PROCEEDINGS

CONFERENCE ON

"RENEWABLE ENERGY"

8TH JANUARY 2025 (WED)
AT FEDERATION OF GUJARAT INDUSTRIES (FGI),
GOTRI, VADODARA 390 011

Jointly Organized By:

THE SOCIETY OF POWER ENGINEERS (I)
VADODARA CHAPTER

CENTRAL BOARD OF IRRIGATION & POWER,
NEW DELHI

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1-DAY CONFERENCE ON "RENEWABLE ENERGY" 8TH JANUARY 2025

SOCIETY OF POWER ENGINEERS (I), VADODARA CHAPTER

TIME	DESCRIPTION
08.30 TO 09.30	**REGISTRATION & hi-tea**
09.45 TO 11.00	**INAUGURATION**
	• Invitation to dignitaries • Digital Prayers & Lighting of Lamp • Floral Welcome • Welcome Address by Dr. AJ Chavda • Addresses 1. Er. H. N. Shah GM (RE), GUVNL 2. Er. Manish Mishra KPI Green 3. Er. Upendra Pande MD, GETCO 4. Er. S. R. Pandey Member, GERC • Felicitation of sponsors • Volte of thanks • National anthem
11.00 TO 11.30	**Networking TEA BREAK**
11.30 TO 13.00	**TECHNICAL SESSION I**
	1. Paper – kp energy 2. Over View, Trends And Potential In Wind Power – Dr. Karunamoorthy 3. Power Quality Assessment as per CEA Connectivity Guidelines – By Saifali Talati ERDA 4. Understanding Of Solar Market Of India – By Shashank Malpande, MBH Power Pvt. Ltd.
13.00 TO 14.00	**Networking LUNCH**
14.00 TO 15.30	**TECHNICAL SESSION II**
	1. Electricity Act and Open Access – By Er. Vasant Patel, GETCO 2. Gujarat Power Network – BY Er. Dipak Patel, GETCO 3. Solar PV Plants Technologies – BY Er. Asheesh Dhaneria, ERDA 4. Alternate Approach for Outreach of GOI RE Schemes – by Er. JC Marathe
15.30 TO 16.00	**Networking TEA BREAK**
16.00 TO 16.40	**TECHNICAL SESSION III**
	1. Applicability Of Green Energy Open Access Charges – BY Er. Umesh Parikh, MEC Power 2. Solarisation of Modhera Sun Temple & town a Battery Back-up Solar Power Plant – by Er. PH Rana 3. Grant Of Connectivity Of RE Projects With State Transmission System – BY Dr. AJ Chavda, Ex. GETCO
16.40 to 17.30	**Open House**

1- DAY CONFERENCE

"RENEWABLE ENERGY"

FEDERATION OF GUJARAT INDUSTRIES (FGI), GOTRI, VADODARA

8th January 2025 (Wednesday), COMMITTEE MEMBERS

1. OVERALL COORDINATION: Er. MR Tilwalli Er. PH Rana **Dr. A J Chavda Coordinator (99252 09590)** **Er. SM Takalkar Convener** Er. YV Joshi	**2.CONFERENCE COORDINATION:** Dr. A J Chavda Coordinator (99252 09590) Er. RS Shah Er. PP Shah Er. SM Godkhindi Er. NV Lathia
3.REGISTRATION & FOOD: **Er. SP Trivedi Convener (9925208063)** Er. NV Lathia Er. NC Solanki Dr. Gitesh Chitaliya Er. HD Joshi Er. RM Athavale Er. Hetal Prajapati	**4.STAGE, INAUGURAL/ TECHNICAL SESSION:** **Er. VB Harani Convener (9925238450)** Er. PA Shah Er. Parag Parmar Er. SM Godkhindi Er. SM Baxi Er. Binal Modi
5.PURCHASE: **Er. Umesh Parikh Convener (9925208061)** Er. RS Shah Er. YV Joshi Er. S M Baxi	**6.TECHNICAL COMMITTEE:** **Er. YV Joshi Convener (9925208091)** Er. SM Takalkar Dr. AJ Chavda Er. PA Shah
7.TRANSPORT: **Er. Hemant Nashikkar (99252 08294)** Er. JK Surti Er. NG Yadav	**8.PRINTING:** **Er. S M Baxi (9909940562)** Er. NV Rede Er. PA Shah

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LOCATION- Jodhpur, Rajasthan

- **Statue of Unity**

CAPACITY- 4 MW
LOCATION- Kevadia, Gujarat

- **Amul- Anand Milk Union Limited**

CAPACITY- 2 MW
LOCATION- Kapadavganj, Kanjari, Gujarat

- **Panchmahal**

CAPACITY- 8 MWp
LOCATION- Gujarat, MP, Maharastra

- **Solar Park**

CAPACITY- 45 MW
LOCATION- Devmori, Bhatpur, Gujarat

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Leading Renewable Energy Company

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Our diversified renewable energy portfolio – among the nation's largest – positions us to execute your sustainability goals, no matter how ambitious.

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Our team of dedicated energy experts works hand-in-hand with you to achieve your ambitious environmental and sustainability goals via customizable wholesale and retail solutions.

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Our purpose and mission are rooted in wind and solar energy, ensuring our customers benefit from its full potential by maximizing your profits and strengthening the certainty of your investment in wind and solar power.

Solutions at a Glance

What We Offer
- Site Selection, Feasibility & Yield analysis
- Approvals and Permissions
- Land Acquisition
- Logistics and Material handling
- Construction of Roads, Substation
- External & Internal EHV & HV Lines
- Erection and Commissioning
- Operation & Maintenance

Our Services
- Turnkey Solutions for Wind, Solar & Hybrid Projects
- Comprehensive O&M for Site development
- Repowering for existing RE Projects
- Battery Energy Storage Systems
- Consulting & Advisory Services
- Logistics & Crane Services.

Our Business Models
- Turnkey EPC Services
- CAPEX (EPC Model)
- OPEX Model (Build Own Operate)
- Captive / Group Captive
- Third Party Sale

Quick Facts

Leveraging 12 years of experience, resources and capabilities for exceptional sustainability results

2,798 MW
Total Renewable Projects

100+
Happy Clients

12 years
Of experience

windplus®
adding value ... always

YOUR TRUSTED PARTNER

Windplus Private Limited provides a wide range of project management consultancy services, which includes but not limited to the services in development, construction, erection, inspection, testing, operation & maintenance for wind energy projects. In addition, the company also offers training and development services. Our commitment is to exceed customer expectations by focusing on the continual improvement of customer deliverables through the application of advanced processes, the constant enrichment of our knowledge in industry best practices and also through technology adoption.

Our strategic approach in the development and implementation of Wind Energy projects starts with identifying potential wind-rich sites that suit power generators (IPPs) involves various methodologies, including conducting field visits, verifying climatic details, and employing data analytics using different sets of software tools and techniques. Obtaining the requisite permits and approvals from respective government bodies to execute power projects within stipulated time frames. Moreover, strategically managing personnel at project locations and transparently handling customer interactions aids in resolving issues effectively and potentially accelerates our progress ahead of other market players.

Our skillful approach with government nodal parties to acquire requisite approvals on time has always facilitated power generators/investors in meeting their target capacity and contributed to the country's renewable energy goals.

Windplus comprises of individuals with many decades of experience in the field of renewable energy, with their support we have consistently undertaken significant responsibilities and commitments over the past few years to contribute to society by advancing electricity generation and raising awareness among students regarding the importance of renewable energy projects.

Join us and let us help you grow your business to achieve its maximum potential!

DMAX REINFRA LLP

EMPOWERING THE FUTURE

Solar Pv Power Plant Developer

Ongoing and Future Projects of Dmax ReInfra LLP

Dmax Re-Infra LLP. Current and projected milestones

Completed Projects

- 18 MW - Narichana, Dhangadhra (75 acres)

Ongoing Projects

- 40 MW - Mathak, Halvad (166 acres):
  - 14 MW to be completed by December 2024
  - 26 MW to be completed by January 2025
- 120 MW - Liya, Surendranagar (540 acres):
  - 45 MW to be completed by March 2025
  - 80 MW to be completed by August 2025

Core Expertise

- EPC for solar power parks
- Development of ready-to-move solar power parks
- Turnkey solutions for renewable energy infrastructure
- Strategic planning and execution of large-scale projects

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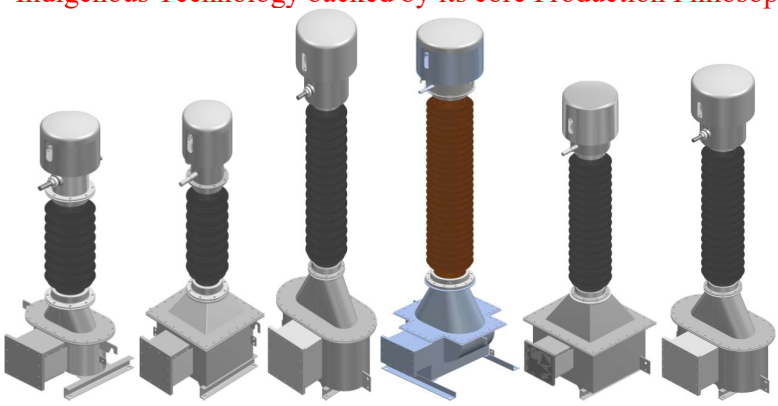

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maketing1@hivoltrans.com

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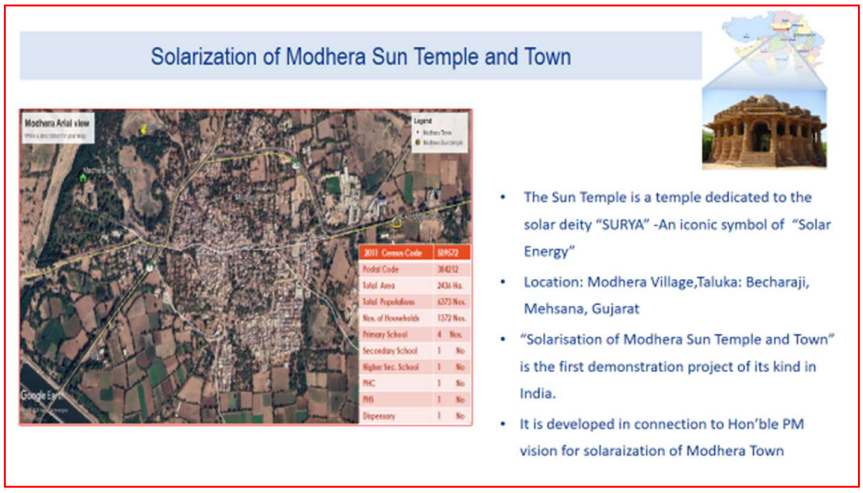
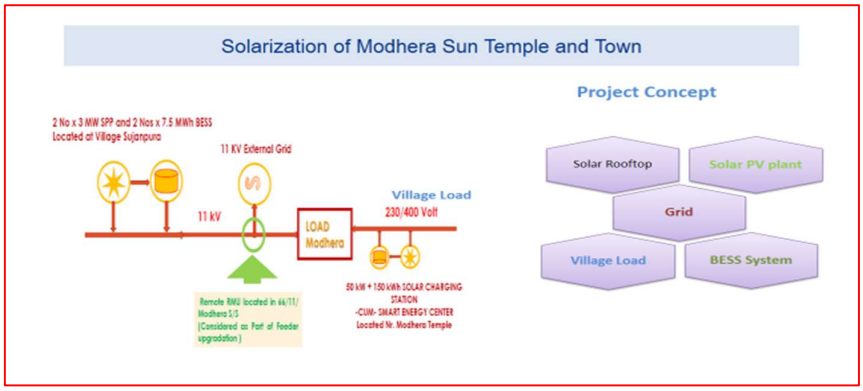
Solarization of Modhera Sun Temple and Town

A BATTERY BACK-UP SOLAR POWER PLANT

By: P. H. Rana





Solarization of Modhera Sun Temple and **Town**

Sr.	Actions Regarding	Project Phases
1	**Project Components**	Following components **of Phase-I** which are commissioned and in operation mode and Components in **Phase-II** are in Execution Phase: 1. 6 MW Solar PV and 15MWh BESS Power Plant near Village Sujanpura. 2. 309 Nos(Phase-I)and 1086 Nos. (Phase-II) 1KW Residential Rooftop Solar PV Systems in Modhera village and project affected area . 3. 100 kW (Phase-I) and 220KW (Phase-II)aggregate capacity of Rooftop Solar PV Systems on Govt. Buildings in various locations of Modhera and Project affected area. 4. Approx.1753 Nos Smart Energy Meters connection in Modhera village. 5. 50 KW Solar based EV Solar Charging Station and Interpretation center cum museum near parking area. 6. 25 Nos. of Articulated Street lights near Sun Temple. *The total cost of the project is 69 Crores for Phase-I and 10 Cores for Phase-II.*
2	**Project Management Consultant (PMC)**	• M/s Gujarat Energy Research and Management Institute (**GERMI**) has selected as PMC
3	**EPC Contractor**	Following single EPC contractor through competitive bidding process for Project: 1. M/s Mahindra sustain Pvt Ltd (**MSPL**)has selected in **Phase-I**. 2. M/s Sanelite Soalt Pvt Ltd (**SSPL**)has selected in **Phase-II**. • The Bidder has been selected and LOI is issued on 5th August 2020 (Phase-I) and 22th March 2022 (Phase-II). • The Major Project components of **Phase-I** are commissioned on 21st August 2021. • All project components of Phase-II will Commission by the month of September 2022.

Technical Details of Battery :-

Solarisation of Modhera Sun Temple and Town Technical Detail of 15 MWh BESS System		
1	1-Battery Modular(Lithium-Ion Battery)	76.8 V/250Ah/19200Wh Max Charge Current:125A Max DisCharge Current:150A Cell Type:FE125A Input Voltage:87.6 Output Voltage :74.4
2	1- Rack (15 nos - Battery Modular Connected In Series)	15 nos - Battery Modular Connected In Series 15 X 76.8 = 1152 DC Voltage Capacity in Wh - 19200 X 15 =288000Wh Capacity in KWh - 19.200 X 15 =288KWh Capacity in MWh - 0.192 X 15 =0.288MWh
3	1- Bank (11 Nos Rack Connected In Parallel)	11 Nos Rack Connected In Parallel Capacity in KWh - 288 X 11 Rack =3168KWh Capacity in MWh - 0.288 X 11 Rack=3.168MWh
4	BESS Room-1 (3 Battery Bank In Room-1)	3 Battery Bank In Room-1 Capacity in MWh - 3168 X 3 Bank= 9504 KWh Capacity in MWh - 3.168 X 3 Bank= 9.504 MWh
5	BESS Room-2 (3 Battery Bank In Room-2)	3 Battery Bank In Room-2 Capacity in MWh - 3168 X 3 Bank= 9504 KWh Capacity in MWh - 3.168 X 3 Bank= 9.504 MWh
6	Total Capacity	6 Bank X 3.168MWh = 19.008 MWh

Technical Details of Battery :-

Battery Charge/Discharge Set Point		
1	Max Battery State of Charge	80%
2	Min Battery State of Charge	20%
3	1st Set Point To Battery Charge	Battery SOC 25% -50% ---40% PV Generation To Grid
4	2nd Set Point To Battery Charge	Battery SOC 50% -60% ---50% PV Generation To Grid
5	3rd Set Point To Battery Charge	Battery SOC 60% Above ---95% PV Generation To Grid

Technical Detail of 6MW Ground mopunted PV Plant :-

1	PV Solar Module	Maximum Power (pmax) =335 W
		Open Circuit Voltage(Voc) =46.80 V
		Short Circuit Current(Isc)= 9.30A
		Maximum Power Voltage(Vmp) =38.10 V
		Maximum Power Current(Imp) =8.80 A
		Maximum System Voltage =1500 VDC
2	String	62 PV Solar Module In Connected
		31 Nos Connected In Series
		31 + 31 = Connected Parallel
3	SCB	TOTAL No.of SCB : 31 Nos.
		13 Nos Of Strings im ome SCB
		One string : Max Voltage - 1500 V DC, Max Amps - 18 Amps
4	PV Inverter (Sungrow)	Total 2 Nos.
		1 No.: 3125 KW
		Max Input Voltage : 1500 V DC
		Output Voltge : 600 V DC
		Max Input Current : 4178 Amps DC
		Max Output Current : 3458 Amps AC

Technical Detail of 6MW Ground mounted PV Plant :-

5	Inverter Duty Trnsformer	Total 2 Nos. (11 KV/ 600 V)
		1 No.: 3000 KVA
		Current : 157.46 A/ 2886.84 A
6	PCS (Power Conversion System)	Total 6 Nos.
		1 No.: 1000 KW
		Max Input Voltage : 1500 V DC
		Output Voltge : 690 V DC
		Max Input Current : 1200 A DC
		Max Output Current : 962 A AC
7	Inverter Duty Transformer (PCS)	Total 2 Nos. (11 KV/ 690 V)
		1 No.: 3000 KVA
		Current : 157.46 A/ (836.76 A x 3 nos.)

PROJECT COMPONENTS

6MW Solar PV cum 15MWh BESS Located at Sujanpura.

To Provide Round the clock (24 X 7)Solar Power to Modhera Village and Temple.

The ability to Resilience the Distribution network during any Grid outage with Micro Grid concept with Battery storage System at Modhera Village any time .

PROJECT COMPONENTS

There are

1. *309(Phase-I) &1068 Nos(Phase-II) 1kw Residential solar installed at Modhera and Project affected area.*
2. *100KW Solar(Phase-I) &220KW(Phase-II)Solar Rooftop system on Government buildings*

1753 Nos. of Smart meters installed in Phase-I at Modhera.

Smart Meter & Rooftop Installation Bifurcation		
Sr. No.	Particulars	Nos.
1	1kW Residential Solar System installed in Phase-I	271
2	1kW Residential Solar Installed by GEDA.	38
3	1kw Residential Solar Installation in Phase-II	1444
	Total	**1753**

PROJECT AT A GLANCE

Commissioning Dates:

- SPP Commissioing-**26th August 2021**
- SPP Operational Acceptance Test-**14th October 2021**
- BESS Energy Capacity Test-**20th September 2021**

BESS Application:

- Solar Smoothening
- Night Time Energy supply to village
- Energy Supply to village during early morning & late evening when PV generation is Low

EMS Functionalities:

- Ensuring Zero import from grid(to meet this criteria EMS checks load , PV generation and battery SOC and decides on battery discharge during early morning & late evening)

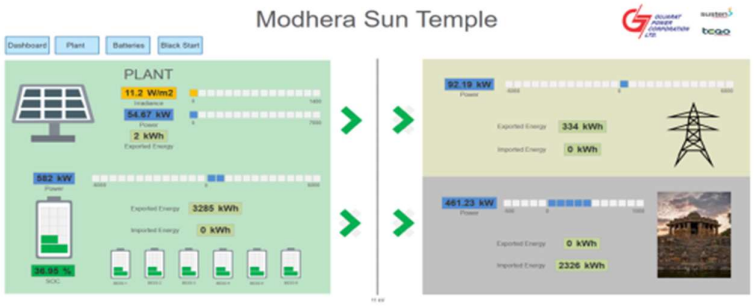
Solar Generation Distribution Among battery and Grid Export limit:

Battery SOC	Battery Charging	Grid Export
30%-55%	60%	40%
55%-70%	50%	50%
>70%	10%	90%

- BESS Losses(HVAC, Auxiliary Consumption & System Losses)-**12.5% of total BESS Capacity**
- Battery response time-**1sec**

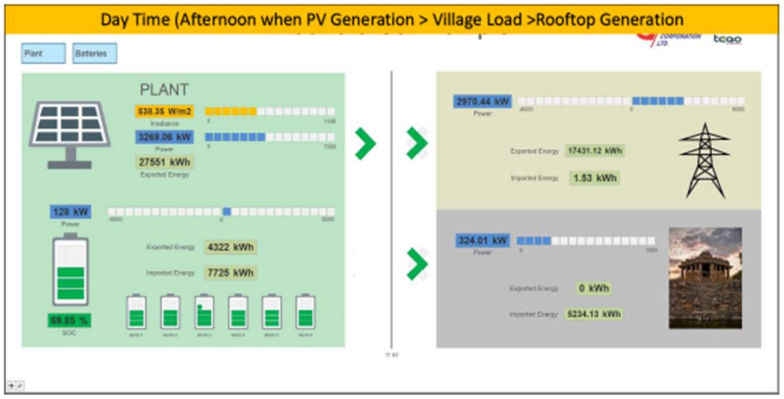
OPERATING CONDITIONS

Day Time (Early Morning & Evening when PV Generation < Village Load and Rooftop Generation <Village Load)



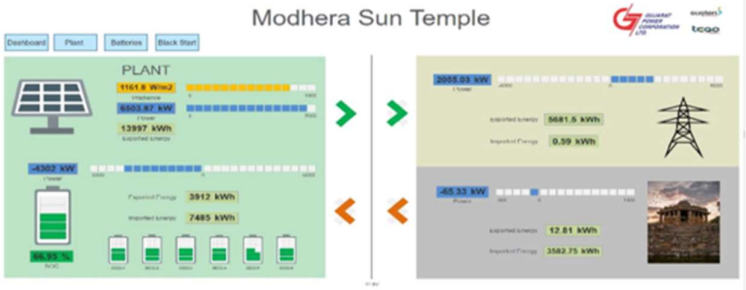
OPERATING CONDITIONS

Day Time (Afternoon when PV Generation > Village Load >Rooftop Generation



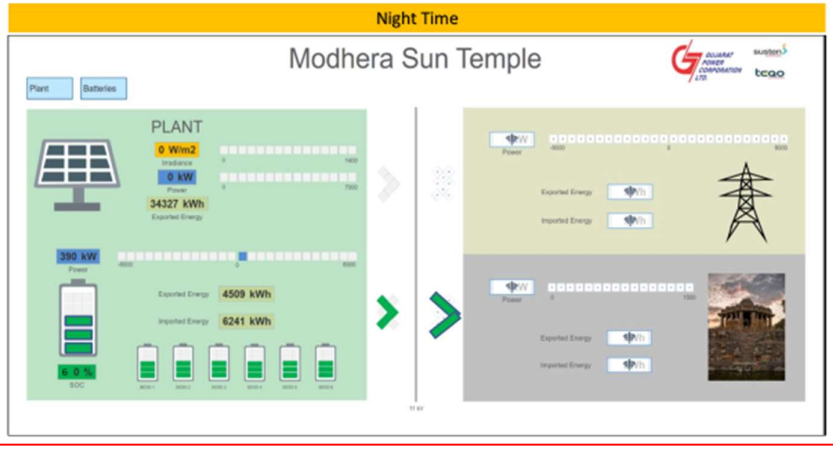
OPERATING CONDITIONS

Day Time(Village Load<Rooftop Gen)

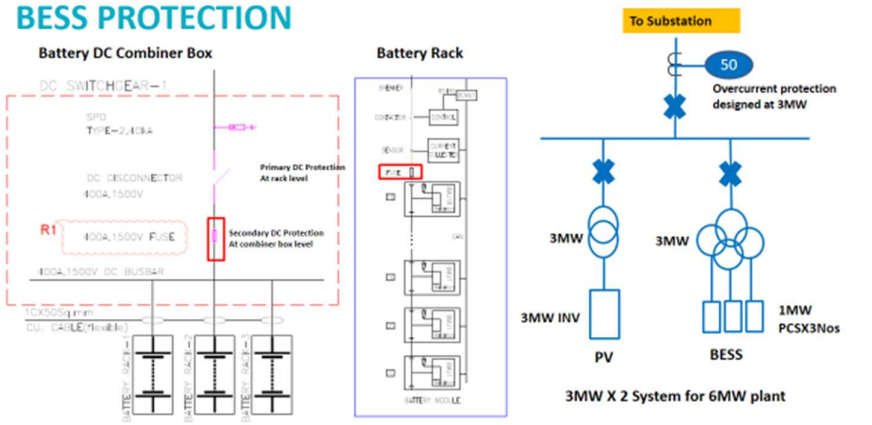


OPERATING CONDITIONS

Night Time



BESS PROTECTION



Both Fuses at Battery rack and combiner box level are high speed tripping fuses which operates within millisecond

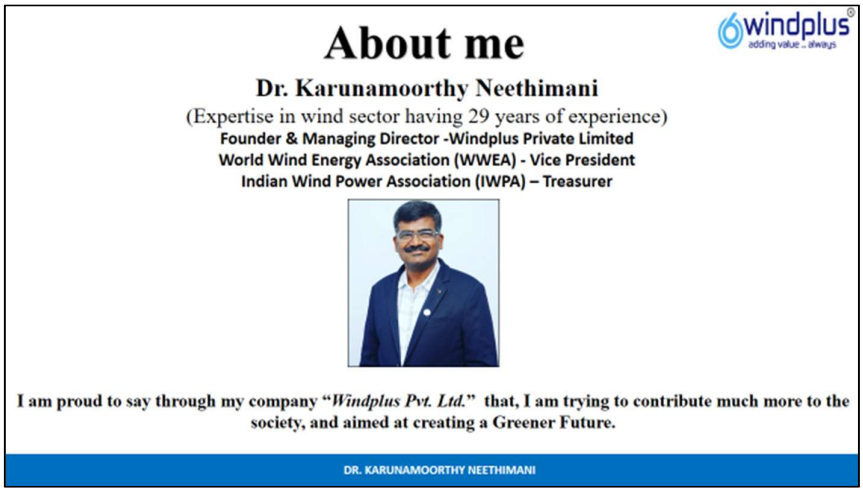
Power export at output is limited to 3MW by Power Plant Controller and EMS

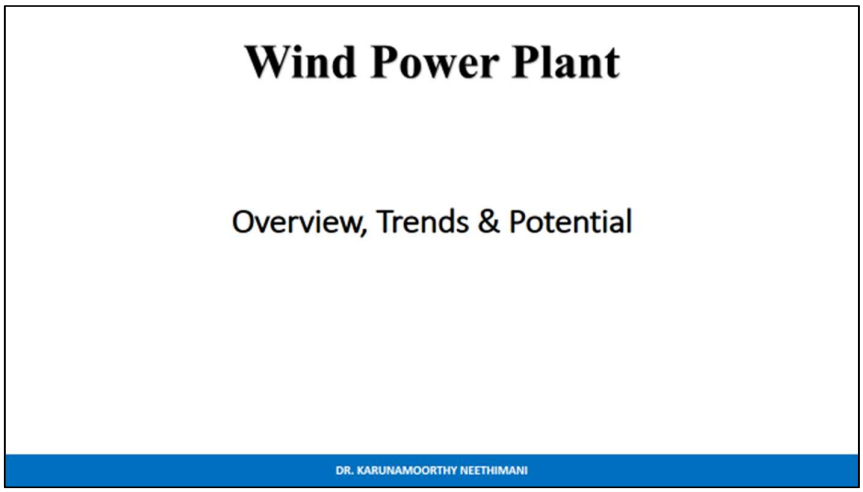
Sample Bill (With out Rooftop Solar -Energy Charges@2.65Rs/unit)

Sample Bill (With Rooftop Solar -Energy Charges@ (2.65 and 2.25)Rs/unit)

Thank you

Over View, Trends and Potential in Wind Power
Karunamoorthy, Windplus





Origin of Wind Power Sector in India

Early 1980's
- The oil crises of the 1970s motivated India to explore renewable energy to
- reduce dependency on imported oil.

1981-83
- Indian government established the Commission for Additional Sources of Energy (CASE).
- Department of Non-Conventional Energy Sources (DNES) was formed to oversee
- Renewable energy development.
- Indian Institute for Tropical Meteorology conducted the first wind resource assessment
- Identifying areas with high wind energy potential.

1985-86
- The first private grid-connected wind turbine was installed in Verawal, Gujarat,
- marking a major milestone in the country's wind energy development.
- DNES launched a wind farm demonstration program, providing grants to install 5
- wind turbines of 550 kW across four states.

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Evolution of Wind Power Sector in India

1987-88
Indian Renewable Energy Development Agency (IREDA) established to offer soft loans for renewable energy projects.
Danish International Development Agency collaborated with India, supporting projects in Gujarat and Tamil Nadu that demonstrated the feasibility of large-scale wind farms.

1991
- Policies encouraging private investment in wind energy, including joint ventures
- with foreign companies, were introduced.

1992-97
- DNES was upgraded to the Ministry of Non-conventional Energy Sources (MNES),
- targeting 500 MW of wind capacity during the 8th Five-Year Plan (1992-97)
- In 1997, the government withdrawn incentives which resulted in the declining trend for some years.

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Policies w.r.t Wind Power sector in the 21st Century

2015-17
National offshore wind energy policy.
Guidelines for development of onshore wind power projects.
National Repowering policy for wind power projects.
Announcement of competitive bidding guidelines for wind.

2018-23
- National Wind-Solar Hybrid Policy
- Wind data sharing policy.
- Introduction of wind specific renewable purchase obligation.
- Removal of reverse auction mechanism.
- Announcement of annual bidding trajectory with atleast 10GW of wind capacity.

2023-24
- Updated policy for repowering and refurbishment of wind power projects.
- Announcement of offshore wind energy lease rules.
- Reintroduction of reverse auction mechanism.
- Amendment to competitive bidding guidelines for wind.
- Viability gap funding scheme for implementation of offshore wind projects.

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Key policies & Support programmes for wind power in India

- Accelerated Depreciation
- Generation based incentive
- Private investment; renewable purchase obligation
- Corporate renewable PPA
- Green Energy Corridor
- National Clean Energy Fund
- Electricity Amendment Bill 2020

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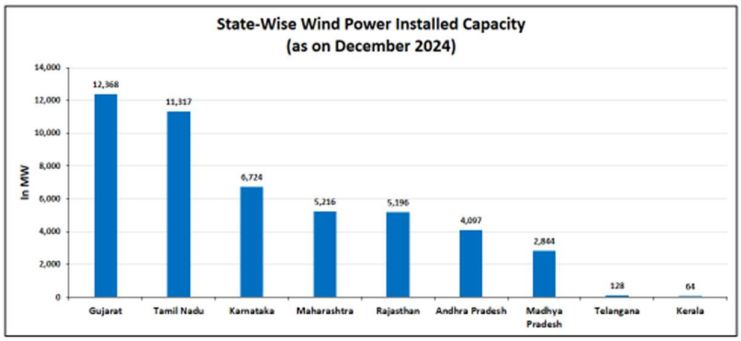
Onshore Wind power Capacity (2024)



- Cumulative installations with nearly ~47.95 GW of capacity by December 2024.

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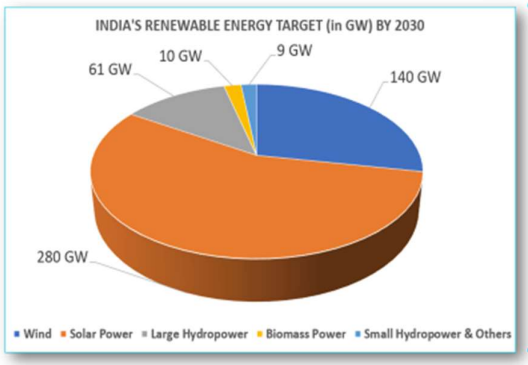
The Path Forward for wind power in India



140 GW target considering the utilisation of maximum potential

- India has an overall ambitious 140-GW target from Wind Sector

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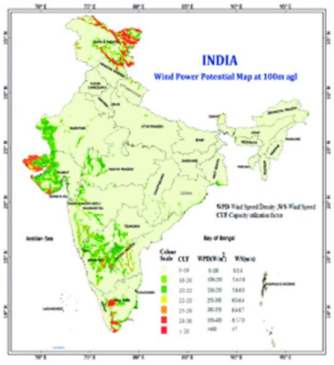
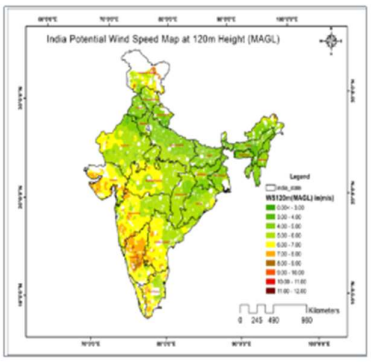
Onshore Wind Power Potential (100 m/120 m) above ground level in India





302 GW at 100 m above ground level

695 GW at 120 m above ground level

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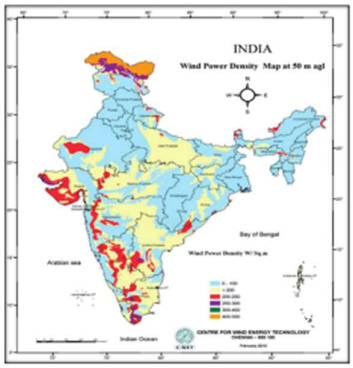
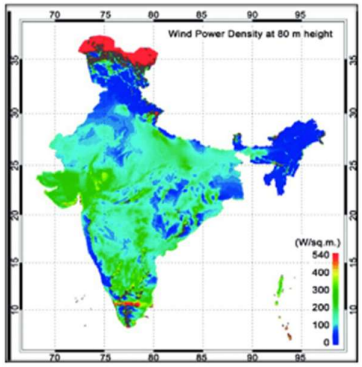
Onshore Wind Power Potential (50 m/80 m) above ground level in India





49 GW at 50 m above ground level

102 GW at 80 m above ground level

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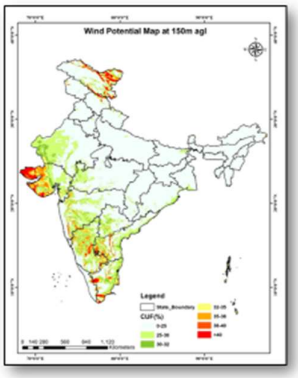
Onshore Wind Power Potential (150 m) above ground level in India



1164 GW at 150m above ground level with P50 CUF

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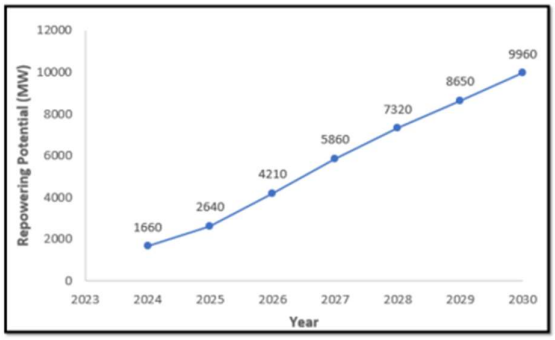
What needs to be done so that windpower can fully contribute to renewable future in India

?

Maximizing Output with Repowering and Refurbishment



The possibilities for repowering is nearly 6 times in the next 7 years.

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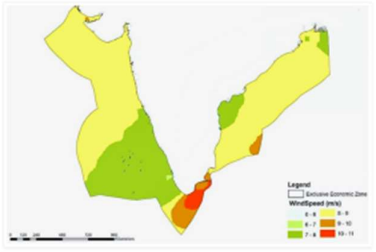
Enabling Offshore Capacity Addition

- While India's onshore wind energy capacity has reached 47 GW (4th highest in the world), offshore wind energy in the country is yet to gain momentum.
- Using Offshore Strategy is very Important for peninsular country like India



- **Gujarat Offshore Potential:** NIWE estimates 36 GW of offshore wind potential off the coast of Gujarat.
- **Tamil Nadu Offshore Potential:** Nearly 35 GW of offshore wind potential off the coast of Tamil Nadu.

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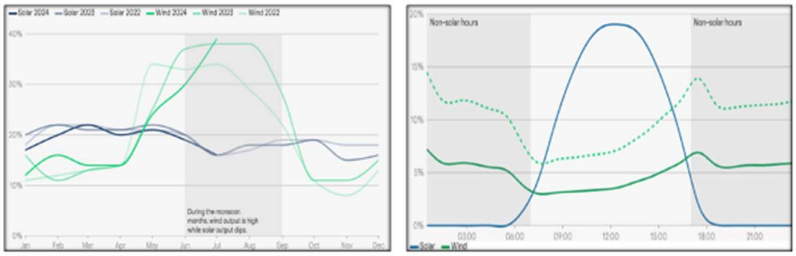
Integration with other renewable energy Systems

- Combining wind power projects with other RE projects to utilise its potential wherever applicable
- Even in areas where solar power reaches its peak, there are times when a gap occurs, and this is when wind energy can be harnessed.



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Local Manufacturing of Wind Turbines

- A robust local manufacturing base for wind turbines would accelerate the deployment of wind power across the country with the right policy support, investment in R&D, and expansion of the local supply chain.

- Domestic Cybersecurity for Wind Systems
- Standardizing component Sizing
- Flexible Financing
- Relaxation in Tax

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Policies and Processes

1. Strengthen the regulatory framework and increase the number of qualified officials responsible for overseeing and approving statutory processes.
2. Streamline land acquisition, improve grid connectivity, and accelerate approval processes to overcome growth barriers.
3. Set state-specific wind capacity targets and enhance central-state coordination. Streamline auctions, ensure project delivery, enforce RPOs, and address policy gaps.

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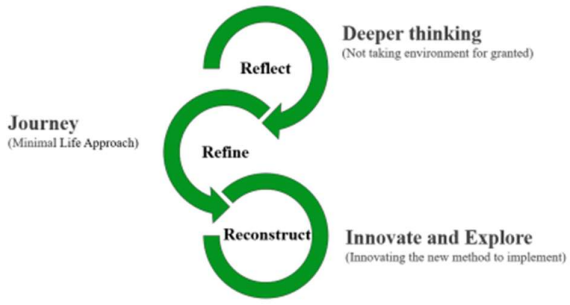
Adherence to Environmental Sustainability



New Approach for 3 R's

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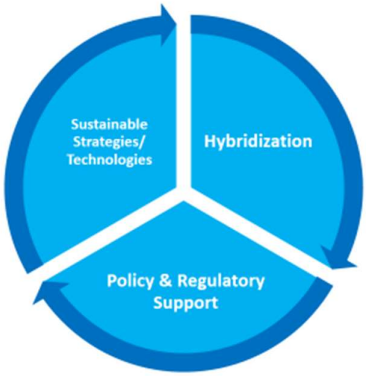
CONSOLIDATED MEASURES TO ACHIEVE FULLEST POTENTIAL



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THANK YOU FOR YOUR ATTENTION

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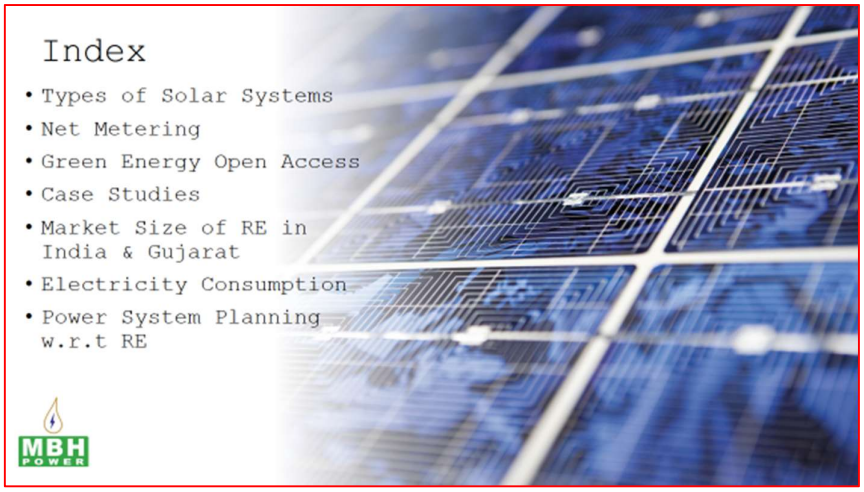
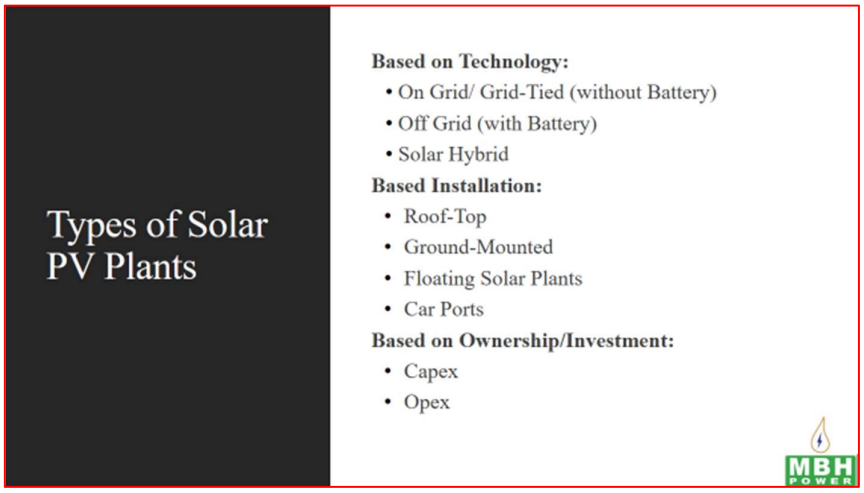
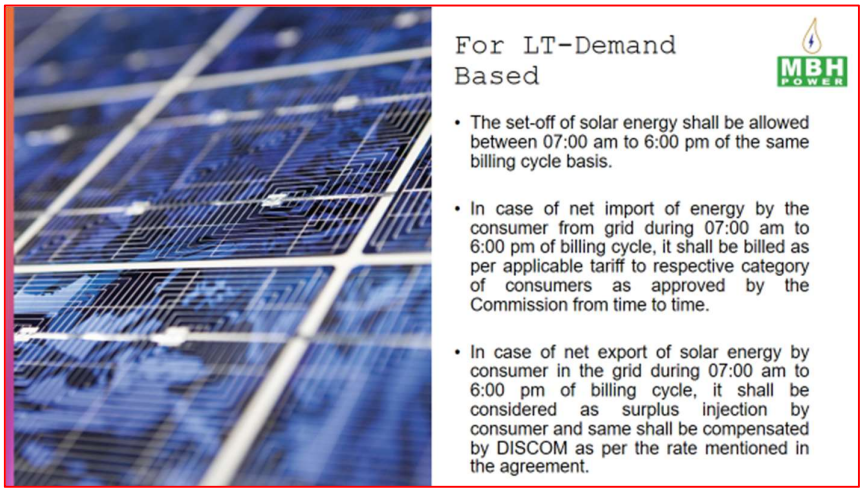
UNDERSTANDING OF SOLAR MARKET OF INDIA

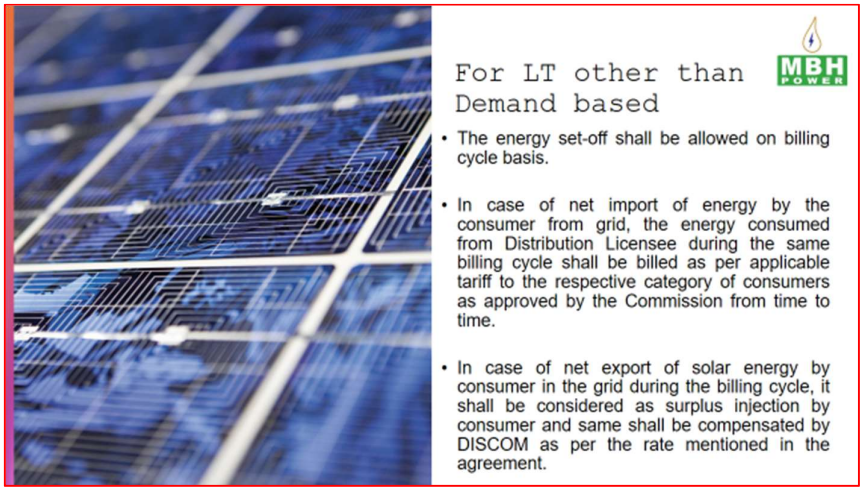
BY – SHASHNAK MALPANDE, MBH POWER PVT. LTD.






Understanding Net-Metering


For LT-Demand Based
MBH POWER
• The set-off of solar energy shall be allowed between 07:00 am to 6:00 pm of the same billing cycle basis.
• In case of net import of energy by the consumer from grid during 07:00 am to 6:00 pm of billing cycle, it shall be billed as per applicable tariff to respective category of consumers as approved by the Commission from time to time.
• In case of net export of solar energy by consumer in the grid during 07:00 am to 6:00 pm of billing cycle, it shall be considered as surplus injection by consumer and same shall be compensated by DISCOM as per the rate mentioned in the agreement.


For LT other than Demand based
MBH POWER
• The energy set-off shall be allowed on billing cycle basis.
• In case of net import of energy by the consumer from grid, the energy consumed from Distribution Licensee during the same billing cycle shall be billed as per applicable tariff to the respective category of consumers as approved by the Commission from time to time.
• In case of net export of solar energy by consumer in the grid during the billing cycle, it shall be considered as surplus injection by consumer and same shall be compensated by DISCOM as per the rate mentioned in the agreement.

Categories of Green Energy Open Access

- **Long Term:** More than 12 to 25 Years
- **Medium Term:** 3 Months to 3 Years
- **Short Term:** 1 Month

Eligibility

- Consumer having Contracted load 100kW or more either through single connection or multiple connection within the same DISCOM
- For Captive consumers there will not be any load limitations in terms of contract demand

Metering

- For Capacities 1MW and above, ABT Compliant meter & RTU with minimum number of time blocks (not more than 12)
- For capacities less than 1MW, Special Energy Meters capable of recording energy on 15 minute time block basis

Other Charges

- **Banking Charges:** INR 1.50/Unit on energy consumed by Consumer from Renewable Power Source
- **Wheeling Charges & Losses:** Applicable in case of Open Access
- **Banking:** 30% of Units consumed from DISCOM (applicable in Open Access)

MBH POWER

Other Charges

- **Banking Charges:** INR 1.50/Unit on energy consumed by Consumer from Renewable Power Source
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- **Banking:** 30% of Units consumed from DISCOM (applicable in Open Access)

MBH POWER

Gujarat Textile Policy-2024

- ***For the first time since inception of Indian Solar Policy, Government is providing Subsidy for Solar Plant in Industry Sector.***
- This is a special subsidy scheme for **Textile Industry Only**
- **Operative Period**: 01/10/2024 to 30/09/2029
- **Eligible Entities**: Any manufacturing unit registered under Companies Law, Partnership Firm, LLP, Industrial Cooperative Society, Proprietary, Pvt. Ltd. and Self-Help Groups

Eligible Activities

- **Activity 1:** Garments, Apparel & made-ups, Technical Textile Activity
- **Activity 2:** Weaving, Knitting, Dyeing & Processing , Texturing, Twisting, Embroidery, MMF Spinning

Interest Subsidy

Category of Taluka	Activity – 1	Activity – 2
Category 1 & PM MITRA Park	@7% on Term Loan for 8 years; Maximum 3% of eFCI per annum	@7% on Term Loan for 7 years; Maximum 2% of eFCI per annum
Category 2	@7% on Term Loan for 8 years; Maximum 2.5% of eFCI per annum	@7% on Term Loan for 7 years; Maximum 2% of eFCI per annum
Category 3	@5% on Term Loan for 6 years; Maximum 2% of eFCI per annum	@5% on Term Loan for 5 years; Maximum 2% of eFCI per annum

Case 1:

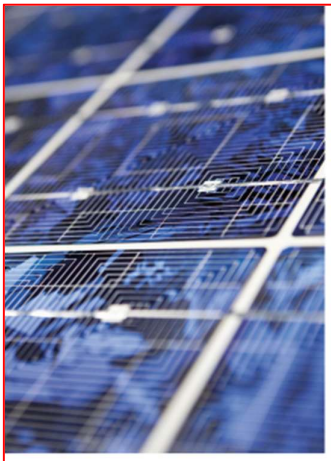
- Annual Electricity Expense: INR 15.0 Lakhs
- Annual Electricity Cost/Turnover Percentage: 4.03 %
- Proposed Solar Plant Capacity: 95kW
- Annual Unit Generation: 1.56 Lakh Units
- Approx. Electricity Cost Savings: INR 11.00 Lakhs p.a.
- Tentative Project Cost: INR 40.0 Lakhs
- Capital Subsidy @ 20% : INR 8.0 Lakhs (Category 3, Activity 1)

Particulars	With Subsidy & Term Loan	Without Subsidy
Loan	90% of Project Cost at 9% Interest for 6 Years	NA
Capital Subsidy	INR 8.0 Lakhs	NA
Actual Interest	INR 10.72 Lakhs	NA
Interest Subsidy	INR 3.90 Lakhs	NA
Subsidized Interest	INR 6.82 Lakhs	NA
Total Tax Savings for 25 Years	INR 14.04 Lakhs	INR 12.00 Lakhs
Total Electricity Cost Savings for 25 Years	INR 2.46 Cr	INR 2.46 Cr
Net Total Savings for 25 Years	INR 2.53 Cr	INR 2.58 Cr
Payback Period	< 3 Years	< 3 Years
Average RoI % for 25 Years	31.7%	32 %
Total Subsidy Received	INR 14.83 Lakhs	NA
Reduction in Production Cost	4.4%	4.8%

Case 2:

Annual Electricity Expense: INR 1.8 Cr	Day Consumption: 13.0 Lakhs Units p.a	Night Consumption: 7.0 Lakhs Units p.a	Annual Electricity Cost/Turnover Percentage: 5.61%
Proposed Solar Plant Capacity: 800kW	Annual Unit Generation: 13.14 Lakh Units	Approx. Electricity Cost Savings: INR 92.00 Lakhs p.a.	Tentative Project Cost: INR 2.4 Cr

Particulars	With Subsidy & Term Loan	Without Subsidy
Loan	90% of Project Cost at 9% Interest for 6 Years	NA
Capital Subsidy	INR 48.0 Lakhs	NA
Actual Interest	INR 64.33 Lakhs	NA
Interest Subsidy	INR 4.80 Lakhs	NA
Subsidized Interest	INR 59.53 Lakhs	NA
Total Tax Savings for 25 Years	INR 89.85 Lakhs	INR 72.00 Lakhs
Total Electricity Cost Savings	INR 20.75 Cr	INR 20.75 Cr
Net Total Savings for 25 Years	INR 21.04 Cr	INR 21.46 Cr
Payback Period	< 2 Years	2.2 Years
Average RoI % for 25 Years	43.85%	44 %
Total Subsidy Received	INR 52.80 Lakhs	NA
Reduction in Production Cost	3%	3.2%



KEY HIGHLIGHTS:

- The country is targeting about 500 Gigawatt (GW) of installed renewable energy capacity by 2030 – about 280 GW (over 60%) is expected from solar.
- The installed solar energy capacity has increased by 26 times in the last 9 years and stands at 94.17 GW as of November 2024. In 2023, India has added 7.5 GW of solar power capacity.
- ***Micro, small and medium enterprises (MSME) remain largely untapped for their rooftop solar potential, currently pegged at around 15GW.***
- According to industry estimates, fiscal year (FY) 2024 will see the largest installations of rooftop solar to date of about 4 gigawatts (GW).

KEY HIGHLIGHTS:

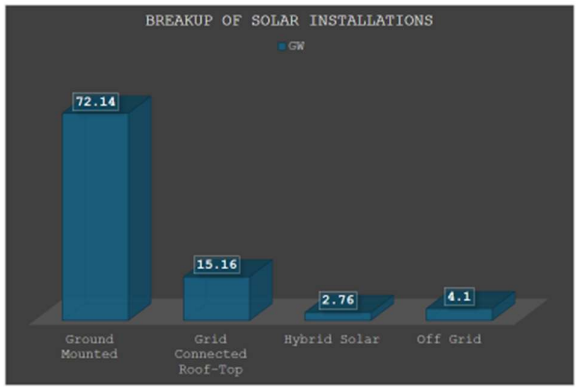
- 50 solar parks with an aggregate capacity of 37.49 GW have been approved in India.
- India aims to produce 5 Mn Tonnes of green hydrogen by 2030. This will be supported by 125 GW of renewable energy capacity.
- The interim Budget for 2024-25 has significantly increased the allocation for the National Green Hydrogen Mission to Rs 600 crore, marking a 102 per cent rise from the previous year's Rs 297 crore and a fivefold increase from the revised estimate of Rs 100 crore.

Physical Achievements

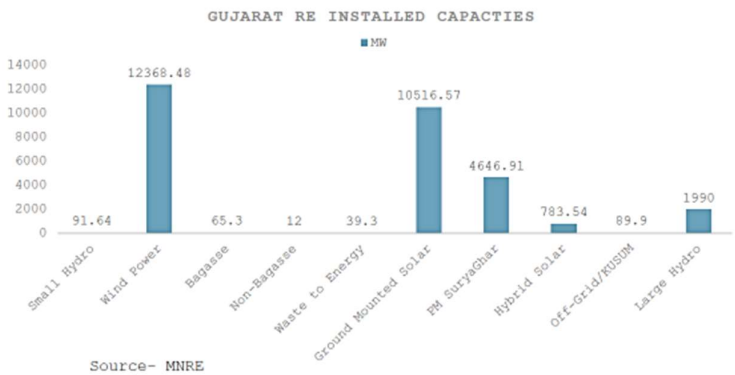
Programme/Scheme wise Cumulative Physical Progress as on November, 2024

Sector	Achievements (1st April 2024-30th Nov 2024) FY 2024-25	Cumulative Achievements (as on 30.11.2024)
I. Installed RE Capacity (Capacities in MW)		
Wind Power	2072.62	47959.13
Solar Power*	12354.21	94167.83
Small Hydro Power	81.00	5084.25
Biomass (Bagasse) Cogeneration	372.86	9806.42
Biomass(non-bagasse)Cogeneration	0.00	921.79
Waste to Power	0.00	249.74
Waste to Energy (off-grid)	27.19	363.25
Total	**14907.88**	**158552.41**

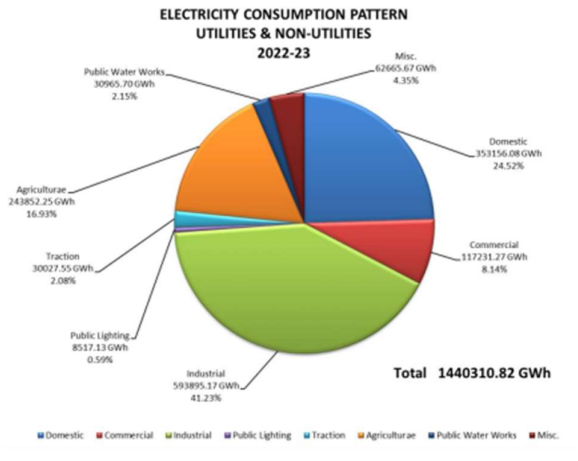
Source- MNRE Website

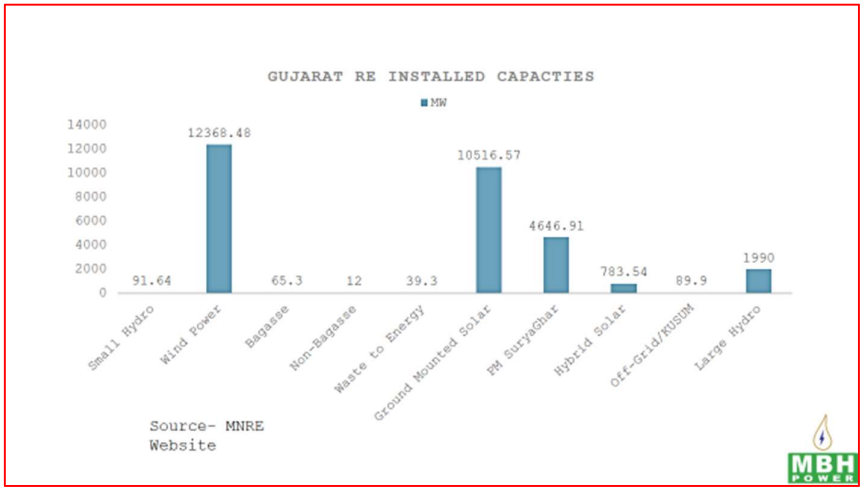


Source- MNRE Website



Source- MNRE Website





Impact of High Penetration of Solar PV

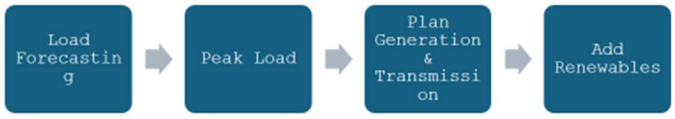
- Voltage Profile
  - oOver Voltage
  - oVoltage Fluctuations
  - oVoltage Unbalance
- Power Factor
- Harmonics & DC Bias

- Traditional electric power systems are designed on the premise of power production in central generating stations and its delivery to the points of end use via transmission and distribution systems.
- The role of generating stations is clear—they produce electric power or, more precisely, convert energy from another source into electric energy
- The role of transmission systems is to interconnect many generators and loads across entire regions and over state and country boundaries. Transmission systems enable the transfer of power over long distances, and thus facilitate economic and system benefits. They are designed and operated to optimize the use of the generation portfolio.
- Conversely, distribution systems are the part of electric delivery infrastructure that brings the power to the loads; they "touch" the load. The interface point between the transmission and a distribution syst a (distribution) substation

Impact of Variable Renewable Energy Generation

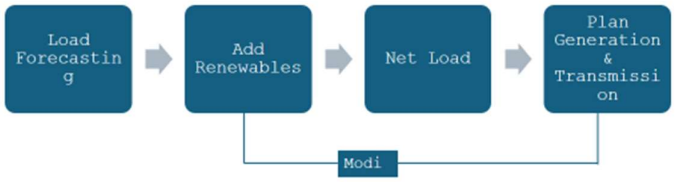
- Generation planners think in **terms of peak load and generation capacity.** At any time, they must have enough available capacity to serve the peak load
- The uncertainty associated with renewable generation variability adds complexity to the planning process, and generally results in more demanding operation of the balance of generation portfolio
- Non-renewable generators now must maneuver more to accommodate the variability of renewable sources
- This increases the operating costs per unit of energy from thermal generation

Traditional Method

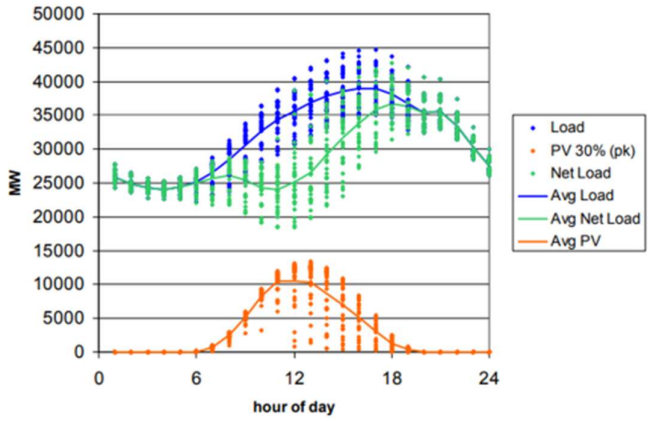


- Renewable generation is taken in "as available" during system operation, and the output from committed thermal units is reduced to enable the intake of energy supplied by the renewable sources.
- The result is sub-optimal system operation; on average, thermal units run below their rated power point, resulting in lower efficiency, higher emissions, and greater operating costs.

Emerging Method



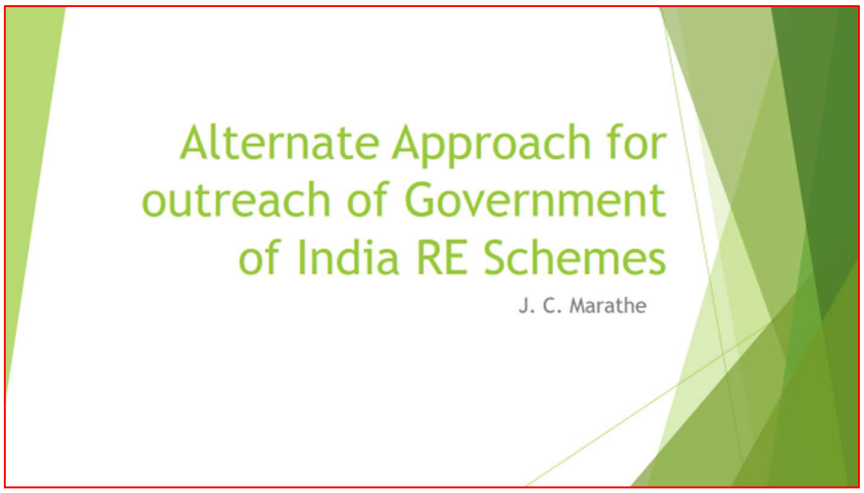
- This allows for full integration of renewable generation into the planning process
- The key is in viewing variable renewable generation as a part of the load
- Generation and transmission then are planned relative to net load, and with sufficient flexibility to meet the net load requirements.

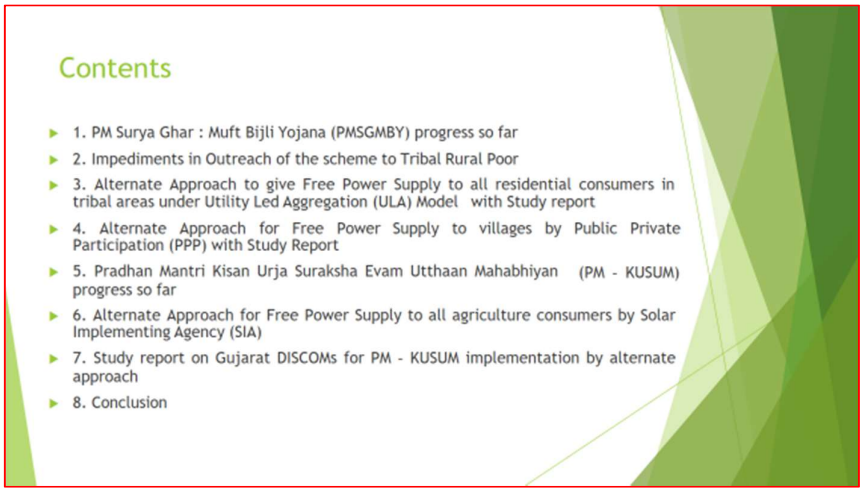


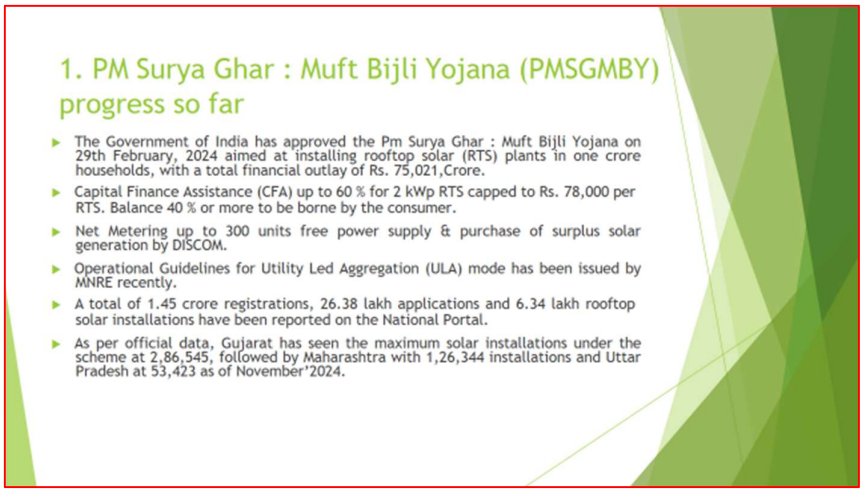
THANK YOU

-Shashank Malpande
MBH Power Pvt. Ltd.

Alternate Approach for Outreach of Government of India
For RE Schemes – By J. C. Marathe







2. Impediments in Outreach of the scheme to Tribal Rural Poor

- Most of the tribal residential consumers are not able to avail the benefits of PMSGMBY for following reasons.
  - Lack of suitable Rooftop for Solar Installation
  - Unable to bear 40 % Contribution to the extent of Rs. 40,000
  - Low average power consumption and subsidised tariff
  - Limited access to finance for low-income consumers;
  - Lack of knowledge about technology, vendor, administrative procedures;
  - Limited capacity of putting up up-front capital to set up system; and
  - Higher perceived technology and financial risks.
  - Lack of knowledge for maintenance & trouble shooting

3. Alternate Approach to give Free Power Supply to all residential consumers in tribal areas under Utility Led Aggregation (ULA) mode

- Demand Aggregation to reduce capital investment in RTS.
- Ground Mounted Community Solar Plants (GMCSP) near the village or 11 kV JGY feeders instead of individual RTS.
- Energy requirement of over 6 Lakhs tribal rural residential consumers of Panch Mahal & Chhota Udepur tribal districts can be catered by 1600 number of 500 kWp GMCSP in a cost-effective manner.
- Reduction in Aggregate Technical & Commercial (AT & C) Losses.
- Huge benefits to the DISCOMs by low-cost solar generation & reduction in losses.
- No financial contribution from any of the tribal rural consumers
- Project funding by 60% subsidy from GoI, 10 % Grant by GoG, 20 % contribution from Pradhan Mantri Janjatiya Unnat Gram Abhiyan (PM JUGA) and balance 10 % by DISCOM under ULA mode guidelines, recently issued.

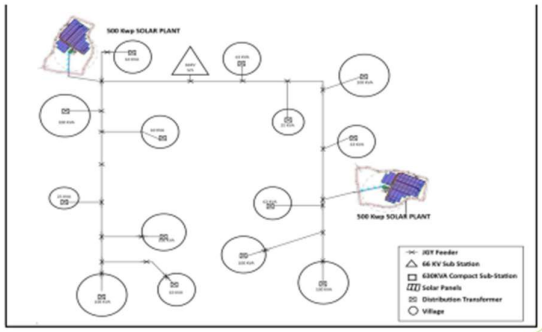
Study Report of ULA model for MGVCL Tribal area consumers

Community Solar Plant Capacity required per village

Sr. No.	Name of District	Name of Division	No. of Villages	Sent MUs (2020-21)	Solar Plant Capacity reqd. (MW)	Average solar plant capacity per Village (MW)
1	Dahod	Dahod	900	364.56	219.03	0.24
2	Panch Mahals	Godhra	254	162.86	97.85	0.39
3	Panch Mahals	Halol	337	173.33	104.14	0.31
4	Mahisagar	Lunawada	670	245.69	147.61	0.22
Sub Total - Panchmahal			2161	946.44	568.64	0.26
1	Chhota Udepur	Bodeli	898	231.84	139.29	0.16
Total Tribal Talukas			3059	1178.3	707.93	0.23

1600 Nos. of 500 kWp united Ground Mounted Community Solar Plants may be required to meet the energy requirement of all residential consumers of tribal areas of MGVCL

Schematic Diagram of 500 kWp GMCSP



Project Highlights - ULA Model

- Solar Plant Capacity : 800 MW (1600 nos. of 500 kWp Unitised GMCSP)
- Project Cost : Rs. 3200 Crore
- CFA by GoI under PMSGMBY @ 60 % : Rs. 1920 Crore
- Grant by GoI under PM JUGA @ 20% : Rs. 640 Crore
- Grant by GoG under Tribal Area Subplan @ 10% : Rs. 320 Crore
- Balance 10 % by MGVCL : Rs. 320 Crore
- Life Cycle Solar generation : 35272 MUs
- Benefit to over 6 Lakhs Tribal Rural consumers in Life Cycle : Rs. 8541 Crore
- Life Cycle Revenue Surplus : Rs. 18,418 Crore
- Payback Period : 4.34 Years
- Payback period for MGVCL : 6 Months

Summary of Total Saving

Sr. No.	Particulars	Amount saved per Annum (Cr.)	Cumulative saving for the project Life of 25 years (Cr.)
1	Saving due to reduction in Cost of Service	140.16	3504
2	Saving in Power Purchase Cost	335.21	8380.25
3	Saving due to reduction in Distribution Losses	471.8	11795
4	Saving in Billing, Metering & Collection (BMC)	7.2	180
5	Saving in Power Purchase cost due to Surplus solar generation	243.98	6099.5
	Total saving (Cr.)	1198.35	29958.75
6	Loss of Revenue of Rural Residential Consumers	341.64	8541
	Net saving in Cr.	856.71	21417.75
7	less Operation & Maintenance Cost @ 4% of Rs. 3000 Cr.	120	3000
	Revenue Surplus	736.71	18417.75

4. Alternate Approach for Free Power Supply to villages by Public Private Participation (PPP) Model

- As per the guidelines of PM Surya Ghar: Muft Bijli Yojana only residential consumers are the beneficiaries of free electricity up to 300 units by installation of Rooftop Solar.
- The feasibility of installation of Rooftop solar on about 1260 residential premises of grid connected consumers of MGVCL has been explored by Gram Panchayat, Nisaraya as under.
  - Total number of Grid connected Residential consumers : 1260 Nos.
  - Number of consumers having RoofTop Solar : 42 Nos.
  - Number of consumers feasible for 3kW RTS : 56 Nos.
  - Number of Consumers Feasible for 2 kW RTS : 114 Nos.
  - Number of Consumers feasible for 1 kW RTS : 206 Nos.
  - Number of consumers not suitable for installation of RTS : 514 Nos.
  - Number of Hutments, Tin Sheds, Kaccha house, etc : 328 Nos.

Alternate Approach for Free Power Supply to villages by Public Private Participation (PPP) Model

- There are difficulties in not only motivating all 1260 numbers of residential consumers of village Nisraya for RTS but it is not possible to provide RTS on all RoofTops of the residential premises due to the small rooftops, congested houses, tin shed houses, hutments, etc.
- The improper orientation of the houses, the obstructions and shadows may further reduce the solar generation output.
- It is difficult for large number of residential consumers to avail the benefit of PMSGMBY due to their inability to bear the initial contribution of 40 % of the Benchmark Cost and also financing of the balance 60 % till the subsidy is received from the Government of India.
- This practical situation is defeating the very purpose of providing free electricity to the poor class of the society.
- Nisaraya Gram Panchayat, Ta. Borsad, Dist. Anand, Gujarat has come forward to give Free Power supply to all Residential grid connected consumers under PM Surya Ghar: Muft Bijli Yojana (PMSGMBY) by Ground Mounted Community Solar Plants (GMCSP) instead of Rooftop Solar (RTS).
- The Panchayat shall finance the project and bear 40 % Contribution of Rs. 252 Lakhs will be borne by donation of Shri Mahendrabhai Patel (Mack Dada) a generous NRI of the village on behalf of individual beneficiary and CFA to the extent of 60 % of the Project Cost by Government of India under PM Surya Ghar Muft Bijli Yojana.

Energy Requirement of Village Nisaraya, Ta. Borsad, Dist. Anand

Feeder Name	RGPR (Residential General Purpose)
11 KV Vasana (JGY) kWh during October 2023 to September 2024	932405
11 KV NISRAYA (AGDOM) during October 2023 to September 2024	26786
RESIDENTIAL CONSUMERS ON OTHER FEEDERS kWh	96459
Total Consumption of all 1260 Consumers (KWh)	1055650
Total Consumption (Mus)	1.056
Add: 25% Energy Requirement for Load Development during Life Cycle Period @ 1% per annum	1.320
Add: 25% for Deration during Life Cycle @ 1% per annum	1.649

Project Highlights : PPP Model

- Solar Plant Capacity : 1260 kW
- Project Cost : Rs. 6.30 Crore
- CFA by GoI under PMSGMBY @ 60 % : Rs. 3.78 Crore
- Balance 40 % will be borne by Nisaraya Gram Panchayat : Rs. 2.34 Crore
- Life Cycle Solar generation : 43.43 MUs
- Benefit to Residential consumers in Life Cycle : Rs. 14.02 Crore
- Life Cycle Revenue Surplus : Rs. 3.84 Crore

Project Viability & Financial Benefits

Fig. in Lakhs

Sr. No.	Particulars	Government of India	Nisaraya Gram Panchayat	Madhya Gujarat Vij Co. Ltd.	Nisaraya Village Consumers	Remarks
1	Project Cost	378	252	NIL	NIL	No contribution from consumers
2	Saving in Power Purchase Cost			34.53	56.09	No payment of energy bills by consumers
3	Sale of Surplus Solar Generation		20.72			
4	Environmental Impact	125				Financial benefit for Life cycle period
5	Life Cycle Benefit (25 years)	125	384	982	1402.25	
6	Life Cycle Expenses @ 2 % of the project cost		315			
7	Net Benefit	125	69	982	1402.25	
8	Total Life Cycle Benefit					2578.25
9	Total Project Cost					630
10	Annualised Benefits					103.13

Payback period thus works out to 6.11 years.

- The Proposal needs to be approved by Ministry of New & Renewable Energy (MNRE) and the project will be implemented as per the guidelines of MNRE outline in the proposal.
- This proposal will be a model for other villages for Public Private Partnership (PPP) or CSR contributions for free power supply to all residential consumers of the villages in the ambit of PM Surya Ghar: Muft Bijli Yojana.
- Such proposal will help to give free power supply to the needy and poor class of the society rather than the benefits to those who can afford to pay the energy bills.

5. Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyan (PM - KUSUM) progress so far

- 1. Component A: Solarisation of off- grid agriculture consumers by solar pumps
- 2. Component B: Solarisation of AG Dominant Feeder level solarisation
- 3. Component C: Solarisation of grid connected Individual Agriculture consumers up to 7.5 HP connected load
- Substantial progress has been made under Component B Feeder level solarisation

Sr. No.	DISCOM	No. of Solar Plants	No. of Solar Feeders	Installed Capacity (MW)	Annual Solar Generation (MUs)
1	DGVCL	159	514	315	524.3
2	MGVCL	80	264	134.5	223.9
3	UGVCL	150	469	397	660.8
4	PGVCL	600	2763	1595	2654.7
Total		989	4010	2441.5	4063.6

- There are over 8500 AGDOM feeders but Solarisation can be taken up only for 50% feeders and for only 20% of the solar plant capacity required.

Poor progress of PM-KUSUM Component C

- 60% CFA only up to 7.5 HP connected load
- 40% to be borne by the agriculture consumers
- Additional financial support by purchase of surplus solar generation @ Rs. 3.5 / unit
- Despite this, the response to the scheme is poor only about 5000 nos. agriculture consumers opted for PM KUSUM
- Only about 700 feeders are covered under Surya-shakti Kisan yojana / PM KUSUM yojana.
- So far, 1068 MUs solar generation with about 22 MW capacity under PM KUSUM as on December 2024.

Reasons for poor progress of PM KUSUM Component C

- 30% CFA of GoI but 30 % CFA of GoG considered as loan.
- CFA available only up to 7.5 HP connected load
- 46% of the cost to be borne by consumer up to 7.5 HP and about 80% by consumers having connected load more than 7.5 HP.
- Inability of agriculture consumers to bear about on & average Rs. 1 lakh for solarisation
- Consumer Mix : While 67% of the consumers are having up to 7.5 HP agriculture load. Its contribution to total connected load is only 31%.
- Agriculture consumers having connected load above 7.5 HP are 33%. Their connected load is 69%
- Unless all agriculture consumers are covered, full benefits of PM KUSUM Component C cannot be availed.

Alternate Approach for Free Power Supply to all agriculture consumers

- There are over 19 lakhs agriculture consumers of various DISCOMs. If all consumers are to be covered for free power supply by solarisation, following table shows the huge requirement of the distributed solar generation capacity required.

Sr. No.	Particulars		DGVCL	MGVCL	PGVCL	UGVCL	GUVNL
1	No. of Consumer	Load up to 7.5 HP	154,418	128297	765588	219091	**1,267,394**
		Load above 7.5 HP	53,963	73144	318375	192833	**638,315**
		Total	208,381	201,441	1,083,963	411,924	1,905,709
2	Connected load in HP	Load up to 7.5 HP	758670	640306.5	4162426.5	1270086	6,831,489
		Load above 7.5 HP	875380	1078193	6179398	6869225	15,002,195
		Total	1,634,050	1,718,499	10,341,824	8,139,311	21,833,684
3	Total Plant Capacity MW	Load up to 7.5 HP	990.44	835.92	5434.05	1658.10	**8,919**
		Load above 7.5 HP	1142.81	1407.58	8067.20	8967.77	**19,585**
		Total	2133.25	2243.50	13501.25	10625.87	28,504
4	Total Project Cost (Rs. In Cr.)	Load up to 7.5 HP	5384.43	4530.23	29075.53	8784.91	47775.11
		Load above 7.5 HP	4717.02	6001.75	32797.03	34039.21	77555.02
		Total	10101.45	10531.99	61872.57	42824.12	125330.13
5	CFA (Rs. In Cr.)	Load up to 7.5 HP	2856.88	2409.34	15574.30	4735.49	25576.01
		Load above 7.5 HP	1491.20	2021.24	8797.90	5328.70	17639.05
		Total	4348.08	4430.58	24372.21	10064.19	43215.06
6	Project Cost to be borne by SIC (Rs. In Cr.)	Load up to 7.5 HP	2527.55	2120.89	13501.23	4049.42	22199.10
		Load above 7.5 HP	3225.82	3980.51	23999.13	28710.50	59915.96
		Total	5753.37	6101.40	37500.36	32759.93	82115.06

- As per the above table, 8919 MW Solar generation capacity is required to cater to the energy requirement of agriculture consumers up to 7.5 HP.
- The DISCOMs have so far been able to identify & implement feeder level solarisation for 4064 MW under PM-KUSUM Component B scheme.
- Solarisation plant capacity required to meet the energy requirement of agriculture consumers about 7.5 HP works out to 19585 MW.
- Such a huge capacity requirement would need over 1 lakh acre land footprint which may not be available.
- The distributed solar plant at the agriculture installations is the only alternative to achieve the objective of free power supply to agriculture consumers.

- A different strategy therefore needs to be evolved with the following alternatives.
- Farmer's contribution to be borne by solar investment company.
- The solar investment company is required for investment of over Rs. 80,000 crores even after CFA of Rs. 43,000 Crores.
- The solar investment company will get fare return on their investment by sale of surplus distributed solar generation to DISCOMs.
- Additional expenses of watchdog transformers, control devices to restrict the usage the power supply for 8 hrs. only.
- DISCOM wise concept papers on solarisation of all agriculture consumers under proposed modified PM KUSUM Component C are available.

Benefits of Distributed Solar generation of Agriculture consumers.

- All farmers will get free of cost electricity.
- All farmers will get DAY TIME Power supply.
- No burden of any investment on Farmers.
- Government will not have to bear any further burden of the subsidy of over Rs. 8000 Cr. to Agriculture Consumers.
- DISCOMs will get cheap power to the extent at least 16 % of their energy input to the extent of Rs. 10,000 Cr.
- Huge saving in Power purchase cost.
- Reduction of Cross Subsidy Burden on Industries.
- Job creation in rural area for operation & maintenance of solar system.
- Additional expenses of watchdog transformers, control devices to restrict the usage of power supply for 8 hrs only, would not be required when the scheme covers all agriculture consumers of the feeder.
- Project will be reducing Carbon Dioxide emission to the extent of 16.05 Crore MT in its Life cycle.
- Carbon Credit Trading will be additional benefit of the project which may be shared between stakeholders proportionate to their stake in the project.

7. Study report on Gujarat DISCOMs for PM - KUSUM implementation by alternate approach

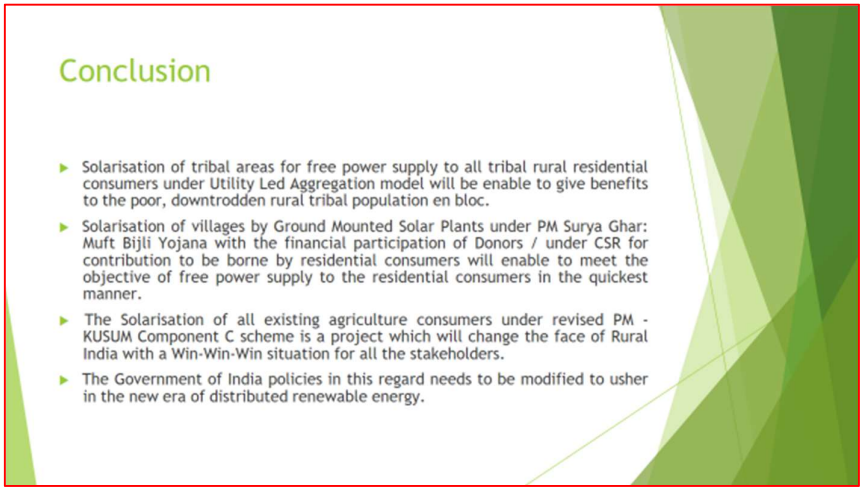
- Concept papers for solarisation of all agriculture consumers under PM KUSUM Component C with the investment on behalf of agriculture consumers by Solar Investment company are available.
- The summary of the report for one of the DISCOMs DGVCL is as under.
- As against the project cost of 10,101.45 Cr. for solar plant capacity of 2133 MW, the quantification of benefits works out to Rs. 72,393 Cr. as under for its Life cycle of 25 years.

Total Solar Capacity in MW	Total Project Cost Rs. in Cr.	Subsidy by GoI Rs. in Cr.	Subsidy by GoG Rs. in Cr.	Cost to be borne by SIC Rs. in Cr.	Life cycle Total Solar Generation in MUs	Total Solar Surplus in MUs	Total Benefit over 25 Years Rs. in Cr.
2133.25	10,101.45	2,127.53	2,220.55	5,753.37	92,101	73,634	72,393.30

Quantification of Benefits of DGVCL Solarisation Project for Life cycle of 25 years

All Fig. in Rs. Cr.

Sr.No.	Particulars	GoI	GoG	DISCOM	Farmer	SIC	Total
1	Capital Investment	2,127.53	2,220.55		21.33	5,753.38	10,122.79
2	Expenses for O & M of Distribution assets	-	-	35.00	-	31.76	66.76
3	Interest Charges	-	-	-	-	460.27	460.27
4	Total Expense	**2,127.53**	**2,220.55**	**35.00**	**21.33**	**6,245.41**	**10,649.82**
5	Savings						
a	Subsidies	-	322.10	-	-	-	322.10
b	Cross Subsidy Charegs	-	527.81	-	-	-	527.81
c	Loss Reduction	-	-	68.04	-	-	68.04
d	Feeder Management Grant	-	778.80	-	-	-	778.80
e	Power Purchase	-	-	831.59	-	-	831.59
f	Agriculture Tariff Charges	-	-	-	146.00	-	146.00
g	Surplus Power	-	-	-	-	1,058.57	1,058.57
6	Total Savings in a year	-	**1,628.71**	**899.63**	**146.00**	**1,058.57**	**3,732.91**
7	Pay Back Period in years		1.36	0.04	0.15	5.90	2.85
8	Life Cycle expenses	**2,127.53**	**2,220.55**	**875.00**	**21.33**	**8,022.15**	**13,266.56**
9	Life Cycle Benefit	-	**22,026.55**	**22,490.75**	**3,650.00**	**24,226.00**	**72,393.30**
10	% Return on Investment (RoI) Life Cycle		**992**	**2,570**	**17,112**	**302**	**546**



BEST WISHES TO

RENEWABLE ENERGY

CONFERENCE &

THE SOCIETY OF POWER ENINGEERS (INDIA)

VADODARA CHAPTER

Power Quality Assessment as per Central Electricity Authority Connectivity Guidelines

By Saifali Talati, ERDA, Vadodara.

Power Quality Assessment as per CEA Connectivity Guideline

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Power Quality

- What is Power Quality?
  - Power quality can be defined as the pure sinusoidal waveform of declared voltage and frequency.

✓ **Utilities Definition: Reliability and Continuity of Supply**

✓ **Customer Definition: Characteristics of power supply which enable smooth (uninterrupted) operation of equipment**

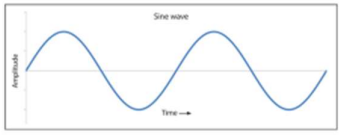
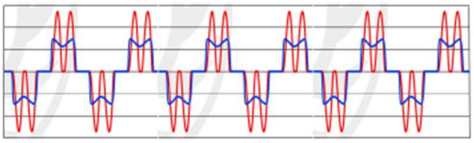


Fig 1. Pure sine wave

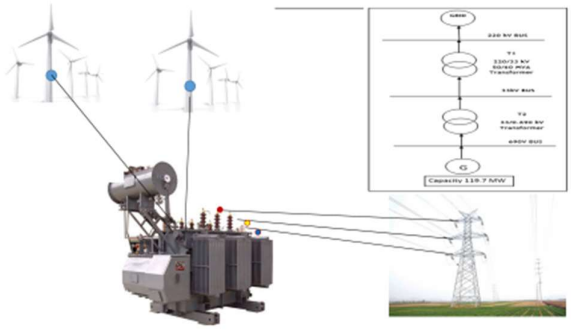
Fig 2. Distorted wave

Culprits Distorting the Sine Wave

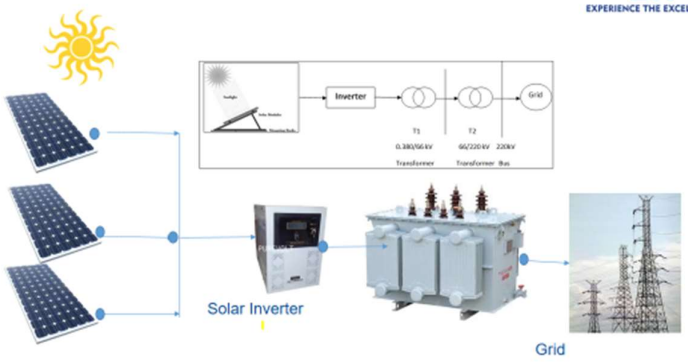
- Non linear Devices
- Electronic chokes, CFL, LED
- VFD, Inverters, converters, DC drives, UPS
- Arc Furnaces, rolling mills
- Solar Parks/Wind farms



Power Generation in Wind Farms



PQ Generation in Solar plants



Block Diagram

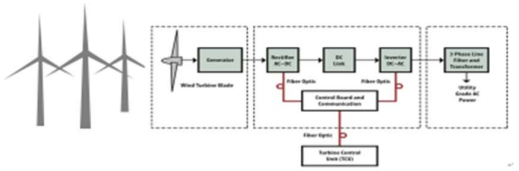


Fig. 1 Simplified Electrical Block Diagram for Wind Power Generation Plant

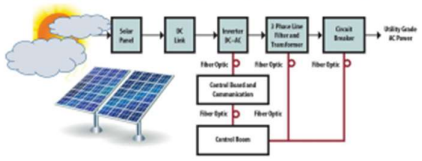


Fig. 2 Simplified Electrical Block Diagram for Solar Power Generation Plant

CEA Guideline

B. Connectivity Standards applicable to the Wind generating stations and generating stations using inverters

These generating stations shall comply with the following requirements besides the general connectivity conditions given in the said regulations and Part I of the Schedule:-

B1. Requirements with respect to Harmonics, Direct Current (DC) Injection and Flicker

(1) Harmonic current injections from a generating station shall not exceed the limits specified in Institute of Electrical and Electronics Engineers (IEEE) Standard 519.

(2) The Generating station shall not inject DC current greater than 0.5 % of the full rated output at the interconnection point.

(3) The generating station shall not introduce flicker beyond the limits specified in IEC 61000.

Provided that the standards for flicker will come into effect from 1st April 2014.

(4) Measurement of harmonic content, DC injection and flicker shall be done at least once in a year in presence of the parties concerned and the indicative date for the same shall be mentioned in the connection agreement;

Provided that in addition to annual measurement, if distribution licensee or transmission licensee or the generating company, as the case may be, desires to measure harmonic content or DC injection or flicker, it shall inform the other party in writing and the measurement shall be carried out within 5 working days";

Applicable Standards

- IEEE 519, IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
- IEC 61000-4-30, Power Quality Measurement Methods
- IEC 61000-4-7, General Guide on Harmonics and Inter harmonics Measurement and Instrumentation, for Power Supply Systems and Equipment Connected Thereto
- IEC 61000-4-15, Testing and Measurement Techniques—Flickermeter—Functional and Design Specifications
- IEC 61000-3-7, Limits -Assessment of emission limits for the connection of fluctuating installations of MV, HV and EHV power systems

Measurement and limit comparison standards

Particulars of Measurement	Applicable standard for Measurement	Applicable Standard for Limit Comparison
Harmonic Measurement	IEC 61000-4-30	IEEE 519:2022
Flicker Measurement	IEC 61000-4-30	IEC 61000-3-7
DC current Measurement	-	CEA guidelines (No.12/X/STD (CONN)/GM/ CEA/2019

Measurement Time Duration – IEC 61000-4-30

B.1.3.8 Harmonic voltages

Measurement interval: one-week minimum assessment period for 10-min values, and daily assessment of 150/180-cycle values for at least 1 week.

B.1.3.4 Flicker

Measurement interval: 1-week minimum assessment period.

Evaluation techniques: 10-min values (P_{st}) and/or 2-h values (P_{lt}) might be considered. The

Instruments compliance

Flicker Meter:

- Class A
- Must register Pst and Plt
- IEC 61000-4-15

Harmonics Meter:

- Class A
- FFT for a window width of 10 cycles (50 Hz)
- IEC 61000-4-7

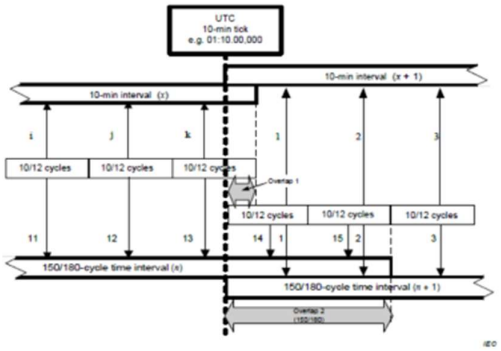


Figure 2 – Synchronization of aggregation intervals for Class A

4.2 Very short time harmonic measurements

Very short time harmonic values are assessed over a 3-second interval based on an aggregation of 15 consecutive 12 (10) cycle windows for 60 (50) Hz power systems. Individual frequency components are aggregated based on an rms calculation as shown in Equation (1) where F represents voltage (V) or current (I), n represents the harmonic order, and i is a simple counter. The subscript vz is used to denote "very short." In all cases, F represents an rms value.

$$F_{n,vs} = \sqrt{\frac{1}{15}\sum_{i=1}^{15} F_{n,i}^2}$$

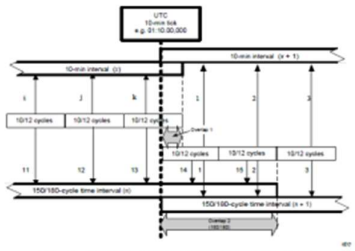


Figure 2 – Synchronization of aggregation intervals for Class A

4.3 Short time harmonic measurements

Short time harmonic values are assessed over a 10-minute interval based on an aggregation of 200 consecutive very short time values for a specific frequency component. The 200 values are aggregated based on an rms calculation as shown in Equation (2) where F represents voltage (V) or current (I), n represents the harmonic order, and i is a simple counter. The subscript sh is used to denote "short." In all cases, F represents an rms value.

$$F_{n,sh} = \sqrt{\frac{1}{200}\sum_{i=1}^{200} F_{(n,vs),i}^2} \qquad (2)$$

IEEE 519:2022

5.1 Recommended harmonic voltage limits

At the PCC, system owners or operators should limit line-to-neutral voltage harmonics as follows:

— Daily 99th percentile very short time (3 s) values should be less than 1.5 times the values given in Table 1.

— Weekly 95th percentile short time (10 min) values should be less than the values given in Table 1.

All values should be in percent of the rated power frequency voltage at the PCC. Table 1 applies to voltage harmonics whose frequencies are integer multiples of the power frequency.

Table 1—Voltage distortion limits

Bus voltage V at PCC	Individual harmonic (%)	Total harmonic distortion THD (%)
$V \leq 1.0$ kV	5.0	8.0
1 kV < $V \leq$ 69 kV	3.0	5.0
69 kV < $V \leq$ 161 kV	1.5	2.5
161 kV < V	1.0	1.5[a]

[a]High-voltage systems can have up to 2.0% THD where the cause is an HVDC terminal whose effects will have attenuated at points in the network where future users may be connected.

IEEE 519:2022

5.3 Current distortion limits for systems nominally rated 120 V through 69 kV

The limits in this subclause apply to users connected to systems where the rated voltage at the PCC is 120 V to 69 kV. These limits shall not be used for the evaluation of an individual nonlinear load, but rather, for the evaluation of the installation containing such nonlinear loads. At the PCC, users shall limit their harmonic currents as follows:

- Daily 99th percentile very short time (3 s) harmonic currents shall be less than 2.0 times the values given in Table 2.
- Weekly 99th percentile short time (10 min) harmonic currents shall be less than 1.5 times the values given in Table 2.
- Weekly 95th percentile short time (10 min) harmonic currents shall be less than the values given in Table 2.

All values shall be in percent of the maximum demand load current, I_L and shall be established at the PCC. Table 2 applies to harmonic currents whose frequencies are integer multiples of the power frequency.

IEEE 519:2022

Table 2—Current distortion limits for systems rated 120 V through 69 kV

Maximum harmonic current distortion in percent of I_L						
	Individual harmonic order[b]					
I_{SC}/I_L	$2 \le h < 11$[a]	$11 \le h < 17$	$17 \le h < 23$	$23 \le h < 35$	$35 \le h \le 50$	TDD
< 20[c]	4.0	2.0	1.5	0.6	0.3	5.0
20 < 50	7.0	3.5	2.5	1.0	0.5	8.0
50 < 100	10.0	4.5	4.0	1.5	0.7	12.0
100 < 1000	12.0	5.5	5.0	2.0	1.0	15.0
> 1000	15.0	7.0	6.0	2.5	1.4	20.0

[a] For $h \le 6$, even harmonics are limited to 50% of the harmonic limits shown in the table.

[b] Current distortions that result in a dc offset, e.g., half-wave converters, are not allowed.

[c] Power generation facilities are limited to these values of current distortion, regardless of actual I_{SC}/I_L unless covered by other standards with applicable scope.
where:
I_{SC} = maximum short-circuit current at PCC
I_L = maximum demand load current at PCC under normal load operating conditions

IEEE 519:2022

Table 3—Current distortion limits for systems rated above 69 kV through 161 kV

Maximum harmonic current distortion in percent of I_L						
	Individual harmonic order[b]					
I_{SC}/I_L	$2 \le h < 11$[a]	$11 \le h < 17$	$17 \le h < 23$	$23 \le h < 35$	$35 \le h \le 50$	TDD
< 20[c]	2.0	1.0	0.75	0.3	0.15	2.5
20 < 50	3.5	1.75	1.25	0.5	0.25	4.0
50 < 100	5.0	2.25	2.0	0.75	0.35	6.0
100 < 1000	6.0	2.75	2.5	1.0	0.5	7.5
> 1000	7.5	3.5	3.0	1.25	0.7	10.0

[a] For $h \le 6$, even harmonics are limited to 50% of the harmonic limits shown in the table.

[b] Current distortions that result in a dc offset, e.g., half-wave converters, are not allowed.

[c] Power generation facilities are limited to these values of current distortion, regardless of actual I_{SC}/I_L unless covered by other standards with applicable scope.
where
I_{SC} = maximum short-circuit current at PCC
I_L = maximum demand load current at PCC under normal load operating conditions

IEEE 519:2022

Table 4—Current distortion limits for systems rated > 161 kV

Maximum harmonic current distortion in percent of I_L						
	Individual harmonic order[b]					
I_{sc}/I_L	$2 \le h < 11$[a]	$11 \le h < 17$	$17 \le h < 23$	$23 \le h < 35$	$35 \le h \le 50$	TDD
< 25[c]	1.0	0.5	0.38	0.15	0.1	1.5
$25 < 50$	2.0	1.0	0.75	0.3	0.15	2.5
≥ 50	3.0	1.5	1.15	0.45	0.22	3.75

[a] For $h \le 6$, even harmonics are limited to 50% of the harmonic limits shown in the table.

[b] Current distortions that result in a dc offset, e.g., half-wave converters, are not allowed.

[c] Power generation facilities are limited to these values of current distortion, regardless of actual I_{sc}/I_L unless covered by other standards with applicable scope.

where

I_{sc} = maximum short-circuit current at PCC

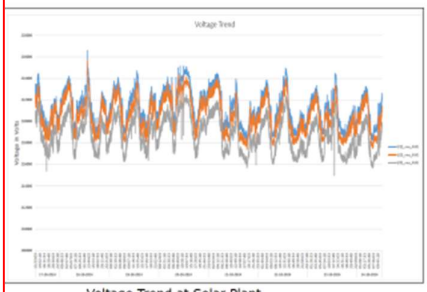
I_L = maximum demand load current at PCC under normal load operating conditions

Limits For Flicker

95th percentile Pst values and all Plt values should be less than the values given in Table below.

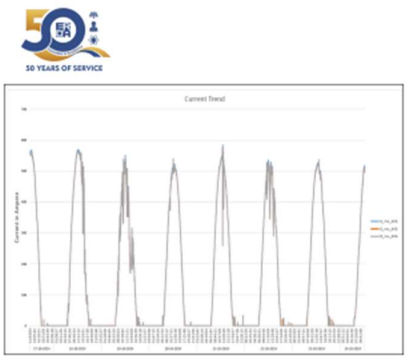
	MV (1kV<MV<35kV)	HV (35kV<HV<230kV) & EHV(>230 kV)
P_{st}	0.9	0.8
P_{lt}	0.7	0.6

Case Studies and PQ Trend Graphs

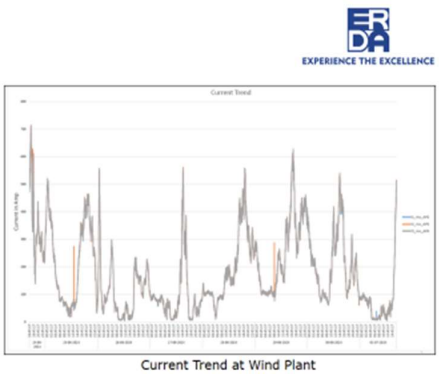


Voltage Trend at Solar Plant

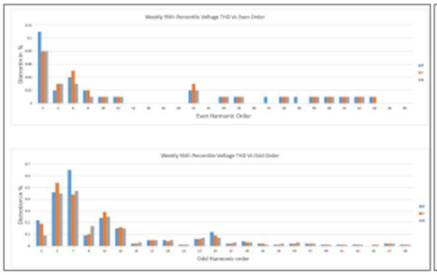
Voltage Trend at Wind Plant



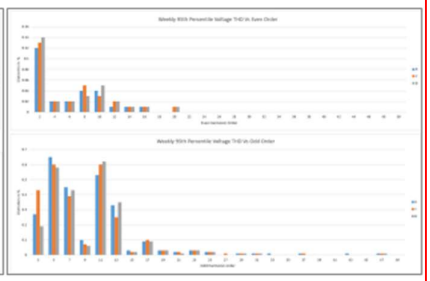
Current Trend at Solar Plant



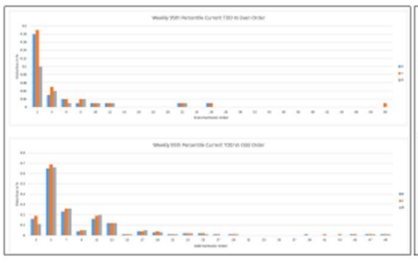
Current Trend at Wind Plant



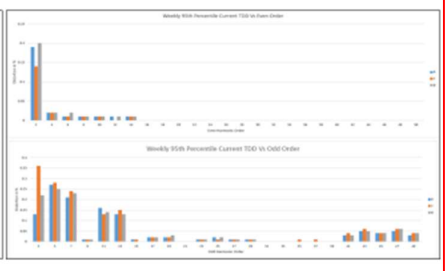
Weekly 95th Percentile Voltage THD Vs Even & Odd Order at Solar Plant



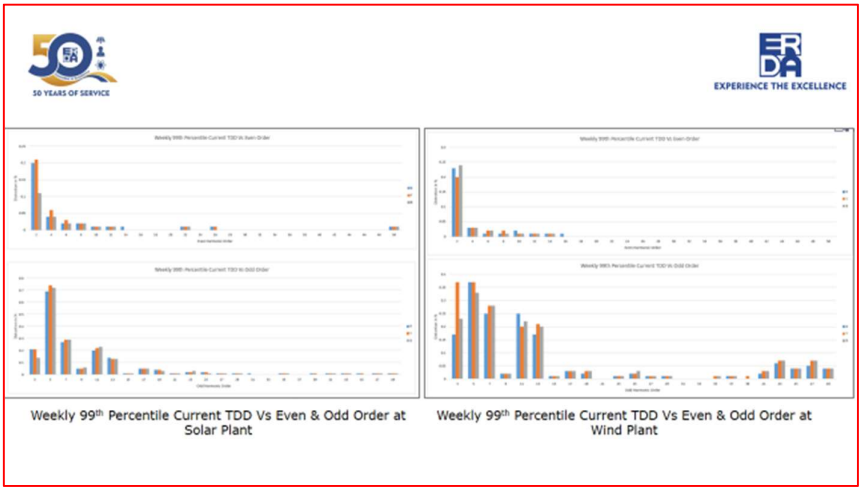
Weekly 95th Percentile Voltage THD Vs Even & Odd Order at Wind Plant



Weekly 95th Percentile Current TDD Vs Even & Odd Order at Solar Plant

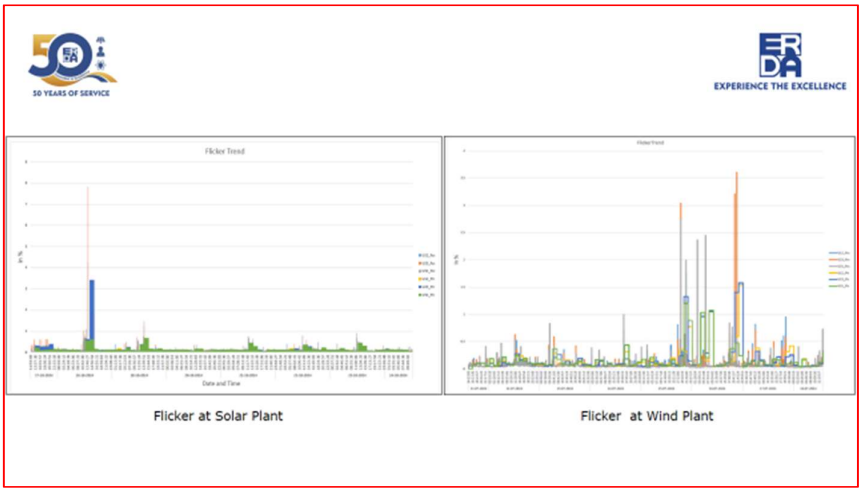


Weekly 95th Percentile Current TDD Vs Even & Odd Order at Wind Plant



Weekly 99th Percentile Current TDD Vs Even & Odd Order at Solar Plant

Weekly 99th Percentile Current TDD Vs Even & Odd Order at Wind Plant



Flicker at Solar Plant

Flicker at Wind Plant

Case 2

Sr. No.	Particulars of test and clause no.	Requirement as per specification.	Obtained value	Remarks
1.	**220 kV Line 1**			
	Current TDD:			
	Weekly Value:	Weekly 95th percentile short time (10 min) current TDD should be less than value given in IEEE 519:2014 Cl. No. 5.4 i.e. 1.5 %	95th percentile values obtained is R-ph: **2.33** Y-ph: **1.95** B-ph: **2.11**	Exceeding limit
		Weekly 99th percentile short time (10 min) current TDD should be less than value given in IEEE 519:2014 Cl. No. 5.4 i.e. 2.25 %	99th percentile values obtained is R-ph: **2.66** Y-ph: 2.22 B-ph: **2.42**	Exceeding limit

Table 1: 95th percentile values observed for individual odd harmonics order at 220 kV line 1

Odd Harmonic Order	Recommended Limit as per IEEE 519:2014	Observed values (%) R	Y	B
3	1.00	0.39	0.35	0.59
5		**2.18**	**1.77**	**1.92**
7		0.73	0.73	0.78
9		0.09	0.05	0.07
11	0.50	0.17	0.15	0.17
13		0.19	0.19	0.19
15		0.04	0.02	0.04
17	0.38	0.07	0.08	0.08
19		0.06	0.06	0.05
21		0.02	0.02	0.02
23	0.15	0.12	0.10	0.09
25		**0.35**	**0.23**	**0.26**

Table 2: 99th percentile values observed for individual odd harmonics order at 220 kV line 1

Odd Harmonic Order	Recommended Limit as per IEEE 519:2014	Observed values (%) R	Y	B
3	1.50	0.58	0.64	0.67
5		**2.49**	**2.04**	**2.25**
7		1.00	0.95	1.05
9		0.12	0.07	0.12
11	0.75	0.30	0.18	0.27
13		0.29	0.29	0.28
15		0.07	0.04	0.06
17	0.57	0.11	0.12	0.10
19		0.06	0.07	0.06
21		0.04	0.04	0.05
23	0.23	0.13	0.11	0.10
25		**0.39**	**0.27**	**0.30**

Case 3

1.	**220 kV Line**			
	Voltage THD:			
	Weekly Value:	Weekly 95th percentile short time voltage THD should be less than value given in IEEE 519:2014 Cl. No. 5.1 i.e. 1.5 %	95th percentile values obtained is R-ph: 1.18, Y-ph: 1.36, B-ph: 1.31	Within limit
	Day 1 Value:	Daily 99th percentile very short time voltage THD should be less than value given in IEEE 519:2014 Cl. No. 5.1 i.e. 2.25 %	99th percentile values obtained is R-ph: 1.16, Y-ph: 1.32, B-ph: 1.26	Within limit
	Day 2 Value:	Daily 99th percentile very short time voltage THD should be less than value given in IEEE 519:2014 Cl. No. 5.1 i.e. 2.25 %	99th percentile values obtained is R-ph: 2.26, Y-ph: 2.45, B-ph: 2.53	Out of limit
	Day 3 Value:	Daily 99th percentile very short time voltage THD should be less than value given in IEEE 519:2014 Cl. No. 5.1 i.e. 2.25 %	99th percentile values obtained is R-ph: 1.17, Y-ph: 1.40, B-ph: 1.22	Within limit

Case 4

Current TDD:			
Weekly Value:	Weekly 95th percentile short time current TDD should be less than value given in IEEE 519:2014 Cl. No. 5.4 i.e. 1.5 %	95th percentile values obtained is R-ph: 0.55, Y-ph: 0.62, B-ph: 0.62	Within limit
	Weekly 99th percentile short time current TDD should be less than value given in IEEE 519:2014 Cl. No. 5.4 i.e. 2.25 %	99th percentile values obtained is R-ph: 0.60, Y-ph: 0.66, B-ph: 0.66	Within limit
Day 1 Value:	Daily 99th percentile very short time current TDD should be less than value given in IEEE 519:2014 Cl. No. 5.4 i.e. 3 %	99th percentile values obtained is R-ph: 0.61, Y-ph: 0.66, B-ph: 0.69	Within limit
Day 2 Value:	Daily 99th percentile very short time current TDD should be less than value given in IEEE 519:2014 Cl. No. 5.4 i.e. 3 %	99th percentile values obtained is R-ph: 0.69, Y-ph: 0.72, B-ph: 0.81	Within limit
Day 3 Value:	Daily 99th percentile very short time current TDD should be less than value given in IEEE 519:2014 Cl. No. 5.4 i.e. 3 %	99th percentile values obtained is R-ph: 0.51, Y-ph: 0.62, B-ph: 0.61	Within limit

Case 4

Flicker:			
Short term Flicker (Pst)	The 95 % probability weekly value of Pst should not exceed the limit (0.8) as per IEC 61000-3-7: 2008-02	95th percentile values obtained is R-ph: 0.30, Y-ph: 0.29, B-ph: 0.29	Within limit
Long term Flicker (Plt)	The 95 % probability weekly value of Plt should not exceed the limit (0.6) as per IEC 61000-3-7: 2008-02	95th percentile values obtained is R-ph: 0.56, Y-ph: 0.52, B-ph: 0.39	Within limit
DC Current Injection:	DC current should not be more than 0.5% of the rated current of the plant as specified in Cl. B.1 of CEA guidelines.	95th percentile values (in %) obtained is R-ph: 0.31, Y-ph: 0.23, B-ph: 0.29	Within limit

Case 4

Table 3: 99th percentile values of voltage THD observed for day 2 : individual harmonic orders at 220 kV line

Even Harmonic Order	Recommended Limit IEEE 519:2014	Observed Distortions (%)			Odd Harmonic Order	Recommended Limit IEEE 519:2014	Observed Distortions (%)		
		R	Y	B			R	Y	B
2	1.50	0.05	0.05	0.04	3	1.50	0.37	0.52	0.31
4		0.02	0.01	0.02	5		1.60	1.65	1.81
6		0.01	0.01	0.01	7		0.51	0.41	0.34
8		0.02	0.01	0.01	9		0.14	0.10	0.14
10		0.02	0.03	0.03	11		1.60	1.71	1.68
12		0.01	0.01	0.01	13		0.39	0.33	0.30
14		0.02	0.02	0.02	15		0.06	0.04	0.05
16		0.01	0.01	0.01	17		0.11	0.11	0.09
18		0.00	0.00	0.00	19		0.07	0.04	0.05
20		0.00	0.00	0.00	21		0.04	0.03	0.02
22		0.00	0.00	0.00	23		0.04	0.04	0.04
24		0.00	0.00	0.00	25		0.03	0.03	0.02

Case 5

- The power quality measurement of a 20 MW solar plant was done after commissioning.
- It was observed that current TDD for all 7 days and weekly values were on higher side.
- The statistical analysis of the measurement showed that the generation profile of the solar plant during the measurement was very low. It was observed that the generation was less than 50 % of maximum generation i.e. 20 MW (rated current of 46.725 A) for maximum number of days
- Total demand distortion (TDD) in the range of 3-4 % during the low generation period, when generation is above 50 %, the current distortion is in the range of 0.6-2.8%.

Power Quality Measurement

➢ Power Quality Parameters:

- Harmonics
- Flickers
- DC Current
- Surges
- -Ve Phase Seq voltages
- -Ve Phase Seq currents
- Load Cycles
- Power Factor
- Real Power (MW)
- Reactive Power (MVAR)
- Apparent Power (MVA)
- Frequency
- Switching Surge

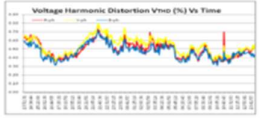
Facilities available:

(1) Power Quality Analysers (08 nos.)

(Class-A, IEC 61000-4-30 Compliant)

Power Quality Analyzer

Measurement in Substation



Harmonic Analysis

BEST WISHES TO

RENEWABLE ENERGY

CONFERENCE &

THE SOCIETY OF POWER ENINGEERS (INDIA)

VADODARA CHAPTER

BEST WISHES TO

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VADODARA CHAPTER

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GUJARAT SOLAR EPC PVT. LTD.

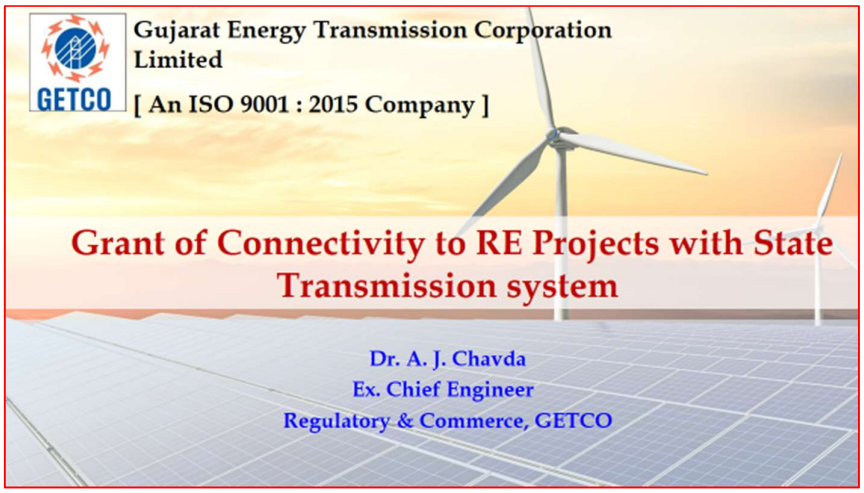
Office: 516/517, Samanvay Silver,
B/d. Hotel Royal Orchid, Akota, Vadodara-390020.
Email : solar.techon@gmail.com

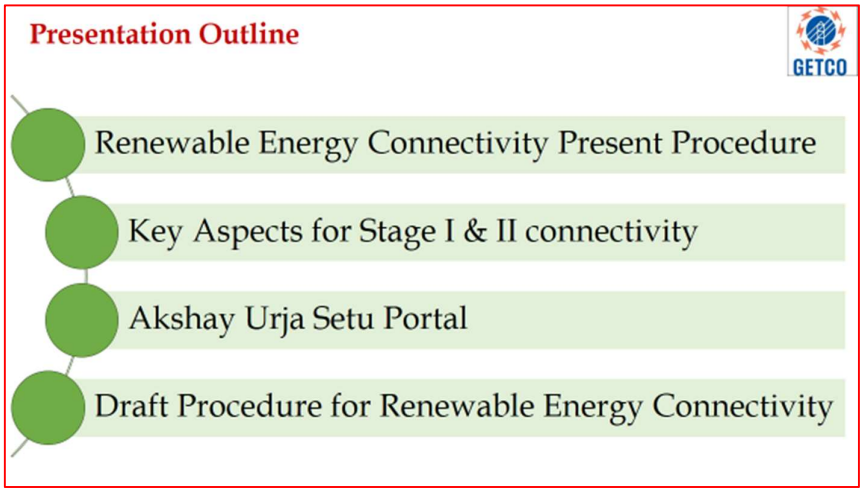
Our Offerings :-

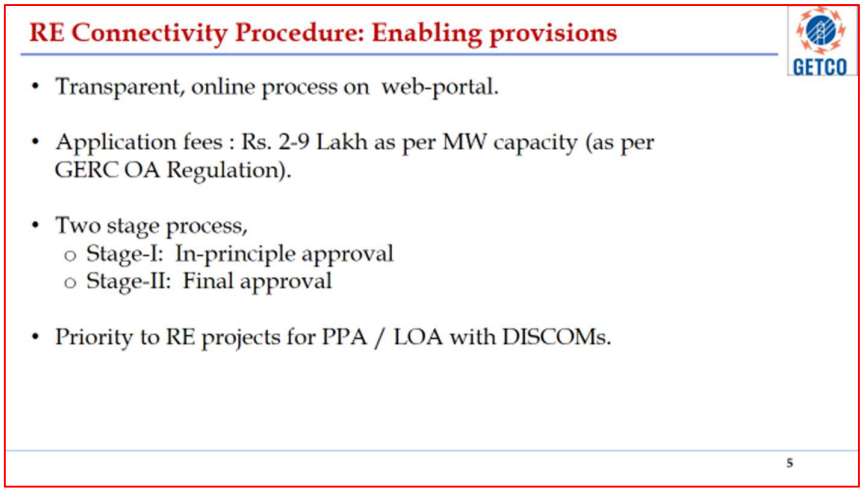
~ Project Strategy & Feasibility
~ Gov. Laisoning with electrical Infra development
~ PPA Facilitation
~ Land Finalization (Purchase / Lease)
~ Consultancy/Detail Engineering Owners Engineers
~ Project Financing & Investment Advisory
~ Risk Assessment / Asset Management service
PMO Advisory/Trading
~ Testing & Inspection

Grant of Connectivity to RE Projects with State Transmission System

By Dr. A. J. Chavda
Ex. Chief Engineer, Gujarat Energy Transmission Corporation Ltd.,







RE Connectivity Procedure: GETCO Timeline

Website Updation

List of existing & planned substations updated on website, depicting -
- Substation name, Capacity available (MW), Geographical coordinates, District, Taluka
- Upcoming substations (within 6 months)

Portal

Stage I	Stage II	Estimate Issuance
Within 60 Days from the date of Application	Within 30 Days from last day of month App. received	Within 30 days of grant of Stage II
• Bay feasibility • System Studies	• Bay feasibility • System Studies	

7

RE Connectivity Procedure: Applicant Timeline

Stage I

Application on Portal

- Notarized Affidavit
- Fees
- Board Resolution
- Copy of Memorandum & Article of Association

Stage II

Within 6 months from grant of Stage-I

- DISCOM Bid : LOA/LOI/PPA

Others:
- Document for 50% land
- Bank Guarantee (BG)
- Financial comfort letter/ financial closure
- Firm sale of 75% capacity.

GETCO Estimate	Payment of Estimate	Sign Agreement
Within 30 days	Within 30 days	Within 5 days of estimate payment

Within 65 days

- No extension of time for payment of estimate and signing of agreement.
- For other than DISCOM bid Stage II Grantee -Balance land documents and balance Firm Sale Agreement to be submitted **within 6 months**

Failure to comply - Stage II connectivity stands revoked and cancelled

9

Key Aspects for Stage – I Connectivity

11

Document submission under Stage I connectivity

Provision - 6.2

1. Notarized affidavit as per Format-1 

2. Application shall be accompanied by a non-refundable fee as per Clause 5(3) of OA Regulations, as amended from time to time + applicable taxes as Stage I Connectivity Fees.

Sr. No.	Quantum of power to be injected/off take into/from Intra-state Transmission and/or distribution system	Application fee (Rs. in lakh) For Connectivity
1.	Up to 100 MW	2
2.	More than 100 MW and upto to 500 MW	3
3	More than 500 MW and up to 1000 MW	6
4.	More than 1000 MW	9

3. Board resolution for proposed project.

4. Copy of Memorandum & Article of Association having provision to take up proposed business / project

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Key Aspects for Stage – II Connectivity

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Document submission under Stage II connectivity – DISCOM Bid winner

Eligibility (Provision - 8.2.1)	An entity which (i) has been issued the Letter of Award (LOA)/LOI/PPA by, **OR** (ii) has entered into a Power Purchase Agreement (PPA) with a Renewable Energy Implementing Agency as notified by the Government or a distribution licensee or an authorized agency on behalf of distribution licensee.
Documents to be submitted (Provision 8.2.1 (a))	i) Tentative land location/ map ii) Bank Guarantee (BG) as per prevailing Regulations or as specified by the State Commission in relevant orders, as applicable time to time.

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Document submission under Stage II connectivity – Other than DISCOM Bid Winner

Eligibility	Entities for Captive or Third Party Sale Projects
Documents to be submitted (Provision - 8.2.2)	(i) Ownership or registered lease agreement or registered land sale agreement for at least 50% of the land area required for the capacity for which Stage-II Connectivity is applied for along with a notarized undertaking as per Format -7 attached with this procedure;

Format - 7 Adobe Acrobat Document

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Document submission under Stage II connectivity – Other than DISCOM Bid Winner

Documents to be submitted (Provision - 8.2.2)	(iii) Financial comfort letter/ financial closure issued by Financial Institution with supporting document, duly supported by Auditor's certificate along with a notarized undertaking as per Format -7 attached with this procedure and; Format - 7 Adobe Acrobat Document (iv) In case of third party sale, agreement/ Contract specifying firm sale/ purchase of energy of 75% of connectivity applied by person/ applicant.

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RE Connectivity : Common Error Observed

- Bank Guarantee: Standard Format available on GETCO website
- Bank Guarantee: Government of Gujarat approved Banks
- Bank Guarantee: Short Amount & Short Duration
- Missing Authorisation letter along with Board Resolution
- Acceptance letter of Loan documents
- Company seal along with company project details
- Registration no. of Charter Accountant
- Missing proper letter from financial institution

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Role of Government Agencies in RE Project

GETCO

GEDA
Project Registration
Developer Permission

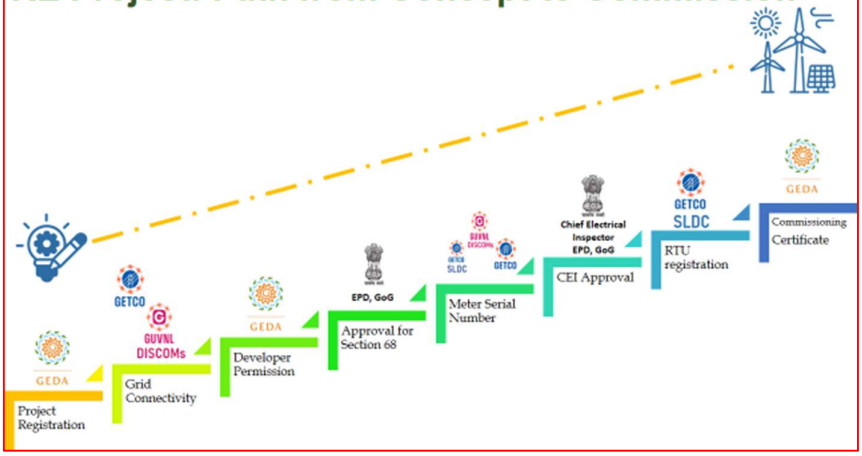
GETCO **GUVNL DISCOMS**
Grid Connectivity, Infrastructure requirement, Metering
≥ 66kV – GETCO
11kV - DISCOMs

Chief Electrical Inspector, EPD, GoG
CEI approval ensuring compliance of safety standard

GETCO SLDC
Energy metering, scheduling, billing, data transmission

Energy & Petrochemical Dpt, GoG
Approval for Section 68 and 164 under EA,2003

RE Project: Path from Concept to Commission



Concept

Centralized Process
From concept to Commissioning all approvals, clearances, and documentation required for RE projects are streamlined through one platform.

Integration of multiple departments
GEDA, GUVNL, GETCO, DISCOMs , SLDC, CEI and EPD, GoG on one portal.

Time-bound Approvals
Strict timelines for various stages of application to enhance application processing speed.

Transparency
Clear visibility on the status of each stage of the approval process.

Key Features

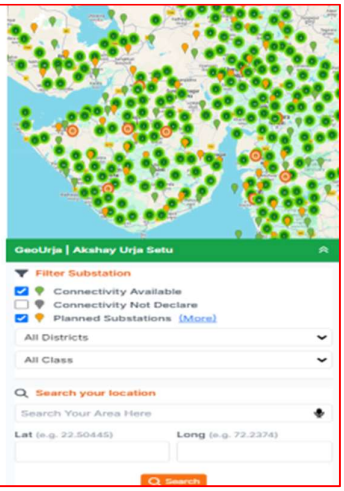
Virtual Mapping of Substations
Geographic representation of substations (Existing/Planned) with their feasible capacity for grid connectivity.

End-to-End Digital Process
Entire application process from submission to commissioning is online.

Document Management System
Easy upload and management of mandatory documents.

Real-time Application Tracking
Unique Project Identity Number given to project to track the status of application throughout the process.

Payment Gateway
Online payment for application fees and other charges.



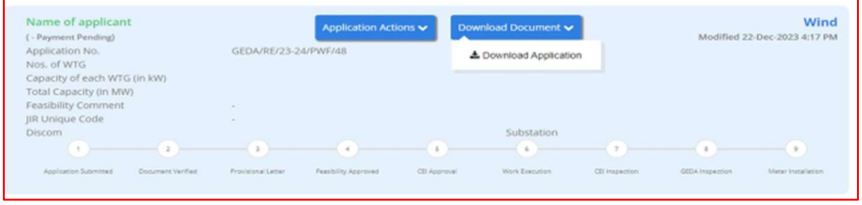
Developer Centric Approach

Easy Project Tracking
Each project is assigned a unique Project Identity Number (PIN) at the time of application, allowing developers to easily track their projects.

Centralized Information Access
All information related to the project is linked with Project number, providing a one-stop reference for developers.

Faster approval
Streamlined application processing at one platform

Real-time Status Updates
Application monitoring in real-time, checking the status of approvals and any pending actions.



Draft Procedure for Grant of Connectivity to RE Projects with State Transmission / Distribution system

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Objective

- Assured Connectivity in RE Potential Area
- Simplification of Procedure (Single Stage)
- Ensuring high RE capacity integration
- Integrated Processing of application

Application Process

GETCO shall publish and update two lists of substation on the website on 3rd day of every calendar Month at 11 AM

List I Existing & 6 months Planned	(a) Existing infrastructure and 6 months planned substations (b) Additional capacity feasible after approved system augmentation along with the tentative timeline.
List II RE Potential Area Existing & approved by Committee – EPD	Planned substations with tentative DoC in potential RE area(s) identified by the Committee constituted by EPD, GoG
Any desired location	Substation/potential area which is not available in list (i) and (ii), Person/Applicant may specify the location where connectivity is desired specifying village / taluka

Applicant shall be allowed to select any three (3) locations in order of preference from 5th day of the month at 11 AM

Document Submission

GERC Approved Procedure, 2023	Draft Procedure, 2024
Stage I • Application Fees • Notarized Affidavit • Board Resolution • Copy of Memorandum & Article of Association **Stage II** • DISCOM Bid : LOA/LOI/PPA Others – • Document for 50% land + Title Clear Report • SD Bank Guarantee (BG) (Rs. 10 Lakh/MW) • Financial comfort letter/ financial closure • Firm sale of 75% capacity	• Application Fees • Notarized Affidavit • Board Resolution • Copy of Memorandum & Article of Association • DISCOM Bid - LOA/LOI/PPA For other than DISCOM bid- • Document for 50% land + Title Clear Report OR Land Bank Guarantee (Rs. 10 Lakh/MW) in lieu of land • Financial comfort letter/ financial closure • Agreement for firm sale of 100% capacity **Before Grant of Final Connectivity -** • Security Deposit Bank Guarantee (SBG) • (Rs. 10 Lakh/MW) in accordance with GERC orders • Associated Transmission System Bank Guarantee (ATS) (Rs. 20 Lakh/MW) in case of strengthening requirement

Note: Minimum land requirement for the RE project as per CTU Land Advisory.

Grant of Connectivity

Feasible Applications	By Last Day of next Month Provisional Grant of Connectivity	Within 10 days after provisional connectivity Acceptance of Connectivity with submission of SD BG	Within 30 days after provisional connectivity Upon submission of BG Final Grant of Connectivity
Non-Feasible Applications	By Last Day of next Month Intimation of Non-feasibility	Within 60 days from last day of month in which application received Provisional Connectivity with System Strengthening/New Infrastructure with timeline	Within 15 days after provisional connectivity Acceptance of Connectivity with submission of SD BG & ATS BG	Within 30 days after provisional connectivity Upon submission of BGs, Final Grant of Connectivity
Any desired location	Within 180 days from last day of month in which application received Provisional Grant of Connectivity with required Infrastructure and tentative timeline	Within 15 days after provisional connectivity Acceptance of Connectivity with submission of SD BG, Land BG, if applicable and ATS BG	Within 30 days after provisional connectivity Upon submission of BGs, Final Grant of Connectivity

Timelines for Connectivity Agreement

Grant of Final Connectivity by STU/DISCOM

Issue of Estimate — Within 30 days

Payment of Estimate — Within 30 days

Sign Agreement

Within 65 days

- No extension of time for payment of estimate and signing of agreement.
- Failure to comply - connectivity stands revoked and cancelled & SBG shall be encashed and Land & ATS BG, if applicable shall be returned.

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Thank you !!!

Applicability of Green Energy Open Access Charges

By Umesh Parikh
General Manager, MEC Power Solutions Ltd

mecpower

Society of Power Engineers(I),Vadodara Chapter

Topic: Applicability of Green Energy Open Access Charges

By
Umesh Parikh
General Manager
MECpower Solutions Ltd
(M:9925208061)

Date: 8th January 2025

umEsh paRikh

Democracy is about
. . . .Giving Choice to the People.

-FoR/PwC

umEsh paRikh

Need of Green Energy

- Ultimate Goal of Green Energy is to mitigate GHG and thereby support to maintain Global temperature.
- Matter of concern for all of us
- Survey: Temperature has increased 0.7 degree C every year
- Predicted to touch 50 degree C in next decade.
- Power sector alone shares 75 % in GHG emission.
- Today, our Conventional(Thermal) installed capacity is 54.87 % and RES contributes to **32.68 %**,Large Hydro 10.60 % and Nuclear 1.85 %

Cheaper Energy will Transform the world Completely

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Need of Green Energy

- Switching to Green Energy option mitigates GHG at the same time reduces cost of electricity optimally.
- Use of Green Energy is a win-win situation.
- GOI at 26th COP convention at Glasgow in Nov-2021 committed towards Climate Actions. Setting target of 500 GW non-fossil fuel based energy Generation and meeting 50 % of Nations Elect requirement from RES.
- To align with this GOI's ambitious Solar Expansion program,GOG notified comprehensive Gujarat RE Policy in Oct-2024
- And GERC notified GERC (T&C for Green Energy Open access)Regulations,2024

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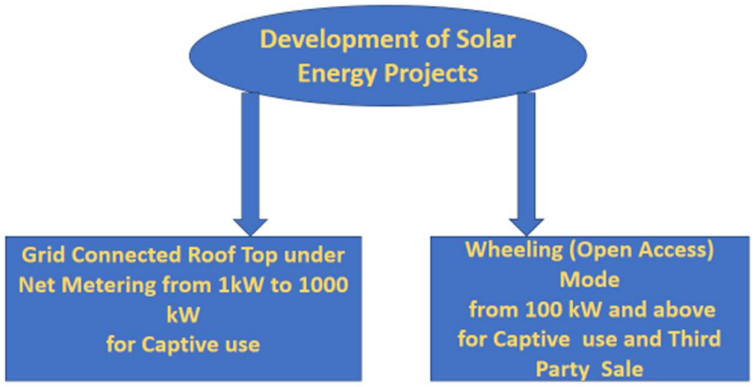

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Open Access Mode

Electricity (Promoting RE through Green Energy Open Access) Rules,2022

FoR: Model Regulation on Methodology for calculation of OA charges and Banking charges for Green Energy Open Access Consumers (April-2023)

Gujarat Renewable Energy Policy 2023 (4th Oct 2023)

GERC (Terms & Conditions for Green Energy Open access)Regulations,2024

Tariff Framework for Procurement of Power by Distribution licensees and Others from Solar & Wind Energy Projects in Gujarat

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Grid Interactive Net Metering Mode

GERC (Net Metering Rooftop Solar PV Grid Interactive Systems) Regulations, 2016 and its Four amendments

Gujarat Renewable Energy Policy 2023

The exponential growth of solar power will change the world

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Business Models

CAPEX Model:

- One of the ownership models, users to pay the total cost of the system to the system developer.
- CAPEX model needs its own Capital Expenditure for the solar power plant setup,
- Customer holds possession of the asset. the customer pays all the equipment, design, installation, and commissioning costs.
- Customer Responsible for O&M
- Usually, contract for O&M of the plant is awarded by the consumer.
- Require to make the upfront investment in owning a solar power plant. In that case, a solar CAPEX model should be explored.

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Business Models

OPEX Model:

- User is not required to pay the total cost of the system upfront to the system developer.
- Users have to pay only cost of energy on per unit basis as per the mutually agreed terms with solar system developer.
- Under the OPEX model, a Renewable Energy Service Company (RESCO) invests, installs, and takes care of an onsite solar plant.
- Customer to pays for the power generated under a long-term/Medium term power purchase agreement (PPA) for a fixed tenure at mutually agreed tariff.

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Business Models

OPEX Model:

- Investment and performance risk of a Capex model is alleviated in OPEX Model
- Customer only pays for the energy generated with no significant asset-based investment, makes the Opex model economical upfront.
- Even with a PPA, the power is considerably cheaper than grid power.
- OPEX model is also known as a third-party ownership model

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Green Energy Open Access

- GEOA can be avail by Licensee-GE Generator-Consumer
- Applicable to CD of 100 kW or more
- Multiple connections with aggregate CD 100 kW or more but located in same Division of DISCOM is also allowed
- No Capacity restriction w.r.t CD to set up projects for Captive use
- Banking Charge Rs. 1.5/kwh is applicable up to 31st March 2025.
- Applicable Banking Charge from 1st Apr 2025 to be decided by GERC

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Nodal Agency

- **CTU for Inter-state LTA and MTOA**
- **STU for Intra-state LTA and MTOA**
- **RLDC for Inter-state STOA**
- **SLDC for Intra-state STOA**

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Energy Accounting

➢Interstate Transactions:

- For Interstate transactions (including Interstate RE Projects located in Gujarat and connected to ISTS network supplying power to consumer in Gujarat) EA shall be as per the provisions of CERC Regulations.

➢Intrastate Transactions:

- Deviation charges payable by Wind/Solar Generator as per F&S regulations 2019

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Green Energy Open Access Charges

➢Transmission Charges:

- For use of Inter state Transmission system: As specified by CERC
- For use of Intra-state transmission system, Transmission charges are to be paid by GEOA consumers as determined by GERC as per prevailing provisions of GERC(MYT) Regulations read with orders passed by Commission.

➢ Wheeling Charges:

- Payable to DISCOM by GEOA consumer as determined by GERC in tariff order in Rs./kWh.
- Wheeling Loss as determined by GERC in Tariff order is also applicable GEOA consumer or generator.

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➢ **Cross Subsidy Surcharge(CSS):**

- CSS as determined by GERC in its tariff order is applicable to GEOA consumers.
- CSS is payable on actual green units consumed during billing period.
- CSS is payable on Rs./kWh basis
- CSS is not levied for GEOA provided to consumer having established CGP for carrying the electricity to destination for own use.
- CSS is also not applicable to non fossil fuel based MSW to Energy plant supplied to GE OA consumer.

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➢ **Additional Surcharge(AS):**

- AS is not applicable to the GEOA consumer to the extent of CD being maintained with Dist. Licensee.
- In case of, GEOA is availed for more than CD with licensee and no fixed charge is paid for additional quantum of demand, in that case AS as determined by GERC is applicable for additional quantum availed over CD.
- As is not applicable for Captive transactions.
- AS is also not applicable to power produced from MSW to Energy plant supplied to GEOA consumer.
- AS is also not applicable to power produced from Offshore wind projects commissioned up to Dec 2032 and supplied to GEOA consumer.

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➢ **Standby Charges:**

- In case GEOA consumer fails to procure power from RE Generator due to outage of generator/Transmission system and the like, the standby arrangement is provided by Dist. Licensee on payment of standby Charges by GEOA consumer to Dist. Licensee.
- Stand by charges at Rate 10% of energy charge including FPPPA charges as applicable to consumer's tariff category.
- Standby charges are in addition to the applicable tariff on standby energy supplied by Dist. Licensee to GEOA consumer.
- Standby charges are not applicable, if GEOA consumer has given notice, in advance at least a day in advance.
- GEOA consumer have option to arrange standby power from any other source.

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Banking

What is Banking with reference to Green Energy Open Access ?

Banking means surplus green energy injected in the grid and credited with Distribution Licensee by the Green Energy Open Access Consumers which is drawn from Dist Licensee on billing cycle basis on payment of charges to compensate Dist Licensee.

Time Block	Net Injected	Drawl	Surplus
11:30 -11.45	200	180	20 (Banked with Dist Licensee)

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➢ Banking facility and Charges:

- Banking facility is permitted for GEOA consumer.
- Banking means surplus green energy injected in grid in 15 Min T/B basis and credited with the Dist. Licensee and allow to draw on billing cycle basis along with charges to compensate Dist. Licensee.
- Banking of energy will be evaluated for energy accounting on 15 Min time block basis. The Difference between injected green energy available at consumption point and consumer's consumption in same 15 Min T/B is considered as Banked energy.

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➢ Banking facility and Charges:

- Consumption of Banked energy is permitted on Billing cycle basis.
- Banked energy available during peak period is allowed to be utilized during peak period and off-peak period.
- Banked energy available during off peak period to be utilized during off-peak period.

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➢ **Banking facility and Charges:**

- Banking facility is Optional.
- In case, consumer opts not to avail banking facility, the same is permitted on furnishing undertaking in this regards.
- Once option is exercised, change is not permitted before completion of three years from date of operationalization.
- In case of banking facility is not availed, the energy accounting will be done in 15 Min T/B basis and surplus energy if any available after adjustment in 15 Min T/B basis will be considered as lapsed energy and for that GEOA consumer is not entitled for REC to the extent of lapsed energy.

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17. Energy Banking facility and charges, Energy settlement and Open Access charges and relinquishment of OA Rights for GEOA.

➢ **Banking facility and Charges:**

- Banking Charge at Rs.1.50/Unit effective from date of notification of regulation up to 30th Sept 2024.
- Permitted quantum of banked energy by GEOA consumer shall be up to 30 % of total consumption of electricity drawn from Dist. Utility.
- Credit of banked energy is not permitted to be carried forward to subsequent billing cycle.
- Unutilized surplus banked energy is considered as lapsed energy at the end of each billing cycle and RE Generator is entitled for REC to the extent of lapsed banked energy.

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➢ Viability of Banking facility primarily needs study of Time block wise consumption pattern *vis-à-vis* Time block wise Solar Generation (*i.e.* Installed Capacity (AC) of solar plant.

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Details of Various charges *(w.e.f. 01st June 2024)*

Sr	Particular	Charges as per GERC
1	Transmission Charges	Rs. 4130.32/MW/Day
2	Transmission Loss	As per SLDC Monthly Report
3	Wheeling Charges	Rs. 0.1473/Unit
4	Wheeling Loss	8.50%
5	Cross subsidy Surcharge	Rs. 1.52/Unit
6	Additional Surcharge	Rs.1.00/Unit
7	Multi-loaction Charge	Rs. 0.05/Unit
8	Banking Charge	Rs. 1.50/Banked Unit
9	Standby Charges	10% of (EC+FPPPA)
10	Transaction Charge	Rs.3000/Month
11	Schedulling Charge	Rs.2000/Day
12	Meter Reading Charge	Rs.1000/Month
13	Reactive Drawl Charges	Rs.0.10 /kWh or Rs 0.50/kWh (As the Case may be)
14	DSM Charge	As per GERC Regulations,2019

Banking Facility for Green Energy Open Access in other States

Sr	State	Banking Charge	Banking facility	Banking Settlement
1	Andhra Pradesh 02nd May 2024	8 % of Energy banked	Banking up to 30 % of Total Monthly Consumption of Green Energy Source	Billing Cycle
2	Haryana 24th April 2024	8 % of Energy banked	Banking up to 30 % of Total Monthly Consumption of Electricity from Dist Licencee.	Billing Cycle
3	Telangana 15th March 2024	8% of Energy banked	Banking at least 30 % of Total Monthly Consumption of Electricity from Dist Licencee.	Billing Cycle
4	Odhisha 11th Jan 2024	8% of Energy banked	Banking up to 30 % of Total Monthly Consumption of Electricity from Dist Licencee.	Billing Cycle
5	Madhya Pradesh 9th Mar 2023	8% of Energy banked	Banking at least 30 % of Total Monthly Consumption of Electricity from Dist Licencee.	Billing Cycle
6	Tripura 9th Mar 2023	8% of Energy banked		Monthly

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Case Study

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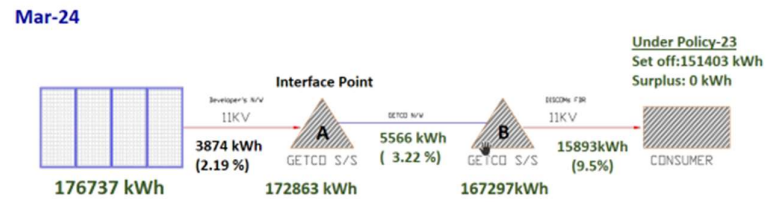
Schematic Diagram of 1.0 MW(AC) Green Energy Open Access under Captive Mode having inter-se location of Injection and Drawl is within same DISCOM



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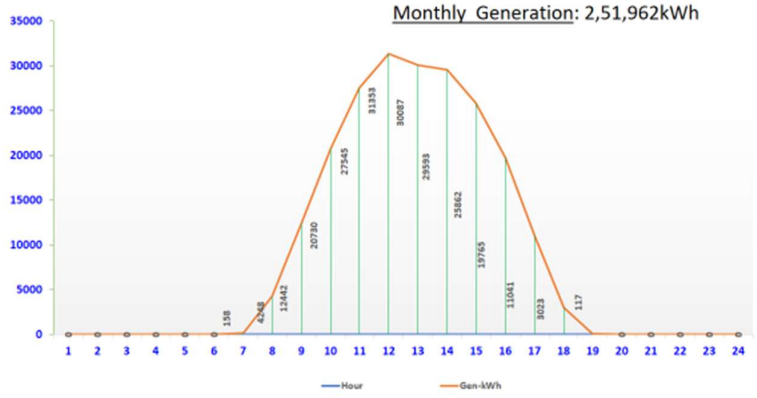
Hourly Solar Generation from 1.26 MW Plant for Oct-2023

Monthly Generation: 2,51,962kWh



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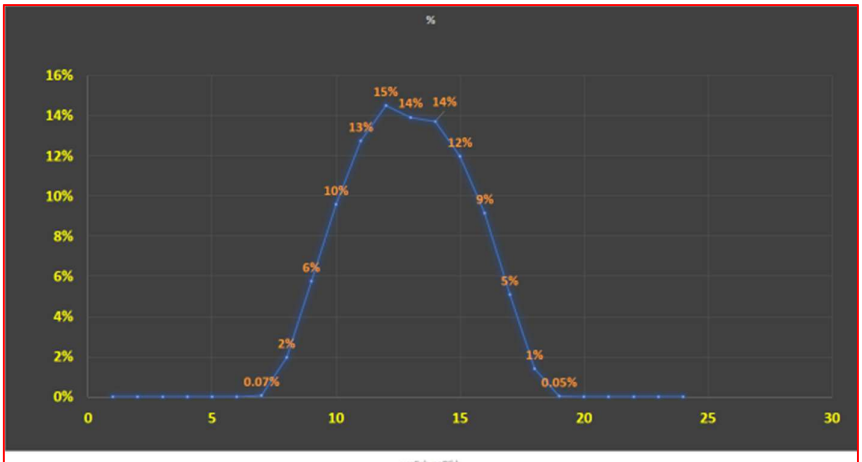

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- Connectivity Agreement
- Wheeling Agreement
- MOU for O&M of dedicated line/bay for 25 years
  - 1.5 % of cost of erected equipment 5 % escalation per year
  - Rs 10,32,000 /kM on RSJ/55 Sq MM for 11 kV HT Line

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Hierarchy for settlement of energy in respect of consumers

It will be as per provisions of relevant policies of Government/ orders/regulations of GERC under which such projects were setup or commissioned with wheeling /Transmission agreement with licensee.

- Priority for the purpose of Energy Accounting availing GE LT-MT-ST OA
  - ✓ LTOA based wheeled energy have highest priority.
  - ✓ MTOA based wheeled energy have priority after LTOA energy.
  - ✓ STOA based wheeled energy have priority after MTOA
  - ✓ FIFO principle for priority amongst same category of aforesaid OA

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Other charges and fees:

- Scheduling charges: GEOA consumer to pay Rs. 2000/day
- RE-DSM Charges: Charges as per GERC(F&S)Regulation.2019 is applicable.
- Transaction & Meter reading charges: GEOA consumer shall pay transaction charges of Rs.3000/Month and Rs. 1000/- Month as monthly meter reading charges.

Payment Security Mechanism:

- LT and MT GEOA consumer shall provide irrevocable Revolving Letter of credit of BG for estimated amount of various charges for period of two months. STOA consumer to pay payment security for entire period of OA.
- No open access granted, if PSM is not provided.

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Curtailment Priority:

- Curtailment priority shall be as under:
  - STOA consumer(other than GEOA consumer) shall be curtailed first followed by curtailment of short term GEOA
  - MTOA consumer(other than GEOA consumer) shall be curtailed first followed by curtailment of Medium term GEOA
  - LTOA consumer(other than GEOA consumer) shall be curtailed first followed by curtailment of Long term GEOA
  - Dist. Licensees shall be curtailed at last resort.

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Metering:

- GEOA consumer having CD of 1 MW and above needs to provide ABT Compliant Meter at generator end, interface points, consumption place which shall be in conformity to CEA Metering regulations,2006 and its amendment form time to time.
- OA consumer demanding GEOA up to 1 MW needs to provide Special Energy Meter capable of energy recording in 15 minutes T/B basis specified by CEA in its Regulations.
- The metering point as well as interconnection points for grid connectivity shall be the nearest Transmission/distribution sub station.
- All GEOA consumers are abide by the Metering standards of CEA.

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Reactive Energy Charges:

- GE Generator needs to pay reactive energy charges in accordance with the Electricity Grid Code notified by GERC read with Tariff order.
- When GEOA consumer procuring power from Dist. Licensee and simultaneously wheeling power from GE supplier in that case reactive energy charge shall be as per applicable tariff order for relevant class of consumers.

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Interpreting Inconsistency:

- In case of inconsistency between provisions of Govt Policy, GERC Order, Regulations, Rules and Act, following provisions shall prevail.
  - ✓ Act prevails over other provisions, rules , Regulations. Orders and Govt Policies.
  - ✓ Rules prevails over other provisions, Regulations. Orders and Govt Policies.
  - ✓ Regulations prevails over Orders and Govt Policies.
  - ✓ Orders prevails over Govt Policies.

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Comparison under Net Metering and Green Energy Open Access Regulations

Sr. No	Particulars	Net Metering Regulations	Green Energy Open Access Regulations
1	Capacity	1kW to 1000kW	≥ 100kW
2	Capacity Restrictions	Without REC - No capacity Restriction	No capacity Restriction
		With REC - Yes 6.1(c) (iii) -3rd Amendment	
3	Location	Rooftop/Consumer premises	Any where -Intrastate
4	Grid Connectivity	**Yes** upto 6 kW-240 V 1 Ph 6kW≤ Loads100kW - 415 Volts 3 ph 100 kW < Load ≤ 1 MW 11kV,3 ph,50 Hz	**Yes** 100kW ≤ Cs 4 MW, Interconnection Pt: 11kV V 3 Ph C > 4MW , Interconnection Pt: 66/132/220/400kV 3 Ph
5	Mode	Captive	Captice-OA Third party-OA
6	Metering	Net Metering for HT & LT	HT- ABT Meter LT- SEM
7	Agreements	Net Metering Inter Connection Agreement	Connectivity Agreement Wheeling agreement O&M Agreement for dedicated line.
8	Surplus	Rs 2.25/Unit for first 5 years and at 75 % of simple Avg tariff discovered for MSME Other than MSME: 75 % of simple Avg tariff discovered	No compensation
9	Banking Charges	No for residential Consumer Yes for other consumer on consumed solar energy @ Rs 1.50/ Unit for Demand based consumers and in case of MSME and Rs. 1.10 for other than demand based consumer	Re. 1.50/Banked unit
10	EA	HT/EHV Consumer: 07:00 Hrs to 18:00 Hrs of the same day LT demand based Captive Cosnumers- 07:00 Hrs to 18:00 Hrs of the same billing cycle Other LT Consumers: Billing cycle base	Billing Cycle

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Environment Support from 1.0 MW Solar Plant

Sr.	Pollutants	Quantity Mitigated
1	CO_2 Carbon Dioxide	1170 Tons/Year
2	NOx	2.84Tons/Year
3	SOx	2.36 Tons/Year
4	Suspended Particulate	163 Kg/Year
5	Planting of Teak wood Trees over lifetime	49,000 Nos

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Sun is present everywhere,
his countless rays reaches all places,

Sun is the force,
The destroyer of darkness &
bestows happiness & wealth

Sun infuses life and removes all problems
- Aditya Hridyam

तमसो मा ज्योतिर्गमय।

THANK YOU

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Thanx for Patience Listening

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Electricity Act 2003 & Open Access

By Vasant Patel, Gujarat Energy Transmission Corporation Ltd.,

Electricity Act 2003 & Open Access

By Vasant Patel

Flow of Presentation

Landmark events of Indian power sector

Framework and glimpse of EA 2003

Connectivity

Open Access

Green Energy Open Access

Regulatory order related to connectivity and open access

3

Landmark events of Indian power sector

5

History of Electricity Sector in India

The first hydel power station in India, was started at Sidrapong near Darjeeling on 10 Nov 1897.

(2 x 65 kW, 1-phase, 83 Hz Generators)

This was replaced in 1931 with 3-phase 50 Hz units. Revived again in 1997 for centenary celebrations.

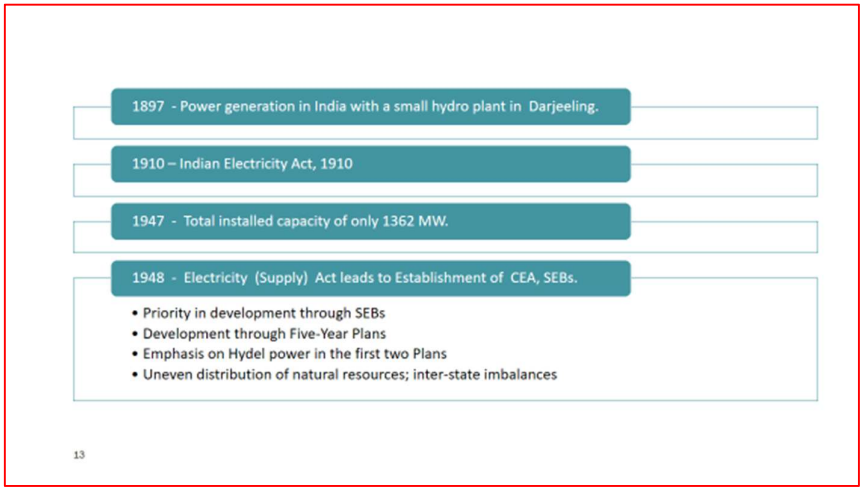
7

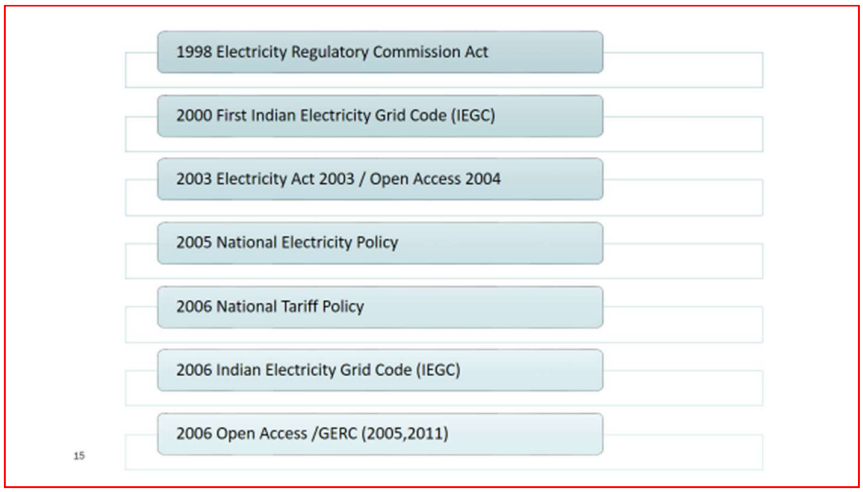
History of Electricity Sector in India

9

Framework and glimpse of EA 2003

11





Indian Power Sector Structure

FUNCTIONS	CENTRE		STATE	
POLICY	MINISTRY OF POWER		STATE GOVERNMENT	
PLAN	CEA			
REGULATION	CERC	CAC	SERC	SAC
GENERATION	CGS, Mega Power Plants		GENCOS, IPP	
TRANSMISSION	CTU	TRANSMISSION LICENSEE	STU	TRANSMISSION LICENSEE
SYSTEM OPERATIONS	NLDC	RLDC	SLDC	
DISTRIBUTION			DISTRIBUTION LICENSEE, State& Pvt	
TRADING	TRADING LICENSEE		TRADING LICENSEE	
APPEAL	APPELLATE TRIBUNAL		APPELLATE TRIBUNAL	

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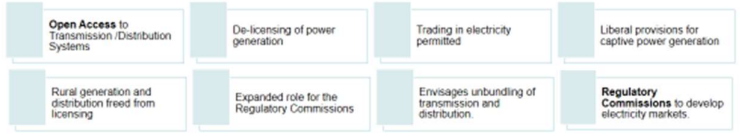
History and Legal framework

Before Electricity Act, 2003, the Indian Electricity sector was guided by

- The Indian Electricity Act, 1910,
- The Electricity (Supply) Act, 1948 and
- The Electricity Regulatory Commission Act, 1998.
- The generation, distribution and transmission were carried out mainly by the State Electricity Boards in various States

Intent of the Act was to promote competition by "freeing" all possible avenues of procurement and sale of power:



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Before Electricity Act, 2003, the Indian Electricity sector was guided by The Indian Electricity Act, 1910 and The Electricity (Supply) Act, 1948 and the Electricity Regulatory Commission Act, 1998. The generation, distribution and transmission were carried out mainly by the State Electricity Boards in various States. Due to politico-economic situation, the cross-subsidies reached at an unsustainable level. For the purpose of distancing state governments from tariff determination, The Electricity Regulatory Commissions Act was enacted in 1998. So as to reform electricity sector further by participation of private sector and to bring in competition, Electricity Act was enacted in 2003.

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With effect from 2 June 2003 India has adopted a new legislation called the Electricity Act 2003, to replace some age-old existing legislation operating in the country. The new act consolidates the position for existing laws and aims to provide for measures conducive to the development of electricity industry in the country. The act has attempted to address certain issues that have slowed reform in the country and consequently has generated new hopes for the electricity industry. This paper reviews the Electricity Act 2003, to highlight how the new features are different from the existing legal provisions and whether these measures have economic rationale.

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An Act to consolidate the laws relating to generation, transmission, distribution, trading and use of electricity by taking the following measures:

-Taking conducive measures to develop electricity industry·

-Supply of electricity to all users· -Protecting consumer Interest·

-Rationalization of electric tariff· -

Transparency in policies regarding subsidies·

-Promotion of efficient & environmentally policies constituted by Central Electricity Authority (CEA), Regulatory commissions & establishment of Appellate tribunal.

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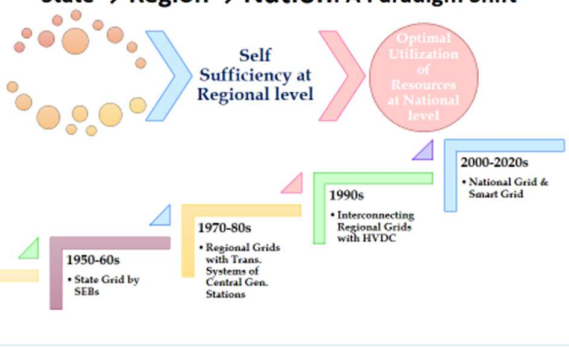
National Grid - Development

State → Region → Nation: A Paradigm Shift



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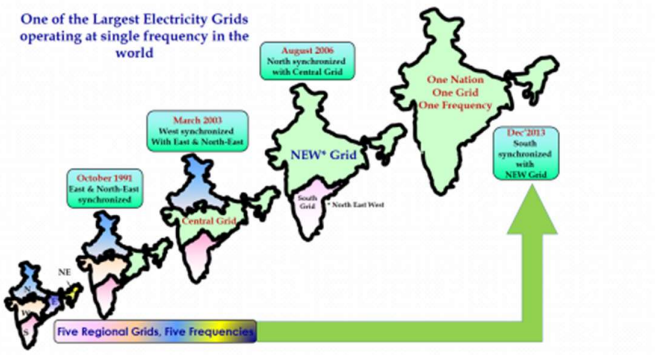
National Grid - Evolution



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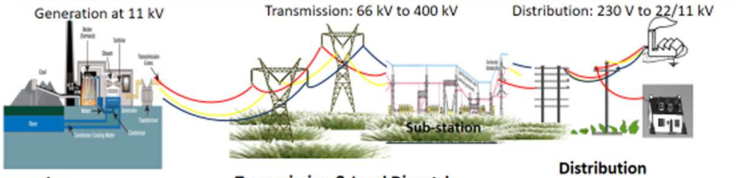
Gujarat Power Sector Overview



Generation
- State Sector
  - GSECL
- Private Sector
- Central Sector

Transmission & Load Dispatch
- Public Sector
  - GETCO

Power Trading

GUVNL ₹

Distribution
- Public Sector
  - DGVCL
  - MGVCL
  - PGVCL
  - UGVCL
- Private Sector
  - Torrent Power Ltd., MUL, GIFT, DPT, AIL, JIL,DSIR,Becharaji

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Connectivity

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Connectivity

Connectivity

- 4MW or above (Consumer / Generator) → Intra-State Transmission System
- Below 4MW (Generator) → Distribution System
- A Distribution Licensee shall be eligible to seek connectivity to Intra-State Transmission System and/or the Distribution System of any other Licensee

Application Procedure →Intra – state Transmission System

- Applicant Shall apply to STU in the prescribed form accompanied by Non refundable fee drawn in favor of GETCO
- Application shall mention details such as proposed location, quantum of power to be interchanged etc.
- If any material change in location or more than 10% change in the quantum of power to be interchanged, applicant need to file fresh application

Application Fee for Connectivity

Quantum of Power to be Interchanged	*Application Fee (Rs.)*
Upto 100 MW	2,00,000.00
> 100 MW and upto 500 MW	3,00,000.00
> 500 MW and upto 1000 MW	6,00,000.00
> 1000 MW	9,00,000.00

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Connectivity (Contd..)

Processing of Application & Grant of Connectivity by STU

- STU shall carryout necessary interconnection study in consultation with other agencies involved
- While granting connectivity, STU shall specify the name of sub-Station/Pooling Station/Switchyard where connectivity is to be granted.
- The Applicant & the STU shall comply with the provisions of CEA (Technical Standards for Connectivity to the Grid) Regulation, 2007
- The Applicant shall sign a connection agreement with the STU
- Grant of Connectivity shall not entitle an applicant to interchange any power unless it obtains LTOA/MTOA/STOA.
- Any Generator / CPP, after getting connectivity, shall be allowed to undertake testing and injecting its infirm power into the grid before commercial operation and after getting approval from SLDC.
- Commercial treatment of such infirm power will be governed by regulations on terms & conditions of tariff notified by the Commission from time to time.
- The STU shall convey its decision on grant of connectivity within a period of 60 days from the date of receipt of application.

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Connectivity for RE under open Access

Earlier Procedure of connectivity

- **Offline** procedure
- Fees: as per GERC OA regulation 2011
- Documents : except application form, No other Documents required
- List of the feasible substation, were published on Website **on quarterly/Half yearly**
- An applicant shall apply to the STU for connectivity in the Form prescribed.
- On payment of system study, if feasible, connectivity was granted.
- Timeline for completion of project was as per respective wind/solar/hybrid order of GERC.

Current Procedure of connectivity

- **Online** procedure (from 21.01.2023)
- Fees: as per GERC OA regulation 2011
- Procedure has two stage: Stage –I and Stage-II
- List of the feasible substation are being published on Website **on monthly**
- Stage-I approval within 60dyas
- Stage-II approval within 30days
- Timeline for completion of project as per respective wind/solar/hybrid order of GERC.
- **Discom Bid has high priority** over other applicant

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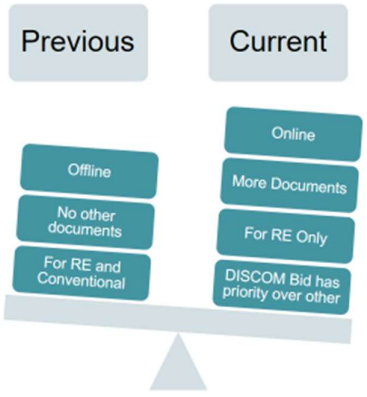

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Open Access

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What is Open Access

"Open access" means the non-discriminatory provision for the use of transmission lines or distribution system or associated facilities with such lines or system by any licensee or consumer or a person engaged in generation in accordance with the regulations specified by the Appropriate Commission

- Open Access is right to use / access of Transmission and Distribution network.

First time, open access envisaged in **Electricity Act 2003**

Open Access to mean "non-discriminatory provision for the use of transmission lines or distribution system

Section 42 of the Act says that, ("2)The **State Commission shall introduce open access** in such phases and subject to such conditions,(including the cross subsidies, and other operational constraints) as may be specified within one year of the appointed date by it and in specifying the extent of open access in successive phases and in determining the charges for wheeling, it shall have due regard to all relevant factors including such cross subsidies, and other operational constraints……."

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GERC has notified the Open Access Regulation in the year 2005.

Various Amendment in OA regulations

Prevailing Open Access Regulation notified by GERC in the year 2011

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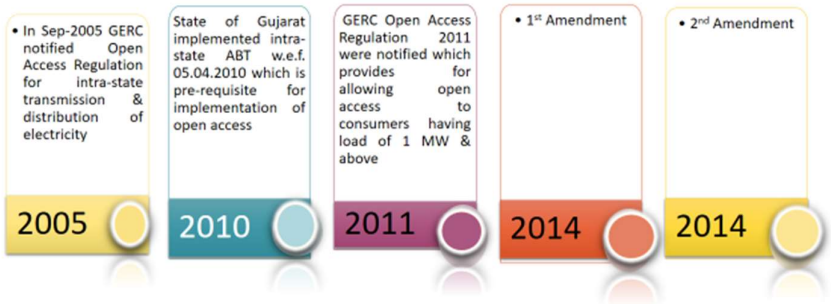
Open Access in Gujarat



Obligation of Licensee under EA 2003

For **Transmission** Licensees

- **Section 39** of Electricity Act 2003 envisages for allowing non-discriminatory open access to the transmission system
- "(d) to provide non-discriminatory open access to its transmission system for use by- (i) any licensee or generating company on payment of the transmission charges ; or (ii) any consumer as and when such open access is provided by the State Commission under sub-section (2) of section 42, on payment of the transmission charges and a surcharge thereon, as may be specified by the State Commission:"

For **Distribution** Licensees

- **Section 42** of Electricity Act 2003 envisages for allowing non-discriminatory open access to the Distribution system
- "(1) It shall be the duty of a distribution licensee to develop and maintain an efficient, coordinated and economical distribution system in his area of supply and to supply electricity in accordance with the provisions contained in this Act. (2) The State Commission shall introduce open access in such phases and subject to such conditions, (including the cross subsidies, and other operational constraints) as may be specified within one year of the appointed date by it and in specifying the extent of open access in successive phases and in determining the charges for wheeling, it shall have due regard to all relevant factors including such cross subsidies, and other operational constraints:"

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Open Access Charges

Transmission Charges

- LTOA & MTOA
  - Tariff as decided by GERC (FY 2023-24 Rs.4130.32 Rs/MW/Day)(5600.32 Cr)
  - Shared by all LTOA/MTOA
  - Will also be shared by GENCos if power from such co. is sold to a consumer outside Gujarat.
- STOA
  - Transmission charges paid by STOA = Transmission Charges payable by LTOA(39.09 Paisa/Unit)

Scheduling & System Operation Charges

- For Inter – State Open Access
  - LTOA & MTOA
    - RLDC Fees & Charges including charges for ULDC as per EA section 28(4)
    - SLDC Fees & Charges as specified by GERC
  - STOA
    - RLDC & SLDC Fees & Charges as specified by the Central Commission
- For Intra – State Open Access
  - LTOA & MTOA
    - SLDC Fees & Charges
  - STOA
    - Scheduling Fee @ Rs. 2000/- day or part of the day

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Open Access Charges (Contd...)

Wheeling Charges

- Shall be payable on the basis of scheduled energy (State Discoms 17.31 Paisa/Unit)
- If any customer was paying wheeling charges directly/indirectly before availing O/A he will continue to pay the same.

Cross Subsidy Charges

- Payable by a subsiding consumer of a DISCOM (Rs 1.60 /unit)
- Payable on Monthly basis on the actual energy drawn
- Charges will be determined by the Commission
- Will not be levied on CPPs who are carrying electricity for their own use.

Additional Surcharge

- An O/A customer, receiving power supply from other than the DISCOM of his area, shall pay Additional surcharge to the DISCOM.
- The DISCOM shall submit a to commission, detailed calculation statement of fixed cost which it is incurring towards its obligation to supply on six month basis (76 Paisa/Unit)
- Payable monthly on per unit basis by the O/A consumers on the actual energy drawn.
- Will not be levied on CPPs who are carrying electricity for their own use.

Standby Charges

- In case of outages of generator supplying to O/A customer under open Access, Standby arrangements shall be provided by DISCOM for a max. period of 42 days in a year. The DISCOM shall collect tariff under Temporary rate of charge for that category of consumer under the prevailing rate schedule.

Other Charges

- Such as Regulatory Charges / Congestion Charges as imposed by GERC/CERC is payable by all O/A consumers.

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Category Open Access

Long-term

- Period –exceeding 12 year but not exceeding 25 years
- Full Transmission charges shall be determined as per the Terms & Conditions of tariff notified by Commission from time to time.
- Exit option for applicant available by paying compensation

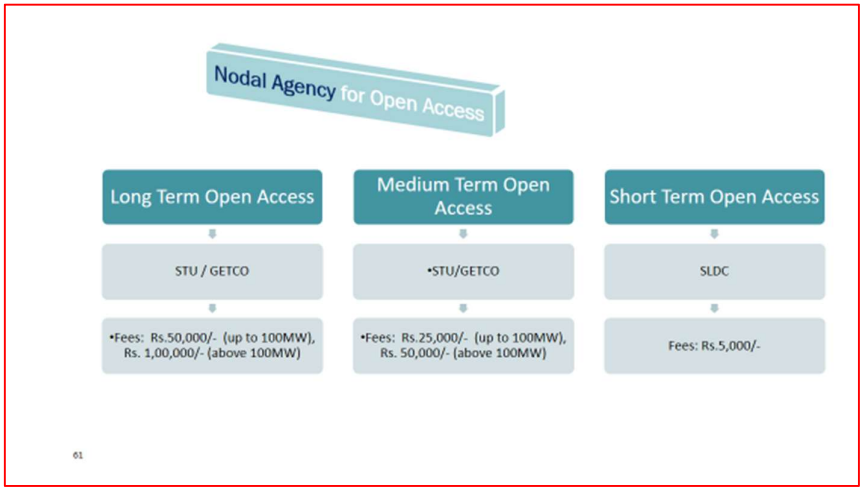
Medium Term

- Period– exceeding 3months but not exceeding 3 years
- Full Transmission Charges
- Exit option available by paying compensation.

Short Term

- Period -- not exceeding 6 months

59


Nodal Agency for Open Access
Long Term Open Access
Medium Term Open Access
Short Term Open Access
STU / GETCO
•STU/GETCO
SLDC
•Fees: Rs.50,000/- (up to 100MW), Rs. 1,00,000/- (above 100MW)
•Fees: Rs.25,000/- (up to 100MW), Rs. 50,000/- (above 100MW)
Fees: Rs.5,000/-
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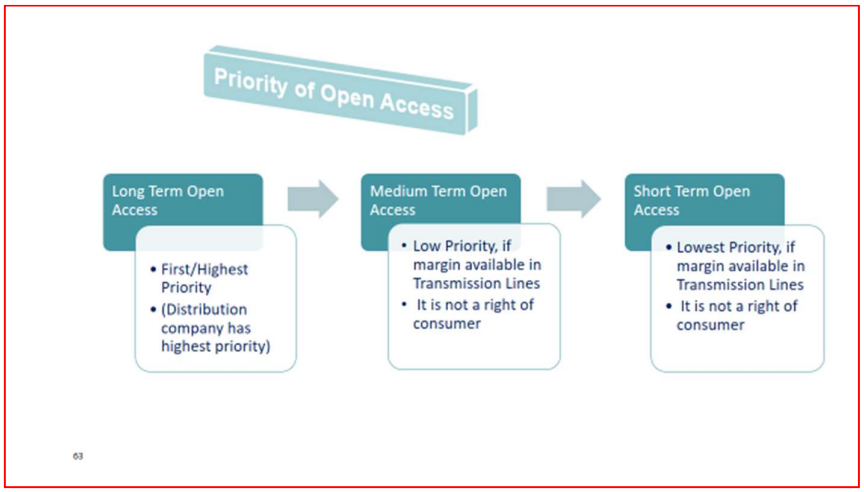
Priority of Open Access
Long Term Open Access
• First/Highest Priority
• (Distribution company has highest priority)
Medium Term Open Access
• Low Priority, if margin available in Transmission Lines
• It is not a right of consumer
Short Term Open Access
• Lowest Priority, if margin available in Transmission Lines
• It is not a right of consumer
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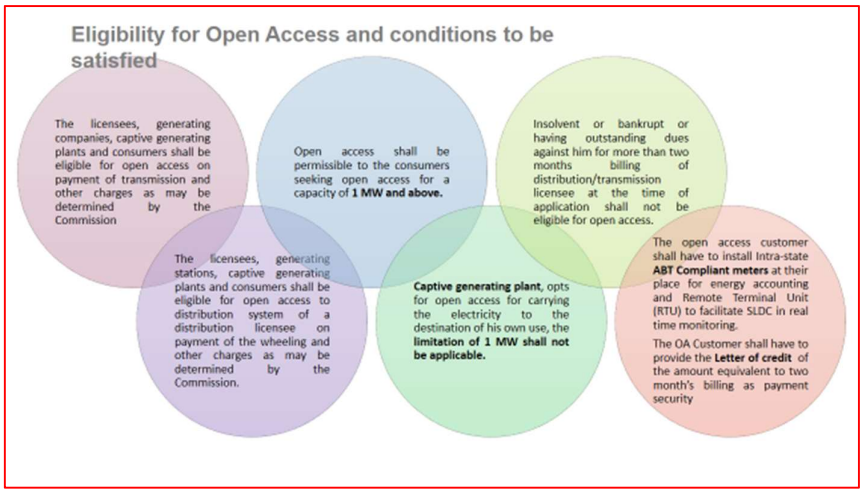
Eligibility for Open Access and conditions to be satisfied
The licensees, generating companies, captive generating plants and consumers shall be eligible for open access on payment of transmission and other charges as may be determined by the Commission
Open access shall be permissible to the consumers seeking open access for a capacity of 1 MW and above.
Insolvent or bankrupt or having outstanding dues against him for more than two months billing of distribution/transmission licensee at the time of application shall not be eligible for open access.
The licensees, generating stations, captive generating plants and consumers shall be eligible for open access to distribution system of a distribution licensee on payment of the wheeling and other charges as may be determined by the Commission.
Captive generating plant, opts for open access for carrying the electricity to the destination of his own use, the limitation of 1 MW shall not be applicable.
The open access customer shall have to install Intra-state ABT Compliant meters at their place for energy accounting and Remote Terminal Unit (RTU) to facilitate SLDC in real time monitoring.
The OA Customer shall have to provide the Letter of credit of the amount equivalent to two month's billing as payment security

Criteria for granting long-term access or medium-term open access or short term open access

- ✓ Before awarding long-term access, the State Transmission Utility shall have due regard to the augmentation required for the intra-State transmission system.
- ✓ Medium-term open access or short-term open access shall be granted if the resultant power flow can be accommodated in the existing transmission system or the transmission system under execution: Provided that no augmentation shall be carried out to the transmission system for the sole purpose of granting medium-term open access or short-term open access of the transmission system for the purpose of this regulation

Connectivity is not considered as deemed Open Access

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Regulatory Commissions

At the Center – CERC

- Powers to regulate centrally owned generating companies and companies having composite scheme for generation and sale of electricity in more than one State.
- To regulate inter-State transmission/Trading

In the States – SERCs

- Powers to regulate intra-State generation, transmission and distribution.
- CERC vis a vis SERCs.

No hierarchical relationship. However, SERCs are to be guided by the principles of tariff determination specified by CERC.

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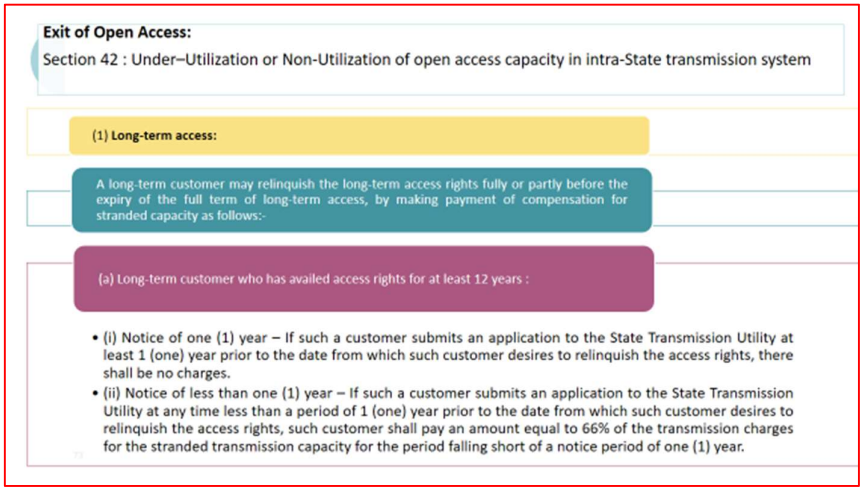
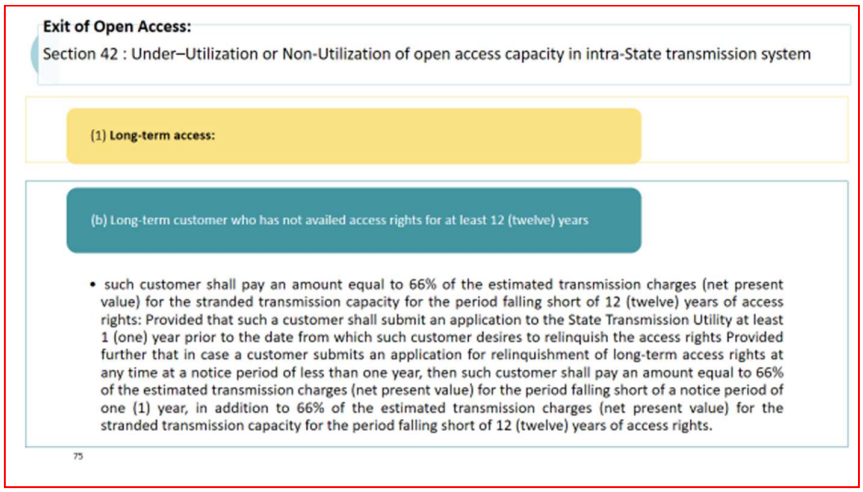

Exit of Open Access:
Section 42 : Under–Utilization or Non-Utilization of open access capacity in intra-State transmission system
(1) Long-term access:
A long-term customer may relinquish the long-term access rights fully or partly before the expiry of the full term of long-term access, by making payment of compensation for stranded capacity as follows:-
(a) Long-term customer who has availed access rights for at least 12 years :
• (i) Notice of one (1) year – If such a customer submits an application to the State Transmission Utility at least 1 (one) year prior to the date from which such customer desires to relinquish the access rights, there shall be no charges.
• (ii) Notice of less than one (1) year – If such a customer submits an application to the State Transmission Utility at any time less than a period of 1 (one) year prior to the date from which such customer desires to relinquish the access rights, such customer shall pay an amount equal to 66% of the transmission charges for the stranded transmission capacity for the period falling short of a notice period of one (1) year.


Exit of Open Access:
Section 42 : Under–Utilization or Non-Utilization of open access capacity in intra-State transmission system
(1) Long-term access:
(b) Long-term customer who has not availed access rights for at least 12 (twelve) years
• such customer shall pay an amount equal to 66% of the estimated transmission charges (net present value) for the stranded transmission capacity for the period falling short of 12 (twelve) years of access rights: Provided that such a customer shall submit an application to the State Transmission Utility at least 1 (one) year prior to the date from which such customer desires to relinquish the access rights Provided further that in case a customer submits an application for relinquishment of long-term access rights at any time at a notice period of less than one year, then such customer shall pay an amount equal to 66% of the estimated transmission charges (net present value) for the period falling short of a notice period of one (1) year, in addition to 66% of the estimated transmission charges (net present value) for the stranded transmission capacity for the period falling short of 12 (twelve) years of access rights.
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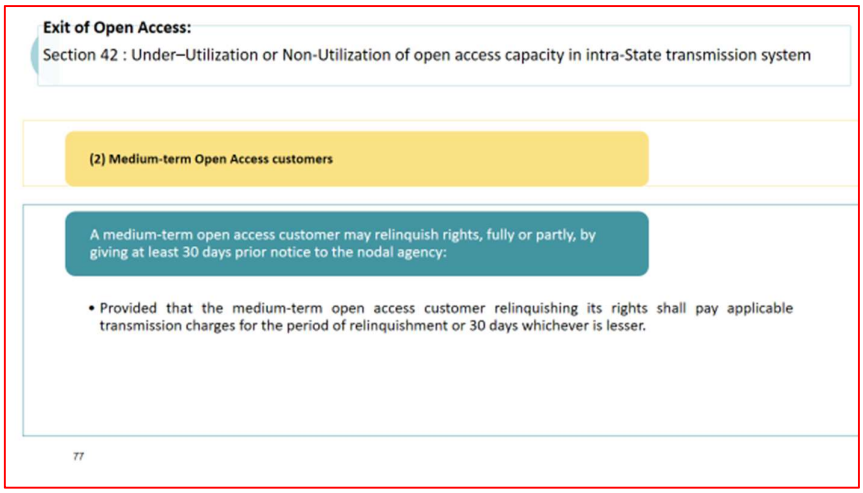
Exit of Open Access:
Section 42 : Under–Utilization or Non-Utilization of open access capacity in intra-State transmission system
(2) Medium-term Open Access customers
A medium-term open access customer may relinquish rights, fully or partly, by giving at least 30 days prior notice to the nodal agency:
• Provided that the medium-term open access customer relinquishing its rights shall pay applicable transmission charges for the period of relinquishment or 30 days whichever is lesser.
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Regulatory order related to connectivity and open access

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Current update of Open access

In 2022, the Government had notified Electricity (Promoting Renewable Energy Through Green Energy Open Access) Rules, 2022 in order to further accelerate India's ambitious programmers, with the objective of ensuring access to affordable, reliable, sustainable and for all.

These rules are notified for promoting generation, purchase and consumption of green energy including the energy from Waste-to-Energy plants.

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Key Features GOR

- There would be a uniform Renewable Purchase Obligation (RPO). Green Hydrogen/Green Ammonia has also been included for fulfillment of its RPO.
- Green Open Access would be allowed to any Open Access Consumer.
- The Green Open Access is allowed to any consumer and the limit of Open Access Transaction has been reduced from **1 MW to 100 kW** for green energy, to enable small consumers also to purchase renewable power through open access.
- The transaction limit would be a minimum of 100 KW for non-captive consumers, but there is no limit for open-access transactions that has been kept for captive consumers.
- Captive Consumers are individuals who have limited or no choice but to purchase a particular product or service due to various factors, such as market conditions, lack of alternatives, or contractual obligations.
- Consumers are entitled to demand supply of Green Power from Discoms. Discoms would be obligated to procure and supply green power to eligible consumers.
- Approval for Green Open Access is to be granted in **15 days** or else it will be deemed to have been granted.
- Commercial and Industrial consumers are allowed to purchase green power on a voluntary basis.
- Consumers will be given Green Certificates if they consume green power and will also be facilitated.

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Green Energy Open Access Regulation, 2024 (Notified by GERC on 20.02.2024)

The Regulations are applicable for green energy open access consumers who have contracted demand or sanctioned load of **100 kW or more**, either through single or multiple connections in the same electricity division of a distribution licensee. There is no capacity restriction for setting up of RE projects for captive use.

Application process:

The application for green energy open access shall be forwarded to the State Nodal Agency by the Central Nodal Agency for verification and **decision within 15 days**. The application shall follow a time schedule with different stages and deadlines as specified.

Processing fee:

The application shall be accompanied by a non-refundable processing fee of **Rs. 50,000 for long-term, Rs. 25,000 for medium-term, and Rs. 5,000 for short-term** green energy open access, payable to the State Nodal Agency

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- **Bank guarantee**:

  The application for long-term/medium-term green energy open access shall also be accompanied by a bank guarantee of **Rs. 50,000 for capacity less than 1 MW** and Rs. 1,00,000 per MW for 1 MW & above, which shall be refunded or encashed depending on the outcome of the application.

- **Payment Security Mechanism:**

  Long-Term Open Access, Medium-Term Open Access, shall require to provide an irrevocable Revolving **Letter of Credit or Bank Guarantee** in favour of the agency responsible for collection of various charges specified in these Regulations for the estimated amount of various charges for a period of two months

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New green energy plants:

New green energy plants or units seeking long-term green energy open access shall commission within 24 months from the date of application or the scheduled date of commencement, whichever is earlier, failing which the open access granted shall be cancelled.

Banking Charge:

The banking charge as **Rs. 1.50 per unit** for green energy open access consumers, effective from the date of notification of these Regulations up to 30th September 2024. After that, the banking charge will be decided by the Commission and notified separately

Inter-State Transmission:

If the green energy generator is connected with the inter-state transmission system/grid and supplies power to the consumer connected with the intra-state transmission and/or distribution system of the state, the banking facility will be governed by the applicable CERC Regulations and MoP Rules.

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- **Scheduling and RE-DSM**:

  The injection of energy from green energy generating stations to the grid will be subject to scheduling as per the GERC (Forecasting, Scheduling, Deviation Settlement Mechanism and Related Matters of Wind and Solar Generating Stations) Regulations, 2019 and relevant Orders of the Commission on different renewable energy-based projects. The green energy open access consumers from wind and solar energy will also be liable to pay deviation charges as per the RE-DSM Regulations.

- **Banked Energy**:

➢ The surplus energy after giving consumption set-off in a 15-minute time block basis will be accounted as banked energy and consumed by the consumer as per the provisions of these Regulations.
➢ The credit for banked energy will not be permitted to be carried forward to subsequent billing cycles and will be adjusted during the same billing cycle.
➢ The unutilized surplus banked energy will be considered as lapsed at the end of each billing cycle and the renewable energy generating station will be entitled to get Renewable Energy Certificate (REC) to the extent of the lapsed banked energy.
➢ Off peak period banked energy shall be utilised in off peak only.
➢ Peak Banked energy shall be utilised during off peak as well as Peak period.

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- **Captive Generating Plant (CGP)**:

  A power plant that is set up by a person or group of persons to generate electricity primarily for their own use.

- **Captive Consumer/User**:

  A person or group of persons who consume electricity generated from a CGP and satisfy the criteria of ownership and consumption as per the Electricity Rules 2005.

- **Criteria of ownership**:

  The captive consumer/user shall hold not less than 26% of the equity share capital with voting rights of the CGP throughout the year.

- **Criteria of consumption**:

  The captive consumer/user shall consume not less than 51% of the net electricity generated from the CGP on an annual basis, in proportion to their shares in ownership in the power plant.

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- **Verification of captive status**:

  The captive consumer/user shall submit the requisite documents to the distribution licensee and the Commission to prove their compliance with the criteria of ownership and consumption.

- **Consequence of failure to meet captive status**:

  The captive consumer/user shall lose their captive status for that year and shall be liable to pay cross subsidy surcharge and other charges as applicable on open access consumers.

- **Online** : Nodal agency to finalise procedure

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Thank you

V R Patel
Dy.Engineer (GETCO),
Energy Manager (BEE)

Solar PV Plant Technologies

By Asheesh Dhaneria, ERDA

Solar PV Plants Technologies

Asheesh Dhaneria, R&D Division
Electrical Research and Development Association (ERDA)
Vadodara

Automatic Solar PV Cleaning System

Automatic Solar PV Cleaning System

Product specifications:

Power source:	Inbuilt rechargeable battery (option for charging via own solar panel also available)
System control:	Automatic (mobile operation) and manual both
Length:	2170 mm (customizable - solar panel dimension)
Width:	352 mm
Height:	352 mm
Weight:	30 kg
Water capacity:	5 Litre
Voltage:	12 V DC
Cleaning system:	Water and water free
Operating temperature:	0 to 70 Deg C
Working and moving area:	On solar panel surface
Material:	Aluminium
Controller:	Electronic

Main features:

- Does not need human intervention to clean
- Directly mountable on existing PV structure system
- Rugged body
- No need of external power supply
- Solar PV panel for charging of the battery
- Auto detection of non-panel zone
- Auto reverse direction
- Size customizable → PV panel structure arrangement

Reactive Power Compensated Solar Inverter

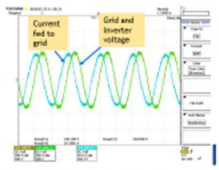
Specifications:

- Reactive power compensation feature in grid tied solar inverter
- Available modes for VAR compensation:
  - Fixed Q mode
  - Fixed pf mode
  - Volt-VAR mode
- Type: Single phase
- Rating: 5 kW
- DSP based digital design
- MPPT tracking with tracking efficiency greater than 99%
- Reliable grid synchronization
- Built in output isolation transformer

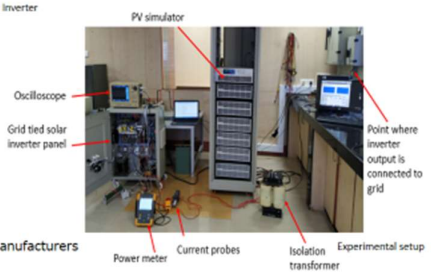
Advantages:
- Indigenous technology
- DSP controller based technology

Beneficiaries:
- Solar inverter manufacturers

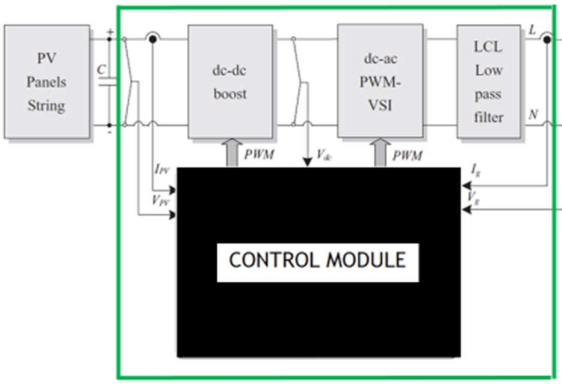
Solar inverter



Waveform for inverter current and voltage showing phase difference

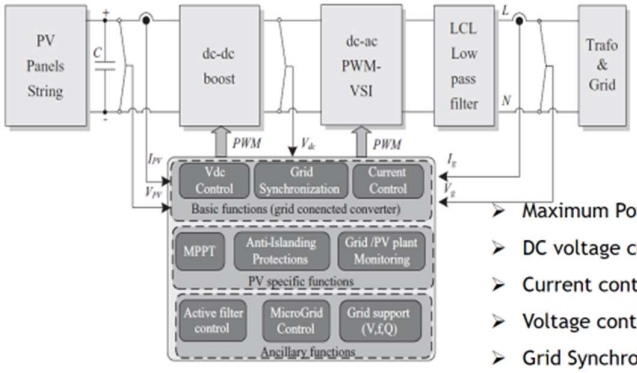


Block diagram – Grid connected Solar Inverter



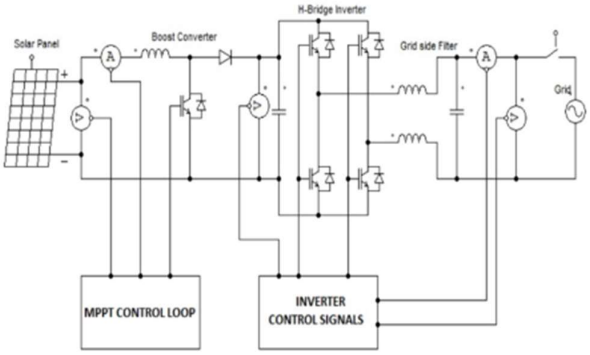
- DC to DC converter
- DC to AC converter
- LCL filter
- CONTROL MODULE

Control modules



- Maximum Power Point Tracking
- DC voltage control
- Current control
- Voltage control
- Grid Synchronization
- VAR compensation

Test setup



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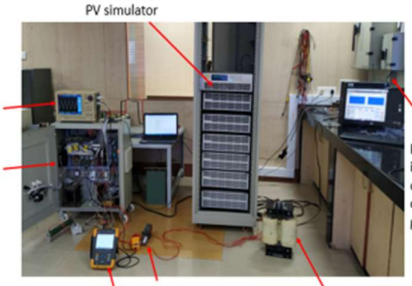
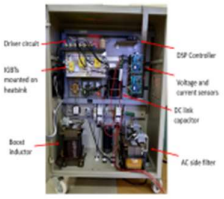
Test setup





Parameters	Values
Grid frequency	50 Hz
MPPT switching frequency	10 kHz
PWM switching frequency	20 kHz
Inverter nominal power	5 kW
Grid voltage	230 V

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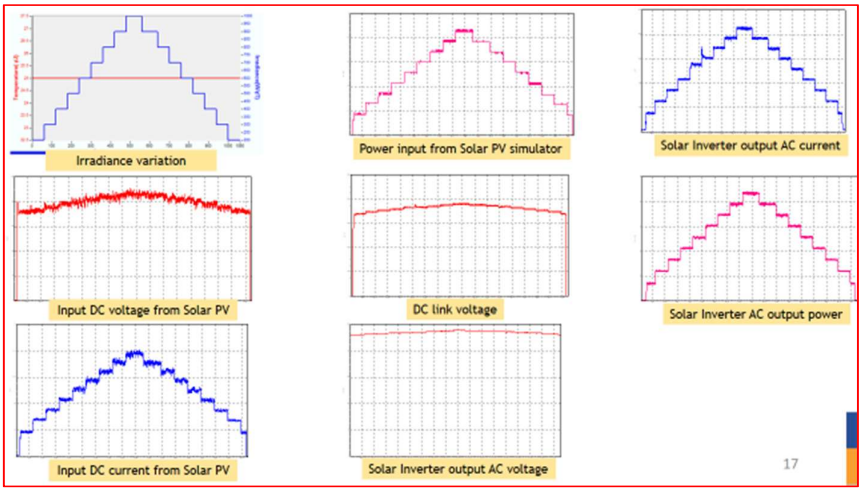

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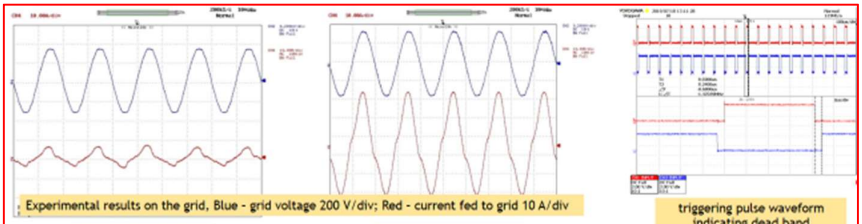
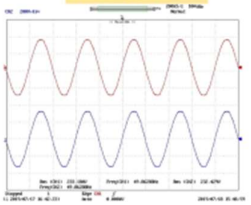


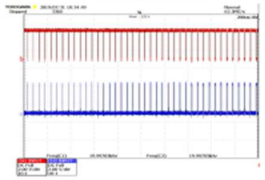
Experimental results on the grid, Blue - grid voltage 200 V/div; Red - current fed to grid 10 A/div

triggering pulse waveform indicating dead band

Solar irradiance: 200 W/m²

Solar irradiance: 1000 W/m²





Inverter output voltage and grid voltage

Switching frequency (20 kHz)

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VAR Compensation feature

Need ????

- Grid connected solar inverter operate at unity power factor
- Solar inverter provides active power only
- Load requirement - active and reactive power
- Currently Reactive power requirement catered by grid only
- Reactive power burdens the grid without contributing to the conduction of energy. So there is need to stabilize the grid using reactive power compensation.
- Dynamic and static devices: system operators add reactance and capacitance to the transmission system
  - Switching in inductor → reduces the voltage at connection point (absorbing reactive power from system)
  - switching in capacitors → raises the bus voltage at the point of connection (supplying reactive power)
  - Response speed is very slow (seconds / minutes)
  - Synchronous condenser → rotating machine → provides reactive power support and do not produce any real power
- Solar inverter → night time is neglected period → no control strategy for this period → no active power output in PV system at night → PV system is not used for about 50% of the time
- RE sources increasing penetration
- Utilization of PV inverter beyond active power generation and helps improving grid stability and voltage regulation.

Reactive power control methods

1) *Constant power factor.* While inverters operate at unity power factor by default, system designers can also configure them using this control mode to operate at a constant non-unity power factor, provided that the set point falls within the inverter's power factor range.
2) *Constant reactive power.* This control mode allows an inverter to produce a constant level of reactive power independent of real power production levels, which vary according to solar resource availability
3) *Real power–dependent operation.* When operating in this control mode, an inverter varies its power factor or reactive power magnitude according to characteristic curves—kW versus power factor or kW versus kVa reactive—that plant operators define by setting internal parameters in the inverter software
4) *Inverter-level voltage control.* When operating according to this control mode, an inverter varies its power factor or reactive power output based on the voltage at the inverter output terminals. Setting internal parameters in the inverter software and defining the desired characteristic curve for voltage versus power factor or voltage versus kilovolt-ampere reactive accomplish this. While some inverters support voltage control at the inverter level, most often a central plant controller manages PV plant voltage at the point of interconnection.
5) *Dynamic set point control.* In this control mode, the inverter dynamically adjusts its power factor set point or reactive power level according to a digital or analog signal sent from a central plant controller.
6) *Reactive power ramp rate.* This mode allows the system to control reactive power ramp rates in much the same way as real power ramp rates, whenever possible limiting the rate at which reactive power output ramps up or down.

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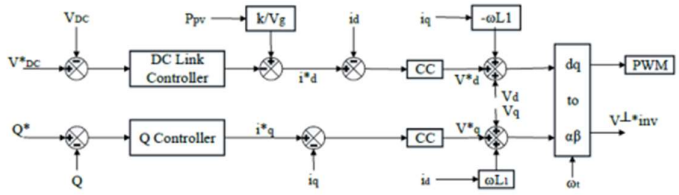
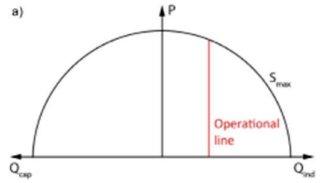
Control circuit

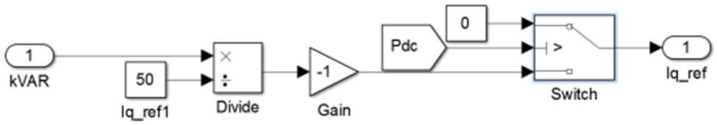


Fixed Q:

1) The inverter delivers or absorbs the same amount of reactive power regardless of other variables in the system.

2) The PV inverter will provide reactive power compensation even when it is not required.





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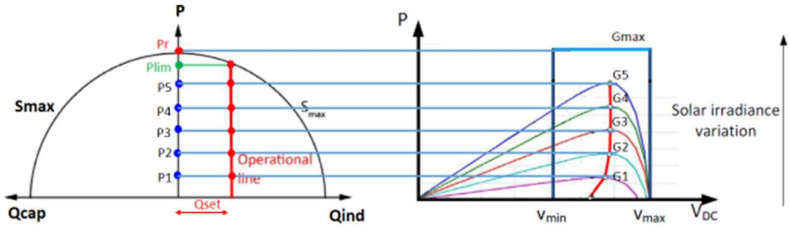
Fixed Q mode:



P-Q curve of Solar inverter

P-V curve of Solar panel

1/6/2025

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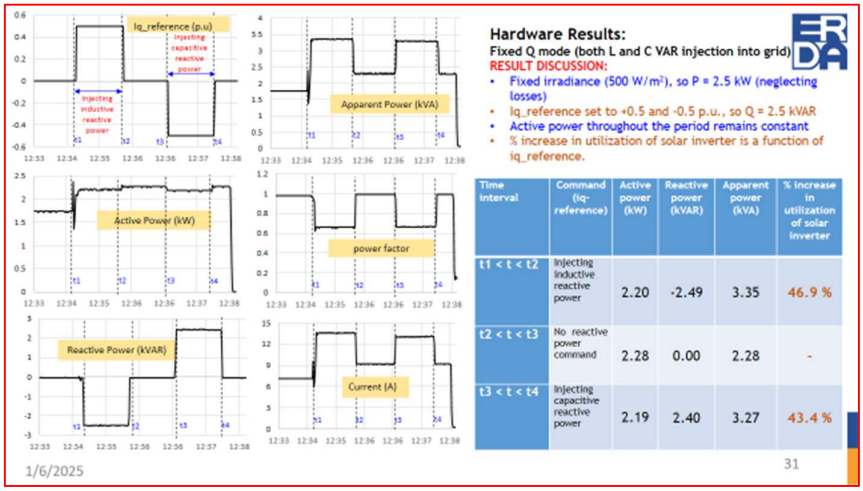
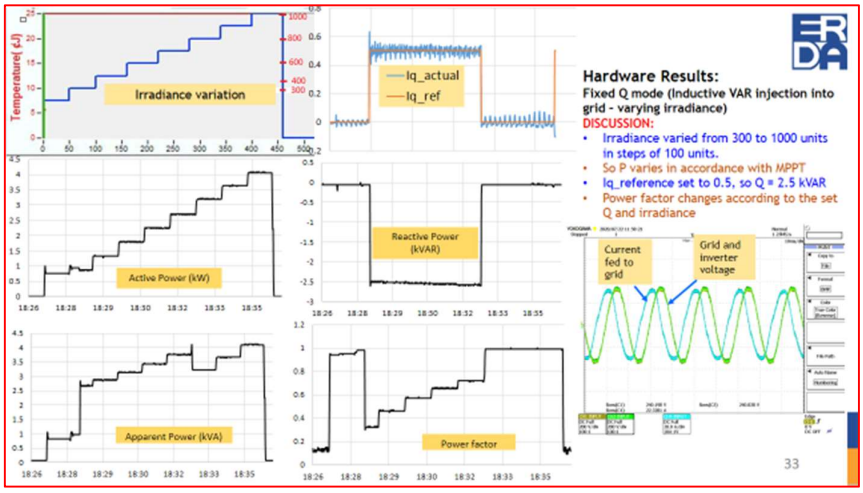
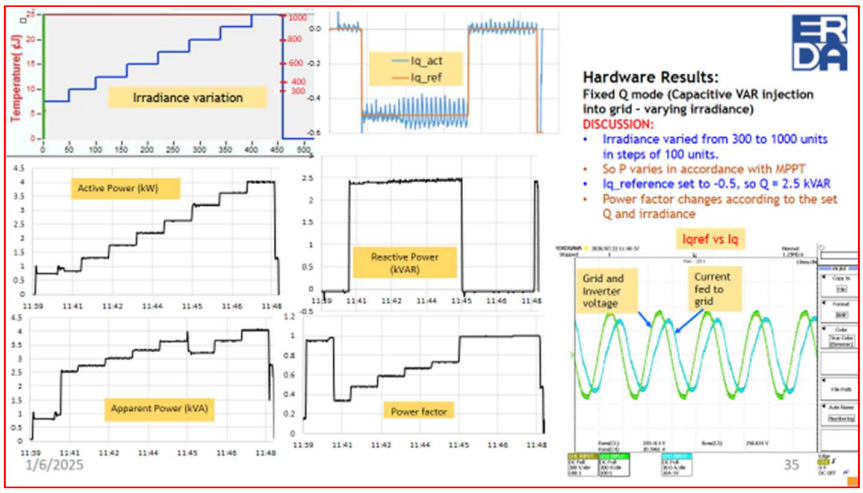


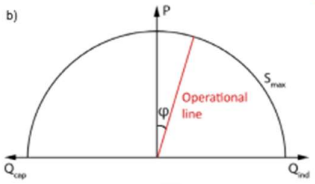
Time interval	Command (Iq-reference)	Active power (kW)	Reactive power (kVAR)	Apparent power (kVA)	% increase in utilization of solar inverter
t1 < t < t2	Injecting inductive reactive power	2.20	-2.49	3.35	46.9 %
t2 < t < t3	No reactive power command	2.28	0.00	2.28	-
t3 < t < t4	Injecting capacitive reactive power	2.19	2.40	3.27	43.4 %

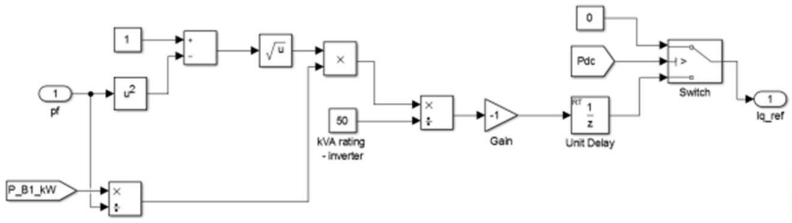




Fixed pf:

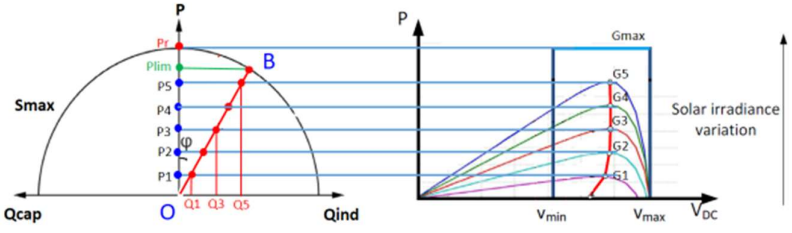
1) The generated reactive power is proportional to the active power.
2) PV inverter is forced to work at fixed pf.
3) The inverter will provide reactive power compensation although it may not be needed.





Fixed pf mode:

Line OB = set operational line



P-Q curve of Solar inverter

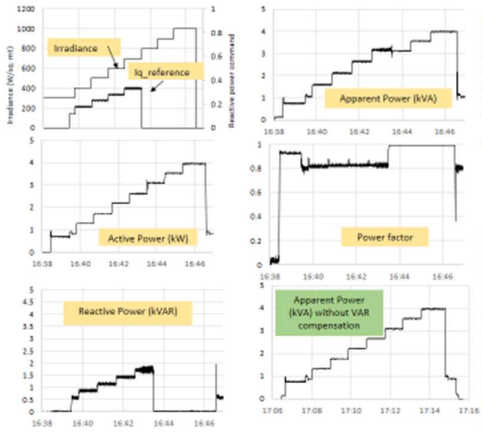
P-V curve of Solar panel

Hardware Results:

Fixed PF mode

RESULT DISCUSSION:

- Irradiance varied from 300 to 1000 units in steps of 100 units
- Pf set to 0.8
- Active power increases in accordance to Irradiance
- Iq_reference sets to value based on the set pf value and irradiance keeping in view the P-Q curve of the inverter
- % increase in utilization of solar inverter is a function pf.



Solar Irradiance (W/m^2)	Reactive power compensation (pf set to 0.8)			pf set to unity	% increase in utilization of solar inverter
	Active power (kW)	Reactive power (kVAR)	Apparent power (kVA)	Apparent power (kVA)	
300	0.74	0.13	0.83	0.76	9.2 %
400	1.29	0.87	1.59	1.32	20.5 %
500	1.74	1.15	2.11	1.77	19.2 %
600	2.17	1.44	2.63	2.21	19.0 %
700	2.61	1.68	3.16	2.65	19.3 %
800	3.08	0.00	3.11	3.09	0.7 %
900	3.52	0.00	3.55	3.53	0.6 %
1000	3.95	0.00	3.98	3.96	0.5 %

Patents: Granted

Sr. No.	Title	Patent No.	Date Of Certificate Issue
1	An on line fault sensor for oil filled transformer	204691	12/04/2007
2	Fault Current Limiter for switchgear and application	289733	20/11/2017
3	Martensitic low alloy steel hammer rings for coal application in ring granulators	319904	05/09/2019
4	Magnetically operated reed switch technology based integrally cast-light weight-gas operated buchholz relay for transformer protection	300645	03/09/2018
5	An improved online incipient fault sensor device for detection of incipient fault in oil-filled electrical apparatuses such as a transformer	341056	10/07/2020
6	Development of organo nano clay for polymer composite	266345	30/04/2015
7	Epoxy Nanocomposite material for insulation in medium and high voltage electrical appliances	418475	18/01/2023
8	Composition and novel process for advanced corrosion resistant paint	422128	17/02/2023
9	Method of making electrical contact tips for switchgears	430867	02/05/2023
10	Automatic solar panel cleaning system	504963	30/01/2024
11	Silver and carbon nanotube metal composite contact tips for switchgear	519775	05/03/2024
12	Voltage presence indicator for safety application in electrical panel	542669	24/06/2024

1/6/2025

Patents: Published

Sr. No.	Title	Publication number	Publication date
1	Anti-Dust / Self clearing coating composition and application thereof	21/2019	24/05/2019
2	A voltage tester device/system for safety application in electrical panel and method thereof	32/2022	12/08/2022
3	Voltage presence indicator for safety application in electrical panel	WO 2023/195017 A1	12/10/2023
4	A voltage tester device/system for safety application in electrical panel and method thereof	WO 2024/023828 A1	01/02/2024

1/6/2025

1/6/2025

Anti-Dust Coating for Solar PV Panels

Application:

Glass substrate of solar PV Panel

Specification:

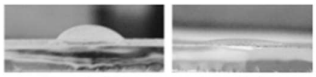
- Coating: Inorganic nano-coating
- Contact Angle: < 21° (Hydrophilic)
- Transmittance: 82 %

Advantages:

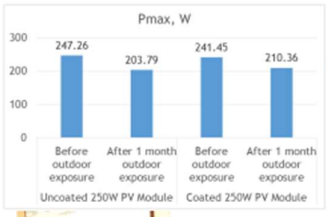
- Excellent Anti-dust properties & decomposes hydrocarbons and prevent organic growth
- Reduced cleaning frequency & hence, saving in expenditure for cleaning

Application Area:

- Approximately 75 ml for 1 sq. meters



Uncoated Glass | Coated Glass



Outdoor performance evaluation

Application of Coating Solar Panel by spray technique

Performance Evaluation: Uncoated & Coated solar PV

Patent Filed - No. IN 201721041951 dt. 23-11-2017

Technology available for sale...

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- MEDIA
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INDIAN WIND POWER ASSOCIATION

IWPA

helping mankind with energy from nature

KNOW IWPA

IWPA is a pan India Association of manufacturers, investors, generators, service providers and consumers of wind energy with more than 1400 members who have around 31 GW of wind energy installations in India. It has offices in seven wind rich states viz., Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Rajasthan, Tamil Nadu and Telangana.

Mission and Objectives of IWPA

To create an enabling regulatory and policy environment for investment in the wind energy sector, thereby supporting the national goals of energy access at affordable prices, economic development of India's manufacturing capacity, energy security and independence and meeting the goals of greater sustainability.

Activities of IWPA

- Actively participate with government in formulation of policy, rules and regulations pertaining to the wind sector.
- To closely liaise with State, Central Government and other agencies on matters affecting the wind energy sector and the interest of its members.
- To promote and protect the common interests of members.
- To collect and disseminate statistical, technical and other information regarding wind energy sector through a monthly magazine and e-mails distributed to all members free of cost.
- To affiliate with organizations having similar objectives.

Where does IWPA function?

IWPA's National Office is based in Chennai with Regional / State Council offices at New Delhi, Mumbai, Bengaluru, Hyderabad, Ahmedabad and Jaipur.

Benefits of being a member of IWPA:

- IWPA offers suggestions / comments and steers policy formulation at the State and National level for the benefit of stakeholders.
- IWPA's views are taken cognizance of and factored in the policy decisions concerning the wind industry.
- Interests of the stakeholders are protected through representations and follow-up with appropriate Regulatory / Government bodies.
- Offers a protective platform to enable members to fight contentious issues legally in a collective forum at an affordable cost.
- The Association organizes International Conferences and Workshops which help members to keep in step with the latest trends and developments in the wind industry.
- Association's activities like the Annual General Meetings, National Council Meetings, Issue based Meetings in various state capitals not only facilitates the dissemination of information, but also helps in networking with professionals from the wind industry.

Who can become a member of IWPA?

- Generating Members / IPPs
- Manufacturing Members (machines / ancillaries)
- Service Providers (including consultants)
- Small Wind & Roof Top (Generators and Manufacturers)
- Educational & Research Institutions and other Promotional Bodies
- Financial Institution Members
- Honorary Members
- Associate Members
- Associations in India
- International Membership

How does IWPA function?

Registered under Societies Act, IWPA works on democratic lines with well conceived Bye-Laws and Rules. The National Council, comprising of elected members, give broad guidelines for the functioning of the Association. The State matters are pursued by the elected members of the State Councils. The National Council Meetings are held by rotation at all Regional / State Council centres.

Serving more than 28 years
Indian Wind Power Association

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Ph : 044 - 4550 4036, 4550 4281 I E-mail : secretary.general@windpro.org I iwpahq@windpro.org
www.windpro.org

Solar Power Projects (Ground Mount)	8211.88(AC) MW
Solar Roof Top Projects	4625.79 MW
Solar Water Heating Systems	2,40,115 Sq.M
Wind Solar Hybrid Projects	1779.25 MW
Wind Energy Projects	10810.69 MW
Biomass Power Generation Projects	91.55 MW
Waste - to - Energy Projects	22.5 MW
Biogas Plants	31385 m^3 per/day
Improved Crematoria	8839 Nos
Energy Audits Water Pump/WTEA	4,450 Nos.
Energy Efficient LED Tube Lights	1,36,621 Nos
5 Star Rated Fans	97440 Nos
Battery Operated Two Wheeler	53192 Nos
Bal Urja Rakshak Dal (BURD) Programme	924 Schools, 46,000 Urja Rakshaks

Data as on 30th Nov. 2024

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