सेंट्रल ट्रांसमिशन यूटिलिटी ऑफ इंडिया लिमिटेड
(पावर ग्रिड कॉर्पोरेशन ऑफ इंडिया लिमिटेड के स्वामित्व में)
(भारत सरकार का उद्यम)
CENTRAL TRANSMISSION UTILITY OF INDIA LTD.
(A wholly owned subsidiary of Power Grid Corporation of India Limited)
(A Government of India Enterprise)

Ref: CTU/W/07/Khavda

21st Dec, 2022

As per Distribution List

Sub: Minutes of Meeting held amongst CEA, CTU, WRPC, GRID-INDIA, GETCO & MSETCL on 19.12.2022 to discuss transmission system for Evacuation of Power from potential renewable energy zone in Khavda area of Gujarat (beyond 15GW) – reg.

Sir,

Please find enclosed the minutes of meeting held amongst CEA, CTU, WRPC, GRID-INDIA, GETCO & MSETCL on 19.12.2022 to discuss transmission system for Evacuation of Power from potential renewable energy zone in Khavda area of Gujarat (beyond 15GW).

Thanking you,

Yours faithfully,

(Partha Sarathi Das)
Sr. General Manager

Encl: Minutes of Meeting

Distribution List:

1.	**Chief Engineer (PSP&A - I)** Central Electricity Authority Sewa Bhawan, R.K.Puram New Delhi-110 066	2.	**Member Secretary** Western Regional Power Committee MIDC area, Marol, Andheri East, Mumbai 400 093
3.	**Director (SO)** POSOCO B-9, Qutab Institutional Area, Katwaria Sarai, New Delhi-110 016	4.	**Exexutive Director** Western Regional Load Despatch Centre F-3, M.I.D.C. Area, Marol, Andheri East, Mumbai-400 093
5.	**Managing Director** Gujarat Energy Transmission Corp. Ltd, Sardar Patel Vidyut Bhawan, Race Course, Vadodara -390 007	6.	**Director (Operation)** Maharashtra State Electricity Transmission Co. Ltd., 4th Floor, "Prakashganga", Plot No. C-19, E-Block, Bandra – Kurla Complex, Bandra (East), Mumbai- 400051

Copy for information:

1. Managing Director Chhattisgarh State Power Transmission Co. Ltd., Dangania, Raipur- 492 013	**2. Chairman & Managing Director** Madhya Pradesh Power Transmission Co. Ltd., Block No. 3, Shakti Bhawan, Rampur, Jabalpur-482 008
3. Executive Engineer Administration of Union Territory of Dadra & Nagar Haveli and Daman & Diu Secretariat, Moti Daman - 395 220	**4. The Chief Engineer** Electricity Department The Government of Goa, Panaji
5. Director (Power System) Solar Energy Corporation of India Ltd. D-3, 1st Floor, A wing, Religare Building, District Centre, Saket, New Delhi-110017	

Minutes of Meeting held amongst CEA, CTU, WRPC, GRID-INDIA, GETCO & MSETCL on 19.12.2022 to discuss transmission system for Evacuation of Power from potential renewable energy zone in Khavda area of Gujarat (beyond 15GW)

A meeting was held amongst CEA, CTU, WRPC, GRID-INDIA, GETCO & MSETCL on 19.12.2022 to discuss transmission system for Evacuation of Power from potential renewable energy zone in Khavda area of Gujarat (beyond 15GW). List of participants is enclosed at **Annexure-II**. Sr.GM, CTUIL welcomed the participants. Thereafter, deliberations as per the agenda commenced and the gist of deliberations are as given below.

I. Background:

It was informed that Govt. of India has set a target for establishing 500 GW capacity from non-fossil energy sources by 2030. In this direction, in December 2020, Hon'ble Prime Minister laid the foundation stone of the world's largest renewable energy park in Gujarat's Kutch. This 30 Gigawatt (GW) capacity hybrid renewable energy park is being built along the Indo-Pak border at Khavda using both wind and solar energy and is expected to play a major role in fulfilling India's vision of generating 500 GW of non-fossil generation capacity by 2030.

Land had been allocated to various renewable energy projects in the Renewable Energy Park at Khavda located near International Border in Kutch, Gujarat for a total capacity of 27.7GW. However, after considering reduction of capacity allocated to SECI from 3GW to 1GW as communicated by SECI in meeting organized by GPCL on 19.01.2022, the total capacity in Khavda area works out to 25.8GW (after reduction in SECI quantum by ~2GW) out of which about 15GW RE capacity is expected to come up by 2024-25 and balance by 2026-27 time-frame. Additional capacity upto 30GW (~4GW) may be anticipated after 2026-27.

It was further informed that Transmission system for evacuation of upto 15GW power from Khavda RE Park has already been evolved in 3 phases as per details below:

Phase	RE Capacity (GW)	Status of Transmission System
I	3	Under Implementation – SCOD of Jan'24
II	5	Under Bidding – Expected SCOD of Jan'25
III	7	Under Approval (NCT) – Targeted commissioning by Mar'25

To cater to above potential, three pooling stations namely KPS1, KPS2 and KPS3 are being implemented in Khavda RE Park.

Sl. No.	Pooling Station	Location	Total RE capacity (GW) by 2026-27	Phase-I to III (By Mar'25)	
				Likely RE capacity (GW) by 2024-25*	RE Capacity considered for Planning study
1	Khavda Pooling	Near AGEL Plot	9.03	6.8	7

Sl. No.	Pooling Station	Location	Total RE capacity (GW) by 2026-27	Phase-I to III (By Mar'25)	
				Likely RE capacity (GW) by 2024-25*	RE Capacity considered for Planning study
	Station-I (KPS1)				
2	Khavda Pooling Station-II (KPS2)	Near GSECL/ GIPCL/ NTPC/ SRL Plot **(Centre)**	9.25	5.055	5
3	Khavda Pooling Station-III (KPS3)	Near SECI/ NTPC/SRL Plot **(Top)**	7.52	2.8	3
			25.8	**14.655**	**15**

**As per inputs from RE developers in meeting organized by GPCL on 19.01.2022*

Against planned system of 15GW in Khavda area, Stage-II connectivity applications for 12.555GW (KPS-I: 6.55GW, KPS-II: 3.755GW & KPS-III: 2.25GW) have already been received. Considering the rapid pace of applications being received in Khavda area and the directions received in the meeting convened under the Chairmanship of Hon'ble Minister (New & Renewable Energy and Power) held on 30th November, 2022, it is imperative to plan for transmission system for entire 30GW Khavda RE Park in advance so that there is no mismatch between RE generation and transmission.

II. Proposed Transmission System

It was informed that a Comprehensive transmission plan for evacuation of balance 15GW RE potential in Khavda RE Park has been evolved in phases as given below (refer schematic at **Annexure-I**):

- Phase-IV (For Generation between Jun'25 to Jun'26): 7GW – HVAC System
- Phase-V (For Generation by Dec'26/Mar'27): 4GW – HVDC System (4GW)
- Phase-VI (For Generation beyond Dec'26/Mar'27): 4GW – Planned with HVDC System Upgradation to 8GW along with 765kV interconnections amongst KPS1/KPS2 & KPS3, as may be required

The RE capacity planned in each of the phases IV & V is detailed below:

		Phase-IV (Jun'25 to Jun'26)		Phase-V (by Dec'26/Mar'27)	
Sl. No.	**Pooling Station**	**Likely RE capacity (GW)**	**Cumulative RE Capacity considered for Planning**	**Total RE capacity (GW)**	**Cumulative RE Capacity considered for Planning**
1	Khavda Pooling Station-I (KPS1)	9.03	9	9.03	9
2	Khavda Pooling Station-II (KPS2)	8.68	9	9.25	9.5
3	Khavda Pooling Station-III (KPS3)	3.94	4	7.52	7.5
		21.65	**22**	**25.8**	**26**

Pooling station-wise RE capacity for Phase-VI (4GW) is not available.

Studies were carried out with following study assumptions:

1. Studies were carried out for 2026-27-time frame for solar maximized scenario (afternoon peak) in February season
2. For evacuation studies,100% Solar dispatch for ISTS solar generation and 80% for intra state solar is considered in Northern region. 100% Solar Generation is also considered for Khavda RE Park. Solar generation in other parts is considered 90%.
3. Low dispatch (up to 10%) of wind generation is considered in Feb season in all regions.
4. All India projected Peak Demand by 2027 is considered as per the 19th EPS of CEA.
5. Central sector/IPP Thermal generation is taken based on merit order dispatch with 55% technical minimum. State sector units dispatched to variable dispatch (55-85%) in a way that maximum thermal units will be available for generation in evening peak.
6. In the studies, all India transmission network up to 220kV level has been simulated. It includes, existing as well as under construction transmission network
7. Dholera 2GW direct injection at Vataman S/s has been considered to simulate worst case scenario.
8. MUL 3.05GW direct drawal of power from Navinal (GIS) S/s (at LILO of Bhuj-II – Lakadia 765kV D/c line) has been considered based on LTA application received from MUL

Transmission System for Evacuation of Power from potential renewable energy zone in Khavda area of Gujarat under Phase-IV (7GW)

Broad details of Transmission System:

- KPS3 – KPS2 765kV 2nd D/c line (20km.)
- KPS1 – Bhuj 765kV 2nd D/c line (60km.)
- KPS2 – Lakadia 765kV 2nd D/c line (160km.)
- Vadodara – Navsari(New) 765kV D/c line (120km.)
- Establishment of 765/400/220kV Boisar-II (GIS) S/s (3x1500, 765/400kV & 2x500MVA, 400/220kV) with 2x330MVAr 765kV and 2x125MVAr 420kV bus reactors
- Navsari(New) – Boisar-II 765kV D/c line
- LILO of Navsari(New) – Padghe(PG) 765kV D/c line at Boisar-II
- Boisar-II – Velgaon(MH) 400kV D/c (Quad ACSR/AAAC/AL59 moose equivalent) line (10km.)
- LILO of Babhaleswar – Padghe(M) 400kV D/c line at Bosar-II along with Reconductoring of Padghe(M) – Boisar-II 400kV D/c line with twin HTLS conductor (LILO route length 65km.)
- Establishment of 765/400/220kV Pune-III (GIS) S/s (2x1500, 765/400kV & 2x500MVA, 400/220kV) with 2x330MVAr 765kV and 2x125MVAr 420kV bus reactors
- Boisar-II – Pune-III 765kV D/c line (200km.)
- LILO of Narendra(New) – Pune(GIS) 765kV D/c line at Pune-III (LILO route length 10km.)
- LILO of Pune(GIS) – Lonikand-II & Pune(GIS) - Jejuri 400kV lines at Pune-III along with opening of Pune(GIS) – Pune-III 400kV D/c line (to take care of fault level / overloading issues)
- ± 300MVAr STATCOM with 3x125 MVAr MSC, 1x125 MVAr MSR at 400kV level of Boisar-II
- ± 300MVAr STATCOM with 1x125 MVAr MSC, 2x125 MVAr MSR at KPS3 400kV Bus section-2
- Augmentation of transformation capacity at KPS1/KPS2/KPS3 as required
- Associated spares and reactive compensation

Note:

- Downstream system from Boisar-II & Pune-III to be finalised in coordination with MSETCL
- **Implementation time-frame:** 24 months from date of allocation to implementing agency

Transmission System for Evacuation of Power from potential renewable energy zone in Khavda area of Gujarat under Phase-V (4GW)

Broad details of Transmission System:

- Establishment of 4000 MW, ± 800 kV KPS2 (HVDC) [LCC] terminal station (2x2000 MW) (with provision to upgrade to 8000MW later)
- Establishment of 4000 MW, ± 800 kV Akola-III (HVDC) [LCC] terminal station (2x2000 MW) (with provision to upgrade to 8000MW later)
- ±800 kV HVDC Bipole line between KPS2(HVDC) and Akola-III(HVDC) (1000km.) (with Dedicated Metallic Return) (capable to evacuate 8000MW with overload capacity as specified)
- Establishment of 6x1500MVA, 765/400kV ICTs at Akola-III(HVDC) along with 2x330 MVAr (765kV) & 2x125MVAr, 420kV bus reactors. The 400kV bus shall be established in 2 sections through 1 set of 400kV bus sectionaliser so that 3x1500MVA ICTs are placed in each section.
- LILO of Wardha – Aurangabad 765kV 1st D/c line at Akola-III (LILO route length 30km.)
- HVDC System will be designed considering 100% power reversal capability and 110% continuous overload capability in forward direction (from KPS2 to Akola-III)
- Associated 400kV Interconnectors between HVDC and HVAC switchyard along with Aux Transformers (400/33kV)

Note:

- The 2000MW pole-1 shall emanate from 400kV bus section 1 of KPS2 and terminate at bus section 1 of Akola-III. Similarly, the 2000MW pole-2 shall emanate from 400kV bus section 2 of KPS2 and terminate at bus section 2 of Akola-III.
- **Implementation time-frame:** 42 months from date of allocation to implementing agency

Transmission System for Evacuation of Power from potential renewable energy zone in Khavda area of Gujarat under Phase-VI (4GW)

- Upgradation of 4000 MW, ± 800 kV KPS2 (HVDC) [LCC] terminal station (2x2000 MW) to 8000MW (i.e. by additional 2x2000MW)
- Upgradation of 4000 MW, ± 800 kV Akola-III (HVDC) [LCC] terminal station (2x2000 MW) to 8000MW (i.e. by additional 2x2000MW)
- Augmentation of transformation capacity at Akola-III(HVDC) by 2x1500MVA, 765/400kV ICTs (1 new ICT on each 400kV bus section)

- **Implementation time-frame:** 48 months from date of allocation to implementing agency (viz. with time gap of 6 months from Khavda Phase-V scheme)

Provision of Dynamic Reactive Compensation at KPS1, KPS3 & Navsari(New) Substations

- ± 300MVAr STATCOM with 1x125 MVAr MSC, 2x125 MVAr MSR at KPS1 400kV Bus section-1
- ± 300MVAr STATCOM with 1x125 MVAr MSC, 2x125 MVAr MSR at KPS1 400kV Bus section-2
- ± 300MVAr STATCOM with 1x125 MVAr MSC, 2x125 MVAr MSR at KPS3 400kV Bus section-1
- ± 300MVAr STATCOM with 3x125 MVAr MSC, 1x125 MVAr MSR at 400kV level of Navsari(New)(PG) S/s

III. **Deliberations and decisions taken in the meeting**

CTU stated that although Pooling station-wise RE capacity has presently been identified upto Ph-V (i.e upto 26GW), the transmission system for complete 30GW capacity envisaged in the Khavda RE Park is proposed to be planned as per the directions received in the meeting convened under the Chairmanship of Hon'ble Minister (New & Renewable Energy and Power) held on 30th November, 2022. The matter was discussed with GPCL wherein they expressed that there is a possibility of higher potential capacity in Khavda area of upto 30GW. The above was noted.

MS, WRPC noted the phasing of transmission system in Khavda area in matching time-frame of associated RE generation and suggested if GETCO could offtake additional power through their system in the Phase-V & VI (total 8GW) of Khavda REZ.

GETCO stated that they are either already drawing or proposed to draw RE power under Phases I to IV (cumulative 22GW) at various ISTS nodes such as from Banaskantha, Navsari(New), Bhuj PS, proposed Vataman S/s etc and they do not require any additional power in Phase V & VI.

CEA enquired if comparison of HVDC in Phase-V & VI (8GW) of Khavda REZ vis-à-vis BESS could be done from transmission system deferral point of view.

CTU stated that BESS suffers from certain drawback vis-à-vis HVDC in the instant case:

- ❖ To ensure transmission deferral of 8GW, equivalent BESS requirement will be much higher i.e. 32GWh (considering 8 GW for 4 hr) or as high as 40GWhr (considering 8GW for 5 hr). This will be a much costly proposition compared to HVDC which will provide round the clock flexibility of operation as well as reverse flow capability.
- ❖ BESS would require a lot of land for installation in Khavda area, much beyond what has been earmarked at KPS1, KPS2 & KPS3
- ❖ Before installation of such large scale of BESS, it is important that BESS Technology adoption matures in India as right now, only one pilot project of installation of 500MW/1000 MWh standalone BESS (Battery Energy Storage Systems) at Fatehgarh-III substation has been recently awarded.

- ❖ The lifecycle of BESS with existing technologies is limited and the typical lifecycle will be around 10 years (may vary depending upon the charging/discharging cycles) as compared to 35 years for HVDC.

After deliberations, it was decided to pursue planning for 30GW evacuation system Khavda area through a combination of HVAC & HVDC systems instead of HVAC & BESS.

MS, WRPC requested GETCO & MSETCL to provide their views on the proposed transmission system.

Both GETCO and MSETCL stated that they shall intimate their views within 2 days.

CTU requested MSETCL to intimate the downstream system from Boisar-II & Pune-III. In response, MSETCL stated that the same shall also be informed within 2 days.

Regarding requirement of STATCOMs with Khavda schemes, it was observed Renewable capacity is characterized by Intermittent, uncertain & variable output as well as Short gestation period of the generation projects. RE potential in Western Region (ISTS) is concentrated heavily in a few pockets (viz. Khavda / Bhuj / Dwarka areas of Gujarat) and power is to be dispatched over long distances to load centres, thereby necessitating long EHV AC systems whose loading shall vary from very low to very high at different times of the day. This shall result in high voltage variations in the Grid and may even result in line trippings under overvoltage/undervoltage in case the line / bus reactors are not managed in synchronism with the voltage variation. In particular, the voltage variations will be most pronounced at Injection end (i.e. KPS1, KPS2 & KPS3) as well as at drawal end (i.e. Navsari(New) & Boisar-II S/s). The STATCOMs will also help to cater to faster system recovery after faults. Considering the above, it was found prudent to provide STATCOMs with different combinations of MSCs/MSRs at KPS1, KPS3, Navsari(New) and Boisar-II Substations. Additional STATCOMs may also be planned at other locations such as Halvad / Vataman / Neemuch-II etc in future based on system studies and space for STATCOMs may be earmarked at these substations in advance.

Regarding reverse flow operation of HVDC, it was observed that by default, HVDC terminals can be operated for 50% of its capacity in reverse mode (4000 MW in this case) and it may further be enhanced to 100% based on initial HVDC specifications. After deliberations, it was opined that HVDC terminals will be implemented with 100% power reversal capability so as to ensure full flexibility of operation. Regarding implementation time frame, it was observed that implementation of HVDC would take much more time than the gestation period of RE and also issues may be encountered in case the HVDC system is awarded to one party and the HVDC Upgradation scheme is awarded to another party, which may lead to cost/time escalation. In view of the above, the implementation of above HVDC scheme may be approved & awarded in one go for the entire 8GW with a time gap of 6 months between Phase-V (4GW) (HVDC scheme) and Phase-VI(4GW) (HVDC Upgradation scheme).

After further deliberations, following was noted/decided:

- The transmission system for Evacuation of Power from potential renewable energy zone in Khavda area of Gujarat - beyond 15GW shall be evolved in phases of 7GW (Ph-IV), 4GW (Ph-V) & 4GW (Ph-VI). The system shall be planned through a combination of HVAC & HVDC systems instead of HVAC & BESS based on techno-economic considerations. The transmission system along with Dynamic Reactive Compensation requirement at KPS1, KPS3, Boisar-II & Navsari(New) Substations were noted and agreed in-principal. Further, it was also decided that the implementation of the HVDC scheme shall be approved & awarded in one go for the entire 8GW with a time gap of 6 months between Phase-V (4GW) (HVDC scheme) and Phase-VI(4GW) (HVDC Upgradation scheme).

- MSETCL & GETCO agreed to provide feedback on above system within 2 days. MSETCL also agreed to intimate regarding the downstream system from Boisar-II & Pune-III within 2 days. Based on comments of MSETCL and GETCO, the scheme shall be taken up in the ensuing CMETS-WR meeting in Dec'22 for deliberations with all WR stakeholders.

- The HVDC terminals shall be implemented with 100% power reversal capability so as to ensure full flexibility of operation especially when the solar generation is Nil in evening/night scenarios and with 10% overload capability in order to evacuate surplus power under peak solar conditions.

- Provision of Dynamic Reactive Compensation at KPS1, KPS3, Navsari(New) and Boisar-II Substations in form of STATCOMs in combination with MSC(s)/MSR(s) as given in Section(II) was in-principally agreed.

Meeting ended with a vote of thanks.

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Annexure-I

Gujarat - Evacuation of 30GW REZs in Khavda area

Annexure-II

List of Participants

Name	Organization	Designation
Vikas Sachan	CEA	Dy. Director, PSPA-I
S. Satyanarayan	WRPC	Member Secretary
P.D. Lone	WRPC	
Pushpa.S	WRLDC, GRID-INDIA	Sr.GM
M Venkateswara Rao	WRLDC, GRID-INDIA	Manager
Dipak H Patel	GETCO	DE (STU)
Sanjeev Bhole	MSETCL	CE (STU)
Umesh Bhagat	MSETCL	EE (CTU)
P. S. Das	CTUIL	Sr GM
V Thiagarajan	CTUIL	Sr GM
Bhaskar Wagh	CTUIL	Ch. Manager
Pratyush Singh	CTUIL	Manager
Shashank Shekhar	CTUIL	Dy. Manager
Ajay Kumar	CTUIL	Engineer