A
Detail Project Report

on

Proposed 220 kV Single, Double, Multi Circuit Transmission Line Route

for

Proposed 450 MW (Wind-Solar) Hybrid Park

At Jaisalmer,Barmer,Districts of Rajasthan

By:

SBE Renewables Ten Private Limited

Adani Corporate House, Shantigram, Nr. Vaishno Devi Circle S. G. Highway, Khodiyar, Ahmedabad – 382 421, Gujarat, India

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1. PROJECT DETAILS

1.1 Introduction

The introduction of Electricity act 2003, competition was brought into power sector and its sub sectors. Power generation business was delicensed which led to huge capacity addition by the private sector and this warranted transmission network to be reinforced so that all the power generated could be supplied to the end users. The provision for independent transmission licenses were created for private sector to get into the business.

The Government of Rajasthan constituted a State Level Empowered Committee (SLEC) with a view to encourage competition in private sector participation for development of transmission projects in State. In order to achieve the target, Various Solar, Wind, Wind-Solar Hybrid policies have been enunciated by Central and State Governments. Rajasthan is the leading front runner state, implementing large capacity renewable projects under these policies.

SBE Renewables Ten Pvt Ltd has planned to develop 450 MW Wind-Solar Hybrid Park in Jaisalmer & Barmer district of Rajasthan. The power generated from the proposed Solar-Hybrid project will be purchase by Solar Energy Corporation of India (SECI) awarded to the Project company through Competitive bidding process on 'Build, Own, Operate' basis.

For power evacuation of the proposed project, a special purpose vehicle (SPV) "SBE Renewables Ten Pvt Ltd" has proposed to develop 220 kV Single, Double & Multi Circuit Transmission Line which will connect SBE Renewables Ten Pvt Ltd PSS to Fatehgarh-II PSS of Power Grid Corporation India Limited (referred as PGCIL).

The objective is to plan, promote and develop an integrated and efficient power transmission system network in all its aspects including planning, investigation, research, design and engineering, preparation of preliminary, feasibility and definite project reports, construction, operation and maintenance of transmission lines, substations, load dispatch stations and communication facilities and appurtenant works, coordination of integrated operation of to meet the increasing demand and grid strengthening across the state of Rajasthan.

In this context, the Central Electricity Authority (CEA), Ministry of Power, Government of India has issued the administrative approval under Section 68(1) in favor of the SBE Renewables Ten Pvt Ltd to establish to meet the increasing demand across the state of Rajasthan

220 kV Single, Double, Multi Circuit Transmission Line with bee line distance between the Connecting points is about 53.068 kms (bee line). All the efforts were made to find a most feasible route which may involves minimum / least forest land through various alternative routes.

1.2 Project Scope

Project scope will include:

Sr. No.	Scheme/ Transmission Works	Completion Target
1	450 MW Wind-Solar Hybrid Park -220 kV Single, Double & Multi Circuit Transmission Line which will connect SBE Renewables Ten Pvt Ltd PSS to Fatehgarh-II PSS of Power Grid Corporation India Limited (referred as PGCIL).	4 Months

1.3 Technical Specification

The technical requirements of this project has been evolved as per CEA technical standards and CTU practices. SBE Renewables Ten Pvt Ltd is mandated to adhere to these requirements during design, engineering and execution.

1.4 Location of the Project

The project is in Rajasthan State. Location of projects including Jaisalmer,Barmer districts are shown in the sketch furnished below:

2. GEOGRAPHICAL INFORMATION

Climate Rajasthan

Broadly speaking, Rajasthan has a tropical desert climate. It is extremely cold from October to February while the scorching sun tortures the land from March to September. There are distinct temperature range variations diurnal and seasonally throughout the state, revealing the most typical phenomenon of the warm-dry continental climate. The summer begins in the month of March while the temperature

keeps rising progressively through April, May and June. West of Rajasthan and the eastern side of Aravalli Range, in the region of Bikaner, Phalodi, Jaisalmer and Barmer, the maximum daily temperature hovers around 40°C to 50°C. Nights of summers see a considerable temperature fall with a minimum daily temperature around 20°C to 29°C. However, Udaipur and Mount Abu, have a pleasanter climate in summers with a relatively lower daily maximum temperature that reaches 38°C and 31.5°C, respectively. The daily minimum temperature at nights for these two stations hovers around 25°C and 22°C, respectively. The major portion of the state that consists of the arid west and the semi-arid mid-west has an average maximum of 45°C in June.

January is the coldest month in the state of Rajasthan. The minimum temperatures sometimes fall to -2°C in the night at places like Sikar, Churu, Pilani and Bikaner. The sandy land gets even colder with occasional secondary Western winds that cross the western, northern and eastern Rajasthan during winter months, and even cause light rainfall and chilly winds can be experienced during this period. Most of the Rajasthan, except the southeast Rajasthan comprising of Kota, Bundi and Baran and western Barmer have an average temperature of more than 10°C. Due to the cold western winds, the whole of Rajasthan sometimes come under the spell of the cold wave for 2 to 5 days during winters.

Rajasthan being the desert area, its climate varies mostly from arid to sub-humid. To the west of the Aravallis, the climate is marked by low rainfall, extreme diurnal and annual temperature, low humidity and high velocity winds. In the east of the Aravallis, the climate is semi-arid to sub-humid marked by lower wind velocity and higher humidity and better rainfall. The southwest monsoon begins in the last week of June in the eastern parts and may last till mid-September. There are occasionally pre-monsoon showers in mid-June while post-monsoon rains may occur in October. Winters may also receive a little rainfall with the passing of western distribution over the region. However, Rajasthan receives most of its monthly rainfall during July and August.

Area

Rajasthan is India's largest state by area (342,239 square kilometres or 10.4% of India's total area). It is located on the western side of the country, where it comprises most of the wide and inhospitable Thar Desert (also known as the "Rajasthan Desert" and "Great Indian Desert") and shares a border with the Pakistani provinces of Punjab to the northwest and Sindh to the west, along the Sutlej-Indus river valley. Elsewhere it is

bordered by the other Indian states: Punjab to the north; Haryana and Uttar Pradesh to the northeast; Madhya Pradesh to the southeast; and Gujarat to the southwest.

Rajasthan is positioned between 23 degrees and 30' and 30 degrees and 11' on the northern latitude and 69 degrees and 29' and 78 degrees and 17' on the east longitude. The total population of Rajasthan state is 6,85,48,437, according to the census of 2001. The density of population in the state is 200 per sq. km.

Topography

Rajasthan has varying topographic features though a major part of the state is dominated by parched and dry region. The extensive topography includes rocky terrain, rolling sand dunes, wetlands, barren tracts or land filled with thorny scrubs, river-drained plains, plateaus, ravines and wooded regions. In a more broad way the topography of Rajasthan can be divided in the following regions- the Aravalli or the Hilly regions, the Thar and the other arid regions, the Plateaus including Vindhaya and the Malwa, the Fertile plains including the Mewar, the Forest Regions and the Water ponds including Rivers.

Rajasthan Desert

The Thar Desert or the Great Indian Desert encompasses about 70% of total landmass of Rajasthan and hence it is identified as the "Desert State of India". The Rajasthan desert which forms a major portion of the Thar Desert is the biggest desert in India and encompasses the districts of Jaisalmer, Barmer, Bikaner and Jodhpur. In fact the Rajasthan Desert comprises the desert triangle of three cities - Jaisalmer, Bikaner and Jodhpur. The desert becomes very hot during the summer and it experiences extreme climate with an average annual rainfall less than 25 cm. Days are hot and the nights are cold. Vegetation consists of thorny bushes, shrubs and xerophilous grass. Various species of lizards and snakes are found here.

Soil & Vegetation

The soil and vegetation of Rajasthan alters with its wide-ranging topography of the state and the availability of water. The varied kind of soils available in Rajasthan are

mostly sandy, saline, alkaline and chalky (calcareous). Clay, loamy, black lava soil and nitrogenous soils are also found.

Owing to the limited rainfall seasonal vegetation such as a few grass species, shrubs and dwarf trees can be found. However food crops are grown in the plains that are drained by the rivers and streamlets owing to the alluvial and clay soil deposits. The hilly tracts of the Aravali are characterized by the black, lava soils that sustain the growth of cotton and sugarcane.

3. TRANSPORT

3.1 Roads

Rajasthan is sufficiently linked with all the major cities in India like Ahmedabad, New Delhi, and Indore through both National and State Highways.

The Rajasthan State Road Transport Corporation (RSRTC), which is a state-owned organization, offers regular bus services to different parts of the state. Privately owned operators also run bus services.

The national highways system in Rajasthan encompasses an overall span of 5,585 km. The NH8, the most well-known highway in the state, joins major cities such as Ajmer, Jaipur, Udaipur, and Chittorgarh. The length of the NH 8 is around 688 km inside the borders of the state. At present, the number of state highways in the state is 85 and the combined span of these thoroughfares is 11,716 km. There are 19 national highways passing through the state which are together 5,585 km in length. This includes NH 3, NH 18,NH 11,NH 11A,NH 11B,NH 12,NH 14,NH 15,NH 65,NH 71B,NH 76,NH79, NH 79A, NH 89, NH 90, NH 112, NH 113, NH 114 and NH 116.

3.2 Rail network

The railway network over the state comes under the geographical jurisdiction of the North Western Railway Zone of Indian Railways centered in Jaipur, which is the zonal headquarters of this zone. The main divisions are Jaipur, Ajmer, Bikaner and Jodhpur. T Rajasthan is connected with the main cities of India by rail. Jaipur, Jodhpur, Kota, Bharatpur, Bikaner, Ajmer, Alwar, Abu Road and Udaipur are the principal railway stations in Rajasthan. Kota City is the only Electrified Section served by three Rajdhani Expresses and trains to all major cities of India. Palace on Wheels is a specially designed luxury tourist train service, frequently hauled by a steam locomotive, for promoting

tourism in Rajasthan. Royal Rajasthan on Wheels a luxury tourist train service covers various tourist destinations in Rajasthan.

3.3 Air Ports

There are three main airports at Rajasthan- Jaipur International Airport, Jodhpur Airport and Udaipur Airport. These airports connect Rajasthan with the major cities of India such as Delhi and Mumbai. There are three other airports in Kota, Jaisalmer and NAL (Bikaner) but are not open for commercial/civilian flights yet. One more airport at Kishangarh, Ajmer .i.e. Kishangarh Airport is being constructed by the Airport Authority of India.

4. METHODOLOGY/ PHILOSOPHY OF ROUTE SELECTION

In order to execute such transmission system, precise planning, costing, scheduling etc. were required. Optimum deployment of resources also was of prime target in implementing this transmission system.

It is essential that at the planning stage itself various alternative routes and technical solutions for transmission lines be examined in detail.

For undertaking such studies, one of the major requirements is obtaining adequate information regarding physical constrains, environmental factors etc. along the route so that optimum solutions are identified. Subsequently, during implementation of the project, it is required to obtain elaborate details about terrain, soil conditions, constraints etc. of the route for proper resource planning, costing etc. as well as reduction in implementation time.

Presently, conventional methods of survey like walk over survey, preliminary survey and detailed survey are carried out at various stages from conceptualization of the project to implementation, which are time consuming tasks. There are new means available which is used to conduct route survey using Google, DGPS based survey etc.

4.1 Preliminary & Route Alignment Survey

Preliminary Survey included the following steps:

- Map study
- Walkover survey

Route survey was carried out for following benefits:

- To select optimal route from the alternatives for ease of construction followed by O&M with economy.
- Maintenance & additional construction cost can be brought to the minimum. Material Estimation and procurement can be done fairly on realistic basis. Any possible delay/hindrance likely to come during the execution of the work, can be avoided, after taking due care of various statutory provisions during the course of selecting route alignment.
- Limited Reserve/Protected/Private Forest Area.
- Proper planning can be done for networks keeping provision for future routes etc.
- Approvals from Railways, Civil Aviation, Forest authorities etc. can be obtained faster.
- Preparation of Master Network and fixing construction/erection targets can be done on realistic basis, which will help in the judicious planning of materials flow, cash flow and manpower requirements.
- Appreciable time can be saved during construction & maintenance of roads, if selection of Rivers, route along hill sections and power line etc., are properly made.

4.2 Map Study

After drawing various routes of alignment network within the topo maps, a comparative study was made on the basis of the following data:

- Route length.
- Nos. and type of important road points in each indicating alignment of each road as measured on the map.
- Nature and number of major crossings.
- Mapping the industrial installations, structures, and important places for identification of Roads.
- Approach to the line in general for construction & maintenance.
- Reaches through protected or Reserved Forests
- Continuously long stretches in paddy fields.
- Close parallelism with Railway lines.
- Restricted areas such as civil and military airfield are avoided.
- Aircraft landing approaches are avoided.

Walkover Survey was carried out going over the area associated with the routes and collecting features observed other than those existing on the map. In addition the indications on following features are also checked.

- Communication lines
- Accessibility and smoother approach.
- Logistics of the route.
- Economic viability of the route.
- Existing and Present course of River
- Power lines (existing)
- Expanding villages and towns
- Rich gardens and plantations
- Reserved forests and high tree areas
- National Parks & Wildlife sanctuaries
- Archeological monuments
- Aerodromes, radar centers etc.
- Steep sloping terrain, Areas prone to landslides, soil instability etc.
- Prohibited areas declared under statutory regulations

4.3 Remote Sensing

Remote Sensing is modern technique in mapping sciences. It is now a major tool to map any area on earth's surface for transmission of power. The planning for installation of large transmission towers needs proper planning. For this, updated base maps are required. Remote sensing imageries can help in updating of the available topographic maps. The recently launched satellites like IKONOS, IRS-1C, 1D(PAN) having its very good spatial resolution of 1mt and 5.8mts through digital image processing techniques; it is able to identify even small features with the resolution as given above.

To select site for putting new transmission towers and lines especially in hilly terrains, the density of trees, elevation differences has to be carefully studied in detail. In such cases, remote sensing is the main technology, plays a vital role for the preparation of database on landforms, land use / land cover and related database. Integrating these informations in GIS platform, it is able to generate three dimensional terrain model (DTMs) of the area, which can be further updated with the multi dated satellite images and aerial photographs also. Digital Photogrammetry is the potential technology to provide the information's on terrain elevation which has to be studied before locating

site for transmission towers and lines. This has found great success in many European countries but yet to be implemented in the developing countries like India.

4.4 Satellite Image (Google Map)

Satellite Images were used as most authoritative document to record latest topographical changes along the surveyed routes. This involved the initiations of the following activities.

- Transferring of images to studios for processing and detailed measurements.
- Ground Verification was undertaken to study the authenticity of the images.

Camera is supposed to see topographic details vividly, that is the only reason, why satellite images are used in detailed survey in comparison to the traditional field work. The ground profile in digital form could be obtained from satellite images, which in turn enable the user to estimate various types earthwork involved like benching, revetments etc. could be computed by using the relevant software.

Appropriate techniques for obtaining soil conditions, depth of ground water, terrain conditions etc. for correct estimation of civil works could be explored.

Due to "Shadow Effect", some errors crop up in the satellite imageries, which affect the preliminary surveys, and it becomes difficult to differentiate between the forests and other greenery, consequently it becomes difficult to mark the forest boundaries etc.

- Proper resolution plays an important role in interpreting satellite images; higher resolution improves the quality of visual Context and may differentiate the ground realities closely.
- Relief data and subsoil data cannot be assessed from Satellite imageries.
- Digitization of Complete Zonal maps, rather selected features would provide a complete replica in integrated environment.
- Satellite data of resolution 1 – 5.8m will be preferable. However, the overall cost economy shall have to be worked out, as this data will be more costly, but will avoid field assignment in many places.
- Symbols of physical features in satellite imageries are not easily recognized by transmission line engineers.

4.5 Updating of Base map using Satellite Imageries

Digital maps prepared are subjected to refinement by using imagery. Details of Topography which might have undergone changes between the period of topographic survey and input of satellite imagery, like the rivers and nala courses, forestry and vegetation, highways and rail routes are re-incorporated in the digitized drawings, by using satellite imageries. The regions where the topography does not match with the imageries, ground verification survey is undertaken. IRS 1D PAN & LISS III images were procured from NRSA. The satellite imagery rectifications include Geo-referencing, ortho-rectification, transformation and projections. The images are rectified using ERDAS Imagine Software. The digitization process involves on screen digitization of imagery using AutoCAD Map and Map Info Software.

i. Satellite Data Selection

For updating of base maps NRSA Pan (5.88 m) and LISS-III (23.5 m) merged imagery are used.

ii. Satellite Data Pre-Processing

This phase includes the standard operations of geometric correction and registration of the satellite images into the required Co-ordinate System. Ground control points (GCP's) on the satellite images and on the topographic/paper maps are identified and the liner geometric correction functions available in the ERDAS Images 8.3.1 are applied.

iii. Satellite Data Classification

For unsupervised classification, the ISODATA methods are applied, and for supervised classification, the Maximum Likelihood Classification (MLC) is preferred. To identify the sample areas for supervised classification, specific procedures and information from topographic/paper maps are used together with thematic maps and expert knowledge of the terrain after field checking.

iv. Satellite Data Interpretation and Vectorization of the Resulting Units

Interpretation and vectorization on the screen, available in Arc View shape format are preferred because polygons created have vector format and can be directly transformed to a land base maps. In order to update line features (railroads, roads, streams) the ERDAS Imagine's Edge Enhancement filter is used.

v. Classification

A Comprehensive and standardized classification system would be created for mapping exercises. The classification of features would use a set of criteria that would allow correlation with existing classifications and legends for creation of land base map.

vi. Field Checking

Field visits would be undertaken in all areas under study to collect terrain information and interpretation keys useful for image interpretation. Later, field checking would be carried out to test accuracy of image interpretation at selected sites and to clarify interpretation assumptions. GPS would be used to precisely locate the ground sites investigated.

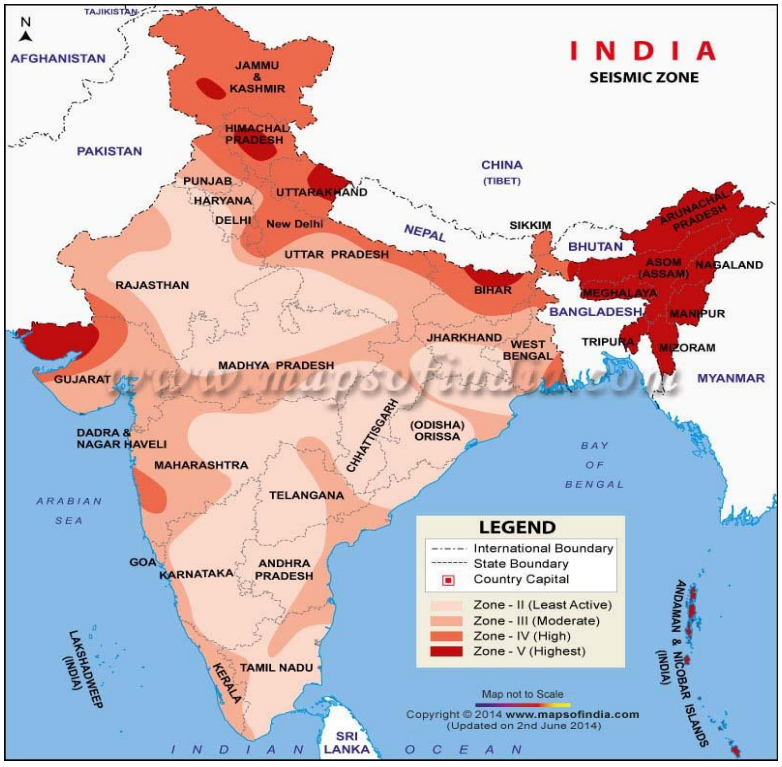
vii. Composition of final Land Base Maps

Vector shape files would be created manually, in Arc View using both the original image and the result of the supervised classification in the background to provide a basis for visual interpretation.

5. SEISMIC AND WIND ZONE DETAILS

India has been divided into five seismic zones depending on the intensity of earthquake. Zone 1 representing the safest zone while the Zone 5 is the most vulnerable and prone to high intensity Earthquake.

Location showing the Seismic zones of India is shown below.

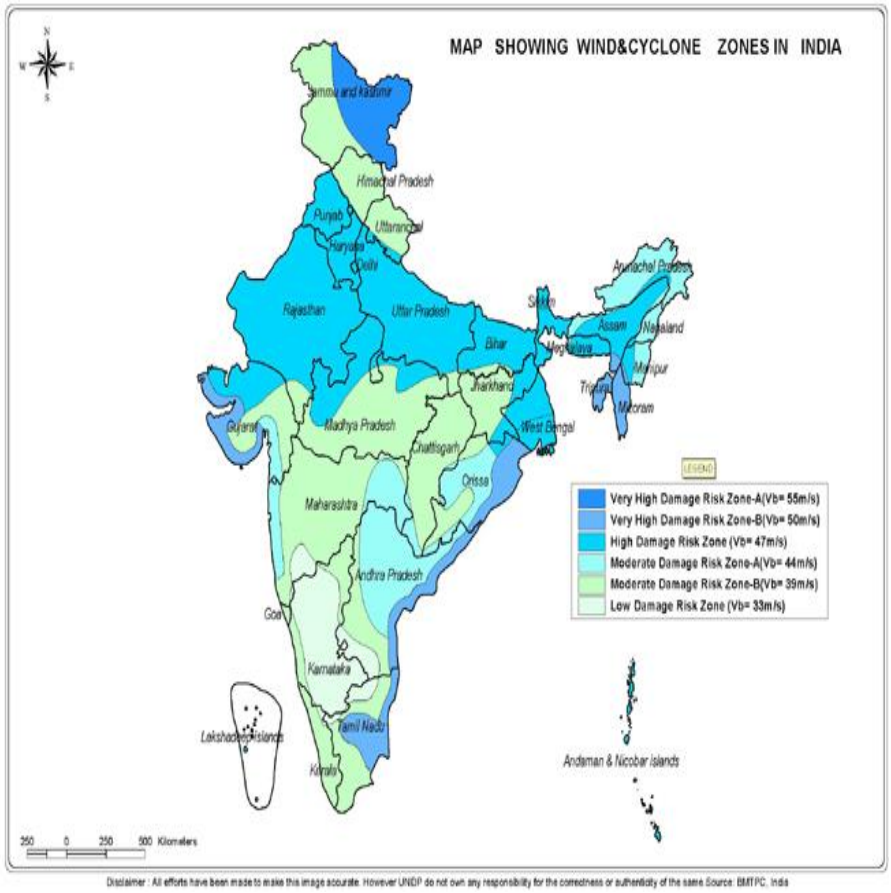


6. WIND ZONE DETAILS

The proposed line routes passing through the following:

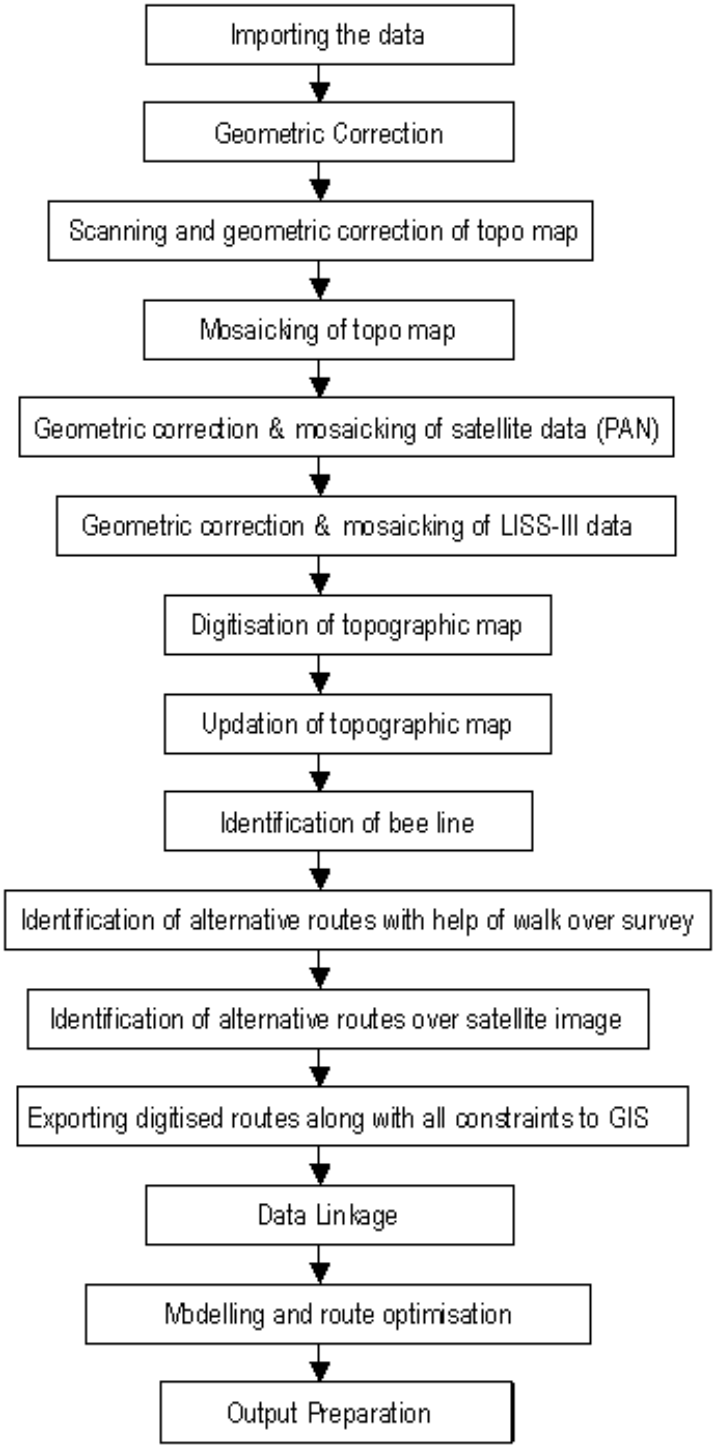
Jaisalmer,Barmer districts falls under wind zone- IV (47m/s) and location showing the seismic zone of India is attached below.

Location showing the Wind zones of India is attached below.



7. METHODOLOGY FOR ROUTE IDENTIFICATION

Fig.: Flow Chart of the Methodology for Route Identification



7.1 Route survey techniques:

The route alignments were carried out by help of satellite images available in google map. Physical walk over survey was conducted on final routes and GPS coordinates were collected at every 100 meters along with soil strata. Based on the information so collected, the best route was selected after evaluation of factors like, minimum forest coverage, angle points, river crossing, power line crossing, habitation etc. the final route length is more or less closer to the bee line route

7.2 Legal Frame Work

It is proposed to execute the above entire transmission system as per provisions contained in the Indian Electricity Act 2003 and the rules made there under and the Electricity (Supply) Act 1910 and 1948, so far as these are applicable.

The following Government approval will be taken. :-

- Approval of under section 68 of Indian Electricity Act 2003.
- Approval of under section 164 of Indian Electricity Act 2003.

8. ENVIRONMENTAL IMPACT ASSESSMENT

8.1 Forest involvement / Clearance

As per the practice, preliminary route selection is done based on such documents as the Forest Atlas and the survey of India maps using "bee" line method followed by field clarification through walk over survey. All possible steps are taken to avoid the route alignment through forest. In case where it becomes unavoidable due to the geography of terrain, the alignment is made in such a way that the route through the forest is the barest minimum.

8.1.1 For selection of optimum routes following points are taken into consideration:

i. The route of the transmission line does not involve any human rehabilitation.
ii. Any monument of culture or historical importance is not getting affected.
iii. The route does not create any threat to the survival of any community with special reference to tribals.
iv. It does not affect any Public Utility Services like Play Ground, School, other Establishment, etc.

v. It does not pass through any sanctuaries, Nation Park etc. if any alternative route is feasible.

vi. It does not infringe with areas of natural resources.

In case where it becomes unavoidable due to the geography of terrain, the alignment is made in such a way that the bare minimum line route through forest is selected.

Name of Transmission line	Forest – Involvement (Approx. Area in Ha)
450 MW Wind-Solar Hybrid Park -220 kV Single, Double & Multi Circuit Transmission Line which will connect SBE Renewables Ten Pvt Ltd PSS to Fatehgarh-II PSS of Power Grid Corporation India Limited (referred as PGCIL).	0.175

9. PROJECT COST

The total project cost including taxes and duties works out to INR **72.47** Crores.

10. APPROVALS AND CLEARANCES

Following approvals and clearances need to be obtained from the various authorities at the different stages of the project. Close follow up will be exercised for the timely approval of the below items.

Sl. No.	Statutory Clearances	Concerned Authority	Remarks
	Required prior to construction:		
1	Approval Under section 68 of E.A 2003	GOI	Obtained
2	Approval Under section 164 of E.A 2003	GOI	Under Process
	Required during/after construction.		
3	Forest Approval	MoEF	Under Process
4	Aviation	AAI	Under Process
5	PTCC clearance	GOI	Under Process
6	Power Line Crossing	Concern Utility	During Construction. Required for particular crossing span.
7	Railway Crossing	Railway Authority	During Construction. Required for particular crossing span.
8	National Highway Crossing	NHAI	During Construction. Required for particular crossing span.
9	Final Charging Clearance approval	CEA/ GOI	Before Charging of System

(GOI- Government of India)