# NATIONAL INSTITUTE OF WIND ENERGY (NIWE)

# CHENNAI

सत्यमेव जयते
Ministry of New and Renewable Energy
Government of India

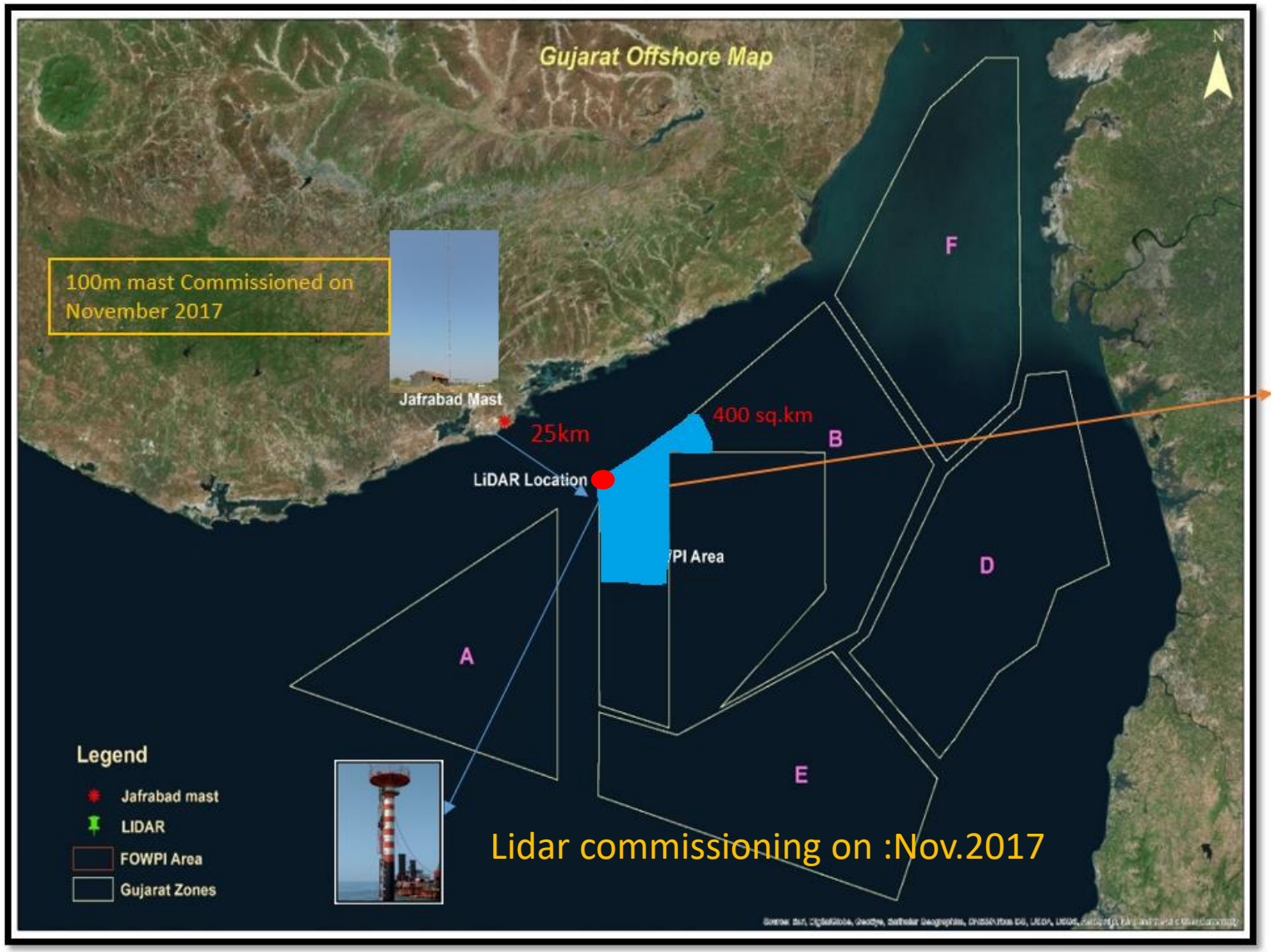
नीवे NIWE

## Expression of Interest (EOI) for 1000MW (1GW)
## OFFSHORE WIND FARM PROJECT IN INDIA

**Under Ministry of New and Renewable Energy (MNRE), Govt. of India**

# Proposed Offshore windfarm project at Gulf of Khambhat , Off Gujarat

Zone-B1




| Site Name | Gulf of Khambhat (Zone –B1) (400 Sq.km) |
|---|---|
| Taluk/District / State | Jaffrabad/Amerli / Gujarat |
| Lidar location | 20°45'19.10"N , 71°41'10.93"E |
| Water Depth | -15m (based on NHO* chart) |
| Distance from coast | 23km |
| Nearest Village | Pipavav |
| Nearest Town | Jaffrabad |
| Nearest Railway Station | Rajula Junction |
| Nearest Airport | Diu |
| Nearest Port | Pipavav/ Jaffrabad |
| Nearest Electrical Substations onshore | Ultratech 220kV |
| CRZ (as per 2011 notification) | Zone IV |

# Lidar Configuration – 12 different heights

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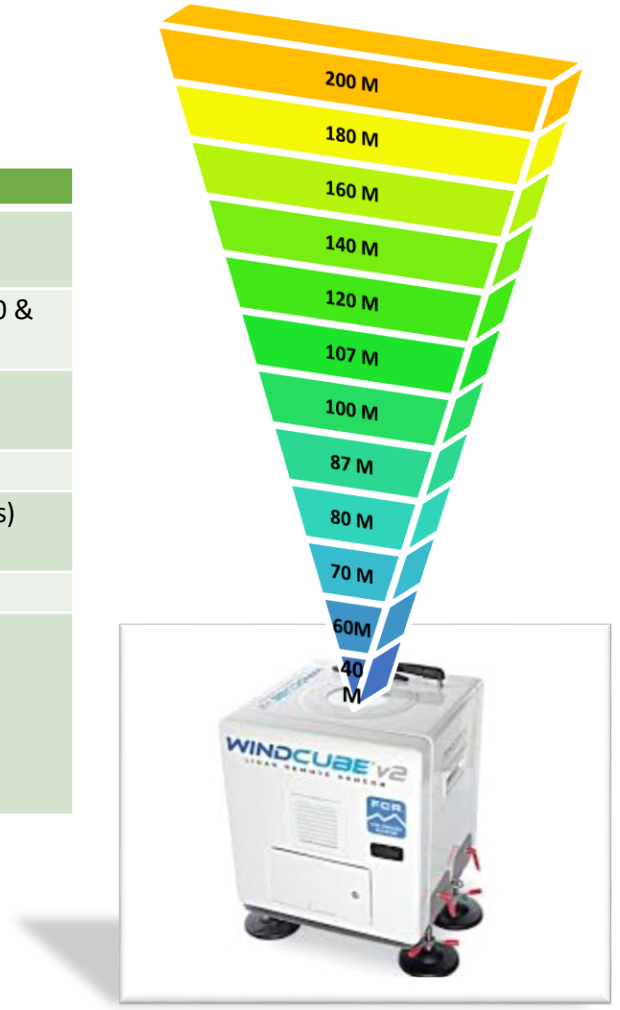
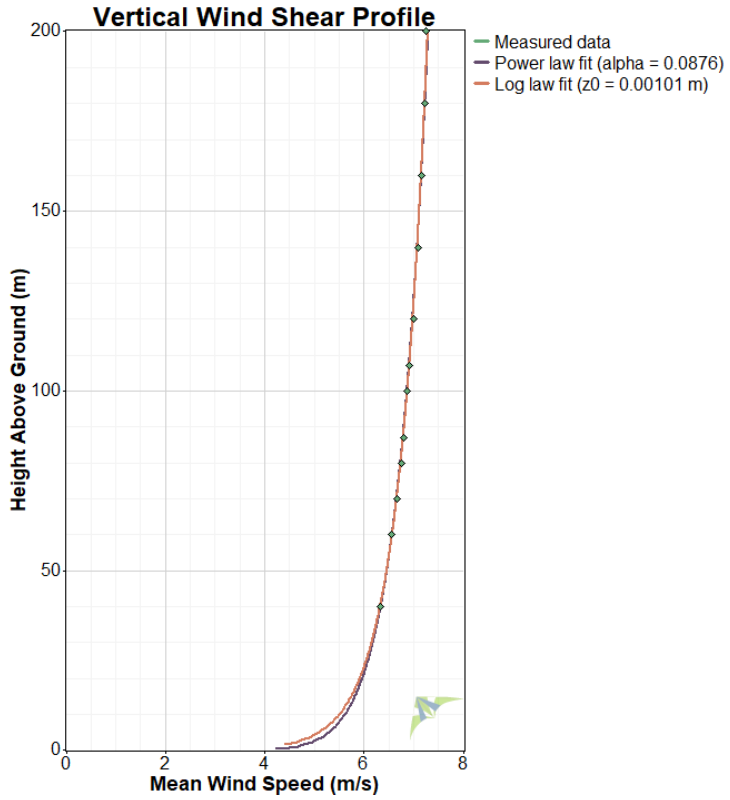
| Measurement Type | WindCube V2 LIDAR |
|---|---|
| Structure height (monopile) | 17m LAT* |
| LIDAR Measurement heights | 40,60,80,87,100, 107,120,140,160, 180 & 200m(MSL)# |
| Location (UTM WGS 84, 42Q) | 779721 Easting, 2297392 Northing |
| Date of Commissioning | 31/10/2017 |
| Measurement Period (Duration) | 01/11/2017 – 30/06/2018 ( 8 months) |
| Measurement interval | 10-minute |
| Parameters | Wind Speed, Wind direction, Temperature, Pressure, Relative humidity |




| Month | Power Law (alpha) | Log Law (z0) |
|---|---|---|
| Nov-17 | 0.145 | 0.093765 |
| Dec-17 | 0.157 | 0.159204 |
| Jan-18 | 0.111 | 0.011593 |
| Feb-18 | 0.083 | 0.000480 |
| Mar-18 | 0.120 | 0.020547 |
| Apr-18 | 0.063 | 0.000011 |
| May-18 | 0.040 | 0.000000 |
| Jun-18 | 0.063 | 0.000012 |

# Lidar wind speed data (m/s)

## (Mean, Minimum & Maximum)

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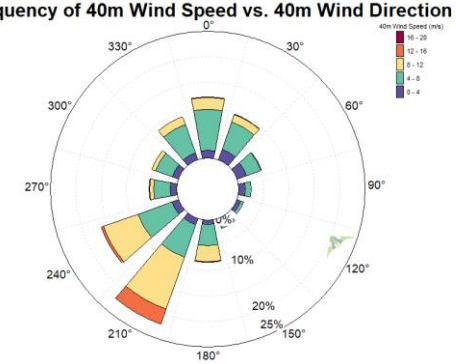
| Height (m) | Nov 17* | | | Dec 17* | | | Jan 18* | | | Feb 18* | | | Mar 18 | | | Apr 18 | | | May 18 | | | June 18 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean | Min | Max |
| 40 | 5.68 | 0.40 | 12.30 | 6.11 | 0.54 | 11.29 | 4.84 | 0.31 | 11.64 | 5.71 | 0.38 | 14.15 | 6.12 | 0.57 | 12.31 | 6.48 | 0.28 | 14.47 | 8.36 | 0.35 | 16.51 | 9.33 | 0.73 | 16.20 |
| 60 | 5.99 | 0.51 | 12.45 | 6.52 | 0.56 | 12.73 | 4.96 | 0.30 | 11.72 | 6.05 | 0.20 | 14.56 | 6.48 | 0.40 | 13.53 | 6.65 | 0.24 | 14.88 | 8.50 | 0.37 | 16.89 | 9.53 | 0.84 | 16.54 |
| 70 | 6.12 | 0.48 | 12.47 | 6.69 | 0.40 | 13.84 | 5.14 | 0.19 | 12.49 | 6.18 | 0.19 | 14.80 | 6.65 | 0.40 | 15.14 | 6.73 | 0.22 | 15.11 | 8.57 | 0.39 | 17.04 | 9.61 | 0.90 | 16.65 |
| 80 | 6.24 | 0.68 | 12.74 | 6.81 | 0.68 | 13.09 | 5.12 | 0.38 | 12.36 | 6.27 | 0.25 | 15.00 | 6.79 | 0.48 | 14.26 | 6.80 | 0.28 | 15.26 | 8.62 | 0.41 | 17.19 | 9.68 | 1.00 | 16.72 |
| 87 | 6.31 | 0.69 | 12.83 | 6.89 | 0.73 | 13.37 | 5.17 | 0.32 | 12.65 | 6.31 | 0.24 | 15.16 | 6.87 | 0.45 | 14.27 | 6.84 | 0.27 | 15.38 | 8.65 | 0.41 | 17.32 | 9.72 | 1.07 | 16.75 |
| **100** | **6.44** | **0.69** | **13.01** | **7.04** | **0.80** | **13.85** | **5.26** | **0.24** | **13.09** | **6.36** | **0.35** | **15.40** | **6.97** | **0.32** | **14.53** | **6.87** | **0.29** | **15.61** | **8.68** | **0.42** | **17.53** | **9.79** | **1.28** | **16.78** |
| 107 | 6.50 | 0.69 | 13.18 | 7.12 | 0.82 | 14.09 | 5.31 | 0.27 | 13.28 | 6.39 | 0.26 | 15.54 | 7.04 | 0.26 | 14.89 | 6.90 | 0.32 | 15.74 | 8.71 | 0.43 | 17.63 | 9.83 | 1.35 | 16.83 |
| **120** | **6.61** | **0.69** | **13.46** | **7.25** | **0.82** | **14.50** | **5.39** | **0.31** | **13.52** | **6.47** | **0.20** | **15.77** | **7.19** | **0.28** | **15.75** | **6.98** | **0.37** | **15.99** | **8.78** | **0.46** | **17.71** | **9.93** | **1.39** | **17.05** |
| 140 | 6.77 | 0.69 | 13.90 | 7.43 | 0.81 | 15.08 | 5.50 | 0.44 | 13.67 | 6.51 | 0.37 | 16.08 | 7.28 | 0.49 | 16.84 | 7.02 | 0.38 | 16.41 | 8.83 | 0.54 | 18.04 | 10.03 | 1.34 | 17.36 |
| 160 | 6.91 | 0.69 | 14.31 | 7.59 | 0.80 | 15.70 | 5.60 | 0.27 | 13.93 | 6.55 | 0.36 | 16.60 | 7.35 | 0.35 | 17.07 | 7.07 | 0.32 | 16.76 | 8.88 | 0.52 | 18.53 | 10.16 | 1.00 | 17.69 |
| 180 | 7.04 | 0.69 | 14.67 | 7.74 | 0.80 | 16.31 | 5.68 | 0.23 | 14.58 | 6.59 | 0.39 | 17.31 | 7.38 | 0.40 | 16.42 | 7.11 | 0.39 | 17.09 | 8.91 | 0.53 | 19.99 | 10.29 | 0.96 | 18.09 |
| 200 | 7.15 | 0.69 | 15.01 | 7.88 | 0.79 | 16.89 | 5.74 | 0.27 | 15.22 | 6.57 | 0.37 | 18.22 | 7.36 | 0.50 | 16.08 | 7.12 | 0.43 | 17.11 | 8.85 | 0.54 | 18.98 | 10.38 | 0.90 | 18.31 |

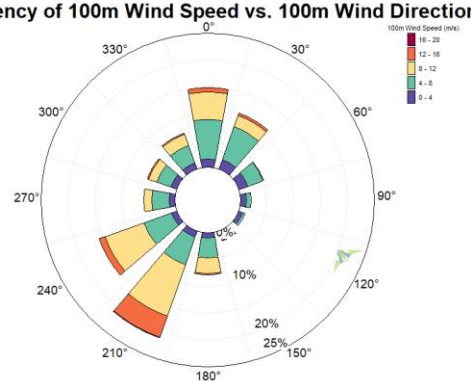
* Low windy season

Wind speeds are increasing due the SW monsoon

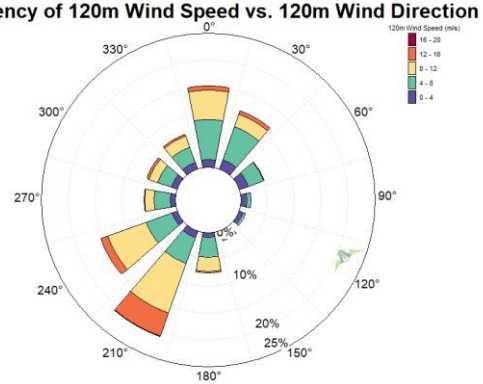
Frequency of 40m Wind Speed vs. 40m Wind Direction



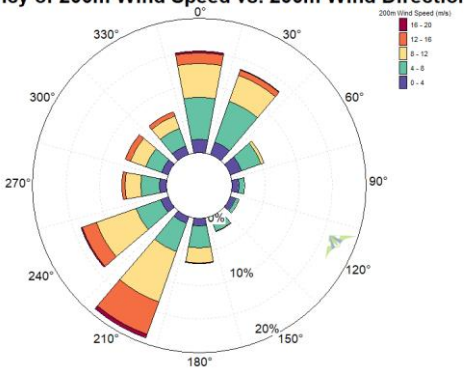
Frequency of 100m Wind Speed vs. 100m Wind Direction



Frequency of 120m Wind Speed vs. 120m Wind Direction



Frequency of 200m Wind Speed vs. 200m Wind Direction



Prominent wind direction-SSW

# Lidar Data – Mean wind speed & WPD (W/Sq.m)

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| Height (m) | Nov 17 | | Dec 17 | | Jan 18 | | Feb 18 | | Mar 18 | | Apr 18 | | May 18 | | June 18 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | WS | WPD | WS | WPD | WS | WPD | WS | WPD | WS | WPD | WS | WPD | WS | WPD | WS | WPD |
| | m/s | W/m2 | m/s | W/m2 | m/s | W/m2 | m/s | W/m2 | m/s | W/m2 | m/s | W/m2 | m/s | W/m2 | m/s | W/m2 |
| 40 | 5.68 | 149.53 | 6.11 | 194.84 | 4.84 | 107.93 | 5.71 | 165.11 | 6.12 | 187.48 | 6.48 | 241.45 | 8.36 | 448.49 | 9.33 | 567.62 |
| 60 | 5.99 | 162.74 | 6.52 | 222.79 | 5.02 | 122.56 | 6.05 | 198.47 | 6.48 | 223.18 | 6.65 | 260.47 | 8.50 | 475.28 | 9.53 | 603.59 |
| 70 | 6.12 | 170.86 | 6.69 | 237.73 | 5.11 | 130.39 | 6.18 | 214.17 | 6.65 | 242.68 | 6.73 | 270.70 | 8.57 | 488.64 | 9.61 | 619.91 |
| 80 | 6.24 | 179.42 | 6.81 | 251.92 | 5.18 | 137.36 | 6.27 | 227.41 | 6.79 | 260.98 | 6.80 | 279.82 | 8.62 | 499.65 | 9.68 | 632.28 |
| 87 | 6.31 | 185.55 | 6.89 | 262.48 | 5.22 | 141.96 | 6.31 | 235.44 | 6.87 | 272.22 | 6.84 | 285.31 | 8.65 | 506.03 | 9.72 | 639.84 |
| **100** | **6.44** | **197.36** | **7.04** | **282.41** | **5.28** | **149.95** | **6.36** | **247.41** | **6.97** | **288.26** | **6.87** | **292.27** | **8.68** | **515.19** | **9.79** | **653.09** |
| 107 | 6.50 | 205.28 | 7.12 | 295.89 | 5.32 | 155.21 | 6.39 | 255.36 | 7.04 | 298.68 | 6.90 | 297.04 | 8.71 | 522.38 | 9.83 | 663.19 |
| **120** | **6.61** | **219.93** | **7.25** | **320.14** | **5.39** | **164.47** | **6.47** | **270.65** | **7.19** | **321.94** | **6.98** | **308.52** | **8.78** | **538.15** | **9.93** | **680.14** |
| 140 | 6.77 | 242.67 | 7.43 | 356.56 | 5.45 | 175.92 | 6.51 | 285.79 | 7.28 | 342.15 | 7.02 | 319.38 | 8.83 | 552.36 | 10.03 | 704.88 |
| 160 | 6.91 | 266.67 | 7.59 | 390.77 | 5.49 | 186.79 | 6.55 | 301.30 | 7.35 | 359.25 | 7.07 | 331.63 | 8.88 | 568.10 | 10.16 | 734.99 |
| 180 | 7.04 | 289.38 | 7.74 | 416.50 | 5.51 | 195.84 | 6.59 | 314.11 | 7.38 | 367.60 | 7.11 | 341.32 | 8.91 | 578.76 | 10.29 | 764.59 |
| 200 | 7.15 | 306.68 | 7.88 | 434.20 | 5.50 | 199.80 | 6.57 | 318.60 | 7.36 | 366.99 | 7.12 | 346.32 | 8.85 | 571.36 | 10.38 | 787.20 |

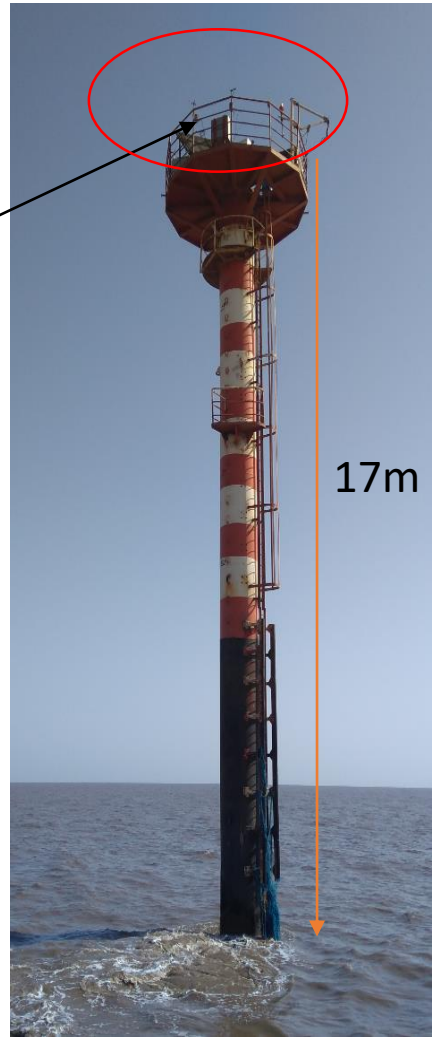
Wind Power Density (WPD) in W/sq.m

## Lidar Data – Temperature, Pressure & RH @ 17m platform

| Sensor at Platform (17m) | Units | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
|---|---|---|---|---|---|---|---|---|---|
| Temperature | °C | 21.8 | 22.5 | 23.2 | 26 | 27.2 | 27.8 | 29 | 29.9 |
| Pressure | mb | 1,010.3 | 1,010.7 | 1,010.9 | 1,010.1 | 1,008.4 | 1,006.7 | 1,004.5 | 1,000.9 |
| Rel Humidity | % | 53.2 | 60.1 | 57.4 | 56.8 | 59.3 | 75.7 | 84.1 | 84 |
| Air density | kg/m3 | 1.190 | 1.220 | 1.200 | 1.210 | 1.190 | 1.160 | 1.150 | 1.140 |

# Automated Weather Station-Platform

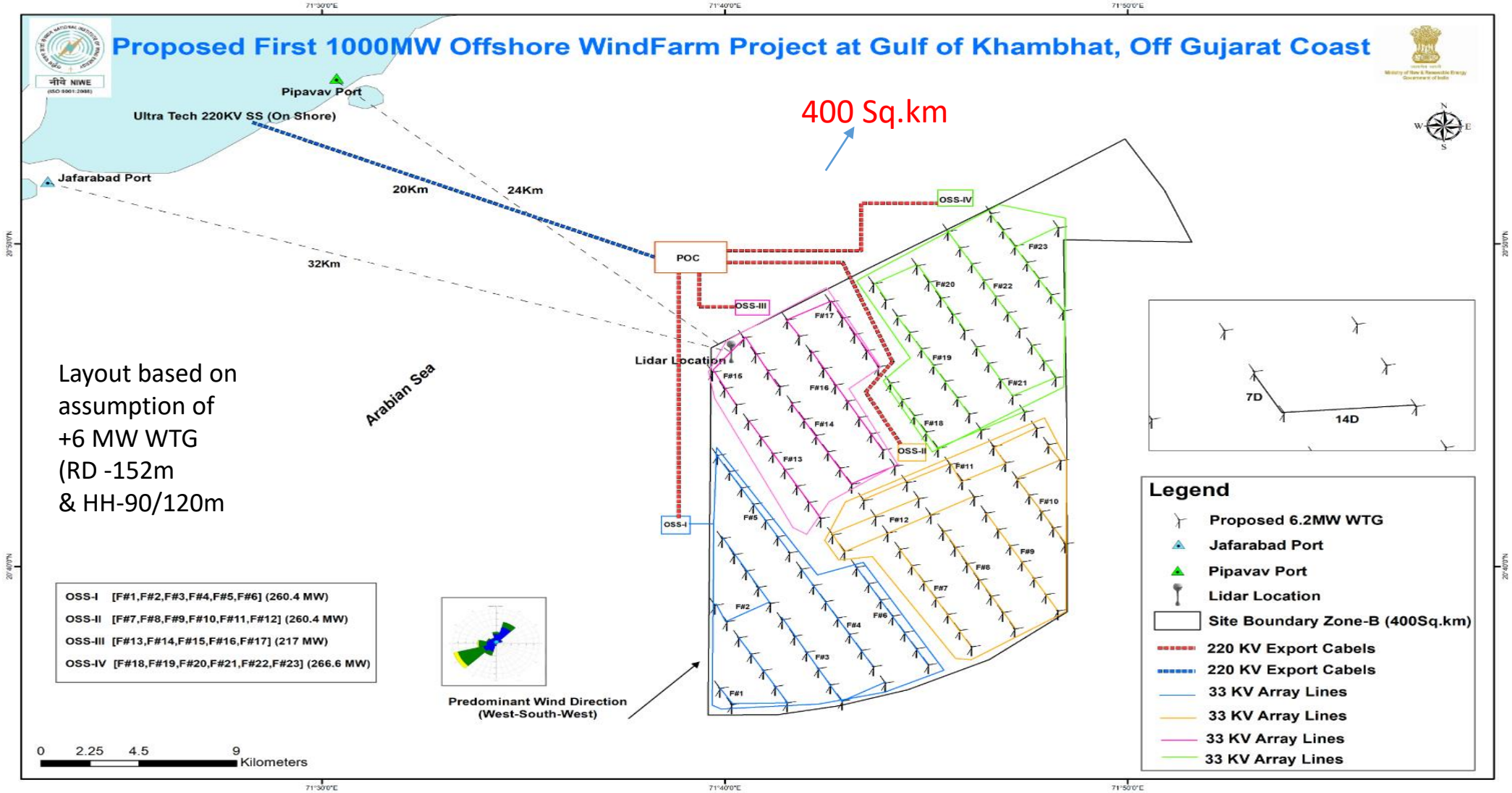
Sensors Installed at 17m height Platform



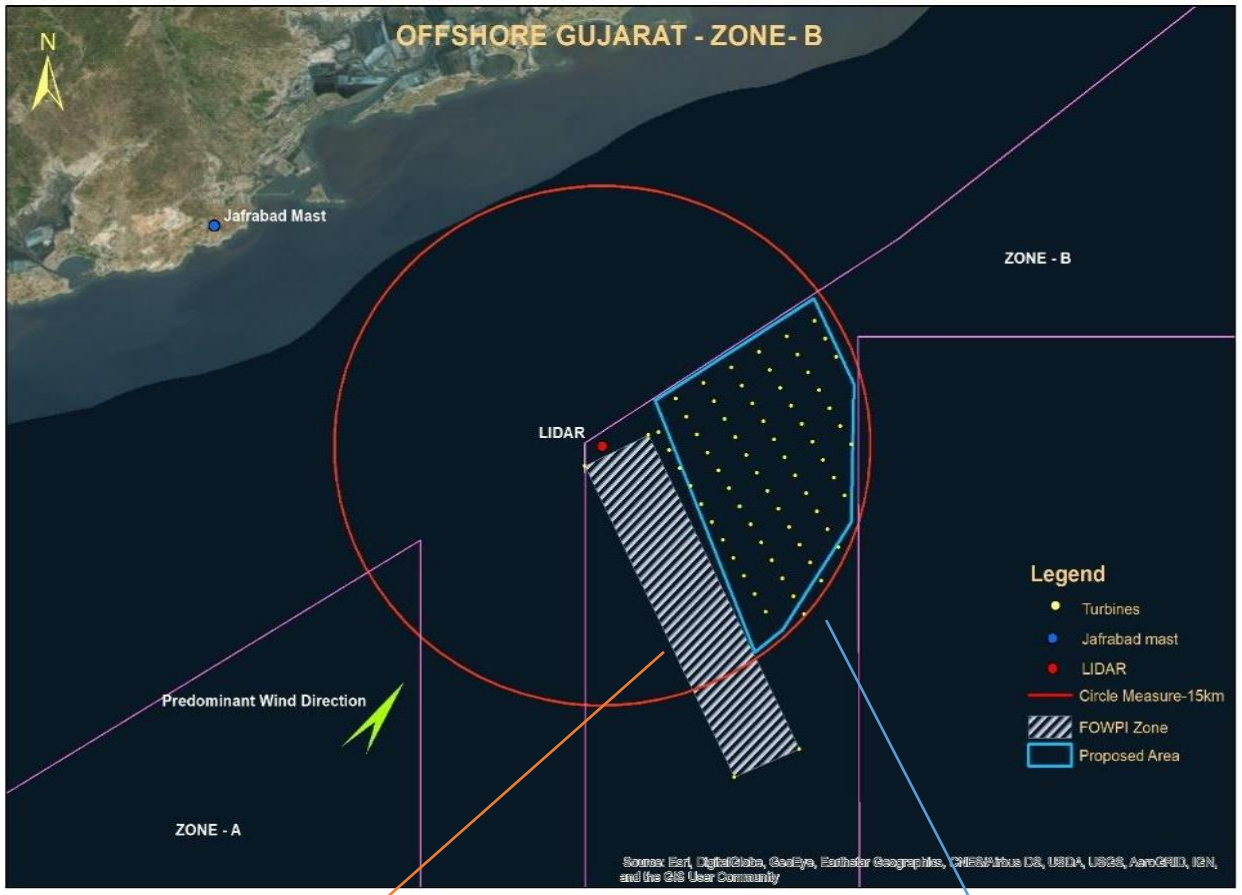

| Month | Temp (°C) | Pressure (mB) | Air Density (Kg/m³) | WS (m/s) | WPD (W/m²) | No.of data available (10 minutes Interval) | Data Recovery % |
|---|---|---|---|---|---|---|---|
| Apr-17 | 27.8 | 1006.7 | 1.165 | 6.92 | 262.00 | 4320 | 100.00 |
| May-17 | 29.0 | 1004.5 | 1.158 | 8.06 | 415.00 | 4464 | 100.00 |
| Jun-17 | 29.9 | 1000.9 | 1.151 | 8.30 | 444.00 | 4320 | 100.00 |
| Jul-17 | 28.7 | 1000.6 | 1.155 | 9.58 | 605.00 | 4464 | 100.00 |
| Aug-17 | 29.0 | 1001.6 | 1.155 | 8.34 | 402.00 | 4464 | 100.00 |
| Sep-17 | 28.5 | 1004.9 | 1.161 | 5.45 | 138.00 | 4320 | 100.00 |
| Oct-17 | 29.4 | 1006.4 | 1.159 | 4.17 | 76.00 | 4464 | 100.00 |
| Nov-17 | 21.8 | 1010.3 | 1.193 | 5.16 | 121.00 | 4320 | 100.00 |
| Dec-17 | 22.5 | 1010.7 | 1.191 | 4.62 | 73.00 | 431* | 9.66 |
| Jan-18 | 23.2 | 1011.0 | 1.188 | 4.39 | 73.00 | 2313** | 51.81 |
| Feb-18 | 26.0 | 1010.1 | 1.176 | 4.39 | 70.00 | 873 | 21.65 |
| Mar-18 | 27.2 | 1008.4 | 1.170 | 4.60 | 87.00 | 2204 | 49.37 |
| Average | **26.91** | **1006.34** | **1.168** | **6.17** | **230.50** | **40957** | **77.71** |

WS-Wind Speed (m/s)
WPD-Wind Power Density (W/sq.m)

# Tentative – Micrositing & Power Evacuation facility



# Geo-physical study data available



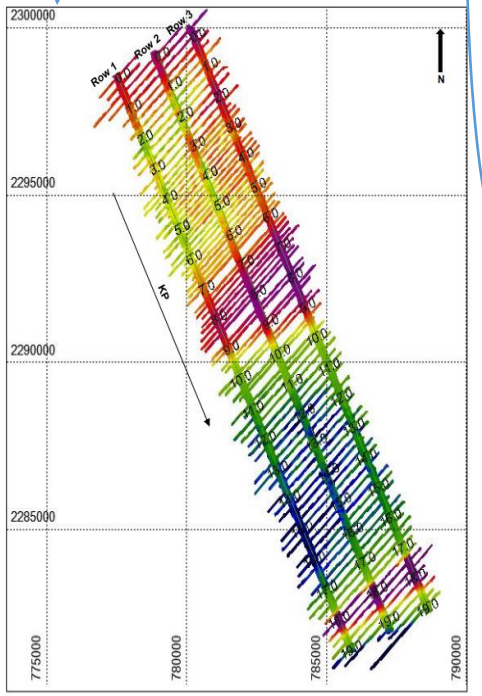

| ID | LATTITUDE | LONGITUDE |
|---|---|---|
| 1 | 20° 45’ 59.78” N | 71° 39’ 35.90” E |
| 2 | 20° 46’ 57.92” N | 71° 41’ 39.50” E |
| 3 | 20° 36’ 16.92” N | 71° 44’ 26.02” E |
| 4 | 20° 37’ 09.57” N | 71° 46’ 32.21” E |

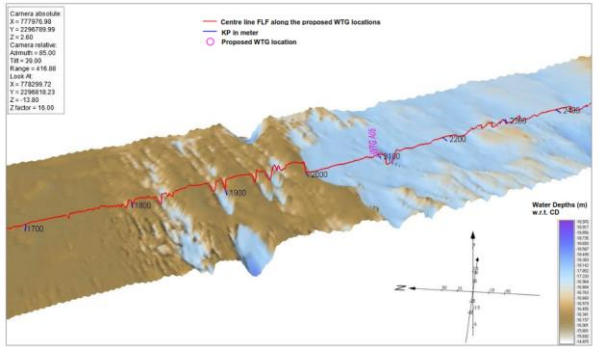
70 sq.km

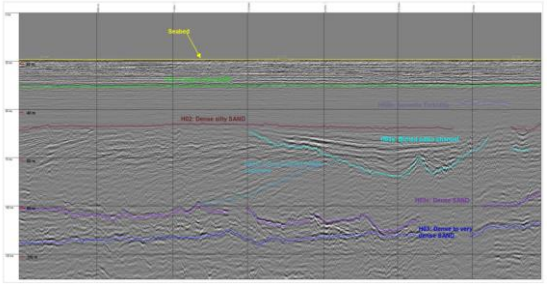
| ID | LATTITUDE | LONGITUDE |
|---|---|---|
| A1 | 20°48'4.58" | 71°41'51.50 |
| A2 | 20°51'17.13 | 71°46'59.51" |
| A3 | 20°48'33.95 | 71°48'24.62 |
| A4 | 20°44'14.88 | 71°48'21.66 |
| A5 | 20°40'47.35 | 71°46'10.16" |
| A6 | 20°40'9.11 | 71°45'6.76 |

135 sq.km

| S.No | Parameters |
|---|---|
| 1 | Echo sounder (Single Beam / Multi-Beam) |
| 2 | Side Scan Sonar(SSS) |
| 3 | Magnetometer |
| 4 | Multi-Channel 2D - UHR survey |



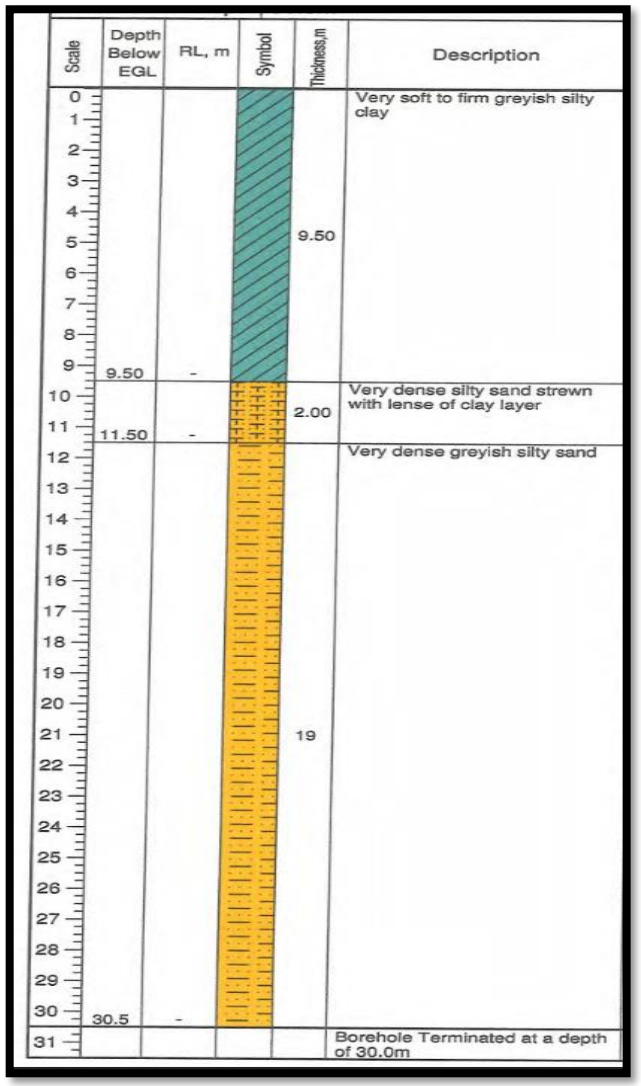



Maximum water depth recorded within the survey corridor: 19.6 m (785701 mE, 2300587 mN).

Minimum water depth recorded within the survey corridor: 11.3 m (788062 mE, 2284045 mN).

# Geo-Technical data available at Lidar location

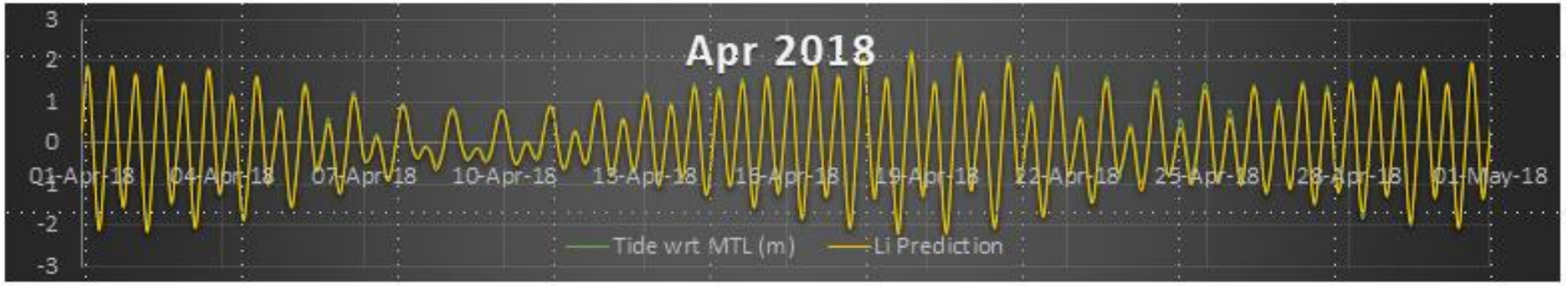


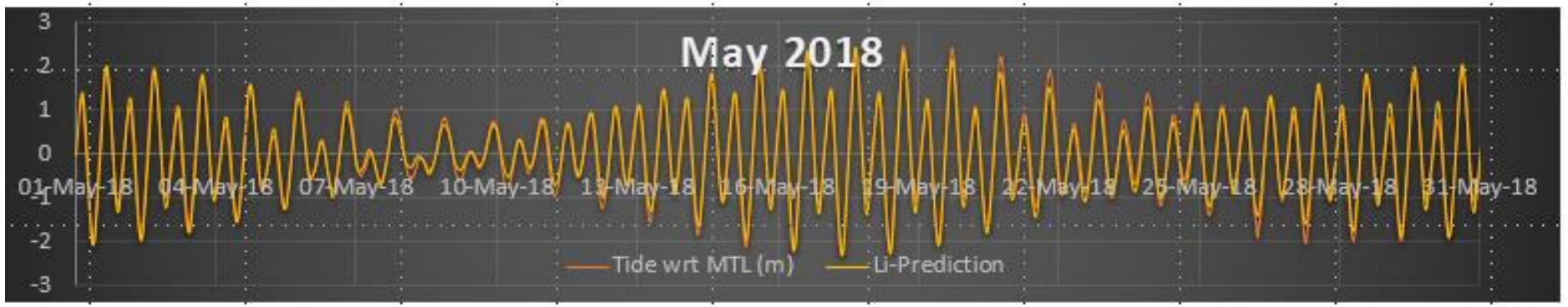

| S.no | Depth(m) | Type of Soil |
|---|---|---|
| 1. | up to -9.5 | Very soft to medium stiff silty clay |
| 2. | -9.5 to -11.5 | Very dense silty sand strewn with the lense of the clay layer |
| 3. | -11.5 to -30 | Very dense silty sand |

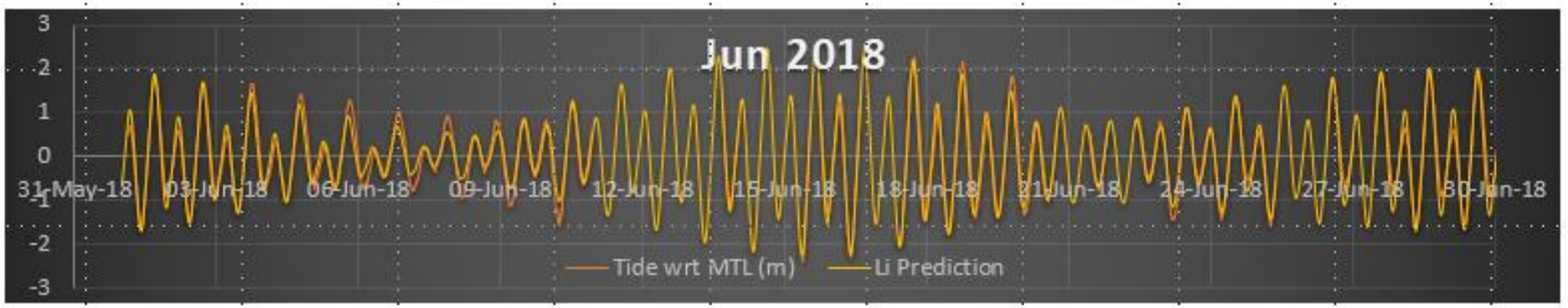
# Radar Tide gauge data available at Lidar location

Commissioned on 23rd March 2018

Low Tide (-2m) & High Tide (+2m)

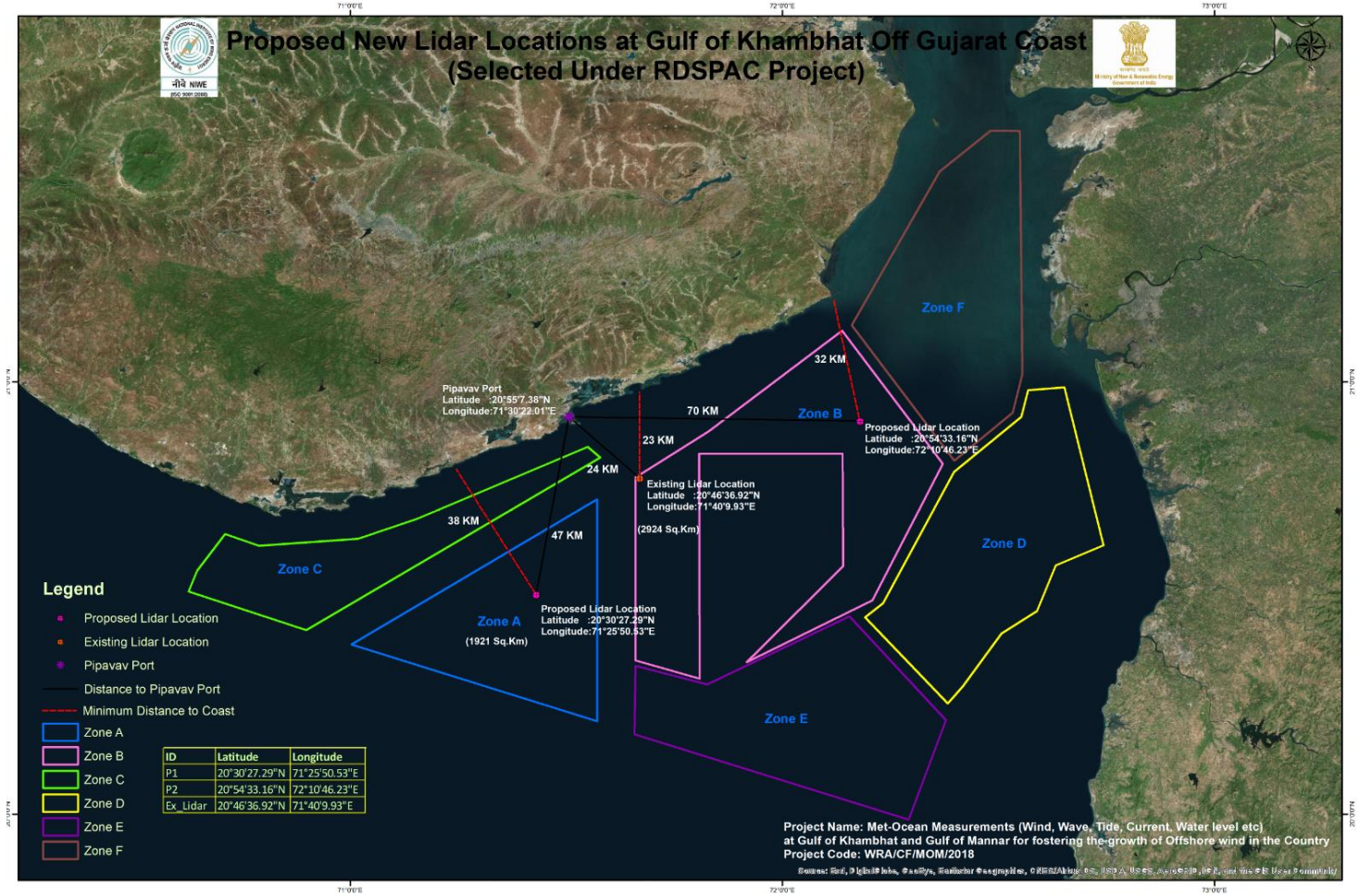



Radar Tide gauge

# Additional LiDAR Measurements




| Zone | Area (sq.km) |
|---|---|
| Zone A | 1921 |
| Zone B | 2924 |
| Total | 4845 |

**Multi-criteria**

- Wind Potential
- Water depth
- Marine traffic
- Proximity to shore
- Logistics
- Seismic risk

Together with the existing LiDAR at Gulf of Khambhat (Latitude: $20^0$46’36.92” N Longitude: $71^0$40’9.93” E) and the satellite data, the proposed 2 nos. of LiDARs can provide information on wind characteristics to cover up an area of about **4800 sq.km**, wherein approximately **10 to 14 GW (~50% of the Installable Potential announced by MNRE)** wind farm capacity can be developed

# NIWE Obtained Requisite clearance/NOC from the following central ministries

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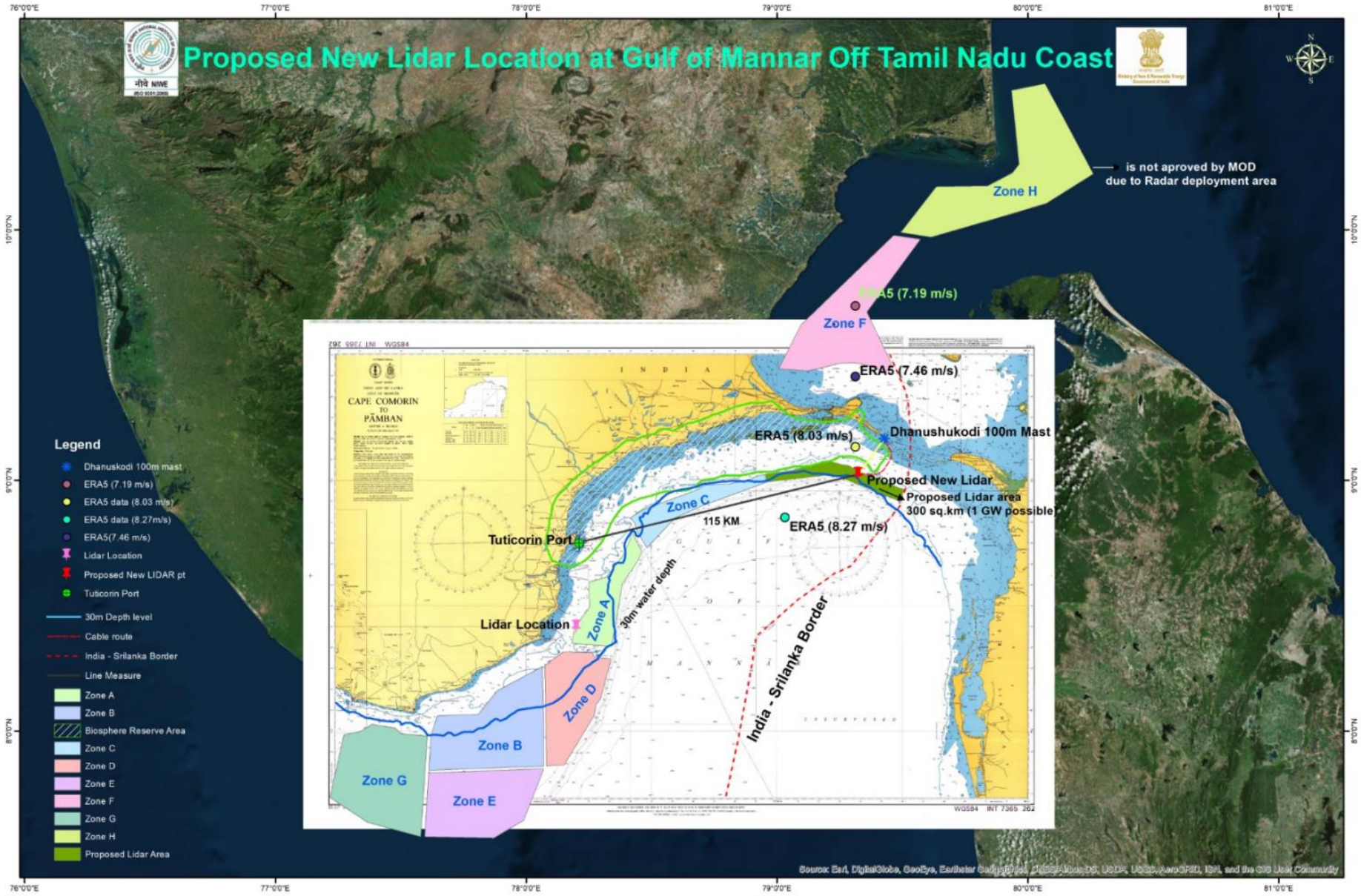
- Ministry of Home Affairs – Obtained Stage 1 clearance
- Ministry of Defence – Obtained Stage 1 clearance
- Ministry of External Affairs – Obtained Stage 1 clearance
- Department of Space – Obtained Stage 1 clearance
- Gujarat Maritime Board (GMB) – Submitted DPR along with EIA FORM-1 – **Awaiting NOC**
- Gujarat State Coastal Zone Management Authority (GSCZMA) – Submitted DPR along with EIA Form-1, Topo map, NHO chart, Pipavav port Google map, Buffer map- **Awaiting NOC.**

# TamilNadu, Gulf Of Mannar



# Met-Ocean measurements (Lidar based wind measurement,wave,tide, water current, salinity, temperature etc) at Gulf of Mannar for fostering the growth rate of offshore wind in the country

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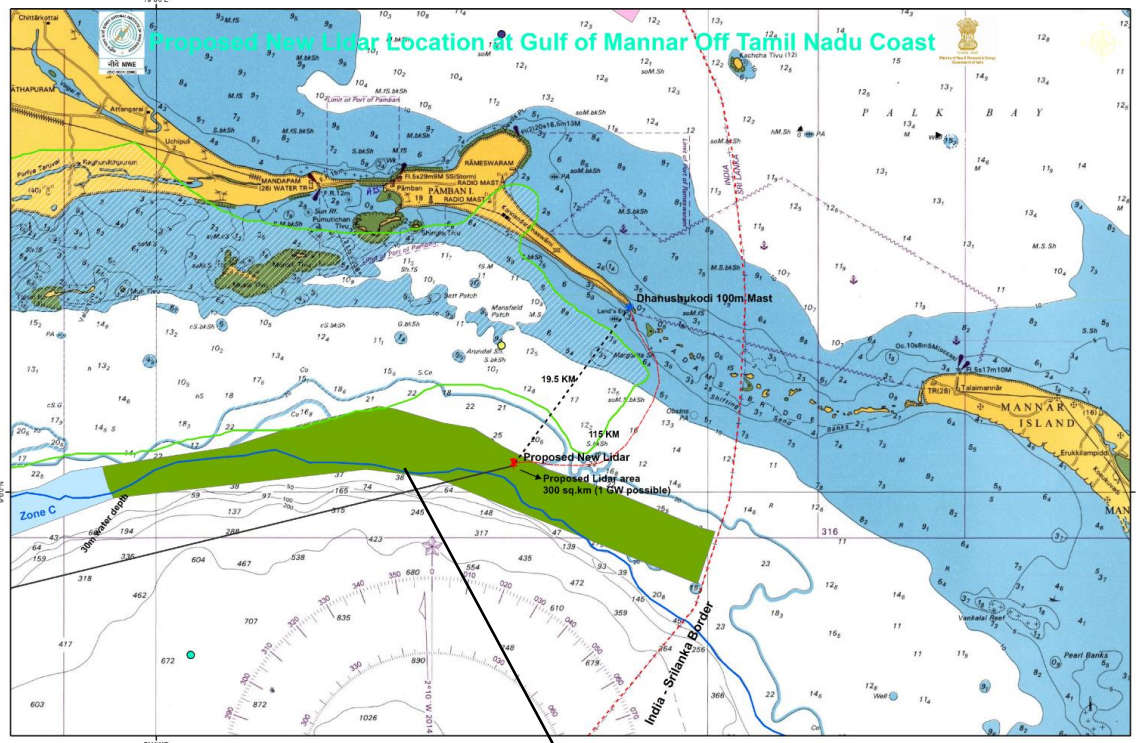
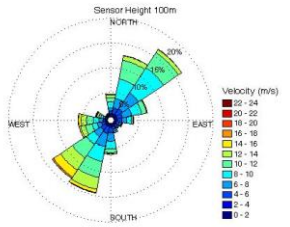




1GW
(300 Sq.km)




| Year | 100m WS |
|---|---|
| 2013 | 8.76 |
| 2014 | 8.29 |
| 2015 | 7.91 |
| 2016 | 8.33 |

# Draft Tender Document- Salient features

- SECI to Invite bids on behalf of NIWE for setting up of 1 GW offshore wind power on “Build Own Operate” (B-O-O) basis.
  - Sea bed area - 400 sq. km in the Gulf of Khambhat region, off Gujarat, India.

- GUVNL(Gujarat Urja Vikas Nigam Ltd)/GPCL (Gujarat Power Corporation Ltd) shall enter into a PPA with successful Offshore Wind Power Developer(OWPD) for a period of 25 years.
  - Purchase price to be finished in consultation with GUVNL/GPCL for 25 years. (Cost/kWh will be discovered in consultation with GUVNL/GPCL)

- Minimum capacity for bidding -250 MW and maximum capacity 1000 MW is proposed.

# Draft Tender Document- Salient features

- Selection of bids – based on cost/kWh through E-Reverse auction

- Inter-connection with transmission network of CTU/STU at voltage level of 220 kV or above
  - Onshore infrastructure for power evacuation :Central Transmission Utility / State Transmission Utility

  - The electrical infrastructure till the point of connection to the onshore substation :Awaiting input from EoI participants

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# Questions?

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# Thank You