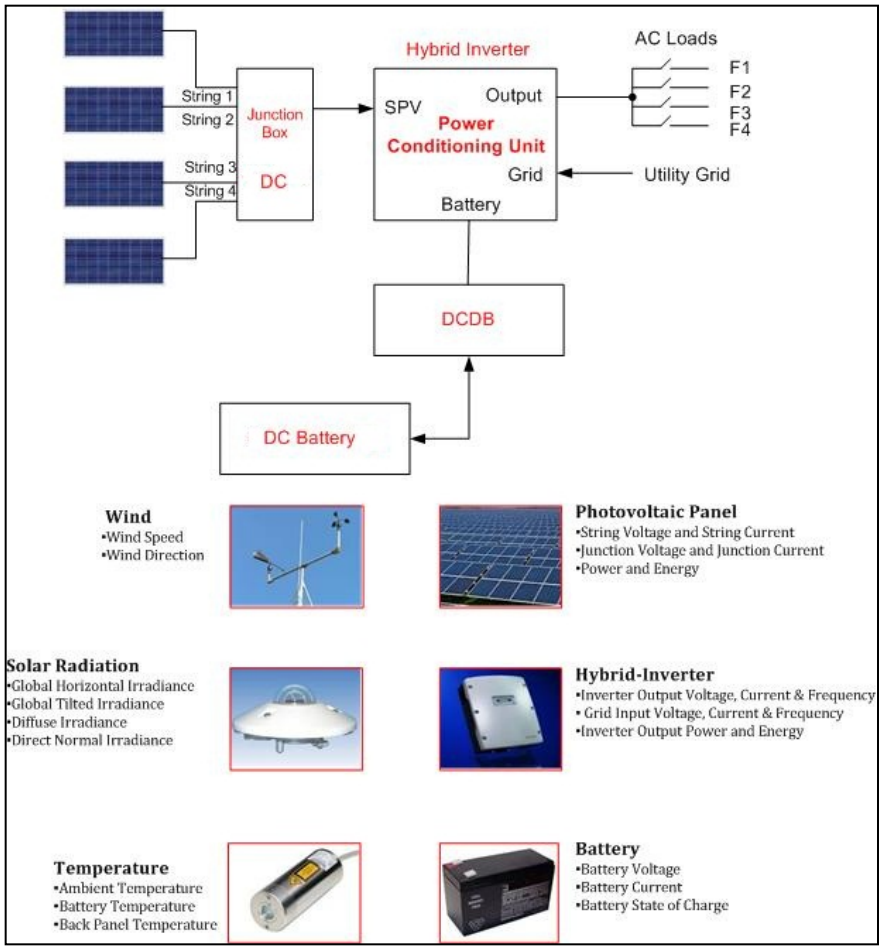

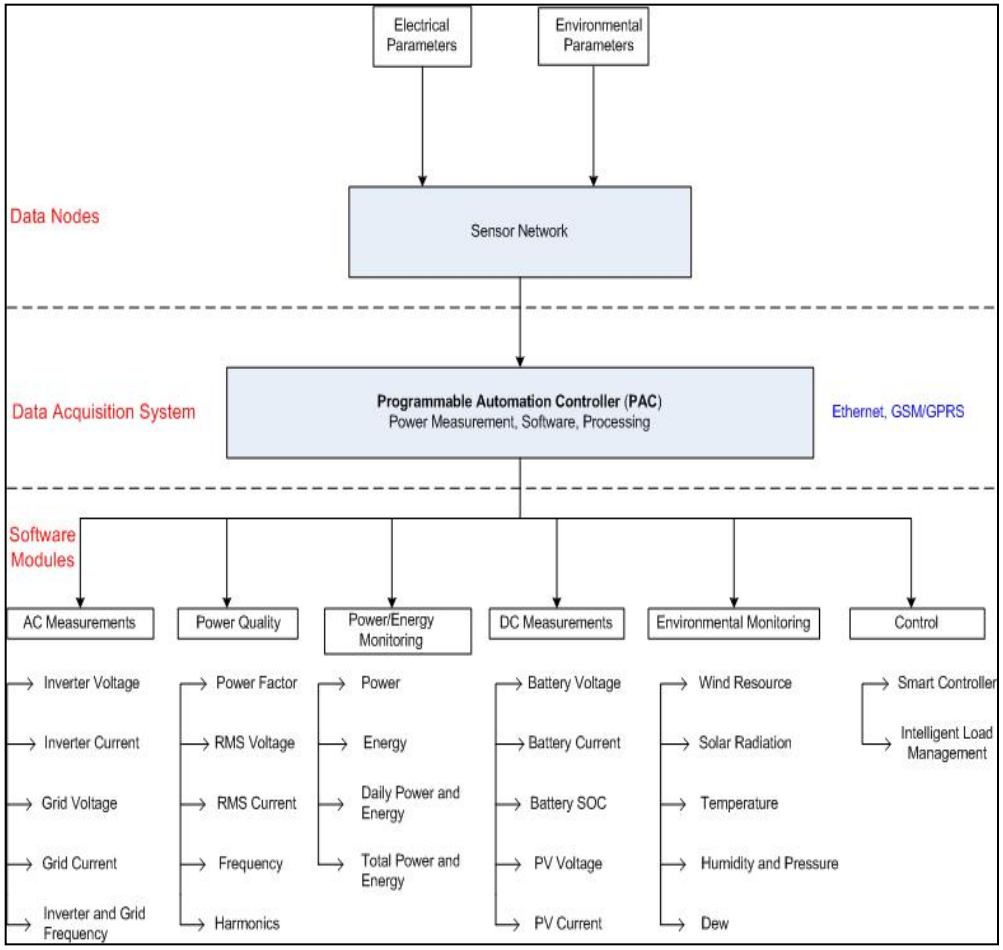

Technical Configuration for Solar Water Pumps

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Description	With DC Motor Pump-Set with Brushes or, Brush-Less DC (BLDC)			With AC Induction Motor Pump-Set and a suitable Inverter		
	Shallow Well (Surface) Solar Pumping Systems	Solar Deep well (Submersible) Pumping Systems		Shallow Well (Surface) Solar Pumping Systems	Solar Deep well (Submersible) Pumping Systems	
PV Array	2700 Wp	3000 Wp	4800 Wp	2700 Wp	3000 Wp	4800 Wp
Motor Capacity	3 HP	Submersible with electronic controller.	Submersible with electronic controller.	3 HP	Submersible with electronic controller.	Submersible with electronic controller.
Shut-Off Dynamic Head	25 Meters	70 Meters	70 Meters	25 Meters	70 Meters	70 Meters
Module Mounting Structure	MS hot dipped galvanized, at-least three times manual tracking facilities.	MS hot dipped galvanized, three times manual tracking facilities.	MS hot dipped galvanized, three times manual tracking facilities.	MS hot dipped galvanized, at-least three times manual tracking facilities.	MS hot dipped galvanized, three times manual tracking facilities.	MS hot dipped galvanized, three times manual tracking facilities.
Water Output*	1,48,000 liters per day from a total head of 20 meters.	63,000 liters per day from a total head of 50 meters.	1,00,000 liters per day from a total head of 50 meters.	1,35,000 liters per day from a total head of 20 meters.	57,000 liters per day from a total head of 50 meters.	91,000 liters per day from a total head of 50 meters.

*Water output figures are on a clear sunny day with three times tracking of SPV panel when solar radiation on horizontal surface is: 5.5 KWH/sq-m/day.

Remote Monitoring and Control for Solar Water Pumps

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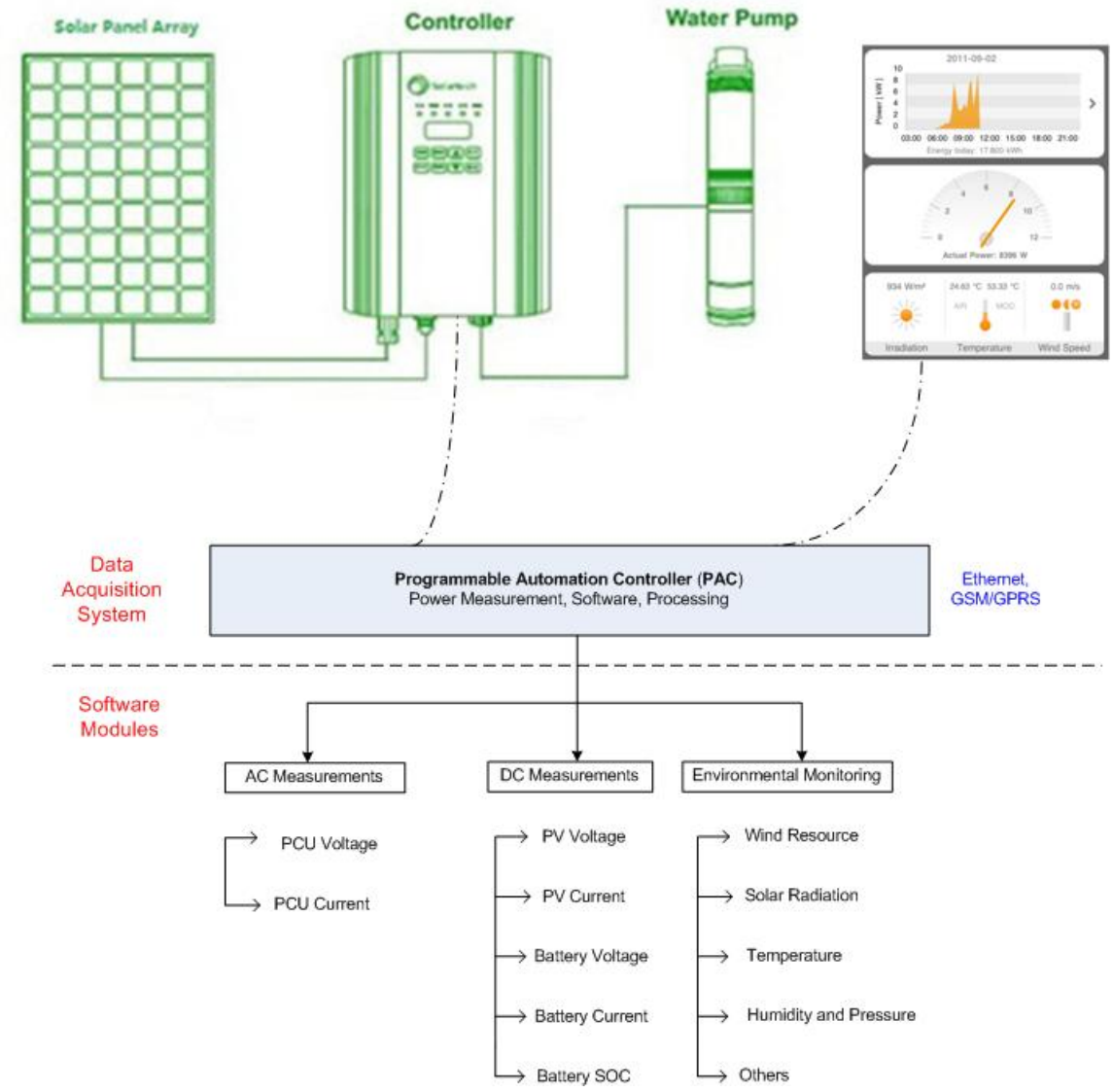

Economics of Solar PV Water Pump

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1 HP Pump Powered by a 2kVA DG Set vis-as-vis a Solar PV Water Pumping System:

Assumptions	
Cost of 1 HP Diesel powered Pump-set	Rs. 25,000
Cost of equivalent Solar PV Water Pump (un-subsidized)	Rs. 2,00,000
No. of Operating Hours per year (200 Days * 5 Hours/day)	1,000 Hours
Cost of Diesel/liter	Rs. 50
Fuel consumption/hr. of 2kVA DG-set	0.75 Liters
Average increase in Fuel prices per Annum	5%
Maintenance cost/year for Diesel Pump	Rs. 2,000
Maintenance Cost/year for Solar Pump	Rs. 500
Life Cycle Period (in Years)	10 Years
Discount Rate	10%

Comparison of 10 years of Life Cycle Cost:

Product	Capital Cost	Net Present Maintenance Cost	Net Present Fuel Cost	Total
SPV Pump	2,00,000	3,072	Nil	2,03,072
Diesel Pump	25,000	12,289	2,78,993	3,16,282

Economics of Solar PV Water Pump (Contd.)

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Cost Comparison at kWh level between Diesel and Solar PV Pump of 1 HP Rating:

Product	Capital Cost	Operating Cost/Year	Net Present Cost	Cost/kWh
SPV Pump	2,59,702#	1,500	Nil	Rs. 8.60
Diesel Pump*	25,000	24,187	2,78,993	Rs. 13.90

*Diesel at Rs. 50/liter.
#The price of the solar PV pump in this table is replicated from the CSTEP report. If the price of the Solar PV pump is assumed to be Rs. 2,00,000, the cost at kWh becomes even lower.

- ✓ Storage of unused solar potential;
- ✓ Other usages like Domestic and Community Lighting, Agriculture, and Small-scale Industry;
- ✓ Connecting to conventional grid;
- ✓ Low cost funding through UN agencies, State Government, or, CSR;
- ✓ Carbon Credit and flow of sum realized to financing future Solar Pump projects;
- ✓ Mass Manufacturing and Cost Reduction;
- ✓ National MIS;
- ✓ Maintenance, Insurance, Control Room, BPO Service etc.
- ✓ R&D for Solar in Agriculture/Horticulture;
- ✓ Solar Parks dedicated to use of Solar Energy in Horticulture/Agriculture;
- ✓ Sharing of Experiences.

Source: To be added here.

Cost for Solar PV Water Pump

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Details of Water Pump	Base Rate (in INR per-set)
	3000 Wp
Surface Pump 20m head	537000
Submersible Pump 20m head	560300
Submersible Pump 50m head	562300
Single Axis Auto Tracker	54000

Source: To be added here.

Collection of Drinking Water Samples

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Sr. No.	Location	Geographic Info.
Water Sample 1	Heer Singh ki Dhani, Revenue Village: Baru.	27.4227 DD N, 71.9359 DD E; Elevation: 680 meters.
Water Sample 2	Arjun Pura, Revenue Village: Baru.	27.2999 DD N, 71.8894 DD E; Elevation: 813 meters.
Water Sample 3	Baru Gram Panchayat Area, BAP Block.	27.3663 DD N, 71.8878 DD E; Elevation: 657 meters.
Water Sample 4	Bhato ki Dhani, Revenue Village: Naya Gaon, BAP Block.	27.44 DD N, 73.39 DD E; Elevation: 668 meters.

Water Sample 1

Water Sample 3

Drinking Water Quality Report

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Conclusion and Way Forward

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- ✓ Recommendation for Solar PV Water Pump of Rating 5 HP;
- ✓ Bhato ki Dhani Cluster at BAP will be one of the best suitable sites for implementation, because of its high visibility through National High-way;
- ✓ There will be scope for providing Basic Sanitation, Safe Drinking Water Supply, Women Empowerment etc.
- ✓ All of those shortlisted sites are required to have electricity access as basic energy needs;
- ✓ Joint Consortium can be formed between Samta Power (Local NGO), Punchline Energy (Private Project Developer), and TERI (as an Independent Consultant) :

http://www.teriin.org/index.php

Punchline Energy

http://www.punchline.in/

Samta Power

An Initative In Power Sector Reforms Through Peoples Participation

http://www.samtapower.com/

Case Study: Smart Mini-Grid (SMG) System developed by TERI

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Retreat is a residential, multi facility complex equipped with modern facilities including conference halls, official and residential premises, laboratories and sports grounds. The electricity demand of the complex varies quite widely depending upon the season, occupancy level of the residential premises, the number of conferences being held and several other factors.

Source: Google Earth (http://www.google.com/earth/index.html)

TERI's Smart Mini-Grid System has integrated following Distributed Energy Resources (DERs)

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- ✓ 10.5kWp Solar Photovoltaic (Crystalline silicon based solar module) system installed on the roof of the North Block of the TERI Retreat;

- ✓ 2kWp Solar Photovoltaic (Crystalline silicon based solar module) system installed on the roof of the Biomass Gasifier building;

- ✓ 1kWp Thin-film based Solar Photovoltaic system on the roof of the South Block of the TERI Retreat;

- ✓ 3.3kW Wind Turbine Generator (WTG);
- ✓ 100kW Biomass Gasifier (woody) system in the Biomass Gasifier building;

- ✓ Battery Bank of 48V, 600Ah for energy storage and,
- ✓ Diesel Gensets/Utility Grid.

Unique features of TERI's Smart Mini-Grid (SMG) System

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- ✓ Integration of multiple DERs, ensuring maximum utilization of renewable energy sources;
- ✓ Resource and load profiling, controlling and forecasting;
- ✓ Centralized control (Intelligent Smart Dispatch Controller) for resource optimization and demand management;
- ✓ Load prioritization (total loads have been classified into critical, essential and non-essential loads)
- ✓ Integrated high-speed Field Programmable Gate Array (FPGA) based digital communication protocols for acquiring data, sending and receiving controls;
- ✓ Real-time data acquisition and monitoring of several electrical, weather and physical parameters through installed sensors;
- ✓ Minimized outages and fast response to network disturbances through automatic connect/disconnect of system components.

Complete Single Line Diagram (SLD) of Smart Mini-Grid System developed by TERI

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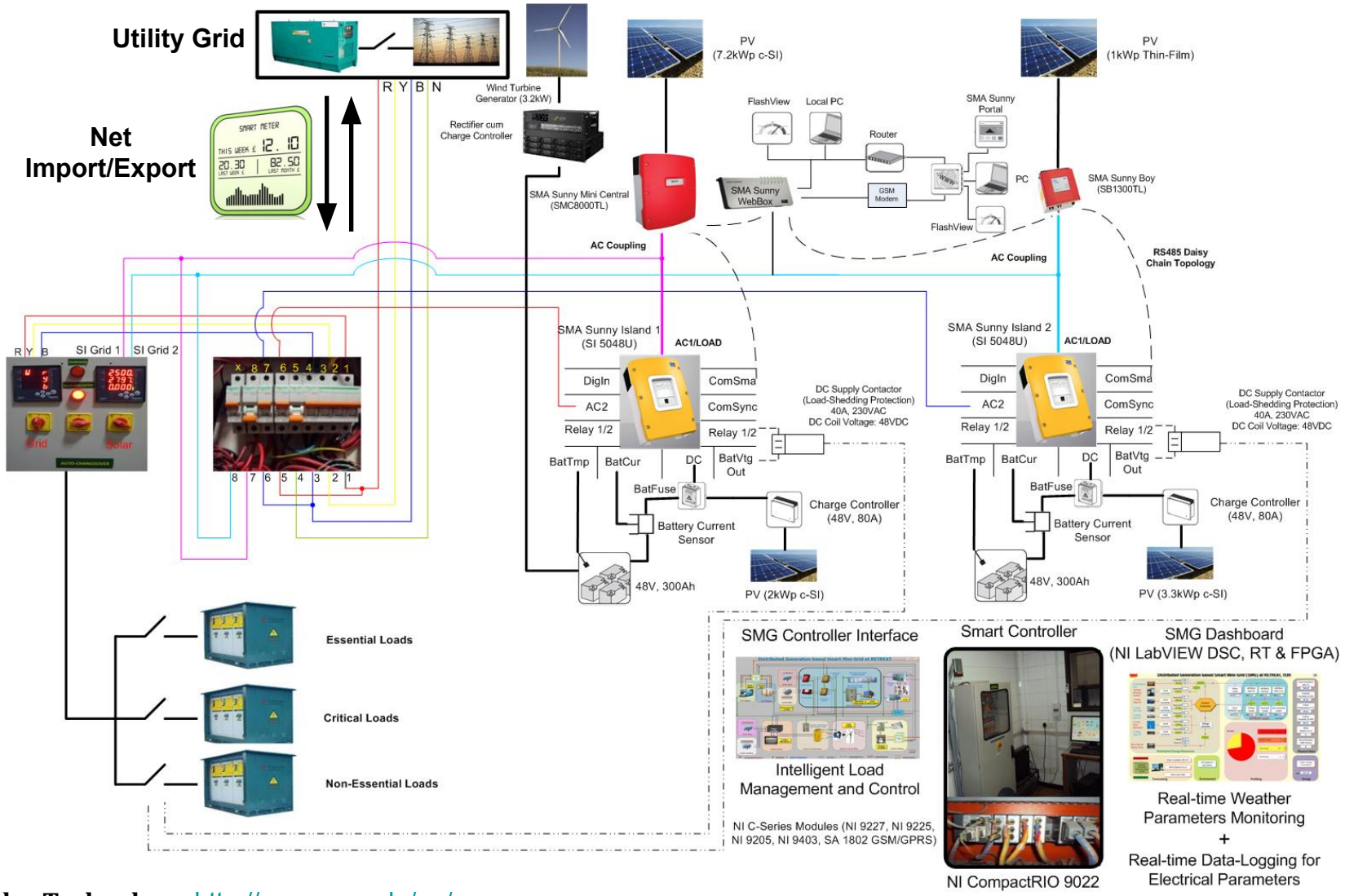

SMA Solar Technology: http://www.sma.de/en/

Real-time Data Acquisition and Control System of Smart Mini-Grid System

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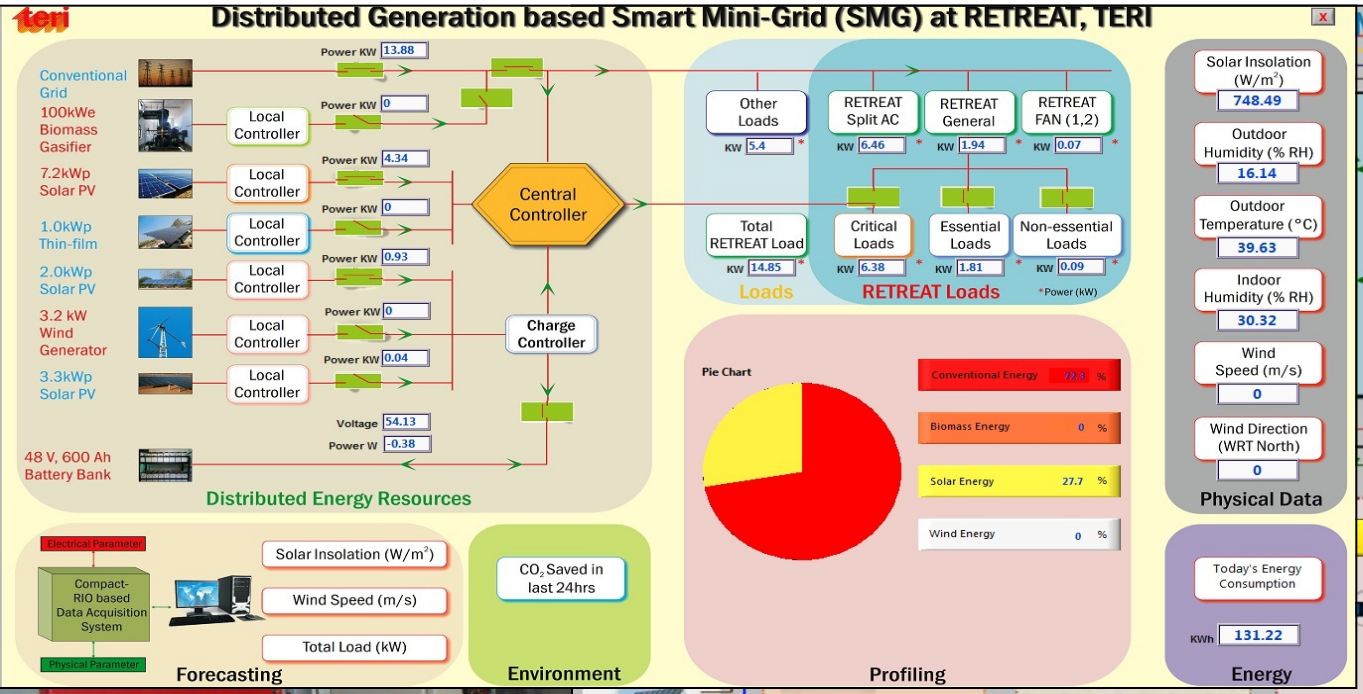

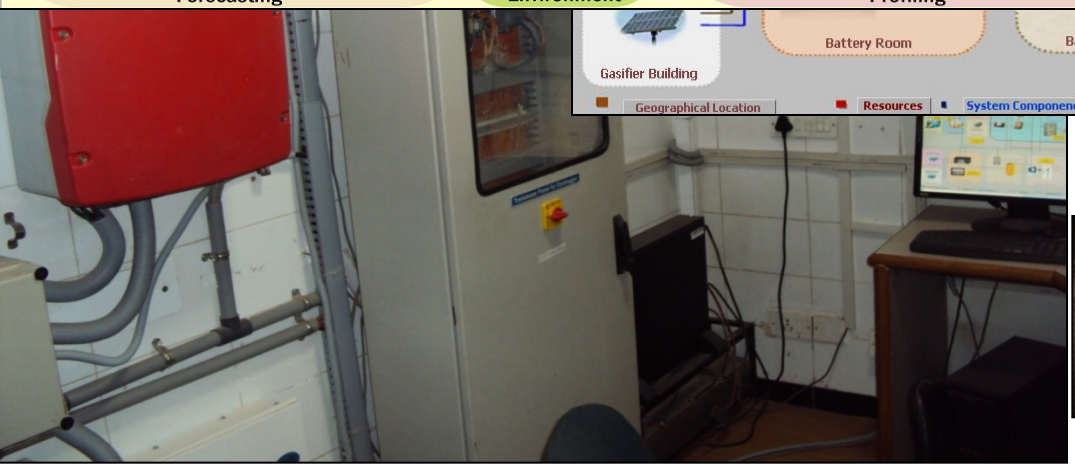

TERI-Smart Mini-Grid.wmv

National Instruments INDIA
• GRAPHICAL SYSTEM DESIGN •
ACHIEVEMENT AWARDS
2012

RUNNER-UP
RESEARCH CATEGORY

TERI SMG @ni.com:
http://sine.ni.com/cs/app/doc/p/id/cs-15019

Achievements Till Date

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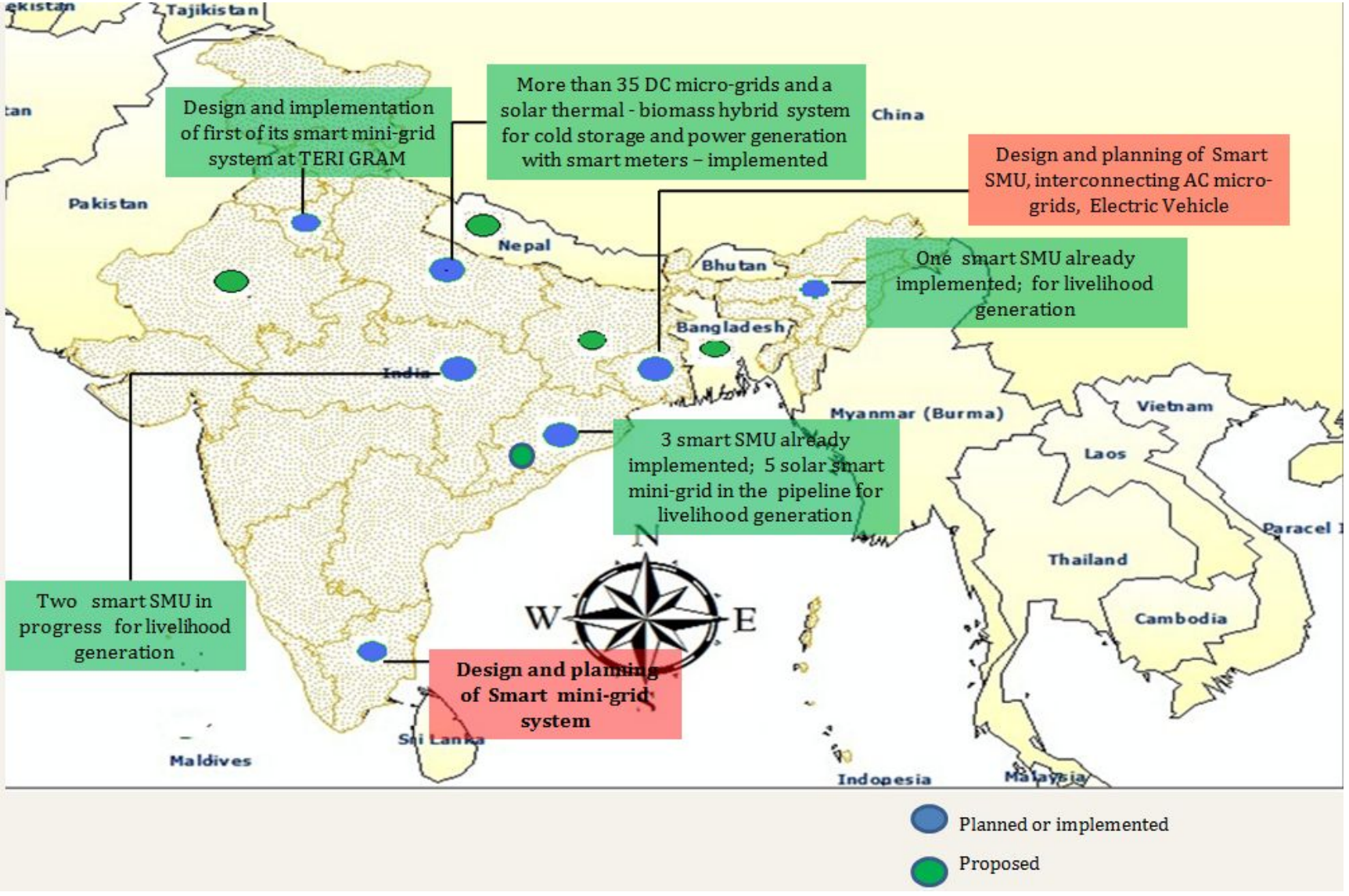

Off-Grid Power Plant Layout of Patapolasahi, Orissa

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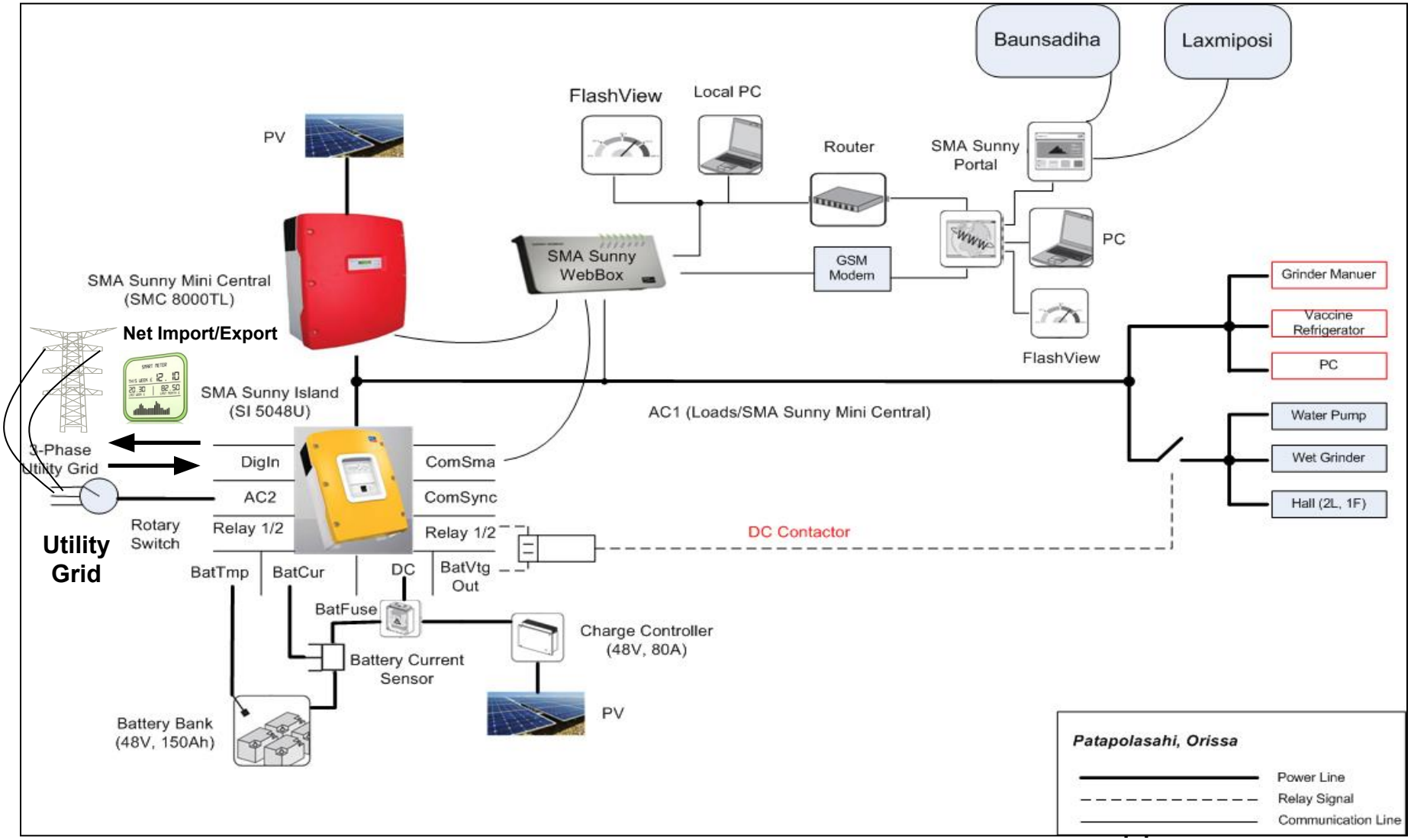

Monthly Generation Data of Solar PV Power Plant

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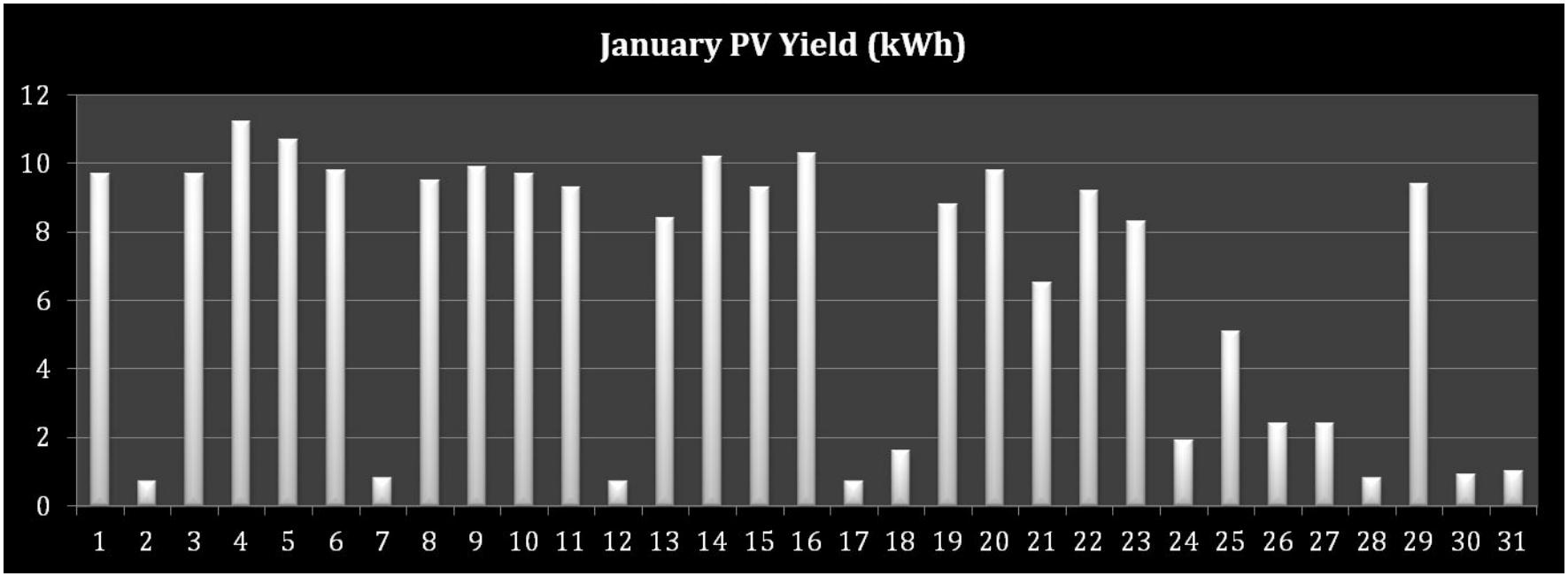

Source: 8kWp Solar PV Power Plant, installed by TERI in Orissa.

Off-Grid Power Plant (3-Phase) Layout of Raisen, MP

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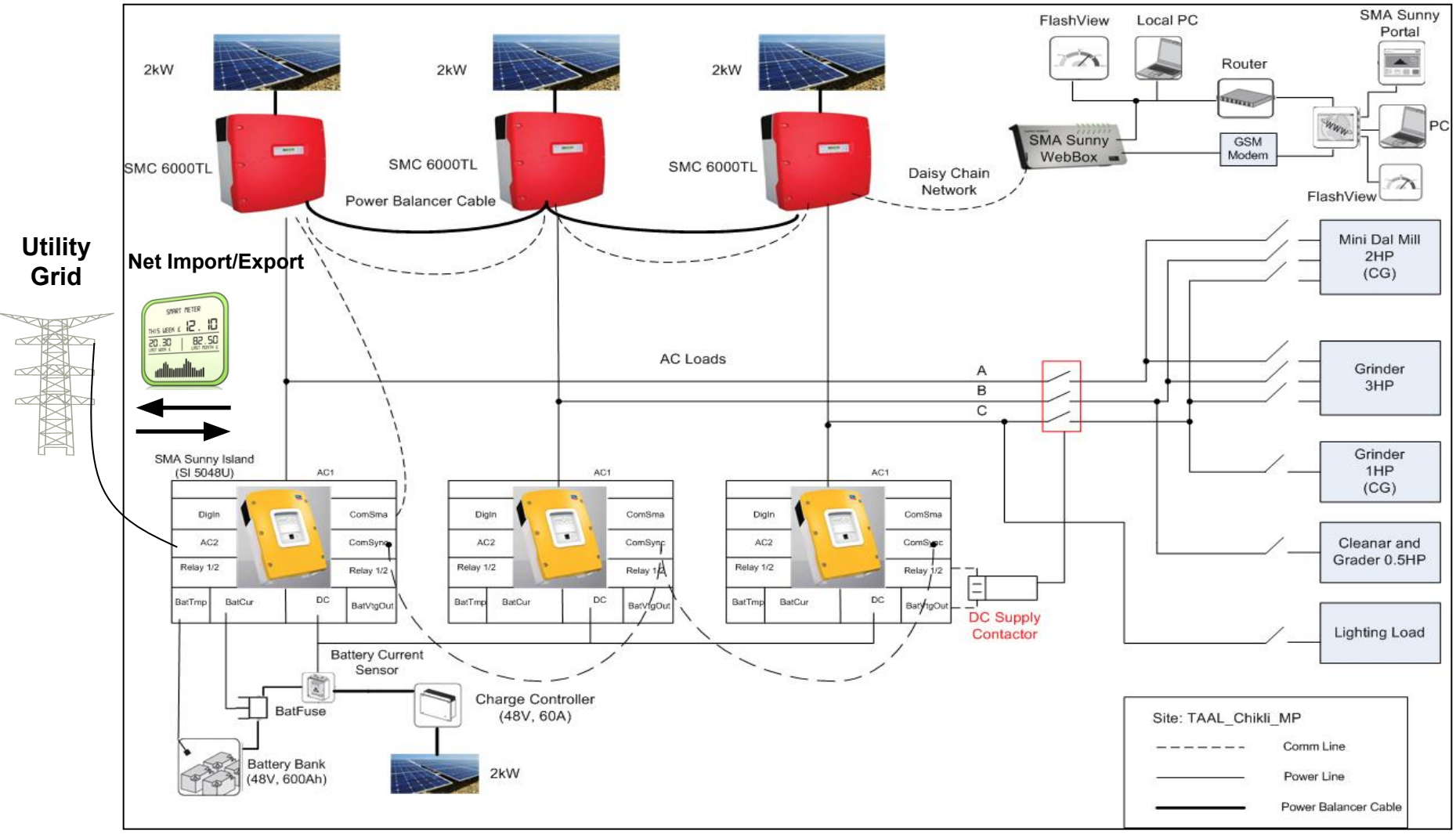

DC Micro-Grid Layout at UP

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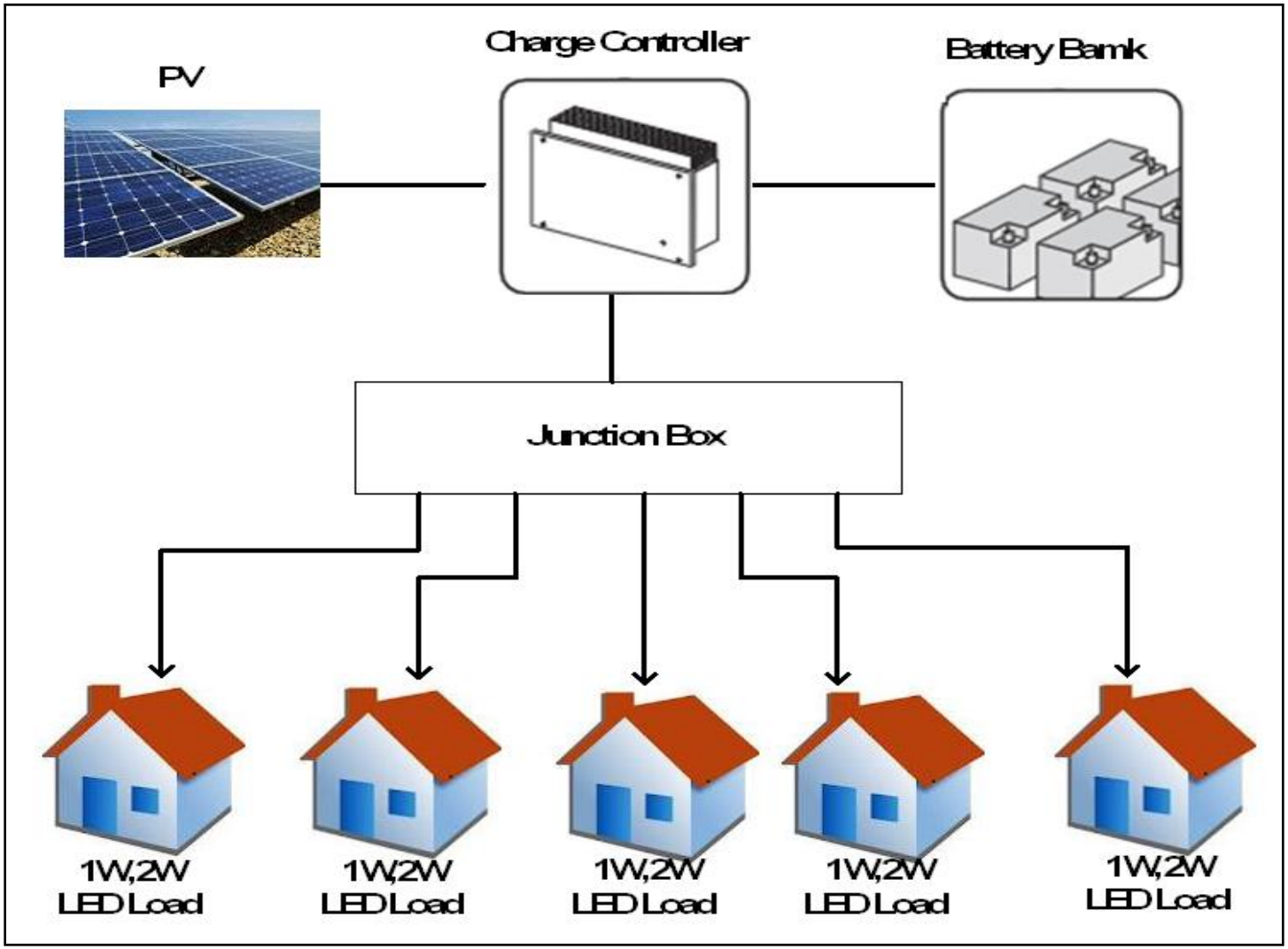

TERI's State-of-the-Art Research Laboratories

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Innovation through 'SMART' Research

Supported By:

The Norwegian Framework Agreement (NFA) between the Norwegian Ministry of Foreign Affairs (MFA) and The Energy and Resources Institute (TERI).

NORWEGIAN EMBASSY

Lab Infrastructural Facilities

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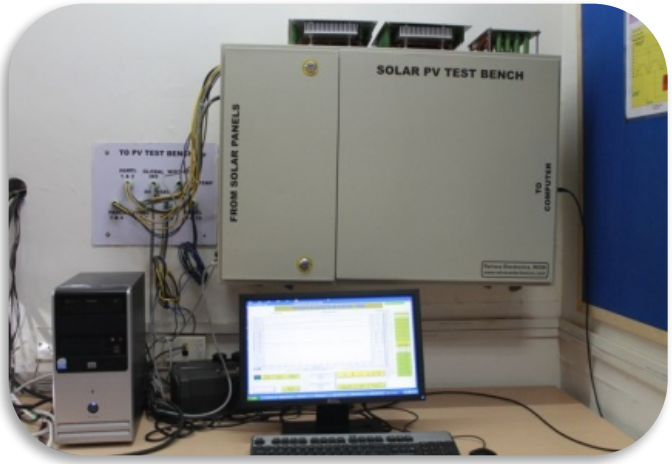
Solar Lighting Laboratory

Sun Simulator



PV Test-bed for Testing Ten (10) Solar PV Modules Simultaneously

Smart Controller Laboratory

Load Emulator

PV Array Simulator

Grid Simulator

Field Testing of different Solar PV Technology

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Professional Expertise within TERI

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Thank You

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