



Off-Grid Power Plants Stakeholder Workshop

12 January 2018

Workshop Agenda

CVK
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Consortium

- CVK Solar Enterprises Ltd
- Standard & Mutual Ltd
- Exeva Consulting Lt
- Murugu & Rigoro Advocates

No	Description	Slide No
1	Introductions & Purpose of Workshop	3
2	Off-grid Power Plants Background	
3	Insights from Example Experiences	XX
4	Review of Design Consultant Recommendations	yy
5	Summary Proposed Transaction Structure	XX
6	A Brief on the Proposed PPA	
7	Way Forward <ul style="list-style-type: none">• Transaction Documents – RFB, Technical Specifications, Business Plan & PPA• RFB Advertisement	

1. Introductions & Purpose of Workshop

CVK
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Consortium

- CVK Solar Enterprises Ltd
- Standard & Mutual Ltd
- Exeva Consulting Lt
- Murugu & Rigoro Advocates

- The CVK Consortium is made up of 4 firms – CVK Solar Enterprises, Standard & Mutual, Exeva Consulting Ltd and Murugu & Rigoro Advocates

2. Off-grid Power Plants Background

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- CVK Solar Enterprises Ltd
- Standard & Mutual Ltd
- Exeva Consulting Lt
- Murugu & Rigoro Advocates

- The CVK Consortium is made up of 4 firms – CVK Solar Enterprises, Standard & Mutual, Exeva Consulting Ltd and Murugu & Rigoro Advocates

3. Insights from Example Experiences - Introduction

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- Exeva Consulting Lt
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- We wish to share insights from executed assignments as we use this knowledge in recommending a structure for KEMP and could be borrowed for KOSAP
- The examples are drawn from India and World Bank and Government of India (GoI), therefore, has a lot of parallels with KEMP
- Consultancy Provided by CVK included site selection, scheme, bid documents, bids scrutiny, contract award, approval of design, support in supervision, witness of commissioning, co-ordination with DISCOM and RVPN (STU), generation reports, verification of generation viz guaranteed generation, O&M of plant, submission of Bills to Discom and Energy verification for REC

We will discuss:

- 5 MW SOLAR POWER PLANT OF OIL INDIA LTD (GOI PSU) AT RAM GARH JAISELMER with 11 km 33 kV line (Com March 2014)
- 9 MW SOLAR POWER PLANT OF OIL INDIA LTD (GOI PSU) AT RAM GARH JAISELMER (Com Feb 2016)
- 350 KW Solar Plant of HPCL (GOI PSU) AT REFUELING PLANT AT SALAWAS JODHPUR (Drawings approved now under erection)

3. Insights from Example Experiences – 5MW Solar Power (Oil) Plant

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- DC Capacity: 5 MW
- AC Capacity: 5 MW
- BIDDING: ON Line, Single Stage Two Bids System
- Bidding through: E-procurement portal , Fixed prices
- Bidding Fees: NO , E portal registration required
- Scope:
 - 1) Design, Supply ,Installation
 - 2) Comprehensive O&M for 25 Years
- Security BG : 1% of plant Cost + O&M cost
- Generation Guarantee: Bidders To offer Generation Guarantee Every years for 25 years with penalty recovery on default .
- Bid Evaluation: Bid rejection Criteria
- Completion Time: 6 months
- Price bid: Opened of Technically Qualified Bidders
- Land Provided: Oil India Ltd
- Plant Commissioned: 23 January 2014

3. Insights from Example Experiences – 5MW Solar Power (Oil) Plant (Contd)

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- Order Placed on: M/S Moser Bear Solar Ltd
- Modules : Moser Bear India
- Inverters: ABB
- Project Completed: 23 January 2014
- PPA : Oil India Ltd and Raj Discom
- Security Cum PBG: Rupeess
- Generation Guarantee: Every year Defined Generation
- Comprehensive O&M Period: 25 Years

3. Insights from Example Experiences – 9MW Solar Power (Oil) Plant

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- Financial Criteria
- Internal Resources Generation : 2.7 Crores (0.3 Cr/ MW)
- Net Worth : 27 Crores (3 Crores /MW , Overall cost 6 Crore/ MW)
- Annual turn Over: 35 Crores

Experience

- Similar project : Design, Supply, Erection Commissioning, including O&M
- Minimum Capacity 5 MW of 1 MW or more
- One of project must be working successfully at least for Six months

3. Insights from Example Experiences – 9MW Solar Power (Oil) Plant (Contd)

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- DC Capacity 9 MW
- AC Capacity 9 MW
- BIDDING ON Line, Single Stage two bids system
- Bidding through E-procurement portal
- Bidding Fees NO, E portal registration required
- Scope 1) Design, Supply ,Installation
- 2) Comprehensive O&M for 25 Years
- Security B G : 77.7 Lakhs, 1% of plant Cost + O&M cost (6 crores/MW +23.7 crores)
- Generation Guarantee : Bidders To offer Generation Guarantee Every years for 25 years with penalty recovery on default .
- Completion Time : 6 months
- Price bid : Opened of Technically Qualified Bidders
- Validity of offer : 120 days
- Land provided : Oil India Ltd after allotment from Govt.

3. Insights from Example Experiences – 9MW Solar Power (Oil) Plant (Contd)

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- Bid rejection Criteria
- Not meeting Financial and Technical qualification
- Bid Evaluation :
- Non submission of EMD
- Not submitted before Scheduled Date and time
- Not submission of requisite certificates or Documents
- Conditional Bid
- If Prices quoted in other than price bid
- Non submission of any Annexure or Schedule
- Financial Criteria
- Internal resources Generation : 2.7 Crores (0.3 Cr/ MW)
- Net Worth : 27 Crores (3 Crores /MW , Overall cost 6 Cr/ MW)
- Annual turn Over: 35 Crores

Experience

- Similar project : Design , Supply , erection Commissioning , including O&M
- Minimum Capacity 5 MW of 1 MW or more
- One of project must be working successfully at least for Six months

3. Insights from Example Experiences – 9MW Solar Power (Oil) Plant (Contd)

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- Financial evaluation
- Overall Project IRR
- Total Cost Of EPC
- Total O&M charges for 25 years
- NMGG
- Fixed Tariff APPC price +REC Cost (Rs 9.4/KW hr)
- 100 % equity Of OIL India Ltd (No loan)
- Bidder with Highest IRR (up to three decimal) bidder was selected
- Order Placed on : Ujaas Energy Ltd
- Duration of Contract : Project Comp Period from LOA 6 months
- O& M contract period : 25 years from Date of Commissioning .

3. Insights from Example Experiences – 9MW Solar Power (Oil) Plant (Contd)

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- Security Deposit Cum performance Bank Guarantee:

i) 7.5 % of EPC contract Order Excluding O & M cost

Period : Up to 10 O&M Period from LOA.

ii) 5 % of EPC contract Order Excluding O & M cost

Period : balance 11 to 25 years O&M period

iii) BG Validity 5 years & Extension of BG after every 5 years .

Contractor has Submitted Complete Design of Plant and plant execution as per design .But basic parameters were given.

- Scope Of O&M : washing, Security
- Bidder Offered: Every Year Generation Guarantee as Quoted in Bid
- Payment of O&M: Every Quarterly after O&M period . Every Year rate is fixed for 25 years .
- Insurance During O&M
- Oil India : GOD Acted Earthquake, Fire, Thunderstorm

3. Insights from Example Experiences – 350kW Solar Power Plant (HPCL)

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- DC Capacity 385 kW
- AC Capacity 350 kW
- BIDDING ON Line, Single Stage two bids system
- Bidding through E-procurement portal
- Bidding Fees NO, E portal registration required
- Scope 1) Design, Supply ,Installation
- 2) Comprehensive O&M for 5 Years
- Validity of offer : 120 days
- EMD/BID B G : 5.34 Lakhs, 1% of plant Cost
- Plant Performance : Demonstrate Performance of plant after commissioning .
- Completion Time : 180 days from LOA
- Price bid : Opened of Technically Qualified Bidders
- Land provided : In HPCL Plant itself
- Scheme : Net metering . Basically captive use

3. Insights from Example Experiences – 350kW Solar Power Plant (HPCL) (Contd)

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- Exeva Consulting Lt
- Murugu & Rigoro Advocates

- Technical Evaluation :
- Bid rejection Criteria
- Not meeting Financial and Technical qualification
- Non submission of EMD
- Not submitted before Scheduled Date and time
- Not submission of requisite certificates or Documents
- Conditional Bid
- If Prices quoted in other than price bid
- Non submission of any Annexure or Schedule

Experience

- Similar project : Design , Supply , erection Commissioning , including O&M and in operation for at least one year .
- Three similar projects each of 1.07 crores Or
- Two similar projects of each of 1.34 crores Or
- One similar project 2.14 crores Or

3. Insights from Example Experiences – 350kW Solar Power Plant (HPCL) (Contd)

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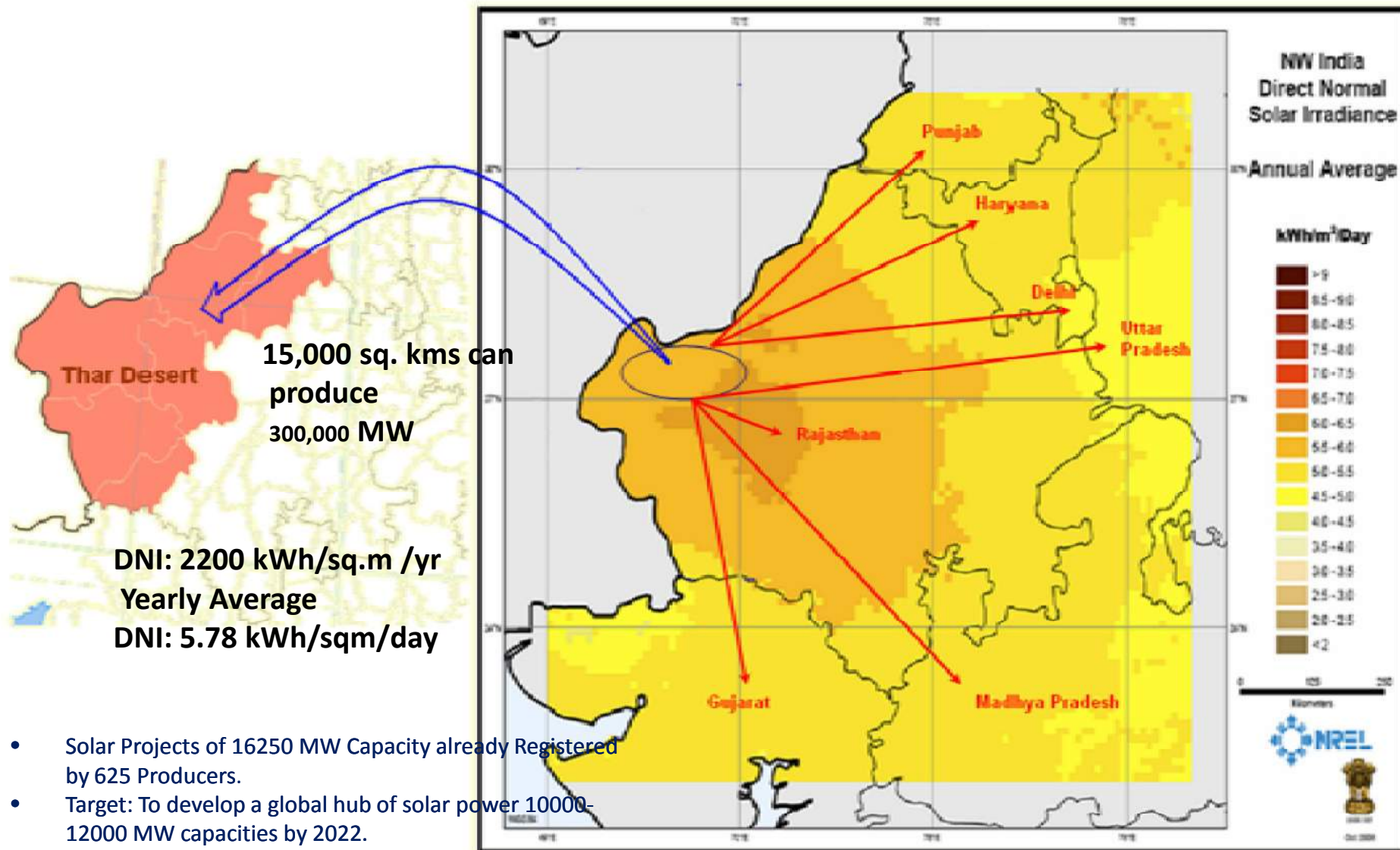
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- Bid Evaluation Cont :
- Technical Scrutiny
- Financial Criteria
- Annual turn Over: Average Turn over for Last 3 years 81 lakhs (approximately 1.5 times plant cost)
- Price bid of Technical acceptable Offer shall be opened
- Least Price of entire contract Selected
- Order Placed on M/ KEC
- Contract Design , Supply, Installation and Performance demonstration of Plant .
- Comprehensive O&M of Plant for 5 years including all spares washing etc . Security is done by HPCL staff .
- 350 kW plant is integrated to 625 kW plant . As load is of order 450 kW
- 250 kVA DG set is not integrated to avoid power feed in to DG set

3. Insights from Example Experiences – Scenario of Solar Energy in Rajasthan (India)

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- Solar Projects of 16250 MW Capacity already Registered by 625 Producers.
- Target: To develop a global hub of solar power 10000-12000 MW capacities by 2022.
- Rajasthan is poised to become International Solar Hub

4. Review of Design Consultant Recommendations

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- ❑ **All the Design Consultants (DC) Lot-1, Lot-2, Lot-3 have forecasted the five year demand mainly**
 - Based on present population and their financial status
 - Possibility of present domestic and commercial consumers and their estimated present demand.
 - House hold, Commercial and other social activity in that area
 - Likely demand of 5 years based on future growth of present status.
- ❑ On basis of estimated demand in 5 years Design Consultants have arrived at some value of Plant size.
- ❑ Design consultant's important study outcome is that approx 70% power is consumed in 6 to 11 pm and approx 30 % of power is likely to be consumed in Day hours .
- ❑ Type, Size and DOC of Battery System and its location in system plays important role in plant design.
- ❑ **Design Consultants have clearly stated that the demand estimate presented by them in report should not be seen as an attempt to exactly represent what the future will be.**

4. Review of Design Consultant Recommendations (Contd)

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- ❑ All the three Design Consultants (DC Lot-1, 2 & 3) have made good work and recommended the results based on their best efforts, know how and studies.
- ❑ All (DC Lot-1, 2 & 3) have made power plant design & estimated the Power Distribution Network in their own ways so each differs viz a viz others .
- ❑ As DC Lot-1,2,&3 results and recommendations are also not on common footing so these are required to be harmonized if Bid documents are to be issued on same footing as well as KPLC norms .

Power Plant with Inverters and Battery

Design Consultant Lot -1 (ECA,TTA & Carbon Africa)

- **Takawiri** : 118 kWp PV, 100 (4x25) kW Inverters, 50 kW x 5 battery Lithium-ion, 1set Power pack Inverter /charger (Type Tesla) 400 Vac, NO DG Set.
- **Ngodhe** : 89.1kWp PV, 75 (3x25) kW Inverters, 50 kW X3, battery Lithium-ion,1 set Power pack inverter Charger (Tesla) 4300 Vac , No DG Set.
- **Mageta**: 594 kWp PV, 500(20x25) kW Inverters , 50x20 kWh battery Lithium-ion, Power pack inverter/charger (Type Tesla) 400 Vac, 630 kVA 400/11kV transformer with 11 kV Gas Insulated Switchgear, No DG Set.

4. Review of Design Consultant Recommendations (Contd)

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❑ Design Consultant Lot -2 (IED)

- 350kWp PV, 350(14x25) kW Inverters, 1984kWh Multi Functional Inverter Devices

❑ Design Consultant Lot -3 (University of Southampton)

- 59.4kWp PV, 48V 4500Ah Battery Storage, 30kWp Inverter, 30kW Generator
- 40.5kWp PV, 48V 3000Ah Battery Storage, 24kWp Inverter, 20kW Generator
- 40.5kWp PV, 48V 3000Ah Battery Storage, 30kWp Inverter, 20kW Generator
- 59.4kWp PV, 48V 4500Ah Battery Storage, 30kWp Inverter, 30kW Generator

❑ Power Distribution Network

❑ Design Consultant Lot-1 (DC Lot-1)

- 100 kW AC Plant at Takawari : 7.09 km Service line , 3 phase 415 V , 1 phase 230 V . Which is in order .
- 75 kW AC Plant at Ngodhe : 4.305 km , 3 phase 415 V , 1 phase 230 V . Which is in order
- 500 kW AC Plant at Mageta : 630 kVA 5.55 km 3 phase 11kV line ,32.2 km 3 phase 415 V & 1 phase 230 V . Which is in order

❑ Design Consultant Lot-2 (DC Lot-2)

- 350 kW AC Plant at Wasini-Mkwiro : 5.635 km 3 phase 11kV line ,3.78 km 3 phase 415 V &1.61 km 1 phase 230 V . Which is in order

4. Review of Design Consultant Recommendations (Contd)

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□ Design Consultant Lot -3 (University of Southpatam)

❖ 59.4kWp PV at Kerio

- 1X250kVA 0.415/33kV Step- Up Sub-station., 3.0km of 33kV overhead line
- 4 no 50kVA 33/0.415kV transformer sub-stations
- 0.860 km of 3-phase 4-wire & 7.88 km of single phase 2-wire overhead
- lines in 50mm² AA bare conductor
- 3no. 3-phase service lines in 25sqmm 4/core Aluminium underground cable.
- 135no. S-phase overhead service lines in 10(16) mm² Al cable.

❖ 40.5kWp PV at Kaeris

- 1X250kVA 0.415/33kV Step- Up Sub-station.
- 3.2km of 33kV overhead line in 75mm² ACSR conductor,
- 4 no 50kVA 33/0.415kV overhead transformer sub-stations
- 1.2km of 3-phase 4-wire and 4.24km of single phase 2-wire overhead lines in 50mm² AA bare conductor
- 6no. 3-phase service lines in 25sqmm 4/core Aluminum underground cable.
- 112no. S-phase overhead service lines in 10(16) mm² Al cable.

4. Review of Design Consultant Recommendations (Contd)

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□ Design Consultant Lot -3

❖ 40.5 kWp PV at site Nana

- 1x 250kVA 0.415/33kV Step-Up Sub-station ,
- 1.7km of 33kV overhead line in 75mm² ACSR conductor,
- 3 no 50kVA 33/0.415kV overhead transformer sub-stations
- 1.1km of 3-phase 4-wire and 4.9km of single phase 2-wire overhead lines in 50mm² AA bare conductor
- 4 no. 3-phase service lines in 25mm² 4/core Aluminum underground cable.
- Provide 105 no. S-phase overhead service

❖ 59.4 kWp PV at site Dabel

- 1x 315kVA 0.415/33kV step-up sub-station.
- 4.4km of 33kV overhead line in 75mm² ACSR conductor,
- 6 no 50kVA 33/0.415kV overhead transformer sub-stations
- 1.725 km of 3-phase 4-wire and 9.28km of single phase 2-wire overhead lines in 50sqmm AA bare conductor
- 9 no. 3-phase service lines in 25mm² 4/core aluminum underground cable.
- 130no. S-phase overhead service lines in 10(16) mm² Al cable.

4. Review of Design Consultant Recommendations (Contd)

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□ Design Consultant Lot -3

- Has given also details of 33 kV and 415 volts and PDN .
- Recommended that Nana is 4 km from grid as such it should be connected to Grid.

□ Design Consultant Lot -2 Recommendations

- As per their design modules shall be oriented to the North with 10° tilt.
- The solar field is the main source of electricity production corresponding to 95% of the used electric energy in 2022.
- The DG set is sized with a minimum capacity of 100 kW in order to supply most of the users in case of failure of the solar or the battery system.

□ Land

- ❖ DC Lot-1 has identified the Land for plant but same is less than required
 - Mageta 500 kWAC: Available Area 3750 Sq m , Required Area 6615 Sq m,
 - Ngodhe 75 kWAC: Available Area 240 Sq m , Required Area 940 Sq m,
 - Takawiri 100 kWAC: Available Area 2542 Sq m , Required Area 1230 Sq m,
- DC Lot-2 has identified the location of Land.
- DC Lot-3 has identified the location of Land.

4. Review of Design Consultant Recommendations – The Differences

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❑ **DG Sets**

- DC Lot -1: DG set is not likely used so they have not considered the same in design.
- DC lot-3 has considered the DG set of -----kw and ---- for -----kW solar plant capacity.
- DC Lot 2 suggested the DG set of capacity 116 kW for solar plant of 350 kW capacity.

❑ **PDN Details**

- DC Lot-3 has given the material details of 33 kV and 415 Volts and 230 Volts lines .
- DC Lot-1 has not given the material details of 11kV , 415 V and 230 V Lines .
- DC Lot-2 has not given the material details of 11kV, 415 Volts and 230 Volts Lines .
- **Transaction Adviser View**
- 33 kV and 415 Volts PDN for Mini Grid must be Grid level and must meet the norms of KPLC so it must be as per standard practice .

❑ **Design Related Recommendations**

- DC Lot-2 suggested a design with modules oriented to the North with 10° tilt for Wasini, whereas others have not made such recommendations .
- DC Lot-2 stated that solar field is the main source of electricity production corresponding to 95% of the used electric energy in 2022.

4. Review of Design Consultant Recommendations – The Differences (Contd)

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❑ DC To AC Ratio of Solar plants

- Design Consultant M/S IDC has mentioned that PV DC should not be more than 15% of AC System. But they have kept 350 kWp with 350 AC inverters .
- DC Lot -1 design has DC to AC ratio in order of **19%**
- DC Lot-3 design has different DC to AC ratio.

❑ TA View/ Suggestion

- In India Solar plants are basically defined as per AC plant capacity (Being Fixed) based on sizes of Inverters . The DC capacity of plant is variable client to client . It can be same or higher to the AC capacity in range of 1 to 1.2 or so .
- Based on recommendation of M/S IDC , Transaction Adviser has kept DC to AC capacity ratio as 1.15 and specified in Bid document.
- **The modules capacity / efficiency de-rates with time and is reduces to 90% after 10 years and 20 % after 25 years . Thus to take care this factor and losses in DC circuit up to inverters it is a very common practice to keep the DC to AC ratio of 1.2 . Inverter can take care extra overloading due to this aspect .**
- **In Bid documents our suggestion is to put AC capacity of plant .**
- **Special for Mini Grids: In initial stages load will be less while after 5 years/ 10 years load will grow and module generation capacity will reduce so for Mini grid projects REA should go for DC to AC ratio of 1.2. This will result in early wake up of Inverter give additional cushion to charge the battery also .**

4. Review of Design Consultant Recommendations – The Differences (Contd)

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□ Modules Size

- **DC Lot-1** have suggested 60 cells, 275 Wp (minimum) modules of grater than 16% efficiency.
- **DC Lot-2** have suggested 60 cells modules of efficiency more than 16.2% .
- **DC Lot-3** has suggested 72 cells modules of 300 Wp .
- **TA Views**
 - ❖ Solar plant design is with Bidder. They should be allowed to select size as per availability in market economically with meeting our efficiency requirements.
 - ❖ Bidder will design the plant layout as per modules sizes. If land availability is less than he is required to go for higher size wattage .
 - ❖ Modules are available in market now a days in 315/320/325/330 /335Wp of 72 cells while 270/275/280/285 Wp of 60 cells .
 - ❖ Nowadays 325 Wp (72 cells) / 275 Wp (60 cells) or higher capacity modules are being produced by manufacturers of efficiency more than 16% in view of big demand of more than 10000 -20000 MW Solar Projects in India, China etc .
 - ❖ Design of Solar Plant with higher capacity modules is more economical and space requirement is less . So we have allowed modules of 72 cells / 60 cells with minimum efficiency of 16% .
 - ❖ CVK has experiance of using 100 kW of 325 watts Adani make modules of efficiency 16.3% for our roof top plants in view of space limitations

4. Review of Design Consultant Recommendations – The Differences (Contd)

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➤ **Module Mounting Structure (MMS) Material**

- In view of corrosive environment in islands, DC Lot-2 suggested use MMS of Aluminum .
- DC Lot-3 has suggested MMS of Aluminum in their design .
- Whereas DC Lot-1 has suggested MMS of Galvanized Steel.
- **TA Views**
- MMS of Hot Dipped Galvanized Steel is used to minimize the investment cost.
- **In island the sites of Mini Grid Solar plants are prone to high winds .**
- Wind pressure plays important role not only in design of MMS structures but also for its foundation. If they are not of properly designed wind pressure on modules pulls out MMS along with Modules. The Hot dipped Galvanised Steel Structures are comparably more Sturdy and also have Nut, bolts and Washer etc are of stainless steel . The MMS Structure leg is in general part of the foundation. So they provide compact design as well as sturdiness in overall to MMS.
- In line material KPLC and REC must be using the hot dipped galvanised steel and nuts washer etc of Stainless Steel. Although water in Rajasthan is salty but in almost 1000 MW solar plant only MMS of hot dipped galvanised has been used .
- In renovation work Aluminum paint is commonly used for Steel Structures . Same can be used by O&M staff in case of any contingency .
- In Bid documents, we have referred MMS of hot dipped galvanized steel and Bidder is allowed to offer alternately MMS of aluminum .

4. Review of Design Consultant Recommendations – The Differences (Contd)

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☐ Poles for Distribution lines

- DC lot -3 has mentioned that
- All sites are in semi-arid areas with many ants and ant hills evident. Wooden poles are not sustainable in these areas as they are eaten by termites leading to collapse. Most of the installed wooden poles in these areas are now rotten and being replaced by concrete poles.
- Eco and concrete poles should therefore be considered for these projects.
- The fittings used should be Aluminum and Steel as per national grid.
- DC Lot -1 and Lot -2 has not given details of Distribution line. They have given the tentative map of lines .
- **TA Views**
- Power Distribution Lines are to be as per Norms and practice of KPLC . So We should follow the practice of KPLC .
- The above aspect is also important and proper attention is required since they are property of KPLC .
- In Bid documents we have to categorically specify that poles of cement or ECO is needed if wooden poles are to be avoided . Otherwise Bidder will use the wooden poles being economical .
- Presently we have mentioned in Bid documents that as per norms of KPLC, PDN will be constructed .

4. Review of Design Consultant Recommendations – The Differences (Contd)

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□ Voltage of Distribution lines

DC Lot-3 has used 33 kV lines and 33 kV transformer for a plant of 30 KW AC and 24 kW AC plants as under :

- 1X250kVA 0.415/33kV Step- Up Sub-station., 3.0km of 33kV overhead line
- 4 no 50kVA 33/0.415kV transformer sub-stations

□ TA Views

- There are norms of each Distribution agency that what should be voltage for a particular load. Every transmission line and transformer has its losses and generator is to meet out these also in addition to meet the load requirement .
- We can not put a small generator to a very high Voltage system .
- DC lot -1 has suggested 415 Volt service line for 100 kW AC plant and 75 kW AC plant . Now if we put 33 kV lines and 250 KVA +200 KVA transformers with only 30 KW AC solar plant or 24 KW AC Solar plant then it will be not correct .

□ Practices in In India

- In general 250 kW plant - 2 MW plant is connected to near by 33/11 kV GSS at 11 kV level by 11 kV line .
- Solar plant of 5 MW and above is connected to 132 kV /33 kV GSS at 33 kV level by 33 kV line .

4. Review of Design Consultant Recommendations – The Differences (Contd)

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□ Storage Battery

- DC Lot-2 recommend to use lead-acid OPzS type batteries with gas recombination systems/ OPzV type/ “gel” lead-acid batteries are “maintenance less”
- DC Lot -2 used Outdoor type battery inverters in estimation.
- DC Lot -1 has used Battery Power Pack in Design of plants .
- DC Lot-2 recommended alternately Lithium-ion batteries because of Longer Life time
- DC Lot-1 recommended 50 kW Lithium -ion battery Power Pack with Tesla Power Pack Inverter / charger and Vac is 400 V .
- DC Lot-3 recommended Solar 1500 Volt Ritar battery .
- **DOC**

TA View

- **Power Pack of 50 KW of lithium-ion Battery with Tesla Power pack inverter or similar for a nominal Voltage of 400 VAC suggested by DC lot -1 is a good option .**

4. Review of Design Consultant Recommendations – The Differences (Contd)

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- This system has following advantage
- Lithium batteries have a long life.
- The solar power plant will be have PV system and inverter like a Grid connected System . In future if Grid arrives than we have to just Disconnect the Power Supply from battery and plant will be run like Grid connected .
- Lead Acid OPzS battery has not such a long life as that of Lithium. REA has to keep provision of replacement of Lead Acid OPzS battery 2 times in 15 year period . While for lithium Battery one replacement will be suffice in 15 year tenure .
- 70% load of consumers during 6 pm to 11 pm is going to be catered by Battery so reliable battery must be chosen and to be indicated in Bid documents . If we indicate any alternative than bidders will supply the same and if battery is consumed than not replaced timely then REA has to face the Consumers .
- Thus we should add in Bid it self that REA will be needed one replacement of Battery in O&M period .

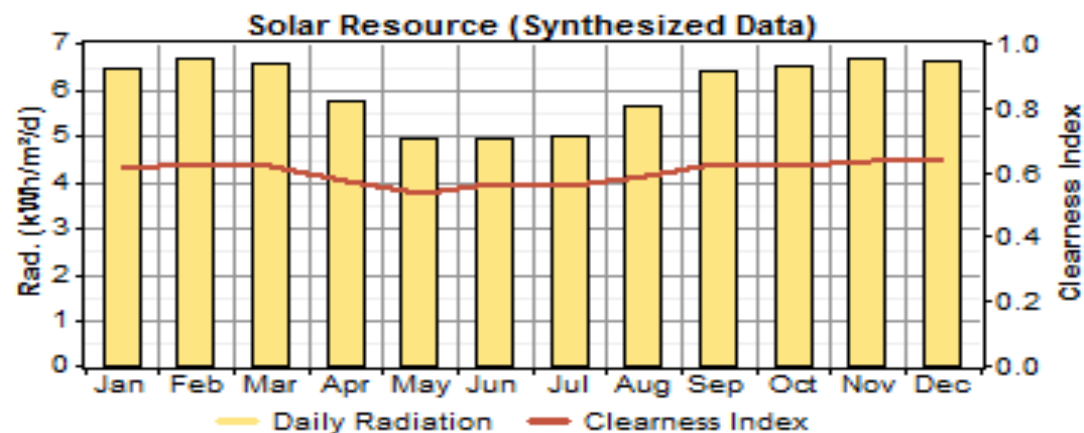
4. Review of Design Consultant Recommendations – The Differences (Contd)

**CVK
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Consortium**

- CVK Solar Enterprises Ltd
- Standard & Mutual Ltd
- Exeva Consulting Lt
- Murugu & Rigoro Advocates

Solar Resource at Wasini

- The data shows a quite high daily radiation values over the year with maximum monthly averages over 6 kWh/m²/day from September to March and minimums near 5 kWh/m²/day from May to July.
- Thus the radiation is similar to Rajasthan and we have practical experience of average Power Generation of order 4.5 Units per KW.
- In Feb- April and Sep- Oct months when temperature is order of 25-35 the generation is more .
- It is known fact that after 40 degree generation is affected by temperature .
- In these sites Temperature is order of 25-35 degree so generation will not be effected by temperature or rather most suited for PV generation .
- The generation will be consistent since Day time is in order of 11.8 to 12.3 Hours during the year .



4. Review of Design Consultant Recommendations – The Differences (Contd)

CVK SOLAR Consortium

- CVK Solar Enterprises Ltd
- Standard & Mutual Ltd
- Exeva Consulting Lt
- Murugu & Rigoro Advocates

- ❑ All the three Design consultants has given different design.
- ❑ Results , studies, and out come of design consultants are to be put in bid document on same footing.
- ❑ Harmonization is based on results summarized by one of the Consultant as well s our working experience .
- ❑ Max energy 5% in year. Should not be more than 25% AC capacity of solar plant from requirement point of view .
- ❑ In this case important point is DG Set should not act as load to Solar power plant. No reverse power flow to DG Set otherwise DG set will be damaged. Proper protection is must .
- ❑ **DC Lot-3 has stated in their report that Nana is 4km from the National Grid and should be considered for grid hook up.**
- ❑ **TA View**
 - **Putting an investment on solar plant and 33 kV line with associated transformers of total capacity 550 kVA as suggested by DC Lot-1 is not economical for long run .**
 - **REA should consider the suggestion of DC Lot -3 DC Lot -3 .**
- ❑ Design Consultant M/S IDC has mentioned that PV DC should not be more than 15% of AC System.
- ❑ Solar plant capacity of at site Kerio, Kaeris, Dabel We suggest that REA we should go for 50 kW AC with DC capacity of 60 (1.20x 50) kWp. They should be connected to 3 phase, 415 Volts line and 230 Volts single ckt line .

4. Review of Design Consultant Recommendations – Harmonization

CVK
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- Murugu & Rigoro Advocates

- ❑ The Solar plant sizes arrived at by Design Consultants may be suffice or may not after 5 years . It all depends upon the future growth of that area financially and commercially . Thus REA can standardised the plants in AC size Viz 25 kW AC , 50 kW AC , 75 KW AC , 100 kW AC, 250 kW AC , 350 kW , 500 kW AC , 600 kW etc AC plant as per population.
- ❑ In respect of Power Distribution Network of 11kV , 420 V and 230 V , KPLC / REA is regularly issuing standard specifications of Poles, Conductors , Insulators, String Hardware's fittings , transformers & CT, PT, breakers and other equipments, DP poles for overhead Substations, Safety equipments, Do Fuses, Fuses, MCCB, MCB, Earthing and earthing materials, consumer meters, consumer cable connection etc .
- ❑ 11kV , 415 Volts, 230 Volts PDN and service connections cables and metering system for Mini Grid must be Grid level and must meet the above norms of KPLC.
- ❑ **Power Pack of 50 KW of lithium -ion Battery with Tesla Power pack inverter or similar for a nominal Voltage of 400 VAC suggested by DC lot -1 is a good option .**
- ❑ **The areas like Nana,-----which are near to the National Grid and should be considered for grid hook up.**

4. Review of Design Consultant Recommendations – Technical Specifications

CVK
SOLAR
Consortium

- CVK Solar Enterprises Ltd
- Standard & Mutual Ltd
- Exeva Consulting Lt
- Murugu & Rigoro Advocates

Scope in Brief SPV Mini-Grid Projects in Un-Electrified Areas:

- Design , Supply Installation, Testing and Commissioning of 1180 kWp (1025kW AC) Solar Photo Voltaic (SPV) Power Generation Plants in Different Locations Under Lot 1 as per Table-1
- O & M of Solar Plant on behalf of REA for 15 years and arranging Joint Meter Reading of Solar Plant Meter at Line terminal every month
- Design, Supply, Installation, Testing and Commissioning of Power Distribution Network (230V, 415V, 11kV) under Lot-1, as detailed in Table -2 below
- Connection to Consumers along with Meters **as per KPLC norms on behalf of KPLC** and claiming Charges, as per Regulatory Commission or **applicable KPLC norms**, from consumers including cost of meter
- O & M of PDN on behalf of KPLC for 15 years **as per KPLC Norms**

4. Review of Design Consultant Recommendations – Technical Specifications

**CVK
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- Standard & Mutual Ltd
- Exeva Consulting Lt
- Murugu & Rigoro Advocates

Sizes and Capacity of Various plants

Design Consultant Recommendations of Plant size and PDN and their Harmonization

Transaction consultant's

Project No -1 of Lot No-1 :Takawiri Mini Grid

General characteristics	Design Consultants**	Transaction Consultant
Estimated Design demand in 5 Year)	440.2kWh/day	440.2kWh/day
Maximum peak demand	61.8 kW	61.8 kW
Night load demand factor	72%	70%
PV generator		
PV generator size	118.8 kWp	115 kWp (115%of AC)
Types of modules	Crystalline	Crystalline
PV mounting	Ground mounted	Ground Mounted
Inverter		
Inverter Continuous Power Rating	100 kW AC(4x25kW AC)	100 kW AC (inverter As per design of Bidder or /Hybrid) (4.5 Units/day x100kW=450 kwh/day)
Power Pack with Inverter	50X2 KW	Do /Hybrid
Battery Inverter set mode	Multi-mode (DC to AC and AC to DC)	Multi-mode (DC to AC and AC to DC)
Wave type	Sinusoidal	Sinusoidal
Battery		
Autonomy	2 days	2 Days
Battery voltage	400 Vac	400 Vac
Battery depth of discharge	80%	80%
Battery capacity	5 1050 kWh	1125kWh (450 Units x2 Days x1/0.8)
Battery type	Lithium-ion	Lithium-ion/ VRLA-GEL Lead Acid

4. Review of Design Consultant Recommendations – Technical Specifications

Sizes and Capacity of Various plants

Design Consultant Recommendations of Plant size and PDN and their Harmonization

Transaction consultant's

Project No -1 of Lot No-1 Takawiri Mini Grid

General characteristics	Design Consultants**	Transaction Consultant
DG SET	Not required	<p>Max energy 5% in year. Should not be more than 25% AC capacity of solar plant from requirement point of view .</p> <p>In this case important point is DG Set should not act as load to Solar power plant. No reverse power flow to DG Set otherwise DG set will damaged</p>
Distribution line		
Distribution type	Low Voltage, 3-phases	Low Voltage, 3-phases
LV distribution line total length	7,090 meters	7090 meters As per Norms of KPLC
Number of poles	143	As per KPLC norms
Number of users year 4	415	415

4. Review of Design Consultant Recommendations – Technical Specifications

Sizes and Capacity of Various plants

Design Consultant Recommendations of Plant size and PDN and their Harmonization Transaction consultant's

Project No -2 of Lot No-1 Ngodhe Mini Grid

General characteristics	Design Consultants**	Transaction Consultant
Design demand	315.4kWh/day	315.4kWh/day
Maximum peak demand	34.5 kW	34.5 kW
Night load demand factor	62%	70%
PV generator		
PV generator size	89.1 kW _p DC	87 kW _p (115% of 75 kW AC)
Types of modules	Crystalline	Crystalline
PV mounting	Ground mounted	Ground mounted
Battery Inverter		
Inverter Continuous Power Rating	75 kW AC _c	75 kW AC (75x4.5 /day=337.5kWh/day)
Power Pack with Inverter	50X2 KW	Do /Hybrid
Inverter set mode	Multi-mode (DC to AC and AC to DC)	Multi-mode (DC to AC and AC to DC)
Wave type	Sinusoidal	Sinusoidal
Battery		
Autonomy	2 days	2 days
Battery voltage	400 Vac	400 Vac
Battery depth of discharge	80%	80 %
	5	5

4. Review of Design Consultant Recommendations – Technical Specifications

Sizes and Capacity of Various plants

Design Consultant Recommendations of Plant size and PDN and their Harmonization Transaction consultant's

Project No -2 of Lot No-1 Ngodhe Mini Grid

General characteristics	Design Consultants**	Transaction Consultant
Battery capacity	840 kWh	842 kWh (337.5 x2/0.8 kWh/day)
Battery type	Tubular Lead Acid /Lithium-ion	Tubular Lead Acid /Lithium-ion
DG SET		
DG Set	Not required	Max energy 5% in year. Should not be more than 25% AC capacity of solar plant from requirement point of view . In this case important point is DG Set should not act as load to Solar power plant. No reverse power flow to DG Set otherwise DG set will damaged
Distribution line		
Distribution type	Low Voltage, 3-phases	Low Voltage, 3-phases
LV distribution line total length	4,305 meters	4,305meters As per Norms of KPLC
Number of poles	88	As per Norms of KPLC
Number of users year 4	223	223

4. Review of Design Consultant Recommendations – Technical Specifications

**CVK SOLAR
Consortium**

- Standard & Mutual Ltd
- CVK Solar Enterprises Ltd
- Exeva Consulting Lt
- Murugu & Rigoro Advocates

Sizes and Capacity of Various plants

Design Consultant Recommendations of Plant size and PDN and their Harmonization

Transaction consultant's

Project No -3 of Lot No-1 Mageta Mini Grid

• General characteristics	Design Consultants**	Transaction Consultant
Design demand	1,720kWh/day	1,720kWh/day
Maximum peak demand	240 kW	240 kW
Night load demand factor	71%	70%
PV generator		
PV generator size	594 kW _{peak}	575 kWp (115%x500kW)
Types of modules	Crystalline	Crystalline
PV mounting	Ground mounted	Ground mounted
Battery Inverter		
Inverter Continuous Power Rating	25kW x20=500 kW	500kW AC (Generation 500x4.5 units/day=2250 per day)
Power Pack with Inverter	50X2 KW	Do /Hybrid
Inverter set mode	Multi-mode (DC to AC and AC to DC)	Multi-mode (DC to AC and AC to DC)
Wave type	Sinusoidal	Sinusoidal
Battery		

4. Review of Design Consultant Recommendations – Technical Specifications

Sizes and Capacity of Various plants

Design Consultant Recommendations of Plant size and PDN and their Harmonization

Transaction consultant's

Project No -3 of Lot No-1 Mageta Mini Grid

General characteristics	Design Consultants**	Transaction Consultant
	*	
Autonomy	2 days	2 days
Battery voltage	400 Vac	400 Vac
Battery depth of discharge	80%	80%
	5	5
Battery capacity	4200 kWh	5625 kWh (2250x2x1/0.8)
Battery type	Tubular Lead Acid /Lithium-ion	Tubular Lead Acid /Lithium-ion
DG Set		Should not be more than 25%. In this case important point is DG Set should not act as load to Solar power plant. No reverse power flow to DG Set otherwise DG set will damaged
DG set to meet out requirement	Not required	Max energy 5% in year. Should not be more than 25% from requirement point of view. In this case important point is DG Set should not act as load to Solar power plant. No reverse power flow to DG Set otherwise DG set will damaged
Distribution line		
Distribution type	Low Voltage& Medium voltage, 3-phases	Low Voltage& Medium voltage, 3-phases
LV distribution line total length	32,200 meters	32,200 meters As per KPLC norms
MV distribution line total length	5 550 meters	5 550 meters As per KPLC norms

4. Review of Design Consultant Recommendations – Technical Specifications

- Standard & Mutual Ltd
- CVK Solar Enterprises Ltd
- Exeva Consulting Lt
- Murugu & Rigoro Advocates

Sizes and Capacity of Various plants

Design Consultant Recommendations of Plant size and PDN and their Harmonization Transaction consultant's

Project No -3 of Lot No-1 Washini-Mkwiro Mini Grid

General characteristics	Design Consultants** *	Transaction Consultant
Design demand for 5 years	1575kWh/day	1575 kWh/day
Maximum peak demand	----- kW	--- kW
Night load demand factor	71%	70%
PV generator		
PV generator size	350 kW _{peak}	402 kW _{peak}
Types of modules	Crystalline	Crystalline
PV mounting	Ground mounted	Ground mounted
Battery Inverter		
Inverter Continuous Power Rating	350 kW	350kWAC (350x4.5/Unit/day=1575kwh/day)
Power Pack with Inverter	168 kVA	Do /Hybrid

4. Review of Design Consultant Recommendations – Technical Specifications

Sizes and Capacity of Various plants

Design Consultant Recommendations of Plant size and PDN and their Harmonization Transaction consultant's

Project No -3 of Lot No-1 Wasini-Mkwiro Mini Grid

General characteristics	Design Consultants** *	Transaction Consultant
Inverter set mode	Multi-mode (DC to AC and AC to DC)	Multi-mode (DC to AC and AC to DC)
Wave type	Sinusoidal	Sinusoidal
Battery		
Autonomy	Not mentioned	2 days
Battery voltage	400 Vac	400 Vac
Battery depth of discharge	80%	80%
	5	5
Battery capacity	1984 kWh	3937 kWh (1575 kWh x2days x1/0.8)
Battery type	Tubular Lead Acid /Lithium-ion	Tubular Lead Acid /Lithium-ion
Transformer 400V/11 kV	-	400 kVA +DG Set capacity
DG Set	100 kw +16 KW	Should not be more than 25%. In this case important point is DG Set should not act as load to Solar power plant. No reverse power flow to DG Set otherwise DG set will damaged

4. Review of Design Consultant Recommendations – Technical Specifications

CVK SOLAR Consortium

- Standard & Mutual Ltd
- CVK Solar Enterprises Ltd
- Exeva Consulting Lt
- Murugu & Rigoro Advocates

Sizes and Capacity of Various plants

Design Consultant Recommendations of Plant size and PDN and their Harmonization

Transaction consultant's

Project No -3 of Lot No-2 Wasini-Mkwiro Mini Grid

General characteristics	Design Consultants** *	Transaction Consultant
Distribution System		
Trans formers 11/0.415 kV	4x25kVA , 1x50 KVA, 160 kVA Total capacity 310 KVA	400 kVA of different sizes
Distribution type	3-phases Low Voltage& Medium voltage	Low Voltage& Medium voltage, 3-phases
LV distribution line total length	3.78 km and 1.61 km	3.78 km+ 1.61 km
MV distribution line total length	5.63km	5.63 km
Number of poles	ECO Poles 225- 10 m : 117 Nos	Lines as per Norms of KPLC
	Twin Eco poles 300 -10 M: 34 Nos	Lines as per Norms of KPLC
	Twin Eco poles 300 -11 M: 6 Nos	Lines as per Norms of KPLC
	Twin Eco poles 300 -12 M: 67 Nos	Lines as per Norms of KPLC
Number of users year 4	-	

4. Review of Design Consultant Recommendations – Technical Specifications

CVK
SOLAR
Consortium

- CVK Solar Enterprises Ltd
- Standard & Mutual Ltd
- Exeva Consulting Lt
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Scope in Brief SPV Mini-Grid Projects in Un-Electrified Areas:

- Design , Supply Installation, Testing and Commissioning of 1180 kWp (1025kW AC) Solar Photo Voltaic (SPV) Power Generation Plants in Different Locations Under Lot 1 as per Table-1
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- Design, Supply, Installation, Testing and Commissioning of Power Distribution Network (230V, 415V, 11kV) under Lot-1, as detailed in Table -2 below
- Connection to Consumers along with Meters **as per KPLC norms on behalf of KPLC** and claiming Charges, as per Regulatory Commission or **applicable KPLC norms**, from consumers including cost of meter
- O & M of PDN on behalf of KPLC for 15 years **as per KPLC Norms**
- Power Supply to consumers on behalf of KPLC for 15 years including timely attending Complaints of consumers to ensure regular supply to consumers **as per KPLC Norms.**
- Collection of revenue from consumers on behalf of KPLC and deposit to Govt. /KPLC Account **as per KPLC Norms.**

4. Review of Design Consultant Recommendations – Technical Specifications

**CVK
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- Standard & Mutual Ltd
- Exeva Consulting Lt
- Murugu & Rigoro Advocates

Kerio

Estimated Design demand in 5 Year	116 kWh/day	116kWh/day
Maximum peak demand	kWh/day	----- kW
Night load demand factor	70%	70%
PV generator		
PV generator size	59.4 kWp	57.5 kWp (115% of AC)
Types of modules	Mono Crystalline	Mono/Poly Crystalline
PV mounting	Ground mounted	Ground Mounted
Inverter		
Inverter Continuous Power Rating	30kW AC(3x10kW AC)	50 kW AC (inverter As per design of Bidder or /Hybrid) (4.5 Units/day x50kW=225 kWh/day)
Power Pack with Inverter		Do /Hybrid
Battery Inverter set mode	Multi-mode (DC to AC and AC to DC)	Multi-mode (DC to AC and AC to DC)
Wave type	Sinusoidal	Sinusoidal

4. Review of Design Consultant Recommendations – Technical Specifications

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Battery		
Autonomy	Not Indicated	2 Days
Battery voltage	Not Indicated	400V AC
Battery Output depth of discharge	Not indicated	80%
Battery capacity	4500 Ah 48V	290kWh (116 Units x2 Days x1/0.8)
Battery type	Lithium-ion	Lithium-ion/ VRLA-GEL Lead Acid Tubular Battery
DG SET	30 kW	<p>Max energy 5% in year. Should not be more than 25% AC capacity of solar plant from requirement point of view.</p> <p>In this case important point is DG Set should not act as load to Solar power plant. No reverse power flow to DG Set otherwise DG set will damaged</p>

4. Review of Design Consultant Recommendations – Technical Specifications

**CVK
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Kaeris

Inception demand	35kWh	35kWh
5 year Future Design demand	91kWh/day	91kWh/day
Maximum peak demand	34.5 kW	34.5 kW
Night load demand factor	70%	70%
PV generator		
PV generator size	40.5 kW _p DC	57.5 kW _p (115% of 75 kW AC)
Types of modules	Mono Crystalline	Crystalline
PV mounting	Ground mounted	Ground mounted
Inverter		
Inverter Continuous Power Rating	24 kW AC	50 kW AC (50x4.5 /day=225kWh/day)
Power Pack with Inverter	----- kW	Do /Hybrid
Inverter set mode	Multi-mode (DC to AC and AC to DC)	Multi-mode (DC to AC and AC to DC)
Wave type	Sinusoidal	Sinusoidal

4. Review of Design Consultant Recommendations – Technical Specifications

**CVK
SOLAR
Consortium**

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- Murugu & Rigoro Advocates

Nana

Inception demand	35 kWh/day	35 kWh/day
5 Year future Design demand	87 kWh/day	87kWh/day
Maximum peak demand	---kW	240 kW
Night load demand factor	70%	70%
PV generator		
PV generator size	40.5 kW_{peak}	57.5 kWp (115% x 500kW)
Types of modules	Mono Crystalline	Crystalline
PV mounting	Ground mounted	Ground mounted
Inverter		
Inverter Continuous Power Rating	30 kW (10 kW X3)	50kW AC (Generation 50x4.5 units/day=225 per day)
Power Pack with Inverter	-----kW	Do /Hybrid
Inverter set mode	Multi-mode (DC to AC and AC to DC)	Multi-mode (DC to AC and AC to DC)
Wave type	Sinusoidal	Sinusoidal

4. Review of Design Consultant Recommendations – Technical Specifications

**CVK
SOLAR**

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- Exeva Consulting Lt
- Murugu & Rigoro Advocates

Battery		
Autonomy	2 days	2 days
Battery Output voltage	400 Vac	400 Vac
Battery depth of discharge	80%	80 %
	5	5
Battery capacity	3000AH , 48 Volt	228 kWh (91x2x1/0.8 kWh/day) 48V 5000Ah
Battery type	Tubular Lead Acid /Lithium-ion	Tubular Lead Acid /Lithium-ion
DG SET		
DG Set	20kW required	Max energy 5% in year. Should not be more than 25% AC capacity of solar plant from requirement point of view. In this case important point is DG Set should not act as load to Solar power plant. No reverse power flow to DG Set otherwise DG set will damaged

4. Review of Design Consultant Recommendations – Technical Specifications

**CVK
SOLAR
Consortium**

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- Standard & Mutual Ltd
- Exeva Consulting Lt
- Murugu & Rigoro Advocates

Dabel

Inception demand	49 kWh/day	49 kWh/day
5 year Future Design demand	110 kWh/day	110 kWh/day
Maximum peak demand	----- kW	--- kW
Night load demand factor	70%	70%
PV generator		
PV generator size	59.4kW_{eak}	57.5 kW_{peak}
Types of modules	Mono Crystalline	Mono/Poly Crystalline
PV mounting	Ground mounted	Ground mounted
Inverter		
Inverter Continuous Power Rating	30 kW (10 kW X 3)	50kWAC (50x4.5/Unit/day=225kwh/day)
Power Pack with Inverter	===== kVA	Do /Hybrid
Inverter set mode	Multi-mode (DC to AC and AC to DC)	Multi-mode (DC to AC and AC to DC)
Wave type	Sinusoidal	Sinusoidal

4. Review of Design Consultant Recommendations – Technical Specifications

**CVK
SOLAR**

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- Exeva Consulting Lt
- Murugu & Rigoro Advocates

Battery		
Autonomy	Not mentioned	2 days
Battery output voltage	Not mentioned	400 Vac
Battery depth of discharge	Not mentioned	80%
Battery capacity	4500Ah,48 Volts	275 kWh (110 kWh x2days x1/0.8) 48V 6000Ah
Battery type	Tubular Lead Acid /Lithium-ion	Tubular Lead Acid /Lithium-ion
Transformer 400V/11 kV	-	400 kVA +DG Set capacity
DG Set		Should not be more than 25%. In this case important point is DG Set should not act as load to Solar power plant. No reverse power flow to DG Set otherwise DG set will damaged.
DG set to meet out requirement	30 kW	Max energy 5% in year

4. Review of Design Consultant Recommendations – Technical Specifications (Lots)

**CVK
SOLAR
Consortium**

- CVK Solar Enterprises Ltd
- Standard & Mutual Ltd
- Exeva Consulting Lt
- Murugu & Rigoro Advocates

How lots be made

Presently We have suggested lot

Lot 1--- Project No.1,2,3 (Lake Victoria Region) & 4 Coastal

Lot 2--- Project No.5,6,7, 8th Project Nana-Not

We can also make following two lots.

Lot1-of MW—700 kW

Lot2-of MW—350+150kW=500kW

In This case project will be of good size.

Other alternative is in three lots area wise

This is the first case so. at least We should go for two or three lots may This give lesser Project can't Viza Viz. All the Project lowest can't This will give exposure to more from and in next bid.

We will have good number of companies.

5. Summary Proposed Transaction Structure

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- Standard & Mutual Ltd
- Exeva Consulting Lt
- Murugu & Rigoro Advocates

- Considering all the TA Recommendations, the summary transaction structure is as follows:

6. A Brief on the Proposed PPA

CVK SOLAR Consortium

- CVK Solar Enterprises Ltd
- Standard & Mutual Ltd
- Exeva Consulting Lt
- Murugu & Rigoro Advocates

7. Way Forward

CVK SOLAR Consortium

- CVK Solar Enterprises Ltd
- Standard & Mutual Ltd
- Exeva Consulting Lt
- Murugu & Rigoro Advocates

Contacts

**CVK
SOLAR**

- CVK Solar Enterprises Ltd
- Standard & Mutual Ltd
- Exeva Consulting Lt
- Murugu & Rigoro Advocates

