

ESSAR BULK TERMINAL LIMITED

**Pre-feasibility Report for Development
of LNG Terminal in Tapi River Estuary
at Hazira, Surat, Gujarat.**

JULY 2017



Environment *for* Development

ESSAR BULK TERMINAL LIMITED

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PROJECT DETAILS							
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1 EXECUTIVE SUMMARY

1.1 Background

Essar Bulk Terminal Limited (EBTL) is operating a captive Deep Draft Terminal at Hazira under Magdalla Port of Gujarat Maritime Board (GMB). Presently EBTL is operating 1150 meters of Deep Draft berth with a 7km Long Navigation Channel with a Turning Circle for handling bulk and break bulk cargo. Construction of additional 500m berth length is under progress.

The Environmental Clearance (EC) for these developments was granted by the Ministry of Environment & Forests (MoEF) in September 2007. Subsequently, in December 2007 the MoEF gave EC for reclamation of 350 ha of the intertidal area to accommodate back-up facilities for the Port by utilizing dredged material generated in dredging the Navigational Channel, Turning Circle, berth pockets etc. Thereafter in May 2014 EBTL received environment clearance for extension of port facility by 4800 berth. Accordingly EBTL has commissioned 550m berth in May 2010 and another 600 m in 2017.

Environment and CRZ clearance of 6th May 2014 for expansion of EBTL port facility envisages development of 4800m berth length with back up storage yard. Breakup of 4800 m berth length is as follows: bulk berth – 700 m, general cargo berth – 700 m, liquid cargo berth – 500 m, containers – 1100 m, trestle, dry dock, offshore support ship repairs etc. – 1800 m. Also environment and CRZ clearance envisaged dredging of channel up to 16m depth and broadening of navigational channel up to 300-350m and reclamation of 334 hectares of land.

EBTL is planning to handle Liquefied Natural Gas (LNG) within 800m berth starting from 100m south of operational 1150 m berth, LNG berth length will be ~400m. Land required for the proposed project is ~ 17 hectares. GMB has already provided in principle allotment of 140 ha of Land to EBTL.

Natural gas is a naturally occurring hydrocarbon gas mixture consisting primarily of methane. It is one of the cleanest, safest, and most useful forms of energy in our day-to-day lives. It is an important source of energy for power generation, industrial fuel requirements, feed for the fertilizer and also used as process material for various industries like steel plant and petroleum refineries. India consumes approx. 136 MMSCMD in 2016-17 of natural gas out of which approx. 67 MMSCMD is imported in the form of Liquefied Natural Gas (LNG). Bombay High is the main source of domestic natural gas and Hazira-Bijapur-Jagdishpur (HBJ) gas pipeline transports gas to various parts of India. HBJ pipeline has made south Gujarat a highly attractive location for LNG import terminals as well and that is the reason why India's first two LNG import terminal were developed in the region at Hazira and Dahej.

Considering the attractiveness of the location, huge untapped gas demand of nearby industries including demand of Essar group companies and fall in LNG prices, there is a strong case for development of a new LNG import terminal at Hazira. To tap these excellent opportunities, EBTL has proposed to develop LNG import terminal.

EBTL's proposed LNG terminal will have a combination of floating and land based storage. Terminal will have Regasification Unit (RU) to vaporize LNG into gas. LNG will be imported through LNG carrier and transferred to Floating Storage Unit (FSU) through well-established ship to ship transfer mechanism using flexible hoses. Transfer of LNG from FSU to the storage on land or RU will take place using fixed marine loading arms. LNG will be regasified at RU using water or air. RU will be connected

to gas grid through high pressure gas pipeline. In addition to RU, road gantry facilities will be developed for transport of LNG in road tankers to end customers.

Essar Steel is presently operating a 10 MMTPA steel plant at Hazira. Out of this total capacity, 6.8 MMTPA of iron making capacity is gas based which uses natural gas for reduction of iron ore to iron. Apart from Steel Plant, Essar also has a 1015 MW gas based power plant at Hazira which requires gas. Total gas requirement of Essar for its steel plant and power plant is 11 MMSCMD out of which approx. 1.5 MMSCMD is expected to be generated as a byproduct of steel production units.

Domestic Gas production in India (net of flare, loss and internal consumption) has declined from 125 MMSCMD in 2010-11 to 68 MMSCMD in 2016-17. Due to reduction in domestic gas production and policy of Government on allocation of gas to priority sector like fertilizer, Essar Steel is not getting gas allocation and is forced to import LNG to meet its process requirement. Essar Power is also not getting domestic gas for operation of its unit. The current fall in prices of LNG has made LNG imports viable for these units and other power plants and industrial consumers of LNG.

1.2 Project Brief

Essar Steel has set up a 10.0 MTPA steel plant at Hazira of which 6.8 MTPA steel capacity (~70 %) is dependent on gas. Further 1015 MW power plant capacity at Hazira is gas based both of which has remained idle due to high prices of LNG in the past.

To meet the high demand of Natural Gas (NG) by Essar Steel and Essar Power and also to cater to the gas demand of nearby industries, EBTL proposes to develop an LNG terminal at Hazira.

Development of FSU and Land based LNG Terminal

EBTL has envisaged to develop a 6 MMTPA LNG import terminal. LNG will be stored in a LNG carrier which will be moored at jetty, this LNG carrier moored to jetty is referred as Floating Storage Unit (FSU). Apart from FSU there will be land based storage as well. Regasification Unit (RU) will be connected to the FSU/land based storage unit through cryogenic pipeline and unloading arms. RU will be connected to gas grid through high pressure gas pipeline. Part of waterfront will be utilized for mooring of FSU and will be available to EBTL for the dedicated use for handling LNG.

The LNG will be imported to Hazira via LNG carriers. EBTL has developed a 7 km long navigational channel for movement of ships and currently 13 m draft vessels are being berthed at EBTL using tide. Draft of largest LNG carriers are 12m-12.5m hence draft at the navigational channel is sufficient for berthing of LNG carriers. LNG will be unloaded from LNG carrier to FSU through flexible hoses which is a standard practice for ship to ship transfer. The LNG will then be transferred from FSU to land based storage/RU via fixed loading arms and cryogenic pipelines.

FSU storage will be up to 266,000 cubic meter while land based storage facilities of 60,000 cubic meter comprising of double walled atmospheric tank and double walled pressurized bullets. LNG will either flow directly from FSU to RU or first flow to land based storage tanks and from land based tanks to RU.

RU of 750 MMSCFD capacity will be installed on the land and fresh water from the power plant of Essar Power Hazira Limited which will be ~ 7 km away from proposed LNG terminal, will be used to vaporize the LNG and cooled LNG will be returned back to power plant. Through this process there will

neither be any consumption of water nor any discharge of water into any water bodies during the regasification process. In addition to fresh water, ambient air may also be used for vaporization of LNG.

Once the LNG is regasified, it will be transported to Essar Steel and Essar Power as well as other party customers connected to the grid. Pipeline connectivity to the gas grid is already in place till the Essar Steel unit.

In addition to RU, road gantry facilities will be developed for transport of LNG in road tankers to end customers.

1.3 Project Location

The project will be set up in the water front (Tapi river estuary) & reclaimed area as approved by MoEF vide letter to EBTL dated 6th May 2014. The project location is 30 km from the Surat city and 3.5 km from Hazira Village. EBTL facilities at Hazira is along the western shore of the Tapi estuary adjacent to the Essar's steel and power complex and the port of Hazira Pvt. Port Limited (HPPL).

Hazira is a notified industrial area with companies such as HPPL (Shell LNG Terminal), Adani Hazira Pvt. Port Ltd. (AHPPL) , Essar Steel, Essar Power, Larsen and Toubro, Reliance industries, NTPC, Kribhco, ONGC etc.

There are also 6 villages within 10 km of the proposed project. They are well-developed with facilities such as school, primary health center and public transport.

Since the proposed project will be set-up in the waterfront and partly on the reclaimed area approved as per the Environment Clearance of EBTL, there is no additional land requirement and there are no resettlement and rehabilitation issues.

2 INTRODUCTION

2.1 Need for the Project

Essar Bulk Terminal Limited had received environment clearance for 550m berth in September 2007. Subsequently in May 2014, EBTL received environment clearance for extension of port facility by 4800 berth. Accordingly EBTL has commissioned 550m berth in May 2010 and another 600m in 2017. Currently EBTL is operating 1150 meters of berth for handling bulk and break bulk cargo. Construction of additional 500 m berth length is under progress.

Environment and CRZ clearance of 6th May 2014 for expansion of EBTL port facility envisages development of 4800m berth length with back up storage yard. Breakup of 4800m berth length is as follows: bulk berth – 700m, general cargo berth – 700m, liquid cargo berth – 500m, containers – 1100m, trestle, dry dock, offshore support ship repairs etc. – 1800m. Also environment and CRZ clearance envisaged dredging of channel up to 16 m depth and broadening of navigational channel up to 300-350m and reclamation of 334 hectares of land.

EBTL is planning to handle Liquefied Natural Gas (LNG) within 800m berth starting from 100 m south of operational 1150 m berth, LNG berth length will be ~400m. Land required for the proposed project is ~ 17 hectares. GMB has provided in principle allotment of 140 ha of Land to EBTL and this project will be developed within that land.

Natural gas is a naturally occurring hydrocarbon gas mixture consisting primarily of methane. It is one of the cleanest, safest, and most useful forms of energy in our day-to-day lives. It is an important source of energy for power generation, industrial fuel requirements, feed for the fertilizer and also used as process material for various industries like steel plant and petroleum refineries. India consumes approx. 136 MMSCMD in 2016-17 of natural gas out of which approx. 67 MMSCMD is imported in the form of Liquefied Natural Gas (LNG). Bombay High is the main source of domestic natural gas and Hazira-Bijapur-Jagdishpur (HBJ) gas pipeline transports gas to various parts of India. HBJ pipeline has made south Gujarat a highly attractive location for LNG terminals as well and that is the reason why India's first two LNG terminal were developed in the region at Hazira and Dahej.

Considering the attractiveness of the location, huge untapped gas demand of nearby industries including demand of Essar group companies and fall in LNG prices, there is a strong case for development of a new LNG terminal at Hazira. To tap these excellent opportunities, EBTL has proposed to develop LNG terminal. EBTL's proposed LNG terminal will have combination of floating and land based storage. Terminal will have Regasification Unit (RU) to vaporize LNG into gas. LNG will be imported through LNG carrier and transferred to Floating Storage Unit (FSU) through well-established ship to ship transfer mechanism using flexible hoses. Transfer of LNG from FSU to the storage on land or RU using fixed marine loading arms.

LNG will be regasified at RU using water and/or ambient air. RU will be connected to gas grid through high pressure gas pipeline. In addition to RU, road gantry facilities will be developed for transport of LNG in road tankers to end customers.

Essar Steel is presently operating a 10 MMTPA steel plant at Hazira. Out of this total capacity, 6.8 MMTPA of iron making capacity is gas based which uses natural gas for reduction of iron ore to iron. Apart from Steel Plant, Essar also has a 1015 MW gas based power plant at Hazira which requires gas.

Total gas requirement of Essar for its steel plant and power plant is 11 MMSCMD out of which approx. 1.5 MMSCMD is expected to be generated as a byproduct of steel production units.

Company	Plant Capacity	Gas Requirement
Essar Steel	10 MTPA	6.75 MMSCMD
Essar Power	1015 MW	4.25 MMSCMD
Total		11.00 MMSCMD

Domestic Gas production in India (net of flare, loss and internal consumption) has declined from 125 MMSCMD in 2010-11 to 68 MMSCMD in 2016-17. Due to reduction in domestic gas production and policy of Government on allocation of gas to priority sector like fertilizer, Essar Steel is not getting gas allocation and is forced to import LNG to meet its process requirement. Essar Power is also not getting domestic gas for operation of its unit. The current fall in prices of LNG has made LNG imports viable for these units and other power plants and industrial consumers of LNG.

2.2 Demand from Essar Companies

Essar Steel has an operating steel plant at Hazira which has 10.26 MTPA of iron making units. 6.8 MTPA iron making units out of 10.26 MTPA total capacity is gas based which uses natural gas for reduction of iron ore to iron. Apart from Steel Plant, Essar also has 1015 MW gas based power plant at Hazira which requires gas. Total gas requirement of Essar for its steel plant and power plant is 11.00 MMSCMD.

	Plant Capacity	Gas Requirement
Essar Steel	10 MTPA	6.75 MMSCMD
Essar Power	1015 MW	4.25 MMSCMD
Total		11.00 MMSCMD

2.2.1 Gas requirement of Essar Steel

Essar Steel is operating 6 gas based iron making modules know as Direct Reduced Iron (DRI) module. These modules use gas for reduction of iron ore/pellets into iron in solid form which is melted and further treated to make steel. Module wise gas requirements are provided below:

Process Units	Gas requirement
	MMSCMD
DRI Module 1	0.66
DRI Module 2	0.66
DRI Module 3	0.66
DRI Module 4	0.83
DRI Module 5	1.33
DRI Module 6	1.41
Auxiliary Units	1.2
Total	6.75

2.2.2 Gas requirement for Essar Power

Essar Power is operating 2 gas based power plants of capacity 515 MW and 500 MW. These power plants are combined cycle power plants which uses both a gas turbine and a steam turbine to generate electricity. Waste heat from gas turbine is routed to the nearby steam turbine which generates extra power. 1015 MW gas based power plants require 4.25 MMSCMD of gas.

2.3 Demand from Other Customers

2.3.1 All India Demand for Natural Gas

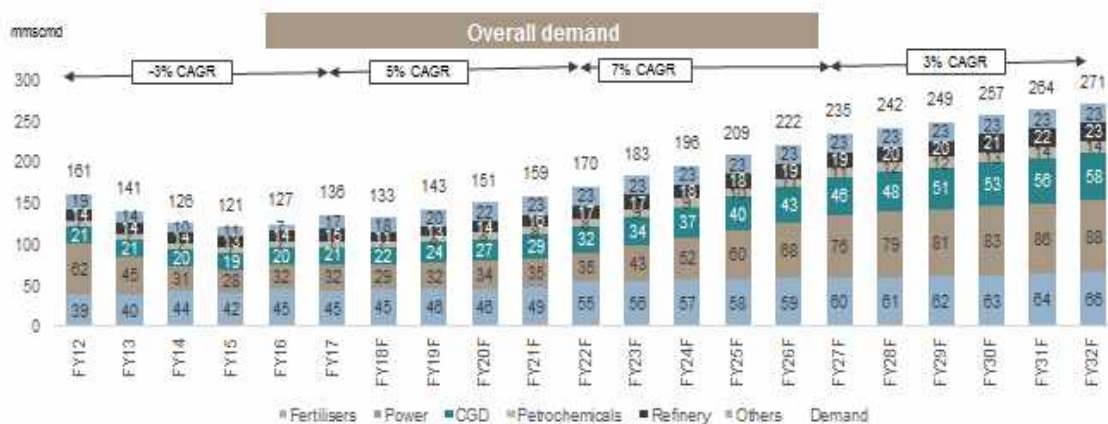
Sectors which lead consumption of LNG include Power, Fertilizers and Industry Sectors:

Power: The supply demand gap is fueled by the fact that gas based power plants are operating much below their capacity. More than 25,000 MW of gas based power plants are installed. Further, cost of power generation through coal is increasing and with the power deficit increasing, natural gas plants will eventually become a competitive and viable option.

Fertilizer: The fertilizer industry in India (primarily gas based Urea production) is increasing substantially which will spur the demand for natural gas. Demand for Urea is expected to grow due to price competitiveness of Urea vis-à-vis other fertilizers. Government initiatives such as capacity additions under New Urea Investment Policy and price pooling mechanism and conversion of naphtha based plants to gas based plants will significantly increase natural gas demand in the fertilizer sector.

Auto & CGD: Shift towards LNG operated vehicles, development of City gas distribution networks are other positive factors for LNG imports.

Other sectors: Other sectors which contribute to natural gas demand include Refinery, Petrochemicals and Steel sectors.



Source: Company reports, MoPNG, CRISIL Research

- Natural Gas Demand is expected to grow in the short term from 136 MMSCMD in FY17 to 170 MMSCMD in FY 22 at a CAGR of 5 %.
- Natural Gas Demand is expected to reach 235 MMSCMD by FY 27 with a CAGR of 7% between FY 22 to FY 27.

- Conversion of naphtha based units, capacity additions under New Urea Investment Policy to drive demand from the fertilizer sector.
- Expansion in CNG and domestic PNG sectors to drive demand growth from the CGD sector.
- Demand growth to be weak from power sector, given weak cost competitiveness of LNG and withdrawing of LNG subsidy scheme.

Huge gap between gas consumption and realizable demand

Various studies on gas demand in India have found that there is a huge demand of gas in the country across the sector. Actual gas consumption is much lower than the demand due to lack of infrastructure and fluctuation of gas prices and related uncertainties. Comparison of working group of 12th five year plan and actual gas demand (for the month of October 2016) is provided below:

(Source: PPAC – Monthly Report on Natural gas production, availability and consumption – October 2016)

Sector	Sectoral Demand projected by working Group 12th five year plan	Domestic gas consumption in October 2016	Imported LNG consumption in October 2016	Total Gas consumption
	MMSCMD	MMSCMD	MMSCMD	MMSCMD
Fertilizer	113	20.76	21.60	42.36
Power	207	25.23	5.98	31.21
City Gas	46	11.77	9.10	20.88
Industrial	27	0.47	1.41	1.89
Petrochemical/refinery/internal consumption and other miscellaneous	72	10.89	29.20	40.08
Sponge iron/steel	8	1.27	1.89	3.15
Total	473	70.39	69.18	139.57

Note: Above figures does not include internal consumption of domestic gas producing companies

- Realizable demand for gas in India is over 3 times the actual consumption of gas.
- Now, imported LNG is almost equal to domestic production.
- With fall in LNG prices, demand for imported LNG will further increase hence there will be huge demand for LNG import terminals.

Broadly, the following factors are expected to drive the increased consumption of natural gas in India:

Macroeconomic setting and policy making

Overall macroeconomic conditions in the economy will set the demand for energy and the growth of energy demand. India has been enjoying higher growth rates since the early 1990s because of economic reforms. This growth will contribute to greater demand for energy.

Fall in LNG Prices

The recent crash in prices of crude oil has led to a reduction in price of LNG as LNG prices follow crude prices with a time lag. Decrease in LNG prices has made LNG imports in India a viable option for

operation of gas based power plants which are currently idle and is likely to spur growth in gas consumption. New liquefaction capacity is getting commissioned in various parts of the world like Australia, new supply will put further pressure on LNG prices and prices are expected to remain for next few years.

Growth of end-user segments

The robust growth outlook for the Indian economy and the resultant increase in the end-user consumption of the natural gas is expected to drive the natural gas market in the future. Reduction in gas prices has made supply of PNG more viable for domestic consumption in both urban and rural cities. Recent fall in the natural gas prices will also make gas based power plants able to competitively run on imported LNG. These units are currently shutdown or operating at very low Power Load Factors. Gas based iron making steel units will also benefit from the fall in LNG prices.

Regulation

The PNGRB Act, 2006 is an overarching framework that would attract, enable and sustain much needed capital into the entire sector. It will also take the shape of protecting consumer interests and those of industry participants. With regulatory clarity, it is envisaged that gas sector would develop in a big way with a number of cities being connected with gas pipelines and city gas distribution networks supplying natural gas to consumers.

Environmental concerns

With India becoming a signatory to the Kyoto Protocol, there is an emphasis on reduction of greenhouse gas emissions. Gas is preferred as it has lowest carbon emissions for a hydrocarbon per unit of energy generated. The promotion of gas can earn certified emission reduction credits and CDM project developers can gain monetarily from such projects / transactions.

New uses of Natural Gas (eg. co-generation)

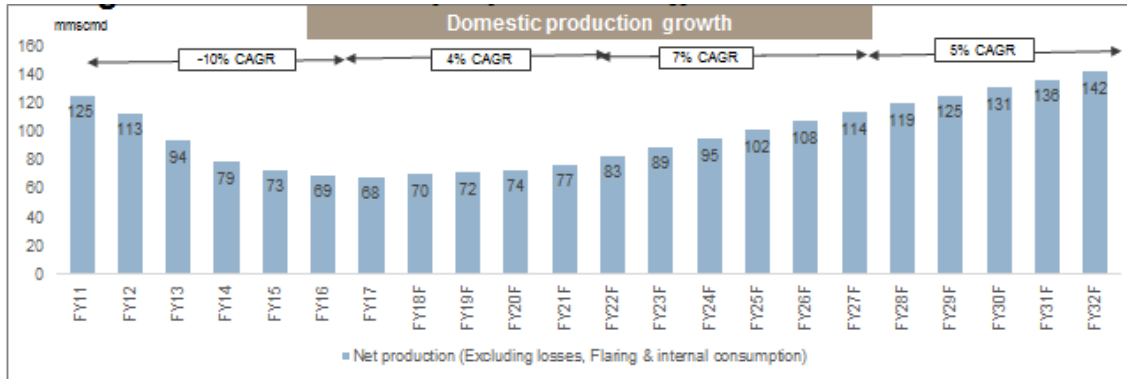
Natural gas can be considered as "single fuel solution", replacing fuel for power for heating and cooling requirements. Use of gas in co-generation of power, refrigeration and heating (CCHP- Combined Cooling, Heating & Power) gives 75% to 90% thermal efficiency. Given the economic advantage in terms of efficiency, industrial and commercial institution are likely to switch to the single fuel application, once natural gas becomes available.

The demand for gas can be categorized as under;

- **Existing gas demand:** The existing gas demand is defined as the present demand for natural gas by the entity based on current supplies from all sources or its gas allocation, whichever is higher.
- **Switching gas demand:** Switching gas demand is defined as the demand resulting from switching of units operating on alternate fuels such as Naphtha/ Fuel Oil/Light Diesel Oil to gas when the same is made available at economical price. This demand is expected to materialize gradually over the forecast period.
- **Gas demand from capacity additions:** This is the gas demand from green field / brown field capacity additions in various sectors and has been estimated on the basis of the demand/ supply

outlook for the sector till 2020. This includes demand from capacities that have been announced and are expected to come up to meet the demand / supply gap in the sector.

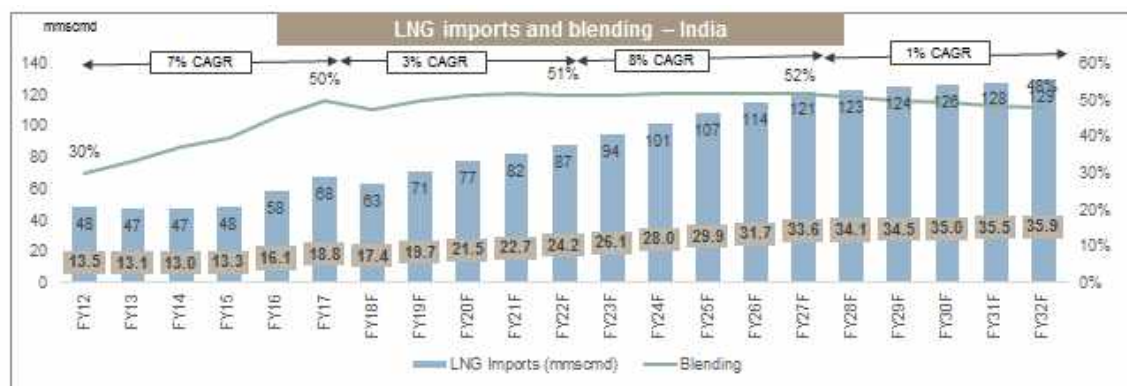
2.3.2 Supply of Natural Gas in India



Source: Company reports, MoPNG, CRISIL Research

- Key sources of Domestic production of natural gas in India include ONGC & RIL onshore and offshore fields as well as Coal Bed Methane (CBM) fields. Production growth over the next 5 years is expected to be led by ONGC’s western offshore fields and rising CBM output. While premium pricing policy and other initiatives are expected to assist domestic gas output, growth is expected to be subdued.
- Domestic gas production (net of flaring, losses and internal consumption) which is currently at ~ 68 MMSCMD is expected to grow to 83 MMSCMD by FY22 at a CAGR of 4% and to 114 MMSCMD in FY 27 at a CAGR of 7% from FY 22 to FY 27.
- Domestic Production in the short term to be subdued, growth is expected through eastern offshore fields in the long term.

2.3.3 Import Potential for LNG



- LNG Imports is expected to increase from 68 MMSCMD in 2017 to 87 MMSCMD in 2022 at a CAGR of 3%.
- LNG Imports is expected to increase from 87 MMSCMD in 2022 to 121 MMSCMD in 2027 at a CAGR of 8%.

- Over the forecast period, share of LNG imports in total gas consumption is likely to remain elevated.

Over the long term, ramp up in gas demand from fertilizer plants setup under the new Urea Investment Policy and improved demand from the Power sector is expected to lead the ramp up in LNG demand.

2.3.4 LNG Infrastructure in India

As of 2017, there are LNG terminals with over 25 MTPA of regasification capacity:

- Petronet LNG Limited (PLL) commissioned its Dahej terminal in April 2004 and has increased capacity to 15 MTPA and then further incremental capacity of 2.5 MTPA. PLL sells gas to GAIL, IOCL and BPCL that sell to consumers in Gujarat and other Northern States.
- Shell-Total together commissioned the LNG regasification terminal at Hazira and with a total capacity of 5 MTPA. Hazira LNG has entered into contracts with both Gujarat State Petronet Limited & GAIL for transporting gas within Gujarat.
- GAIL Dabhol Terminal has a capacity of ~ 1.7 MTPA (Development in first phase without breakwater) which is expected to expand to 5 MTPA.
- Petronet LNG Limited (PLL) Kochi has a capacity of 5 MTPA. Utilization at this terminal currently is low due to connectivity issues to the hinterland.

LNG Regasification Infrastructure (FY2017 H1)

Name	Ownership	Stake	Existing capacity (MTPA)	Incremental capacity (MTPA)	Utilisation
Dahej	PetronetLNG	100%	15	2.5	97%
Hazira	Shell Gas B.V	74%	5	-	76 %
	Total	26%			
Dabhol	GAIL	26%	5 (1.6 due to lack of breakwater)	-	56.3%
	NTPC	26%			
Kochi	PetronetLNG	100%	5	-	~5%

Evacuation infrastructure for LNG Terminals (FY 2017 H1)

Name	Evacuation pipeline	Entity	Capacity (mmscmd)	Utilisation
Dahej	DVPL	GAIL	54	~49%
Hazira	HVJ	GAIL	53	~64%
	DUPL	GAIL	20	~83%
	EWPL	RGITL	80	~25%
Dabhol	DUPL	GAIL	20	~83%
	DBPL	GAIL	16	~8%
Kochi	KKBM	GAIL	6	~18%

Pipeline Connectivity

Pipeline connectivity is extremely important to deliver natural gas to industries such as fertilizer and power plants which are stranded. Once completed, the expanded pipeline infrastructure will enable

actual consumption to increase closer towards the realizable demand. Development of new LNG import terminals will be required to meet the enhanced consumption generated as a result of newly developed pipeline infrastructure.

Key Pipelines expected are as follows:

- Jagdishpur to Haldia Pipeline (extension of HVJ) by FY 2020
- Kochi-Mangalore-Bengaluru Pipeline (KBMPL) by FY 2019
- Shahdol – Phulpur by FY 2017
- Ennore – Nellore by FY 2020
- Kakinada – Srikakulam by FY 2019
- Ennore-Thiruvallur-Bengaluru-Puducherry--Nagapattinam-Madurai-Tuticorin by FY 2020

2.4 Traffic Estimate for Essar LNG Terminal

Company	Requirement	Quantity (MMSCMD)
Essar Steel unit	Process Unit	6.75
Essar Power and Bhandar Power units	Power – 1015 MW	4.25
Total Essar Group (MMSCMD)	-	11.00
Total Essar Group (MTPA)	-	3.0
Other(MMSCMD)	-	11.00
Other (MTPA)	-	3.0
Total (MTPA)	-	6

2.5 Employment Generation

The Proposed LNG Terminal development will generate direct employment for approximately 100 people. There will be indirect employment generation of around 300 people from the Project.

This project is critical for the survival of Essar Steel which will directly employ an additional 1000 people and indirectly employ an additional 5,000 people and similarly for Essar Power which will directly employ additional 300 people and indirectly employ additional 1000 people.

2.6 Project Details

EBTL proposes to develop LNG terminal at Hazira. The proposed Terminal will have capacity of 6 MTPA.

2.6.1 LNG Terminal

EBTL proposes to develop a LNG terminal at Hazira. The proposed Terminal will have a capacity of 6 MTPA.

The proposed LNG terminal will have a configuration of a Floating Storage Unit (FSU), land based storage tanks and land based regasification facilities.

EBTL is planning to handle Liquefied Natural Gas (LNG) within 800m berth starting from 100 m south of operational 1150 m berth, LNG berth length will be ~400m.

The terminal will have a capacity of 6 MMTPA which will cater to the demand of anchor customers such as Essar Steel and Essar Power as well as other customers.

The LNG will be imported to Hazira via LNG carriers. EBTL has developed a 7 km long navigational channel for movement of ships and currently 13 m draft vessels are being berthed at EBTL using tide. Draft of largest LNG carriers are 12m-12.5m hence draft at the navigational channel is sufficient for berthing of LNG carriers. LNG will be unloaded from LNG carrier to FSU through flexible hoses which is a standard practice for ship to ship transfer. The LNG will then be transferred from FSU to land based storage/RU via fixed loading arms and cryogenic pipelines.

FSU storage will be up to 266,000 cubic meter while land based storage facilities of 60,000 cubic meter comprising of double walled atmospheric tank and double walled pressurized bullet. LNG will either flow directly from FSU to RU or first flow to land based storage tanks and from land based tanks to RU.

RU of 750 MMSCFD capacity will be installed on the land and fresh water from the power plant of Essar Power Hazira Limited, which is ~ 7 km from proposed LNG terminal, will be used to vaporize the LNG and cooled LNG will be returned back to power plant. Through this process there will not be any consumption of water nor any discharge of water into any water bodies during the regasification process. In addition to fresh water, ambient air may also be used for vaporization of LNG.

Once the LNG is regasified, it will be transported to Essar Steel and Essar Power as well as other customers connected to the grid. Pipeline connectivity to the gas grid is already in place till the Essar Steel unit and only additional 4 km connectivity within Essar land from LNG terminal to Essar Steel complex is to be developed.

Reception and Storage of LNG

LNG will be imported via LNGC carriers and unloaded via flexible hoses to the floating storage unit (FSU). There will be 6 flexible hoses for handling of LNG and vapor during Ship to Ship Transfer. The FSU will be another LNGC vessel which will be leased and will have capacity up to 266,000 cubic meters. The storage tanks on the FSU may be walled or membrane type tanks where LNG will be stored at approximately – 161 oC. The FSU will be moored to the Jetty. Additionally, land based storage facilities of 60,000 cubic meter comprising of double walled atmospheric tank and double walled pressurized bullet may be developed. LNG will either flow directly from FSU to RU or first flow to land based storage tanks and from land based tanks to RU.

Jetty and Marine Facilities

FSU will be moored within ~ 400 m out of 800m berth starting from 100 m south of operational 1150 m berth.

The jetty facilities will also include fenders and bollards to facilitate mooring. Cryogenic loading arms for transport of LNG will also be installed at the jetty as well as interconnecting pipelines for transport to the regasification skid.

LNG Loading Arms

Three fixed unloading arms will be installed at the jetty for transfer of LNG and vapor from FSU to land based storage facilities or Regasification Unit. One unloading arm will be used for transfer of LNG in liquid state, one will be for vapor movement and one will be a spare which can be used for liquid or vapor. Unloading arm will be a capacity of 2000 cubic per hour for liquid movement and 12 TPH for vapor movement.

Regasification of LNG

LNG will be transported via cryogenic pipelines from the FSU or the land based storage facilities to the Regasification unit. Regasification Unit will have capacity of 750 MMSCFD and will be based on water and ambient air.

Regasification Unit will be installed on the land and fresh water from the power plant of Essar Power Hazira Limited will be used to vaporize the LNG and cooled LNG will be returned back to power plant. Through this process there will not be any consumption of water nor any discharge of water into any water bodies during the regasification process. For transportation of water from power plant to RU there will be 2 water pipelines of 48" diameter each and for return of water back to power plant, there will be 2 water pipelines of 48" diameter each. In addition to fresh water ambient air may also be used for vaporization of LNG. Both water based and ambient air based Regasification Units will contain the associated high pressure pumps, motors, heat exchangers, recondensor, instrumentation and control systems and interconnecting piping.

LNG inlet temperature - - 160 °C

Gas outlet temperature – 5 to15 °C

NG Outlet pressure – 20 – 100 barg

Transport of Gas

Regasified LNG coming out of the regasification module will be transported via two 24" diameter pipelines to Essar Steel and Essar Power and other customers. GAIL and GSPC pipeline network is already connected to Essar Steel Plant and connection to that network will be made to transport LNG of other customers.

Dispatch of LNG via Road

In addition to regasification of LNG into natural gas and transfer via pipeline, LNG will be delivered to end customers via road tankers. 2 Road Gantry facilities of 8 bays each (total of 16 bays) will be developed with a capacity of 1.5 MTPA of LNG.

Material Characteristics

The facility will cater to import of 6 MTPA LNG based on the criteria referred below and the same shall be taken into account for planning of the system.

LNG Composition	Lean case (mol %)	Rich case (mol %)
C1	97.7	81.6
C2	1.8	13.4

C3	0.2	3.7
C4+	0.2	0.7
N2	0.1	0.7
Molecular Weight	16.4	19.3
Liquid Density (kg/m ³)	427	485

Key Design Parameters

Key design parameters are elaborated in the table below which shall be key factors for deciding complete system design:

Sr. No.	Description	Assumption
1	Availability of berth for operation	360 days /annum
2	Productive cargo handling hours when ship is at berth	21 hours (average)/day
3	Shift Operations	
	a) LNGC Unloading	3 shifts (round the clock)
	b) FSU Storage	3 shifts (round the clock)
4	Ship Size (LNGC)	160,000 - 180,000 cbm
5	Night Navigation	No restriction
6	Time for peripheral activity	~6.0 hours / ship
	a) Piloting, arrival time	~0.75 hours.
	b) Berthing time	~0.75 hours.
	c) Connection / documentation time	~1.50 hours.
	d) Disconnection / documentation time	~1.50 hours.
	e) De-berthing time	~0.75 hours.
f) Departure time	~0.75 hours.	
7	LNGC to FSU transfer	Flexible Hoses
8	FSU to land transfer	Cryogenic LNG Loading arms
9	Ship arrival pattern	Generally regular with possible variation in mean inter arrival time.
10	Queue discipline	Generally FIFO
11	Cargo Storage	Floating Storage Unit and Land Based Storage
12	Flexible Hose transfer rate	6,000 cbm per hour
14	Regasification Capacity	750 MMSCFD

Functional Planning

Ship Size

Berth length shall be ~400 m with a draft of 14 m. LNGCs will arrive at jetty for unloading.

Capacity of System

Capacity at Jetty/FSU

- Regasification capacity of 750 MMSCFD = 21.24 MMSCMD = ~ 6 MTPA
- Taking a density of LNG of 450 kg per cbm, regasification capacity = 13 million cbm of LNG
- Parcel size of LNGC = 140,000 cbm
- No. of ships required to handle 13 million cbm of LNG per year = 94 ships
- Total Time taken per vessel:
 - LNGC to FSU loading rate = 6,000 cbm
 - Parcel size = 140,000 cbm
 - Time to unload an LNGC = ~ 24 hrs
 - Time for Peripheral activity (berthing, documentation etc.) = 6 hrs
 - Total time per vessel = 24 + 6 = ~ 30 hrs = 1.25 days
- Total time at berth to meet ragas capacity – 94 X 1.25 days = 117.5 days = ~118 days
- Therefore occupancy at berth in a year = 118 days/365 days = ~ 32%

Occupancy of berth is very low at 32% indicating that capacity of the system is governed by the regasification capacity and not capacity at jetty/FSU.

Capacity at regasification skids

Capacity of the system will be dependent on the regasification capacity of the regasification skids.

- Capacity of regasification skids = 750 MMSCFD = 21.24 MMSCMD
- No. of operating days assuming full capacity are operating = 329 days (assuming 90% efficiency)
- SCM to MMBTU conversion factor = 25.2
- Million MMBTU of LNG Conversion = (21.24 MMSCMD X 350 days)/ 25.2 = 295 Million MMBTU

Amount of Freshwater required for the regasification skids

If full 750 MMSCFD Regasification Unit operates on fresh water, quantity of fresh water required will be approx. 8000 cubic meter assuming 15 degree temperature drop between inlet temperature (40 °C) and outlet temperature (25 °C). Hot fresh water availability at power plants of Essar is much higher than required hence availability of fresh water is not a concern

2.6.2 Project Proponent

In view of existing shortage in natural gas in the country, the natural gas import is unavoidable to fill up the increasing supply-demand gap. This project shall have priority to supply natural gas within Essar and excess gas will be supplied through the gas grid network of the Gujarat state/central grid.

Table 2-1: Brief profile of the Company

Name of the Company	Essar Bulk Terminal Limited
Registered Office	27th KM, Surat-Hazira Road, Hazira – 394270, District Surat, Gujarat
Site Office	27 K.M. Surat Hazira Road, Surat -394270
Date of Incorporation	Nov 21, 2006
Sector	Ports & Terminals
Constitution	Public Limited Company

Stock Listing	Not Listed
Site Location	Hazira , Surat

2.7 Design Concepts - Regasification Technology

2.7.1 Regasification system

Regasification Unit will have capacity of 750 MMSCFD and will be based on water and ambient air.

For water based vaporizers, fresh water will be sourced from power plant of Essar Power Hazira Limited and cooled water will be circulated back to the power plant so there will not be any consumption of water during the process nor any discharge of water into any water bodies. For ambient air based vaporizers, ambient air will be used to vaporize LNG. Since vaporization through ambient air will be slow, large cross section for heat transfer in the vaporizers will be required compared to water based vaporizers. Several air based vaporizers will be installed which will be made up of aluminum and stainless steel.

Both water based and ambient air based Regasification Unit will contain the associated high pressure pumps, motors, heat exchangers, recondensor, instrumentation and control systems and interconnecting piping.

2.7.2 Recondenser System

The module will be equipped with a recondenser system. Main equipment for the recondenser system is BOG coolers which will take LNG to condense the boil off gas. Recondensing capacity will be sufficient for condensation of boil off gas from FSU and land based storage tanks.

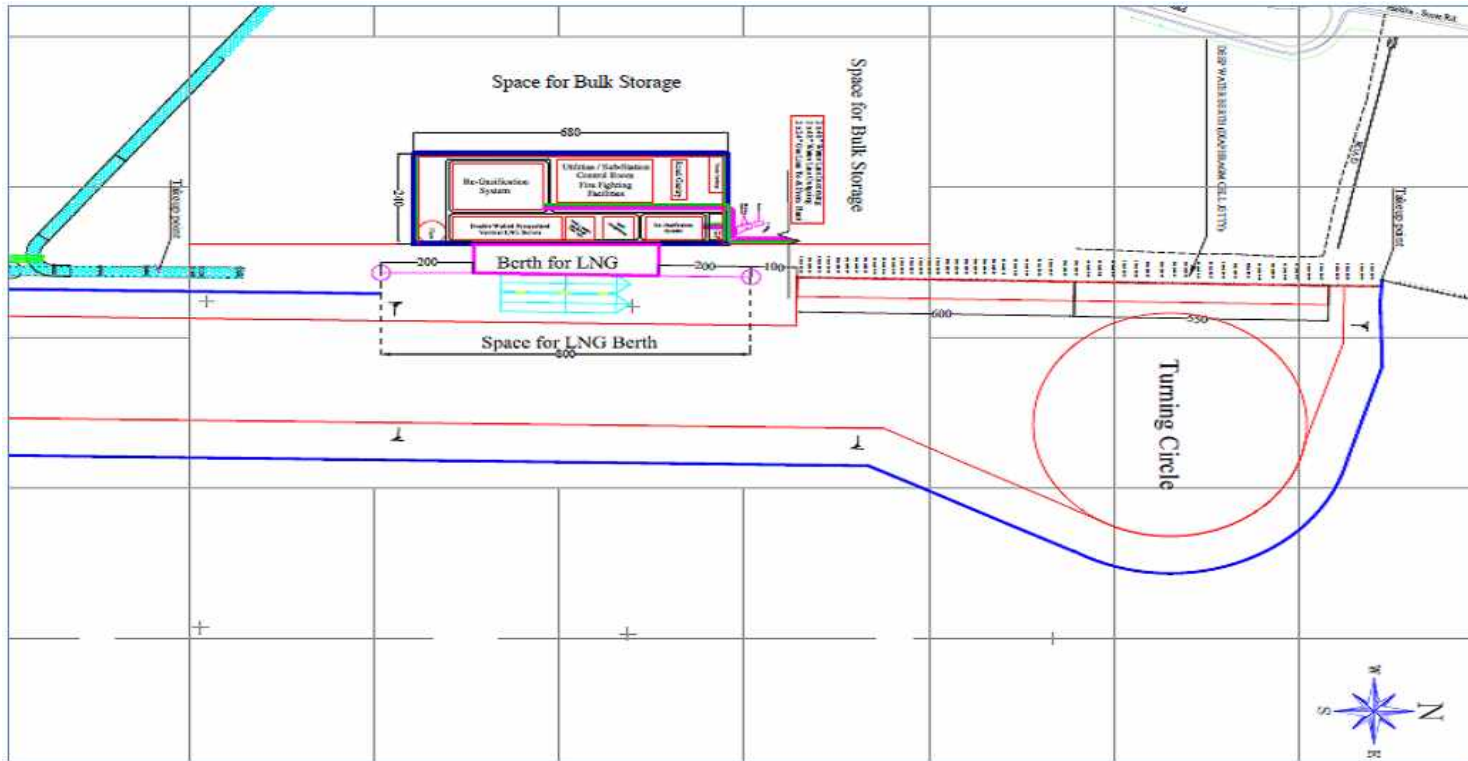
2.7.3 Control System

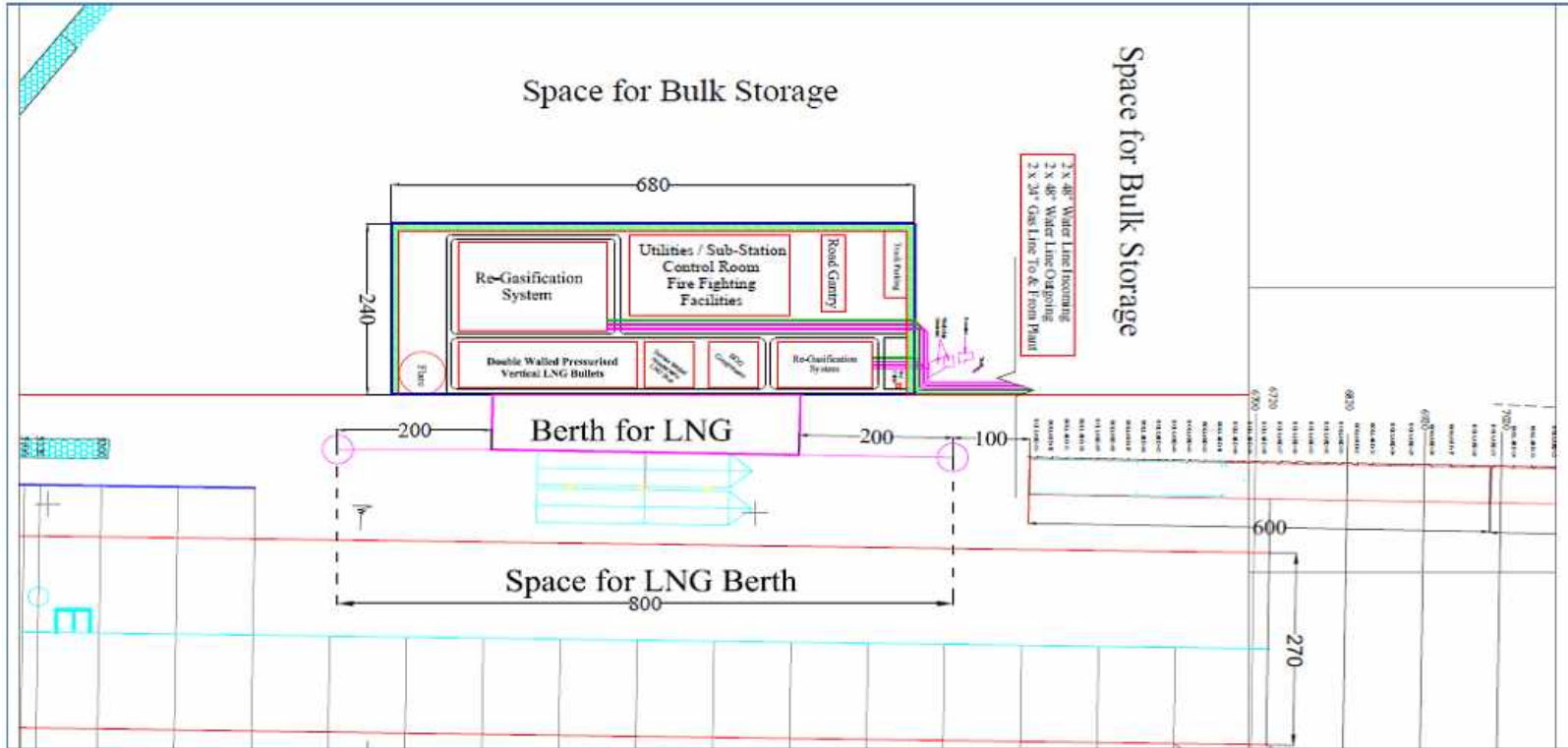
There will be one common control system for all the re-gasification module and eventual optional equipment.

2.8 Proposed Layout

The proposed layout highlighting the location for setting up the LNG terminals is as follows:

Figure 2-1: Proposed Layout of LNG Terminal





LNG terminal will be developed within 800m berth starting from 100 m south of operational 1150 m berth. The terminal will occupy ~ 400 m length. The navigational channel is of 7 kms length with a width of 300 m.

The unloading area near the carrier berthing structure would support the primary equipment needed to safely unload LNG, including LNG loading and vapour return arms (hard or flexible); LNG and vapour transfer piping and manifolds; gas and fire detection, fire protection, and firefighting facilities; life-saving equipment; telecommunications equipment; an access gangway; and a small crane.

2.9 Distance to Existing Gas Transmission Infrastructure

From regasification unit, the gas transmission network of GSPC and GAIL connected to Essar Steel pipelines are at approx. 4 km. Connection will be made with pipelines of GSPC as well as GAIL.

2.10 Health, Safety and Environmental (HSE) System

Studies such as Risk Assessment, Bathymetry etc. are undertaken to identify and reduce all HSE risks. It is also important to integrate all the elements (health, safety, security, environment and social performance) of HSSE risks as early as possible. All the decisions in the conceptualization stage and during design stage will balance and reduce overall risk. This ensures that the residual risks handed over to the operation group are as low as reasonably practicable (ALARP) and will continue to be managed as part of the Operations Phase of the project

The guiding principle is that the best HSE outcome results from the identification and management of critical HSE issues as early as possible in the project development. For many activities, high-level screening activities or coarse studies are specified in early project stages followed by detailed studies as more data become available.

2.11 HSE Management in Operations

An HSE Management System will be established as the framework for systematically managing all HSE risks; it will define the organisation structure, responsibilities, practices, procedures and resources for managing business and marine activities. It will be the responsibility of senior operations staff to provide leadership and so ensure that an HSE culture is embedded within the entire workforce and that everyone involved on the land-based facilities and FSU fully understands, participates in and is committed to HSE.

Existing operations will also comply with ISPS standards. A Port Facility Security Officer (PFSO) included in terminal organization will be trained and certified.

Key staff will ensure that process and personal HSSE considerations are fully understood and evaluated throughout the life cycle, from the concept stage, through project execution, start-up and operations and finally to decommissioning. Performance targets will be set and indicators will be established to determine how well the operation is performing in key areas.

An HSE case or safety case will be prepared, which gives an overview of the potential hazards affecting the project, focuses on the major HSSE issues as the design develops, records how these have been controlled or mitigated and, ultimately, provides assurance to regulators and other interested parties of the safety of the facility. It will eventually be developed to become the operational safety case prior to start-up in accordance with regulatory requirements. QRAs, HAZIDs and HAZOPs are supporting elements of the HSSE case.

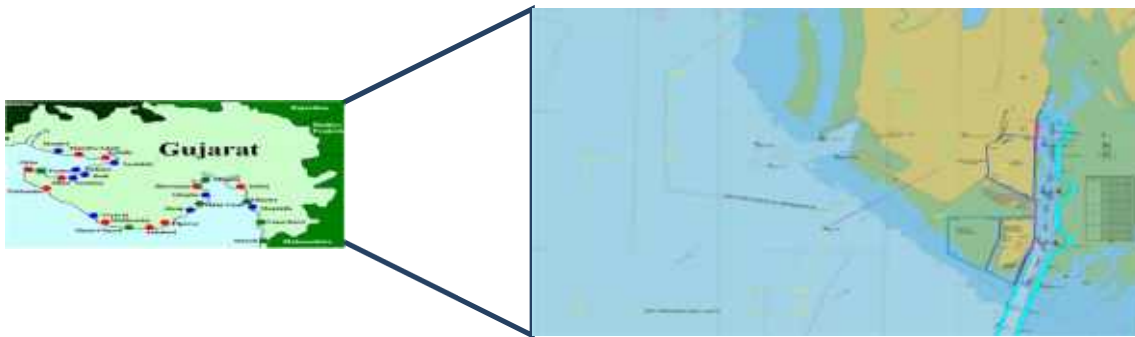
An Emergency Response (ER) plan will develop contingency plans that focus on the management of all the potential incidents during all phases of the life cycle of the integrated production system.

The FSU will maintain a crew that is fully trained and competent to deal with emergencies on board and supplemented as required by the local authorities in the event of escalation.

3 SITE ANALYSIS

3.1 Port Location

The Site Hazira is situated 230 km north of Mumbai, 30 km from Surat city, access is via National Highways 6 and 8 and Surat domestic airport. Four/Six-lane project of NH -6 is underway and widening of the road with flyover on Kribhco and ONGC railway line at Hazira is under construction. The proposed LNG Terminal will be located between following latitude and longitude.



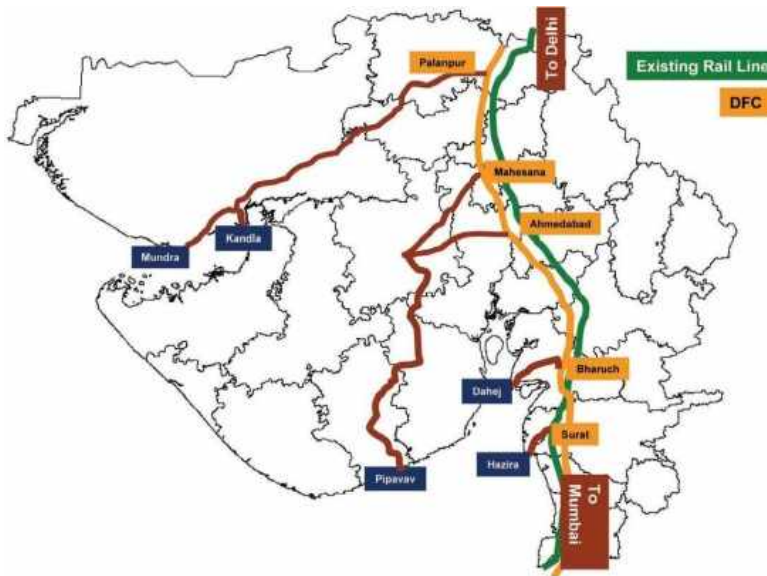
Source: Gujarat Map, Essar Bulk Terminal, Hazira – Proposed Location

3.2 CONNECTIVITY

Hazira is situated 230 km north of Mumbai, 30 km from Surat city, access is via National Highways 6 and 8 and Surat domestic airport. Four/Six-lane project of NH -6 is underway and widening of the road with flyover on Kribhco and ONGC railway line at Hazira is under construction. It is expected that complete 6 lane project will be completed by Dec'2014.

Road and Rail Network: The below Map shows that Surat which is just 40 Km away from Hazira is located on the important broad gauge route that runs between Delhi and Mumbai. This route has double tracks, completely electrified and the tracks are designed to handle faster trains thus ensuring that transportation of cargo are both faster and more efficient as compared with other rail routes.

Figure 3-1: Road & Rail Network to Hazira Connectivity to Essar Port



3.2.1 Rail Transportation

It is planned by the GOG and Railways that the railway line will be laid from Main Railways line between Surat Vadodara stations of western Railways to Hazira. It is estimated that 3 years would be required to lay the railway line and Connect Hazira to Railways network.

3.3 Meteorological Data

Hazira industrial belt on the banks of the Tapi estuary falls in the Surat District of Gujarat. Prior to 1980s when industrialization commenced, Hazira region comprised of 3 islands connected by a causeway. The islands with villages Mora, Suvali and Hazira were in the midst of extensive tidal flats particularly on the seaward side. Large areas of these flats have been reclaimed over the years for setting-up of industries and their townships. Surat is roughly 27 km from Essar establishment at Hazira and is well connected to the city by road and railway. The 720 km long Tapi River originates near Multai in Madhya Pradesh and after meandering through the hilly terrain of the Western Ghats before entering the coastal alluvial plains of Gujarat to meet the Arabian Sea near Hazira. The flow of the Tapi to the sea is controlled by the Ukai and Kakrapar Dams constructed on the river at 141 and 115 km upstream respectively. Mean runoff of Tapi which was 17982 million m³ in 1975 has reduced considerably after the construction of dams. In 1995 a weir-cum-causeway was constructed across the river at Rander, about 2.5 km upstream of Surat that prevents seawater incursion further inland. The Surat District has an extensive network of canals originating from the Kakrapar Dam and other weirs downstream. The industries at Hazira receive water through the Kakrapar Right Bank Canal, Jahangirpura Weir and from the pump-house at Variav. The ground water in the Hazira belt generally has high total dissolved solids due to ingress of salinity.

3.4 Climate

The climate at Hazira is tropical and may be characterized by annually recurring seasons:

Table 3-1: Hazira Climate variation

Period	Season	Characteristics
Mid Jun-Sept	SW monsoon	Winds mod-strong, Occasional cyclones
Oct-Nov	Interim Period	Winds lighter, Occasional cyclones
Dec-Feb	NE monsoon	Winds light NE, effectively no cyclones
March-Mid June	Hot season	Winds mod-strong SW, May/June frequent mostly distant cyclones

3.4.1 Temperature

The month of January is the coldest month of the year with mean maximum and minimum temperatures as 31.5 °C and 14.3 °C respectively. Likewise June is the hottest month of the year with maximum and minimum temperatures as 33.8 °C and 26.6 °C respectively.

3.4.2 Rainfall

The south-west monsoon normally enters into the state in the first week of June and prevails till last week of September. The average annual rainfall in the study area district is 1209.4 mm. Majority of rainfall (85%) is received under the influence of south-west monsoons during June to September. January and February are generally the driest month of the year.

3.4.3 Humidity

The relative humidity was observed to be high during the monsoon months from June to September. The relative humidity was lower in other months of the year, with the lowest being recorded in the months of November to January.

3.4.4 Winds

The annual average wind speed ranged between 1 and 19 km/h with predominant wind in the SW direction during March-October and NE in November-February, and (iv) the relative humidity in the region varied from 32.8% (March) to 86.6% (August).

Figure 3-2: Annual Wind Rose Diagram at Surat

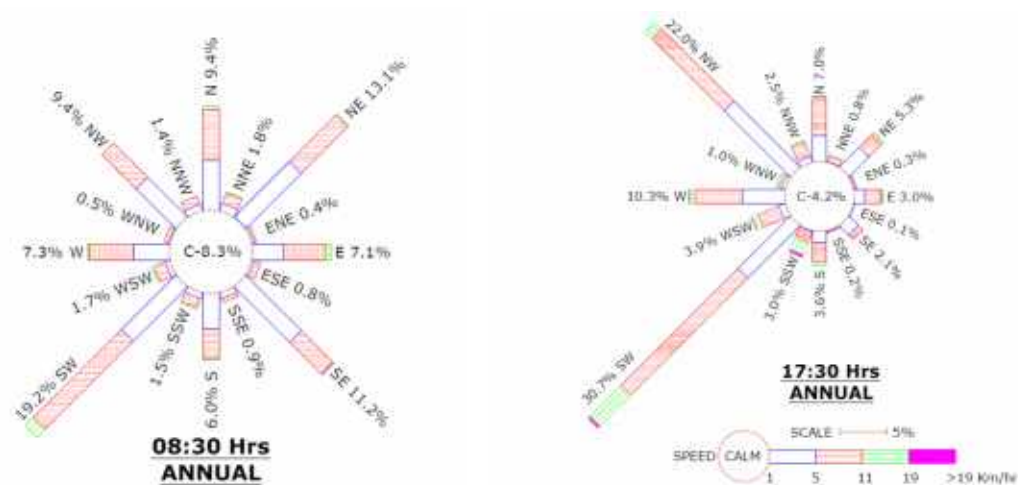


Table 3-2: Average meteorological conditions of the project area district

Month	Mean Temp. Daily (°C)		Rainfall (mm)	No. of rainy days	Relative Humidity (%)	
	Max.	Min.			8:30 hrs	17:30 hrs
January	31.5	14.3	0.0	0.0	65	39
February	33.5	16.1	0.4	0.0	62	33
March	36.2	20.1	1.5	0.2	64	32
April	37.7	23.7	0.3	0.0	66	38
May	36.4	26.4	7.3	0.3	68	55
June	33.8	26.6	249.3	8.0	79	70
July	31.0	25.4	417.7	15.4	88	79
August	30.6	25.0	299.4	13.2	89	79
September	32.2	24.4	190.7	7.6	86	70
October	35.9	23.0	27.2	1.2	72	49
November	35.3	19.3	13.0	0.8	61	43
December	32.9	16.1	2.6	0.1	65	43
Total			1209.4	46.8		

Source: India Meteorological Department (IMD)

3.5 Cyclones

Between 1877 and 1982 (105 years) 8 cyclones hit the region, out of which 6 cyclones were of a severe nature, with wind speeds exceeding 24.2 m/s. This results in an average of one cyclone every 13 to 17 years (only the severe storms are counted).

TRS are associated with the onset of the SW- monsoon and the NE-monsoon. Generally these occur during May/June and October/November.

Table 3-3: Summary of historic TRS events recorded

Year	Start	End	Duration	Max. Wind Speed- (knots)	Minimum Pressure- (HPA)
1980	12-11-1980	19-11-1980	174	35	995
1981	25-10-1981	02-11-1981	192	60	979
1982	04-11-1982	09-11-1982	108	90	952
1987	02-12-1987	13-12-1987	246	45	991
1989	07-06-1989	13-06-1989	132	35	996
1996	15-06-1996	19-06-1996	114	65	972
1998	05-06-1998	09-06-1998	108	105	938
1998	16-10-1998	18-10-1998	48	35	994

3.6 Barometric Pressure

The barometric pressure has been measured over a period of 30 years at Surat Meteorological Station. At the station level of 12 m above MSL, the following average pressures have been recorded.

Average Barometric Pressures at Surat Met Station

Month	Morning (mbar)	Evening (mbar)
January	1013.9	1010.8
February	1012.9	1009.1
March	1011.1	1007.1
April	1009.0	1004.0
May	1004.1	1002.4
June	1002.4	999.5
July	1001.2	999.2
August	1003.2	1000.8
September	1004.4	1003.5
October	1010.1	1004.4
November	1012.8	1009.3
December	1014.4	1010.9

3.7 Tides

The funnel shape of the Gulf coupled with the resonance effect results in exceptionally high tides in the region. Along its eastern shore the mean spring high water range increases from 5.7 m at Hazira to 7.4 m at Luhara Point.

Tapi estuary experiences fairly high tidal ranges in the mouth segment due to its proximity to the Gulf. Marked changes in the tidal range and durations of flood and ebb phases, however, occur as the tide progresses along the length of the estuary. Available information indicated that the spring rise of 5.7 m at Hazira decreases to 4.5 m at Magdalla and further down to 2.3 m at Surat. During neap, this decrease is from 2.3 m at Hazira to 1.7 m at Magdalla and 0.4 m at Surat.

There are instances when high precipitation in the catchment in the monsoon season leads to considerable freshwater dominance in the estuary. During such instances, flood duration of 6 h in the open shore reduces to 4 – 5 h in the estuary mouth and is barely 2 h at Surat with the corresponding increase in the ebb period. Decrease in the flood period, though to a lesser extent, occurs into the estuary during the dry season also.

Occasional flood during July-September raises the water level substantially particularly when the flood coincides with spring tide. Since 1883 high floods in Tapi occurred 12 times during July – September. The flood of August 2006 was devastating when the water level of 0.9 m near Surat (Hop Bridge) on 5th August 2006 rose to 12.4 m on 8th August 2006. The high monsoonal river flow effectively cleanses the estuary of accumulated contaminants particularly in the inner segments, at least on a yearly cycle.

The tide measurements carried out off the Deep Water Berth of Essar are illustrated. These recordings were made over 20 – 30 days during January, April and July 2011. From these results it is evident that spring and neap tidal changes off the Deep Water Berth were 6.7 - 7.1 and 3.5 - 4.5 m respectively.

3.8 Currents

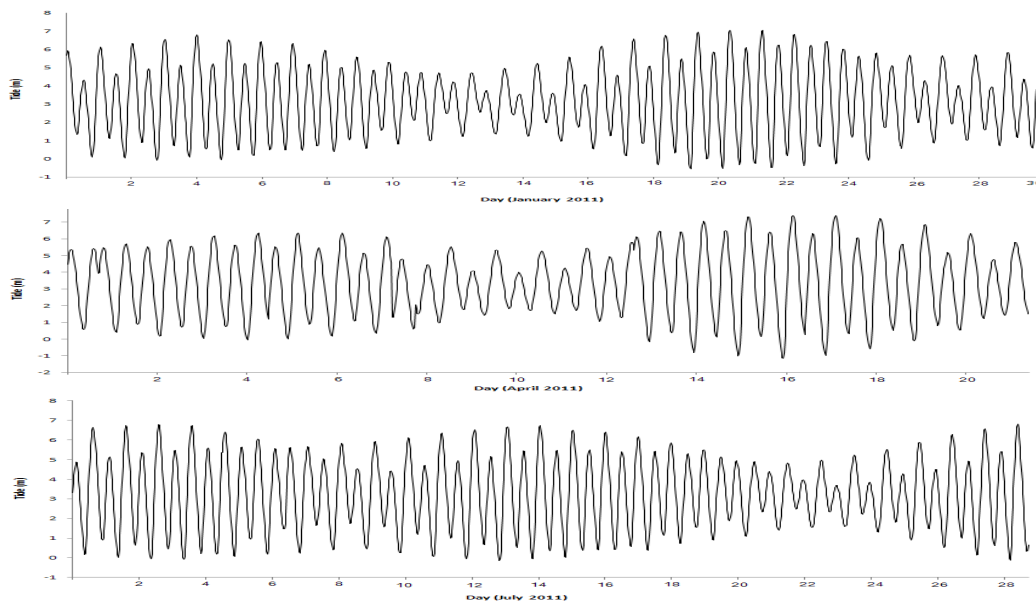
The measured currents at the Captive Port (CM 1) and at the mouth of the estuary (CM 2) in September 2005 are illustrated in below table. The maximum current speeds recorded are as follows:

Table 3-4: Measured Currents in Tapi Estuary

Tide	Flood (Max)	Ebb (Max)
Spring	1.47 m/s	0.83 m/s
Neap	0.8 m/s	0.42 m/s

The currents are bimodal reversing with the tide with no significant effect of freshwater flow in the estuary during September. The predominant flow is in the east-west direction and coincides with the channel geometry. The currents are markedly influenced during July-August by the river discharge associated. At times when the runoff is heavy, the surface flow is unidirectional in the estuary for the greater part of a tide cycle.

Figure 3-3: Tide recorded off Deep Water Berth during (a) January, (b) April, and (c) July 2011



3.9 Currents and Flushing Time

The high tidal influence leads to strong currents the speeds in the Gulf particularly in the channels in-between the sand and mud banks. Speeds of 2 m/s are common off Hazira during spring tide and increase substantially in the inner Gulf areas. Typically, the currents are bimodal in the Gulf with prominent northerly direction during flood and southerly direction during ebb.

The representative measured currents off the Deep Water Berth during the present study are illustrated in below:

Figure 3-4: Current & tide recorded during 10 – 23 May 2011 off Deep Water Berth

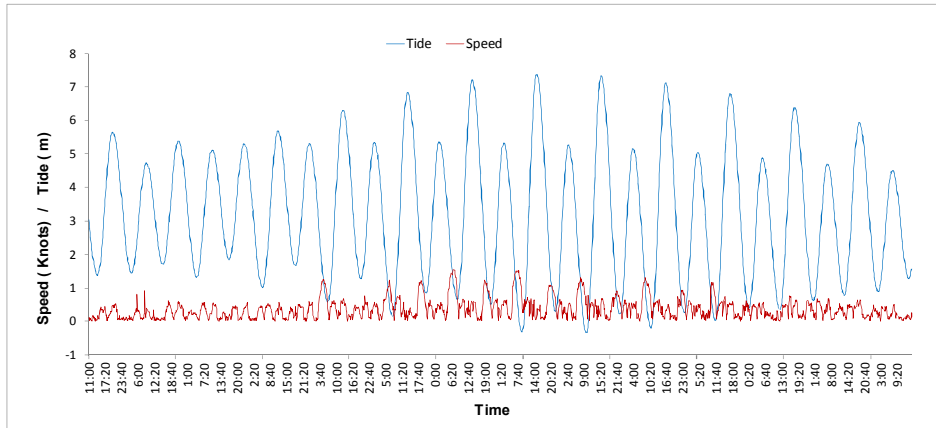
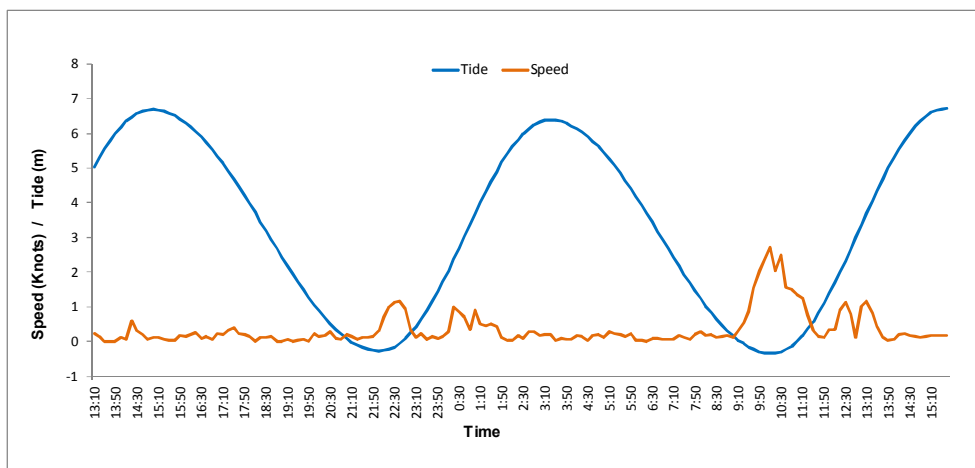


Figure 3-5: Currents & tide recorded off Deep Water Berth in August 2011



The shallow Tapi estuary is well flushed with flushing time of less than 2 tide cycles calculated based on the tidal prism method. Modified Tidal Prism Method indicated the flushing time of 3 – 7 tide cycles for the Magdalla-Hazira segment of the estuary when the river freshwater flow is meagre 10 – 45 cum/s.

The flushing time however increases to 11 – 24 tide cycles when the whole estuary is considered thereby indicating that the inner estuary is flushed at a much slower rate. Thus, due to excellent flushing of the Magadalla-Hazira segment, the contaminants entering the outer estuary are effectively removed to the sea and the accumulation of contaminants in this segment of the estuary where the present developments are considered, is unlikely.

This is the main process because of which the outer estuary is largely free from the effects of contaminant entering the estuary, particularly sewage that is released in the inner segments.

3.10 Water Environment

3.10.1 Tapi Estuary

The estuary of the Tapi River is just about 25 km long though the river which originating in the Multai Ghats in Betour district of Madhya Pradesh runs over a distance of 720 km and passes through three states: Madhya Pradesh, Maharashtra and Gujarat. The estuary opens in the Arabian Sea in the mouth of the Gulf and hence experiences considerably high tides in the outer zone.

In the upper reaches, the river receives discharge from 14 main tributaries of which the Purna and the Girna are the most important, accounting for 45% of the total catchment area of 65,145 km². The estuary receives an annual average river runoff of 7,686 million m³ with annual ground water flow of 18,000 million m³. The high seasonal monsoonal discharge effectively flushes the estuary on a yearly cycle. During monsoons, the Tapi River is frequently in spate and floods occasionally cause havoc in the plains of lower reaches. The floods of 1998 and 2006 were severe and several industrial complexes at Hazira had to shut down their operations for a few days.

The Tapi and the adjacent Mindola Rivers open to the Arabian Sea through a common wide and shallow mouth. The shallow and wide lower segment of the Tapi River exhibits characteristics of a typical estuary with variable salinity and strong currents associated with significantly high tidal influence up to 25 km upstream. Further inland however, seawater excursion is restricted due to the Rander weir which also regulates the freshwater outflow during lean periods. Phulwadi a hamlet about 1 km downstream of Rander and 1.5 km upstream of Surat is the location of release of part of the untreated domestic effluents.

The Tapi River cuts across the city of Surat, where a jetty is available, which is approachable only to small crafts during high tide due to shallow reaches. Downstream of Umra the segment is shallow and wide up to Magdalla which is a minor port. In the mouth segment, the estuary bifurcates into 2 channels due to the presence of Kadia Bet and Mora Bet which are low-lying areas that largely submerge at high spring tides. The eastern channel is shallow and has limited navigability, while, the western channel has been recently dredged to create navigational channel to the Deep Water Berth of Essar.

3.10.2 Marine environment

The general domain of the South Gujarat coast is under the profound influence of the Gulf. Malacca Banks lie in the entrance to the Gulf off the Tapi estuary with deep channels cutting through the shoals. Out of these, the Grant and Sutherland Channels are safe navigational routes than the channels between the banks. Malacca Banks itself consists of four prominent shoals several kilometers long and named as Eastern Bank, Breaker Bank, Narmada Bank and Western Bank. Sands and banks in the inner part of the Gulf are subject to changes due to tidal bores and voluminous freshwater inflows through rivers during monsoon

The hinterland along the east coast of the Gulf is urbanized and industrialized. A considerable fraction of effluents generated in the coastal region is transported to the Gulf either via rivers or released directly depending on the location of the settlement / industry. The available information however indicates that the ecological quality of the coastal area has not been grossly changed due to these anthropogenic interventions.

Environmental Sensitivity of the Project:

The environmental sensitivity of the project region within 15 km radius from Landfall point are given below:

S. No	Areas	Name/ Identity	Aerial distance (within 15 km) proposed project location boundary)
1	Areas protected under international conventions, national or local legislation for their ecological, landscape, cultural or other related value	None	
2	Areas which are important or sensitive species for ecological reasons – wetlands, watercourses or other water bodies, coastal zone, biospheres, mountains, forests	None	
3	Areas used by protected, important or sensitive species of flora or fauna for breeding, nesting, foraging, resting, over wintering, migration	No	
4	Inland, coastal, marine or underground waters	Yes.	Project will come in Tapi river estuary & Gulf of Khambhat
5	State, national boundaries	None	-
6	Routes or facilities used by the public for access to recreation or other tourist, pilgrim areas	None	-
7	Defense installations	None	-
8	Densely populated or built up area	None	Surat – nearest densely populated city – is located 30 km from the proposed location
9	Areas occupied by sensitive man-made land uses (hospitals, schools, places of worship, community facilities)	Yes	Essar Township Hospital & School – 5.0 Km (NW) Junagram School - 2.0 (W) Hazira School – 6.5 Km (W) Gundardi School – 8 Km (W)
10	Areas containing important, high quality or scarce resources (ground water resources, surface resources, forestry, agriculture, fisheries, tourism , minerals)	None	-
11	Areas already subjected to pollution or environmental damage (those where existing legal environmental standards are exceeded)	None	-
12	Areas susceptible to natural hazard which could cause the project to present environmental problems		The project falls under Seismic Zone (III). Structures will be designed

	(earthquakes, subsidence, landslides, erosion, flooding or extreme or adverse climatic conditions)	Seismic Zone (III) & Stable Coast	accordingly and no environmental problems are envisaged. As per MoEF based on Anna university study, this Hazira Coast is stable and no erosion is envisaged.
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4 EXISTING FACILITIES

4.1 Facilities

EBTL entered into a Lease agreement with GMB on March 25, 2010 for construction and use of 550 m Deep Draft Captive jetty for handling of captive cargo for a period of 25 years. EBTL has developed a 550m deep water berth (jetty), with a turning circle of 600m diameter, dedicated navigational channel of 7.2 kms length with a width of 300 m (initially 230 m) and operational tidal draft of ~14 m along with cargo handling equipments like ship unloaders, conveyors for transportation of raw materials to the stack house.

Essar Bulk Terminal Limited had received environment clearance for 550 m berth in September 2007. Subsequently in May 2014 EBTL received environment clearance for extension of port facility by 4800 berth. Accordingly EBTL has commissioned 550m berth in May 2010 and another 600m in 2017. Construction of additional 500m berth length is under progress.

EBTL will cater to off takers such as Essar Steel Limited and Essar Power Limited.

4.1.1 Essar Steel

The 10 MMTPA Hazira Steel Complex spans the entire value chain, comprising of iron making units, steel-making units, steel finishing facilities and down-stream facilities besides specialized products like Wide Plates, Pipes, etc. The facilities are configured in a manner to provide flexibility in the use of inputs for steel-making [-Direct Reduced Iron (DRI), hot metal, scrap] and energy sources (natural gas, coal, corex gas, coke).

The Steel Complex is also connected by a sophisticated Inter-Plant Logistics network comprising of rail and specialised (Essar-patented) carriers to transport materials and finished products in an efficient manner.

ESIL uses all the three technologies of iron making, i.e. DRI / HBI, Corex and Blast Furnace technology in a single location. While DRI / HBI are in solid form, Corex and Blast Furnace produce molten iron or Hot metal. While DRI / HBI Plant use natural gas, the Blast Furnace uses Coke and the Corex modules uses Coal as the source of energy. Besides, ESIL has a Sinter plant which helps in recycling the steel plant waste generations (iron ore fines, coal fines, lime etc.) and feeds the Blast furnace. The Cold-Rolling Complex at Hazira comprises of pickling and oiling lines, a reversing 6 Hi Cold Rolling mill, a continuous Tandem Cold Rolling mill, two galvanizing lines, Hot Skin pass facilities etc. The Hazira complex also houses downstream facilities like Slitting lines, Shearing lines, etc. A dedicated Coke oven is also being set up to effectively control the cost of coke and insulate ESIL from fluctuations in international prices of Coke.

ESIL also operates a 1.50 MMTPA capacity, wide width Plate Mill in Hazira capable of producing high-grade plates with width upto 5000 mm (5 m wide).

The Pipe Mill plant at Hazira has facilities to produce both Longitudinally Submerged Arc Welded (LSAW) and Helical Submerged Arc Welded (HSAW) pipes with internal and external coating facilities. The LSAW pipes are manufactured out of Plates/ Sheets. The plate is formed, blended and expanded

to give it a round uniform pipe with one welded seam. The HSAW pipes are made out of strips/ coils formed helically and welded simultaneously.

4.1.2 Essar Power

Essar Power Limited, also an Essar Energy subsidiary, is one of India's leading private power producers with a 14-year operating track record. Essar Power has seven operational power plants in India and one operational power plant in Algoma, Canada, with a total installed generation capacity of 3,910 MW.

Essar Power Assets at Hazira include Natural Gas fired power plants of Essar Power (515 MW) and Bhandar Power Limited (500 MW).

515 MW multi fuel combined cycle power plant, Hazira, Gujarat (EPoL) – The multi fuel combined cycle plant with gross capacity of 515 MW can operate on both natural gas and Naphtha. The plant started its commercial operation in 1998. For evacuation, it is connected to the 220 KV switchyard, which in turn is connected to Essar Steel's Main Receiving Sub-Station. The annual natural gas requirement of the plant is 35,804,762 MMBTU. The plant is not operational since June 2013. Reason behind non-operation of plant is unviable economics due to non-allocation of domestic natural gas and high cost of imported natural gas in recent past.

500 MW natural gas based power plant, Hazira, Gujarat (BPL) – The natural gas based combined cycle power plant with gross capacity of 500 MW started its commercial operation in 2006. The plant is captive to Essar Steel. For evacuation, it is connected to the 220 KV switchyard, which in turn is connected to Essar Steel's Main Receiving Sub-Station. The annual natural gas requirement of the plant is 34,761,905 MMBTU. The plant is not operational since early 2013 due to unviable economics owing to non-allocation of domestic natural gas and high cost of imported natural gas in recent past.

5 STUDIES AND INVESTIGATION

5.1 Geo Technical Studies

To determine the soil properties of the area and to arrive at the most suitable foundation system for the proposed structure and select the type of dredger to execute the dredging work for the proposed expansion of the deep water berth, the soil exploration was undertaken by M/S DBM Geotechnical and Construction Pvt. Ltd, Mumbai.

The subsurface investigation was carried out as per IS: 1892-1979. Various Tests were carried out,

- Standard Penetration Tests (i.e. SPT) were carried out in soil at maximum intervals of 1.5m, in accordance with IS 2131-1981.
- Static Cone Penetration Tests (SCPT) were conducted at this site.
- Electrical resistivity tests are carried out.
- Wenner's four pin electrode method is used for investigation.
- Undisturbed soil (UDS) samples were obtained using reusable thin walled tube samplers of 100mm diameter, as per IS-2132.
- Select soil and water samples were subjected to laboratory testing.
- Laboratory tests on SPT and UDS samples included mechanical analysis, and, grain size, Atterberg Limits, shear tests specific gravity were conducted according to IS2720 relevant parts. Triaxial Tests and Unconfined.
- Compression Tests were also conducted on UDS samples in the Laboratory.

5.2 Hydrographic Studies

In order to study the changes in coastal hydrodynamics and siltation pattern due to the proposed development, mathematical model studies were conducted by CWPRS for simulating tidal hydrodynamics and sedimentation in the approach channel.

5.3 Navigational Studies

The Navigational studies of the channel carried out to optimize the approach channel dimensions and orientation for safe navigation of the ship under the prevailing environmental conditions of wind, waves and currents. For the LNG Terminal Navigation studies are being conducted for mooring analysis, ship collision studies and marine risk assessment.

5.4 Risk Assessment Study & HAZOP

HAZOP study will be conducted for the FSU operations. Site selection has taken place for the proposed FSU and Land based regas terminal. Quality Risk Assessment will also be conducted for the FSU based terminal. Key features of the study are as follows:

- QRA Study will include process hazards for the facilities comprising of LNG unloading from LNGC, FSU operations, onshore receiving facility and land based regasification facility, pipeline upto take off point.
- The study will include identification and appraisal of risks associated with flammable and toxic hazards, identification of onsite and offsite risks and mitigation measures, Risk assessment to confirm the risk can be reduced will be consistent with the as low as reasonably possible (ALARP) principle.
- The assessment will be carried through HAZID, risk matrix in addition to HAZOP.
- Identification of hazardous scenarios associated with loss of containment of gas from the pipelines, FSU, LNGC, onshore regas facilities
- Estimation of frequency of failure of identified hazardous scenarios, consequent and impact analysis, risk integration and risk evaluation
- Suggestion of navigation exclusion zone and nearest possible distance passing ship to be maintained (as per international standards)
- Consequence estimation related to hazards.

5.5 Mooring Navigational Risk Assessment, Dredging & Siltation Study

There is a need to undertake ship navigation, mooring, risk assessment and sedimentation studies to examine the terminal design ideas and the port area layout, along with identifying the limiting operational conditions for safe operations. This will also be used in conjunction with proposed met ocean modelling to examine the breakwater length and orientation to provide shelter to the LNG berth. An initial breakwater layout will be examined in the met ocean modelling and ship mooring analysis to determine if sufficient shelter is provided. The breakwater length and orientation will then be examined and altered if required to better protect the LNG terminal, with the met ocean modelling and ship mooring analysis being repeated to evaluate the optimized layout.

The ship navigation study will be used to examine the manoeuvres of LNG carriers (LNGCs) to and from the terminal with the optimized breakwater design to determine:

- Adequacy of navigation channel width and depth
- Stopping distance and manoeuvrability
- Turning area (location and size to be specified)
- Limiting wind, wave and current conditions for the safe arrival and departure of LNG carriers
- Bollard pull and number of tugs required
- Suggested changes for improvement.

The ship mooring study will examine the FSU and LNGCs under various conditions, such as in their laden/ballast conditions, at high water/low water, in operation/storm conditions, to determine:

- Adequacy of proposed mooring systems
- Operating limits for wind, wave current, etc.
- No-operation and vessel emergency departure limits
- Impact of passing ships
- Recommend types of bollards, fenders, winches with SWL.

The risk assessment study will be used to address any risks identified in the ship navigation and ship mooring studies, and also examine any other, associated, marine related risk to the terminal.

These studies will be supported by met ocean modelling to provide the required wave and current inputs to the ship mooring analysis and wave modelling.

6 REHABILITATION AND RESETTLEMENTS (R&R) PLAN

Since the Project does not require private land and that the location being reclaimed intertidal area there is no Rehabilitation and Resettlement (R&R) involved in the project.

7 PLANNING BRIEF

7.1 Resource Utilization

- **Fresh water for plant:** For operation of the facility approximately 600 m³ per day of freshwater is required for Domestic/Fire system. Fresh water sourced from existing Essar Steel facilities.
- **Recirculating water from Essar Power Hazira Limited Power Plant for Regasification Unit:** 8,000 m³ per hour of freshwater required for the terminals gasification process which will be sourced from the cooling towers of the neighboring power plants.
- **Fuel:** required is approximately 40 MT/day for FSU and regasification operation.
- **Power:** Power required for offshore and onshore facilities including area lighting at jetty is ~ 10 MW per day.
- **Construction materials:** Construction material such as steel, cement, aggregates, steel sheet piles, armour rock.

7.2 Utilities

The key utility systems include the following:

- **Firewater system:** firewater system to comply with both marine and offshore safety practices.
- **Firefighting system:** to include electrical based as well as diesel engine based firefighting system. Existing firefighting system of EBTL will be used and if requirement same will be augmented for this project.
- **Power:** 10 MW power will be required for the project and same will be sourced from power plants of Essar Power Hazira Limited or other power plants.
- **Standby Power and distribution system:** for backup power distribution
- **Compressed air systems:** for the supply of compressed air such as Plant air, compressed un-dried air, compressed dry air, air driven tools, instrument air,
- **Nitrogen:** Nitrogen required for continuous and purging operations
- Miscellaneous instrumentation and automation systems.

7.3 Waste Management

7.3.1 Liquid and solid waste

Conversion of liquefied LNG to re-gasified LNG may not lead to or generate any process waste. Whatever waste, generated from FSU will be transported to port waste management facility for treatment and disposal. Mainly the following wastes will be generated from FSU

- Bilge water from FSU - 20 m³/day
 - Will be disposed as per MARPOL Regulations
- Waste Oil from FSU & Jetty side equipments – 50 KL/year
 - Will be disposed to GPCB/CPCB authorized recyclers
- Treated Sewage water from FSU- 30 m³/day

- Will be disposed as per GPCB Standards

7.3.2 Air Emissions

Since LNG is a clean fuel and no combustion of fuel is planned. It's only a phase transfer of LNG. There might be possibilities for generation of NOx emissions while power generation with Blow off gas at FSU and Flue gases generation from Diesel operated Fire pumps. A suitable flare stack will be provided if needed.

7.4 Greenbelt

Greenbelt will be developed around the storage facilities and other areas. Development plan will be finalized based on CCoE approval/ and considering the safety aspects & PESO regulations.

8 PROJECT SCHEDULE AND COST ESTIMATE

8.1 Implementation Schedule

The Project shall be implemented within shortest possible time once all the permission and clearance from State and Central statutory bodies are obtained. It is estimated that since the start of the construction work it will take 24 months to commission the Terminal.

8.2 Cost Estimates

Project cost is estimated to be ~ 2,000 Crores which shall comprise of the following components:

- Reclaimed Land Development
- Marine Civil Works
- FSU
- Land Based Regasification Units
- Land Based Storage Facilities
- Marine Equipment and Top Side
- Onshore civil works
- Preliminary and pre-operative expenses



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