No.15/1/2016-Fin.
Government of India
Ministry of Power
*****

Shram Shakti Bhavan, Rafi Marg,
New Delhi, the 10th April, 2017

OFFICE MEMORANDUM

Subject: SFC Proposal for Establishment of Renewable Energy Management Centre (REMC)-reg.

The undersigned is directed to forward herewith a copy of SFC Memo on the above subject. It is requested that comments on the proposal may please be furnished to this Ministry at the earliest. Soft copy of SFC Memo has also been uploaded on website of Ministry of Power.

Encl: As above.

10.04.2017

(Nishat Kumar)
Under Secretary to the Government of India
Tele No.011-2332 4359

1. Joint Secretary (PF-II), Department of Expenditure, Ministry of Finance, North Block, New Delhi
2. Advisor (PAMD), NITI AAYOG, New Delhi.
3. Secretary, Ministry of Environment & Forests, Paryavaran Bhawan, Jor Bagh Road, New Delhi.
4. Chairperson, CEA, Sewa Bhawan, New Delhi.

Copy to: Director (PG), Ministry of Power: It is requested that replies/clarifications to the observations made by the appraisal agencies, may be sent to them directly in a half margin note under intimation to Finance Branch.

Copy for information to:

I. PPS to Secretary (P) / PPS to AS (SP)/ PS to JS&FA / PS to JS (Transmission), Ministry of Power, New Delhi.
II. CMD, PGCIL

Copy also to: Technical Director (NIC), MoP with a request to upload the enclosed soft copy of the above SFC memo on the website of Ministry of Power.

SFC Proposal

For

Establishment of Renewable Energy Management Centre (REMC)

April, 2017

Government of India
Ministry of Power
Shram Shakti Bhawan, Rafi Marg,
New Delhi -110001

TABLE OF CONTENT

No. 11/66/2014-PG(REMC)
Government of India
Ministry of Power
(Transmission Division)

Dated the April, 2017

SFC MEMORANDUM: PROPOSAL FOR CONSIDERATION

1. Scheme Outline

1.1. Title of the scheme

Establishment of Renewable Energy Management centre (REMC) in Southern Region (Tamil Nadu, Andhra Pradesh, Karnataka SLDCs & SRLDC), Western Region (Gujarat, Maharashtra, Madhya Pradesh SLDCs & WRLDC) and Northern Region (Rajasthan SLDC & NRLDC) & NLDC as part of Green Energy Corridor scheme.

1.2. Sponsoring agency (Ministry/Department/Autonomous Body or undertaking)

Ministry of Power, Government of India

1.3. Total cost of the proposed scheme

For ease of implementation, REMC project is segregated into three (3) packages viz. Southern region (Tamil Nadu, Andhra Pradesh, Karnataka SLDCs & SRLDC), Western Region (Gujarat, Maharashtra, Madhya Pradesh SLDCs & WRLDC), Northern Region (Rajasthan SLDC & NRLDC) and NLDC. As per the GiZ appointed consultant's DPR (under Indo-German technical assistance programme), estimated total cost of the project 409 Cr. (SR package – 154 Cr., WR package – 153 Cr. & NR package including NLDC – 102 Cr.)

1.4. Proposed duration of the scheme

The installation & commissioning of the REMC project shall be 15 months from the date of award. It is envisaged that REMCs (SR/WR/NR) shall be commissioned progressively in 2018-19. Further the scheme also includes REMC Annual Maintenance (6 years after 1 year of warranty) and Forecasting & Weather Service (4 years) upon post operational acceptance.

1.5. Nature of scheme: Central Sector Scheme/ Centrally Sponsored Scheme

Central Sector Scheme. No financial component/support is involved from respective State Govts.

1.6. For central sector schemes, sub-scheme/components, if any, may be mentioned. For centrally sponsored scheme, central and state components, if any, may be mentioned.

No sub scheme/components.

1.7. Whether a New or a continuing scheme? In case of a continuing scheme, whether the old scheme was evaluated and what were the main findings?

New scheme. It is a part of Green Energy Corridor scheme

1.8. Whether in-principal approval is required? If yes, has it been obtained?
Yes. In principle approval is obtained vide letter ref 59(04)/PF-II/2017 dated 15.02.17

1.9. Whether a Concept Paper or a Detailed Paper has been prepared and stakeholders consulted? In case of new Centrally Sponsored Schemes, whether the State Governments have been consulted?

Yes, a detailed concept paper has been prepared. In addition, DPR was also prepared by the Consultant, (M/s E&Y led consortium) appointed by GiZ (Govt of Germany) under its technical assistance programme, in consultation with respective SLDCs/RLDC/POSOCO.

1.10. Which existing schemes/sub-schemes are being dropped, merged or rationalized?
N/A

1.11. Is there an overlap with an existing scheme/sub-scheme? If so, how duplication of effort and wastage of resources are being avoided?
No, there is no overlap.

1.12. In case of an umbrella scheme (program) give the details of schemes and sub schemes under it along with the proposed outlay component-wise.
Note: It may kindly be noted that the word scheme here is used in a generic sense. It includes programs, schemes and sub-schemes, which, depending on need, can be appraised and approved as stand-alone cost centres.

REMC is part of Green Energy Corridor scheme. In order to facilitate integration of envisaged Renewable Generation capacity, a comprehensive transmission plan comprising intra state and interstate transmission system strengthening as well as Control Infrastructure was identified under "Green Energy Corridors". Control infrastructure requirements included establishment of Renewable Energy Management centers (REMC) at SLDC/RLDC/NLDC level also.

2. Outcomes and Deliverables

2.1. Stated aims and objectives of the Scheme

The scheme aims to address variability, intermittency & ramping aspect of the renewable integration through deployment of State-of-the-art monitoring, forecasting and scheduling system. This will help grid operator to effectively manage power system operations with economy, reliability & security.

Scheme Objective includes :

- Forecasting of RE generation on different levels such as State/region aggregated, pooling station wise etc based on information from Forecast Service provider

FSP) as well as Weather Service provider (WSP).

- Renewable Generation Scheduling
- Real time tracking of generation of RE sources, integration with REMC SCADA & its visualization
- Close coordination with respective LDC for RE generation & integration with existing SCADA

2.2. Indicate year-wise outputs/deliverables in a tabular form

Components	16-17 Advance		17-18 (On account of material dispatch)		18-19 Commissioning		19-20 to 25-26 (annual AMC & Forecasting services cost)		Total	
	Physical	Financial	Physical	Financial	Physical	Financial	Physical	Financial	Physical	Financial
1.	0	7	11 control centres	137	11 control centres	167	0	98	11	409

**Details attached at Annexure I*

*** Unit for Physical & financial parameter is nos. and Rs Cr respectively*

2.3. lndicate outcomes of the Scheme in the form of measurable indicators which can be used to evaluate the proposal periodically. Baseline data or survey against which such outcomes should be benchmarked should also be mentioned.

RE being variable generation, requires its real time monitoring as well as forecasting. REMC shall provide forecasting system to help system operators to better manage grid operation and ensure power system security and stability. The measurable indictors shall be i) Forecasting & scheduling of renewable resources, ii) Real time monitoring and visualization of RE resource at control centers iii) REMC SCADA integration with existing SLDC/RLDC. In this manner, REMC shall help in integration of RE while maintaining grid stability as well monitoring and operation of RE.

Out of total envisaged capacity of RE plan i.e. 160 GW (wind& Solar) by 2022, seven (7) RE resource rich states in which REMCs are being established, constitute about 104 GW RE i.e. about 65% of envisaged RE capacity. The investment for development of above RE capacity (about 104 GW) in above seven RE rich state shall be about Rs 5,20,000 Cr (assuming capex of Rs 5 Cr/MW). REMCs shall help in integrating above RE capacities into the grid thus accommodating increasing RE penetration levels. The envisaged RE capacity integration (104 GW) shall also lead to carbon emission reduction by up to 150 million tons of CO2 per annum as well as reduction in coal import bill. In this way this shall enable clean energy development shall go a long way in building nation's energy security & sustainability.

This would also help in fulfillment of GoI targets of 175 GW RE by 2022.

2.4. lndicate other schemes/sub-schemes being undertaken by Ministries/Departments which have significant outcome overlap with the proposed scheme. What convergence framework have been evolved to consolidate outcomes and save public resources?

No

3. Target Beneficiaries

3.1. If the scheme is specific to any location, area and segment of population, please give the details and basis for selection.

The scheme is envisaged in the renewable resource rich states/regions co-located with respective SLDCs/RLDCs & NLDC. Establishment of REMC is envisaged in Southern Region (Tamil Nadu, Andhra Pradesh, Karnataka SLDCs & SRLDC), Western Region (Gujarat, Maharashtra, Madhya Pradesh SLDCs & WRLDC) and Northern Region (Rajasthan SLDC & NRLDC) & NLDC

3.2. Please bring out specific interventions directed in favour of social groups, namely SC, ST, differently abled, minorities and other vulnerable groups.

Not applicable.

3.3. If the scheme has any gender balance aspects or components specifically directed at welfare of women, please bring them out clearly?

The proposal does not have any specific gender component.

3.4. Please bring out special interventions, if any, in North East, Himalayan, LWEI Island territories and other backward areas.

Not applicable.

3.5. In case of beneficiary oriented schemes, indicate the mechanism for identification of target beneficiaries and the linkage with Aadhaar/UID numbers.

Not applicable. Beneficiary is nation as a whole.

3.6. Wherever possible, the mode of delivery should involve the Panchayati Raj Institutions and Urban Local Bodies. Where this is intended, the preparedness and ability of the local bodies for executing the proposal may also be examined.

Not applicable.

4. Cost Analysis

4.1. Cost estimates for the scheme duration: both year-wise, component-wise segregated into non-recurring and recurring expenses.

A total budget requirement to provide CFA as per the DPR is estimated as Rs 409 Cr. The component wise segregation is given in ***Annexure II.*** Estimated cost of control centers broadly varies on account of forecasting & weather services for nos. of STU/ISTS pooling stations (RE) in each RLDC/SLDC REMC as well as Hardware requirements at control centers.

4.2. The basis of these cost estimates along with the reference dates for normative costing.

The cost is as per DPR estimates on Aug/Sep'16 with validity of 1 year. DPR cost includes Project Management Cost (PMC) charges also. PMC paid/being paid to PGCIL in respect of NERPSIP, Srinagar-Leh 220 KV Transmission system, comprehensive scheme for improvement of T&D system in Arunachal Pradesh and Sikkim is 12%. Keeping in view the new technology involved in implementation of REMCs, PMC charges may be kept as 10%.

4.3. In case pre-investment activities or pilot studies are being carried out, how much has been spent on these?

N/A

4.4. In case the scheme involves payout of subsidy, the year wise and component wise expected outgo may be indicated.

N/A

4.5. In case the land is to be acquired the details of cost of land and cost of rehabilitation/resettlement, if any.

Not applicable. The REMC shall be co-located with respective SLDC, RLDC and NLDC.

4.6. In case committed liabilities are created, who will or has agreed to bear the legacy burden? In case assets are created, arrangements for their maintenance and upkeep?

Not applicable, as REMC system annual maintenance cost (6 years after 1 year warranty) as well as forecasting & weather service cost (4 years) is part of the project cost. A detail of cost estimate is enclosed at ***Annexure-II***. The system shall be owned and operated by respective states-LDCs/POSOCO. Apart from the estimated capital cost of REMC control centers, maintenance cost is already included for the contract period. Further operation part including manpower etc shall be taken care by respective REMCs (SLDC/RLDC).

5. Scheme Financing

5.1. lndicate the sources of finance for the Scheme: budgetary support, extra-budgetary sources, external aid, state share, etc.

Scheme is proposed to be financed from 100% Gross Budgetary Support. No financial component/support is involved from respective State Govts / State DISCOMs. At present no expenditure has been incurred on establishment of REMCs, though there has been expenses related to issuance of tender, field visits etc, such expenses are part of PMC head.

5.2. If external sources are intended, the sponsoring agency may indicate, as also whether such funds have been tied up?

N/A

5.3. lndicate the component of the costs that will be shared by the State Governments, local bodies, user beneficiaries or private parties?

No financial component/support is involved from respective State Govts/State DISCOMs.

6. Approvals and Clearances

6.1. Requirement of mandatory approvals and clearances from various local, state and national bodies and their availability may be indicated in a tabular form (land acquisition, environment, forestry, wildlife etc.)

Land not required as REMC shall be co-located with respective SLDCs/RLDCs & NLDC.

7. Human Resources

7.1. Indicate the administrative structure for implementing the Scheme. Usually creation of new structures, entities etc. should be avoided

Owner of REMC will be existing SLDCs, RLDCs & NLDC. REMC is entirely a new technical project in India which has lot of security concerns as the information compiled in REMC will be linked to the Load Dispatch Centre (RLDC, NLDC & SLDCs). The high level security is to be maintained for all the LDCs. Further, PGCIL has already executed many such control center project in past for State/regional LDCs. Accordingly, the scheme was given to PGCIL, a Govt. company & CTU on nomination basis, for its implementation on consultancy assignment. PGCIL will handover the REMC to respective states/POSOCO upon its commissioning.

7.2. Manpower requirement, if any. In case posts, permanent or temporary, are intended to be created, a separate proposal may be sent on tile to Pers. Division of Department of Expenditure (such proposals may be sent only after the main proposal is recommended by the appraisal body.

Existing manpower of SLDC/RLDC/POSOCO may be utilized for REMC operations

7.3. In case outsourcing of services or hiring of consultants is intended, brief details of the same may be provided.

DPR for establishment of REMC has been prepared by the consultant appointed by GiZ, Germany as part of Indo-German technical assistance programme. In the present proposal, no consultant is intended.

8. Monitoring and Evaluation

8.1. Please indicate the monitoring framework, including MIS, and the arrangements for internal/statutory audit.

CEA will closely monitor implementation of scheme to ensure that timeline as envisaged for completion of various activities are adhered. PGCIL will furnish periodical reports to CEA. The report /MIS would be listed by respective SLDC/RLDC/NLDC. The progress of the scheme will also be monitored by MoP independently

8.2. Please indicate the arrangement for third party independent evaluation? Please note that evaluation is necessary for extension of scheme from one period to another.

Evaluation of the scheme viz implementation, third party inspection and performance after commissioning of REMC would be undertaken by CEA.

9. Comments of the Financial Advisor, NITI Aayog, Department of Expenditure and other Ministries/Departments may be summarized in tabular form along with how they are being internalized and used to improve this proposal.

Comments of FA annexed at ***Annexure-III.***

10. Approval Sought:

Recommendation of SFC is solicited for establishment of REMC in Southern region, Western region and Northern region (including NLDC) as a part of Green Energy Corridor with an estimated cost of Rs. 409 crores.

(Archana Agrawal)
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Annexure I: Annual Fund flow requirements

Sno	Project	Annual Fund flow requirement (Rs Cr)**									
		2016-17@	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**2025-26**
1	**REMC**	7	137	167	17	24	23	17	7	7	3
	Grand Total (Rs Cr)	409									

@ Includes advance for SR package – based on contractor request

*** The fund flow requirement includes REMC Annual Maintenance Charges (for 6 years after 1 year of warranty) and Forecasting & Weather Service charges (4 years) post operational acceptance*

Annexure II: Detailed Cost Estimate

S.no.	REMC	Estimated Cost (₹ Cr)						
		H/W & S/W (SCADA, Forecasting & Scheduling etc.) and Contingency	Training	Forecasting & Weather Services (4 years)	REMC AMC (6 years)	PMC** cost	Taxes, duties and F&I**	Total
	Southern Region							
1	Tamil Nadu	**17.9**	**3.0**	**13.4**	**3.0**	**2.2**	**6.0**	**45.4**
2	Andhra Pradesh	**18.6**	**3.0**	**4.5**	**3.0**	**2.2**	**5.2**	**36.5**
3	Karnataka	**19.4**	**3.0**	**7.5**	**3.7**	**2.2**	**5.2**	**41.0**
4	SRLDC	**17.1**	**3.0**	**1.5**	**3.0**	**1.5**	**4.5**	**30.5**
	Western Region							
5	Gujarat	**20.1**	**3.0**	**9.7**	**3.7**	**2.2**	**5.2**	**44.0**
6	Madhya Pradesh	**17.9**	**3.0**	**5.2**	**3.0**	**2.2**	**4.5**	**35.8**
7	Maharashtra	**19.4**	**3.0**	**6.0**	**3.7**	**2.2**	**5.2**	**39.5**
8	WRLDC	**20.1**	**3.0**	**1.5**	**3.7**	**2.2**	**4.5**	**35.0**
	Northern Region							
9	Rajasthan	**20.1**	**3.0**	**4.5**	**3.7**	**2.2**	**5.2**	**38.7**
10	NRLDC	**20.1**	**3.0**	**1.5**	**3.7**	**2.2**	**4.5**	**35.0**
11	NLDC	**16.4**	**3.0**	**0.0**	**3.0**	**1.5**	**3.7**	**27.6**
	Grand Total	**207.1**	**32.8**	**55.1**	**37.3**	**23.1**	**53.6**	**409.0**

*@ **As per the DPR estimates (**considering currency conversion rate 1 Eur- 74.5 INR)*
***PMC = Project Management Consultancy Charges; F&I = Freight & Insurance*

Annexure II (a): Detailed Cost Estimate (as per DPR)

S.no.	REMC	Estimated Cost (Euro Million)						
		H/W & S/W (SCADA, Forecasting & Scheduling etc.) and Contingency	Training	Forecasting & Weather Services (4 years)	REMC AMC (6 years)	PMC** cost	Taxes, duties and F&I**	Total
	Southern Region							
1	Tamil Nadu	**2.4**	**0.4**	**1.8**	**0.4**	**0.3**	**0.8**	**6.1**
2	Andhra Pradesh	**2.5**	**0.4**	**0.6**	**0.4**	**0.3**	**0.7**	**4.9**
3	Karnataka	**2.6**	**0.4**	**1**	**0.5**	**0.3**	**0.7**	**5.5**
4	SRLDC	**2.3**	**0.4**	**0.2**	**0.4**	**0.2**	**0.6**	**4.1**
	Western Region							
5	Gujarat	**2.7**	**0.4**	**1.3**	**0.5**	**0.3**	**0.7**	**5.9**
6	Madhya Pradesh	**2.4**	**0.4**	**0.7**	**0.4**	**0.3**	**0.6**	**4.8**
7	Maharashtra	**2.6**	**0.4**	**0.8**	**0.5**	**0.3**	**0.7**	**5.3**
8	WRLDC	**2.7**	**0.4**	**0.2**	**0.5**	**0.3**	**0.6**	**4.7**
	Northern Region							
9	Rajasthan	**2.7**	**0.4**	**0.6**	**0.5**	**0.3**	**0.7**	**5.2**
10	NRLDC	**2.7**	**0.4**	**0.2**	**0.5**	**0.3**	**0.6**	**4.7**
11	NLDC	**2.2**	**0.4**	**0**	**0.4**	**0.2**	**0.5**	**3.7**
	Grand Total	**27.8**	**4.4**	**7.4**	**5**	**3.1**	**7.2**	**54.9**

*@ **As per the DPR estimates***

***PMC = Project Management Consultancy Charge; F&I = Freight & Insurance*

ANNEXURE-III

S.No.	Observation/Comments of IFD, MOP	Reply/Clarification
1.	As per Para iv (i) of the D/o Expenditure OM dated 05.08.2016, in principle approval of D/o Expenditure may have to be obtained as this will be a new scheme.	In principle approval has been obtained vide letter ref 59(04)/PF-II/2017 dated 15.02.17
2.	Programme Division has prepared the SFC Memo in the old format of SEC Memo, thus Programme Division would be required to prepare Memo in a ccordance with the new formats as given at Annexure-IV A of the D/o Expenditure OM dated 05.08.2016.	Revised SFC memo prepared in new format, as advised
3.	Relevant portions of the DPR may be provided for examination of the cost estimates.	Relevant portions of DPR have been provided for cost estimate. Details also enclosed at Annexure-II (a) in SFC memo.
4.	Break up of cost, component-wise may be explicitly specified along with phasing of expenditure. The breakup of cost given is only center-wise.	Incorporated in SFC memo, Annexure-II
5.	The completion schedule of the project indicating broad timelines of the project as a whole may be specified.	Incorporated in SFC memo, section 1.4
6.	REMC is to be set up across different regions of the country. It may also be specified whether there is any financial component involved in funding of the proposal from State Govts., as it has been stated that the scheme is a Centrally Sponsored Scheme.	Incorporated in SFC memo, section 5.1
7.	Rationale behind giving PGCIL the contract of implementing REMC may also be specified. The basis of fixation of PMC charges may also be indicated.	Incorporated in SFC memo, section 7.1 & 4.2 respectively
8.	As REMC will be a part of Green Energy Corridor scheme, it may be explicitly specified at relevant places in the SFC/EFC memo.	REMC is a part of Green Energy Corridor scheme is explicitly specified at relevant places in the SFC memo

9.	IFD's comments given vide note on page 8/ante and thereto reply of programme Division have not been incorporated in the Memo, the same needs to be incorporated at Para 9 of the SFC Memo.	Incorporated in SFC memo at section 9
10.	D/o Expenditure vide Para 2 (iii) of its OM dated 15.02.2017 has suggested that as 100% Gross Budgetary Support has been proposed for the project thus the project will result in savings and it may be explored if the project can be funded partly from the internal resources of DISCOMS, nothing has been specified in this regard. It is requested to provide a reply in this regard and incorporate the same at relevant place in the SFC Memo.	Incorporated in SFC memo section-5.1
11.	Details of expenditure that has already been incurred on the proposal (if any) may also be incorporated in the SFC Memo and ex-post facto approval for the expenditure (if any) may also be sought with the extant proposal.	Incorporated in SFC memo section-5.1
12.	Para 10 for approval sought has been amended, the same needs to be incorporated in the SFC memo.	Incorporated
13.	From the proposal it is observed that setting up of the Renewable Energy Management Centre will result in better management of grid operation and will also ensure power system stability & security amidst increasing RE penetration. With the forecasting system, wastage of energy can be avoided, resulting in optimum utilization and better management of the power in the grid. The outcome/benefits of the scheme are only mentioned as stability and security. They may also be quantified in quantitative and financial terms.	Incorporated in SFC memo, section 2.3
14.	The proposal is in the nature of a project. The Financial Internal Rate of Return (FIRR) and Economic Rate of Return (ERR) may be computed.	Since project is to be funded from 100% GBS, quantification in terms of FIRR/ERR not envisaged.

15.	100% Gross budgetary Support has been proposed for the project. As the project will result in savings, it may be explored if the projects can be funded partly from the internal resources of DISCOMs.	Incorporated in SFC memo section 5.1
16.	Proposed cost of Rs. 409 cr includes cost of Hardware, Software, AMC etc. for the period 4 years (RE forecasting and weather Service Charges) to 7 years (AMC for six years and warranty for one year). The Concept paper does not highlight whether after the lapse of the contract period, fresh investment for capital and revenue cost will be required or for only revenue expenditure. Details of post project maintenance may be indicated. Estimated life of the asset created may also be brought out in the revised Concept note.	Incorporated in REMC concept note, page-3, para-3
17.	Though REMCs are proposed to be in the nature of Control Centres, there may be additional cost: both capital cost (other than forecasting system) as well as revenue (operation, maintenance, manpower) cost. This may also be brought out in the revised concept note.	Incorporated in SFC memo, section 4.6 as well as concept paper X-Finance
18.	It has been observed that there is variation in cost estimation of different centres. Reasons for variation may be brought out in the SFC note	Incorporated in SFC memo, section 4.1 as well as concept paper X-Finance

Executive Summary

Govt. of India has set an ambitious plan for establishing about 175 GW renewable generation capacity by 2022 including 100GW Solar, 60 GW wind and 15 GW other renewable sources.

Renewable energy (RE) sources especially Wind & Solar, unlike conventional sources of energy, is characterized by intermittency, variability and uncertainty. Increasing Renewable penetration, due to above challenges, may affect grid stability & security. It may be noted that about 70% of the total envisaged capacity of Wind & Solar generation (160 GW) shall be mainly in seven (7) RE resource rich states viz. Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra, Madhya Pradesh, Gujarat and Rajasthan only.

Existing Control Centers (SLDC/RLDC) don't have RE forecasting system which can assess how much renewable is needed to be integrated into the grid in various time horizons. This poses limitation in integration of RE. To deal with these challenges, RE forecasting is crucial in long term planning as well as operation process including for reserves management. Further, RE forecasting systems are also needed to be integrated with scheduling as well as monitoring system. Renewable Energy Management Centre (REMC) equipped with above facilities shall address RE integration issues to a large extent. Implementation of such state-of-the-art RE forecasting & monitoring systems is also a global best practice and is already under operation in various countries like Spain, Germany, USA, Denmark, Belgium, Australia etc. to facilitate grid integration of RE.

Considering this, establishment of Renewable Energy Management Centers (REMC) equipped with following functionalities are envisaged, as part of **Green Energy Corridor** scheme.

- Forecasting of RE generation on different levels such as State/region aggregated, pooling station wise etc based on information from Forecast Service provider (FSP) as well as Weather Service provider (WSP).
- Renewable Generation Scheduling

- Real time tracking of generation of RE sources, integration with REMC SCADA & its visualization
- Close coordination with respective LDC for RE generation & integration with existing SCADA

REMCs are proposed to be co-located with the existing Load dispatch centers in the renewable resource rich states viz. Tamil Nadu, AP, Karnataka, Maharashtra, MP, Gujarat and Rajasthan and their respective regions for close coordination.

In REMCs, main objective of the RE forecasting tool/system is to provide prediction of wind and solar power generation close to actual at State/region aggregated, pooling station level etc. The forecasting tool will run in the Application server. RE forecasting tool shall be getting inputs from multiple (3) forecasting service providers (FSPs) as well as weather service providers (WSPs). RE forecasting tool shall also have an internal forecasting module which will take input from WSPs and internally generate power forecast. Based on all these inputs, the tool will generate an optimal combinational forecast. FSPs or WSPs shall provide input forecasting parameters based on outcomes of Numerical weather prediction (NWP) models etc. Their statistical models shall convert above parameters to generate expected power output from RE generators as well as correct for biases and errors. Over the period of time, these statistical models shall be improved based on actual production data.

RE Forecasting tool output shall be available in Day ahead as well as Intra Day time period which will support SLDC and RLDC in conventional generation scheduling, dispatching, balancing need assessment, grid operation planning, load flow calculation etc. For this, RE generation forecasting shall be done starting from RE Developer Pooling station upto the state/region aggregated level for each time block 15 mins and same will be displayed on the Video projection system (VPS). RE scheduling tool shall obtain quantum of power to be injected into the grid by renewable energy resources in a particular area from respective RE developers, so that integrated planning for supply-demand gap management in that area may be dealt well ahead. It shall involve collection of information from RE generators and integration with forecasting tools, which are processed and accordingly final schedule will be prepared. Real time monitoring of RE generation will be facilitated through REMC SCADA. A Visualisation for trending/analytics shall also be provided which shall have display capabilities for

forecasts at different levels w.r.t to actual generation, generation profile, accuracy evaluation etc.

REMCs in this way shall help in integration of RE leading to facilitate fulfilment of GoI targets of 175 GW RE by 2022 towards energy security and sustainability.

In the present scheme, establishment of REMC is envisaged in Southern Region (Tamil Nadu, Andhra Pradesh, Karnataka SLDCs & SRLDC), Western Region (Gujarat, Maharashtra, Madhya Pradesh SLDCs & WRLDC) as well as Northern Region (Rajasthan SLDC & NRLDC) & NLDC. Under an Indo-German technical assistance programme, GiZ appointed Consultant (E&Y led consortium) prepared detailed project reports (DPR) for establishment of REMCs at above locations in consultation with respective SLDCs/RLDCs & POSOCO. As per the DPRs, total estimated cost of REMC at above 11 (eleven) locations is about Rs 409 Cr. The proposal cost includes components viz. RE Forecasting Tool, RE Scheduling Tool, REMC SCADA, Visualisation tool, display unit, corresponding hardware(H/W) & Software(S/W), REMC Annual Maintenance Charges (for 6 years after 1 year of warranty), RE Forecasting & Weather Service charges (4 years), training as well as Project Management Consultancy (PMC) Charges. The expected life cycle of control centre infrastructure is generally 7 years therefore after the lapses of contract period i.e. 7 years, fresh investment of capital cost may be required. However, provision for extension of AMC for further 2 years on same terms & conditions is also kept in the contract.

The project is proposed to be financed from GBS allocation by Ministry of Power, Government of India. PGCIL is assigned an implementing agency for REMCs system as part of a consultancy assignment whereas Owner of REMC shall be respective SLDCs, RLDCs & NLDC. PGCIL will hand over the REMC upon its commissioning to respective owners (SLDC/RLDC-POSOCO). The implementation period for REMCs shall be 15 months from the date of award.

Concept Paper on Renewable Energy Management Centers (REMC)

i. Context/Background:

India is bestowed with abundant Renewable potential, which offers an excellent solution to attain energy security & sustainability, provide energy access as well as address environmental concerns. Considering this, the Government of India has up-scaled the target of renewable generation capacity to 175 GW by the year 2022 which includes 100 GW from solar, 60 GW from wind and balance 15 GW from other RE resources. Tentative State wise break up of Renewable generation by 2022, as envisaged by MNRE, is enclosed at ***Annexure-I***.

As Renewable generation especially wind & solar has inherent characteristics of variability and intermittency due to its nature of resource i.e. Wind or Solar, it adds up supply side variability thereby posing additional challenges to the Grid Operator. Further, increasing Renewable penetration poses new challenges in ensuring grid security & reliability. It may be noted from the list (at ***Annexure-I***) that about 70% of the total envisaged capacity of Wind & Solar generation (160 GW) shall be mainly in seven (7) RE resource rich states viz. Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra, Madhya Pradesh, Gujarat and Rajasthan only.

To deal with challenges like variability and uncertainty in renewable generations, RE forecasting is crucial in planning and operation process including resource or reserves management. Keeping in view expected increase in renewable penetration into the grid, there is a need to equip Power System Operators with additional State-of-the-Art tools along with real time tracking of generation from RE sources. Keeping above in view, establishment of Renewable Energy Management centers (REMC) equipped with advanced forecasting tools, RE scheduling solutions, real time monitoring of RE generation, closely coordinating with SLDC/RLDC was proposed as part of ***Green Energy Corridor scheme***. REMCs are proposed to be co-located with their respective Load dispatch centers in the renewable resource rich states/regions.

In the present scheme, establishment of REMC is envisaged in Southern Region (Tamil Nadu, Andhra Pradesh, Karnataka SLDCs & SRLDC), Western Region (Gujarat,

Maharashtra, Madhya Pradesh SLDCs & WRLDC) as well as Northern Region (Rajasthan SLDC & NRLDC) & NLDC as part of ***Green Energy Corridor scheme***.

For establishment of Green Energy Corridors, a Joint Declaration of Intent was signed between Govt. of Germany and Govt of India by which German side expressed its willingness to provide concessional loans of upto 1 billion Euro through KFW for development of Green Energy Corridors. Govt. of Germany also agreed to share their technical expertise for realizing Green Energy Corridor Plan including Technical assistance (2 Million Euro) in the field of renewable integration under Indo-German technical cooperation and to be realized through GiZ. As part of technical assistance cooperation, GiZ awarded contract to consortium of E&Y India, E&Y Germany, University of Oldenburg, Fraunhofer IWES and Fichtner & Co. which included scope for preparation of detailed project reports (DPR) for establishment of REMCs at above locations. REMC DPRs are already prepared by the consultant in consultation with the respective SLDCs/RLDCs & POSOCO.

ii. Problem to be addressed

Renewable are characterised by its variability, intermittency and uncertainty. In higher renewable penetration scenario, this may affect grid stability & security. To deal with such issues, forecasting is crucial in planning and operation horizons including resource or reserves management. Further RE forecasting systems are also needed to be integrated with scheduling as well as monitoring systems. Existing Control Centers (SLDC/RLDC) don't have RE forecasting system which can assess how much renewable can be integrated into the grid in various time horizons. This poses limitation in integration of RE.

To take care of above, Renewable Energy Management Centre (REMC), equipped with RE Forecasting & Scheduling Tools as well as Real Time Monitoring & visualization of RE generation is proposed. REMCs shall closely coordinate with the Grid Operations team for safe, secure and optimal operations of the overall grid. Implementation of such state-of-the-art RE forecasting & monitoring systems is also a global best practice and is already under operation in various countries like Spain, Germany, USA, Denmark, Belgium, Australia etc. to facilitate grid integration of RE.

iii. Aims and Objectives

The scheme aims to address variability, intermittency & ramping aspect of the renewable integration to help grid operator to effectively manage power system operations while maintaining grid stability & security.

REMC Objectives include:

- Forecasting of RE generation on different levels such as State/region aggregated, pooling station wise etc based on information from Forecast Service provider (FSP) as well as Weather Service provider (WSP).
- Renewable Generation Scheduling
- Real time tracking of generation of RE sources, integration with REMC SCADA & its visualization
- Close coordination with respective LDC for RE generation & integration with existing SCADA

iv. Strategy

Renewable forecasting is very crucial in dealing with challenges due to its variability & intermittency. This helps grid operator in planning and operation process including resource or reserves management. Establishment of dedicated Renewable Energy Management Centres is proposed at RE resource rich locations to facilitate grid integration of large scale renewable envisaged in such states/regions. REMC shall help in integration of RE leading to facilitate fulfillment of GoI targets of 175 GW by 2022. PGCIL is entrusted with implementation of REMC project. PGCIL shall implement the project in coordination with respective stakeholders (SLDCs/RLDCs/NLDC). Upon commissioning, REMCs shall be handed over to respective SLDCs/RLDCs & NLDC. For its smooth implementation, REMC project is segregated into three (3) packages viz. Southern region (Tamil Nadu, Andhra Pradesh, Karnataka & SRLDC), Western Region (Maharashtra, Gujarat, Madhya Pradesh & WRLDC) and Northern region (Rajasthan, NRLDC & NLDC). Bidder shall be selected trough competitive bidding procedure. POWERGRID has also kept provision of conducting an e-reverse auction for further optimizing the price by bidders.

v. Target Beneficiaries

Establishment of REMC is envisaged in Southern Region (Tamil Nadu, Andhra Pradesh, Karnataka SLDCs & SRLDC), Western Region (Gujarat, Maharashtra, Madhya Pradesh SLDCs & WRLDC) and Northern Region (Rajasthan SLDC & NRLDC) & NLDC, which will benefit all these states in particular and nation in general.

vi. Legal Framework

NA

vii. Environmental Impact

REMCs in above seven (7) states shall help in integrating envisaged RE capacities into the grid thus accommodating increasing RE penetration levels. This shall lead to carbon emission reduction by up to 150 million tons of CO2. In this way this shall enable clean energy development having positive environmental impact.

viii. Technology

REMC shall include deployment of state-of-the-art SCADA system, forecasting and scheduling tools, visualisation tool, display unit, corresponding hardware (H/W) & software (S/W) etc. In REMC, the main objective of the RE forecasting tool/system is to provide prediction of wind and solar power generation. The forecasting tool will run in the Application server. RE forecasting tool shall be getting inputs from multiple (3) forecasting services providers (FSPs) as well as weather service providers (WSPs) to generate an optimal combinational forecast based on various algorithms. These FSPs or WSPs provide pooling station wise input forecasting parameters based on outcomes of Numerical weather prediction (NWP) models. Statistical models convert above parameters to generate expected power output as well as correct for systematic biases and error patterns. Over the period of time, these statistical models shall be improved based on actual production data.

RE Forecasting tool output shall be available in Day ahead as well as Intra Day time period which will support SLDC and RLDC in conventional generation scheduling comprehensively, balancing need assessment, grid operation planning, load flow estimation etc. For this, RE generation forecasting shall be done starting from RE

Developer Pooling station upto the state/region periphery aggregated level for each time block 15 mins and same will be displayed on the Video projection system (VPS). RE scheduling tool shall obtain quantum of power to be injected by renewable generation sources in a particular area from RE developers, so that integrated planning for supply-demand gap management in that area may be dealt well ahead of occurrence. It shall involve collection of information from RE generators and integration with forecasting tools, which are processed and accordingly final dispatch schedule will be prepared. Real time monitoring of RE generation will be facilitated through REMC SCADA. A Visualisation for tending/analytics shall also be provided which shall have display capabilities for forecasts at different levels w.r.t to actual generation, accuracy evaluation etc

ix. Management

Owner of REMC shall be respective SLDCs, RLDCs & NLDC. PGCIL shall be the implementing agency for REMCs system as part of a consultancy assignment. PGCIL will hand over the REMC upon its commissioning to respective owners (SLDC/RLDC-POSOCO). Existing manpower of SLDC/RLDC/POSOCO may be utilized for REMC operations.

x. Finance

For ease of implementation, REMC project is segregated into three (3) packages viz. Southern region (Tamil Nadu, Andhra Pradesh, Karnataka SLDCs & SRLDC), Western Region (Gujarat, Maharashtra, Madhya Pradesh SLDCs & WRLDC), Northern Region (Rajasthan SLDC & NRLDC) and NLDC.

As per the consultant (E&Y) DPR prepared in consultation with SLDC, RLDC & NLDC, estimated total cost of the REMC project is ₹ 409 Cr. (SR package – 154 Cr., WR package – 153 Cr. & NR package including NLDC – 102 Cr). The cost estimate include components viz. RE Forecasting Tool, pooling station wise forecasting, RE Scheduling Tool, REMC SCADA, Visualisation tool, display unit, corresponding hardware(H/W) & Software(S/W), REMC Annual Maintenance Charges (for 6 years after 1 year of warranty), RE Forecasting & Weather Service charges (4 years), training as well as Project Management Consultancy (PMC) Charges. Estimated cost of control centers broadly varies on account of forecasting & weather services for nos. of STU/ISTS

pooling stations (RE) in each RLDC/SLDC REMC as well as Hardware requirements at control centers. Details of cost estimate in this regard is enclosed at ***Annexure-II***. The project is proposed to be financed from GBS allocation by Ministry of Power, Government of India. No financial component/support is involved from respective State Govts / State DISCOMs.

Apart from the estimated capital cost of REMC control centers, maintenance cost is already included for the contract period. Further operation part including manpower etc shall be taken care by respective REMCs (SLDC/RLDC).

Annual fund flow requirement for the scheme is tabulated as under:

S. No.	**Project**	**Annual Fund flow requirement (Rs Cr)**									
		2016-17@	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**2025-26**
1	**REMC**	7	137	167	17	24	23	17	7	7	3
	Grand Total (Rs Cr)	409									

@ Includes advance for SR package
*** The above fund flow requirement includes REMC Annual Maintenance Charges (for 6 years after 1 year of warranty) and Forecasting & Weather Service charges (4 years) post operational acceptance*

xi. Time Frame

The implementation period for REMCs shall be 15 months from the date of award. It is envisaged that REMCs (SR/WR/NR) shall be commissioned progressively from 2018-19.

xii. Cost benefit analysis

Out of total envisaged capacity of RE plan i.e. 160 GW (wind& Solar) by 2022, seven (7) RE resource rich states in which REMCs are being established, constitute about 104 GW RE i.e. about 65% of envisaged RE capacity. The investment for development of above RE capacity (about 104 GW) in above seven RE rich state shall be about Rs 5,20,000 Cr (assuming capex of Rs 5 Cr/MW). REMCs shall help in integrating above RE capacities into the grid thus accommodating increasing RE penetration levels. The

envisaged RE capacity integration (104 GW) shall also lead to carbon emission reduction by up to 150 million tons of CO2 per annum as well as reduction in coal import bill. In this way this shall enable clean energy development shall go a long way in building nation's energy security & sustainability.

xiii. Risk Analysis

For the project, technology risk has a very low portability of occurrence. SCADA system is a well established product. Forecasting tools along with Forecasting services are already being used globally, are also perceived to have a low portability of occurrence in term of risk.

xiv. Outcomes

REMC shall facilitate in better managing grid operation and ensure power system stability & security amidst increasing RE penetration. REMC shall also help in monitoring and operation of RE leading to facilitate fulfillment of GoI targets of 175 GW RE by 2022.

xv. Evaluation

Evaluation of the scheme viz. implementation, third party inspection and performance after commissioning of REMC would be undertaken by CEA.

Annexure I to Concept Paper :
Tentative State wise break up of Renewable generation by 2022

State/UTs	Solar Power (MW)	Wind (MW)	SHP (MW)	Biomass Power (MW)
Delhi	2762			
Haryana	4142		25	209
Himachal Pradesh	776		1500	
Jammu & Kashmir	1155		150	
Punjab	4772		50	244
Rajasthan	5762	8600		
Uttar Pradesh	10697		25	3499
Uttrakhand	900		700	197
Chandigarh	153			
Northern Region	**31120**	**8600**	**2450**	**4149**
Goa	358			
Gujarat	8020	8800	25	288
Chhattisgarh	1783		25	
Madhya Pradesh	5675	6200	25	118
Maharashtra	11926	7600	50	2469
D. & N. Haveli	449			
Daman & Diu	199			
Western Region	**28410**	**22600**	**125**	**2875**
Andhra Pradesh	9834	8100		543
Telangana		2000		
Karnataka	5697	6200	1500	1420
Kerala	1870		100	
Tamil Nadu	8884	11900	75	649
Puducherry	246			
Southern Region	**26531**	**28200**	**1675**	**2612**
Bihar	2493		25	244
Jharkhand	1995		10	
Orissa	2377			
West Bengal	5336		50	
Sikkim	36		50	
Eastern Region	**12237**		**135**	**244**
Assam	663		25	
Manipur	105			
Meghalaya	161		50	
Nagaland	61		15	
Tripura	105			
Arunachal Pradesh	39		500	
Mizoram	72		25	
North Eastern Region	**1205**		**615**	
Andaman & Nicobar Islands	27			
Lakshadweep	4			
Other (New States)		600		120
All India	**99533**	**60000**	**5000**	**10000**

Annexure II to Concept Paper:
Detailed Cost Estimate

S.no.	REMC	Estimated Cost (₹ Cr)						
		H/W & S/W (SCADA, Forecasting & Scheduling etc.) and Contingency	Training	Forecasting & Weather Services (4 years)	SCADA AMC (6 years)	PMC cost**	Taxes, duties and F&I**	Total
	Southern Region							
1	Tamil Nadu	**17.9**	**3.0**	**13.4**	**3.0**	**2.2**	**6.0**	**45.5**
2	Andhra Pradesh	**18.6**	**3.0**	**4.5**	**3.0**	**2.2**	**5.2**	**36.5**
3	Karnataka	**19.4**	**3.0**	**7.5**	**3.7**	**2.2**	**5.2**	**41.0**
4	SRLDC	**17.1**	**3.0**	**1.5**	**3.0**	**1.5**	**4.5**	**30.6**
	Western Region							
5	Gujarat	**20.1**	**3.0**	**9.7**	**3.7**	**2.2**	**5.2**	**43.9**
6	Madhya Pradesh	**17.9**	**3.0**	**5.2**	**3.0**	**2.2**	**4.4**	**35.7**
7	Maharashtra	**19.4**	**3.0**	**6.0**	**3.7**	**2.2**	**5.2**	**39.5**
8	WRLDC	**20.1**	**3.0**	**1.5**	**3.7**	**2.2**	**4.5**	**35.0**
	Northern Region							
9	Rajasthan	**20.1**	**3.0**	**4.5**	**3.7**	**2.2**	**5.2**	**38.7**
10	NRLDC	**20.1**	**3.0**	**1.5**	**3.7**	**2.2**	**4.5**	**35.0**
11*	NLDC	**16.4**	**3.0**	**0.0**	**3.0**	**1.5**	**3.7**	**27.6**
	Grand Total	**207.1**	**33**	**55.3**	**37.2**	**22.8**	**53.6**	**409.0**

*@ **As per the DPR estimates** (considering currency conversion rate 1 Eur- 74.5 INR)*

** DPRs for NLDC package is under approval by Stakeholders*

***PMC = Project Management Consultancy Charges; F&I = Freight & Insurance*

Annexure II (a) to Concept Paper :
Detailed Cost Estimate (as per DPR)

S.no.	REMC	Estimated Cost (Euro Million)						
		H/W & S/W (SCADA, Forecasting & Scheduling etc.) and Contingency	Training	Forecasting & Weather Services (4 years)	SCADA AMC (6 years)	PMC** cost	Taxes, duties and F&I**	Total
	Southern Region							
1	Tamil Nadu	**2.4**	**0.4**	**1.8**	**0.4**	**0.3**	**0.8**	**6.1**
2	Andhra Pradesh	**2.5**	**0.4**	**0.6**	**0.4**	**0.3**	**0.7**	**4.9**
3	Karnataka	**2.6**	**0.4**	**1**	**0.5**	**0.3**	**0.7**	**5.5**
4	SRLDC	**2.3**	**0.4**	**0.2**	**0.4**	**0.2**	**0.6**	**4.1**
	Western Region							
5	Gujarat	**2.7**	**0.4**	**1.3**	**0.5**	**0.3**	**0.7**	**5.9**
6	Madhya Pradesh	**2.4**	**0.4**	**0.7**	**0.4**	**0.3**	**0.6**	**4.8**
7	Maharashtra	**2.6**	**0.4**	**0.8**	**0.5**	**0.3**	**0.7**	**5.3**
8	WRLDC	**2.7**	**0.4**	**0.2**	**0.5**	**0.3**	**0.6**	**4.7**
	Northern Region							
9	Rajasthan	**2.7**	**0.4**	**0.6**	**0.5**	**0.3**	**0.7**	**5.2**
10	NRLDC	**2.7**	**0.4**	**0.2**	**0.5**	**0.3**	**0.6**	**4.7**
11*	NLDC	**2.2**	**0.4**	**0**	**0.4**	**0.2**	**0.5**	**3.7**
	Grand Total	**27.8**	**4.4**	**7.4**	**5**	**3.1**	**7.2**	**54.9**

*@ **As per the DPR estimates***

**DPRs for NLDC package is under approval by Stakeholders*

***PMC = Project Management Consultancy Charge; F&I = Freight & Insurance*