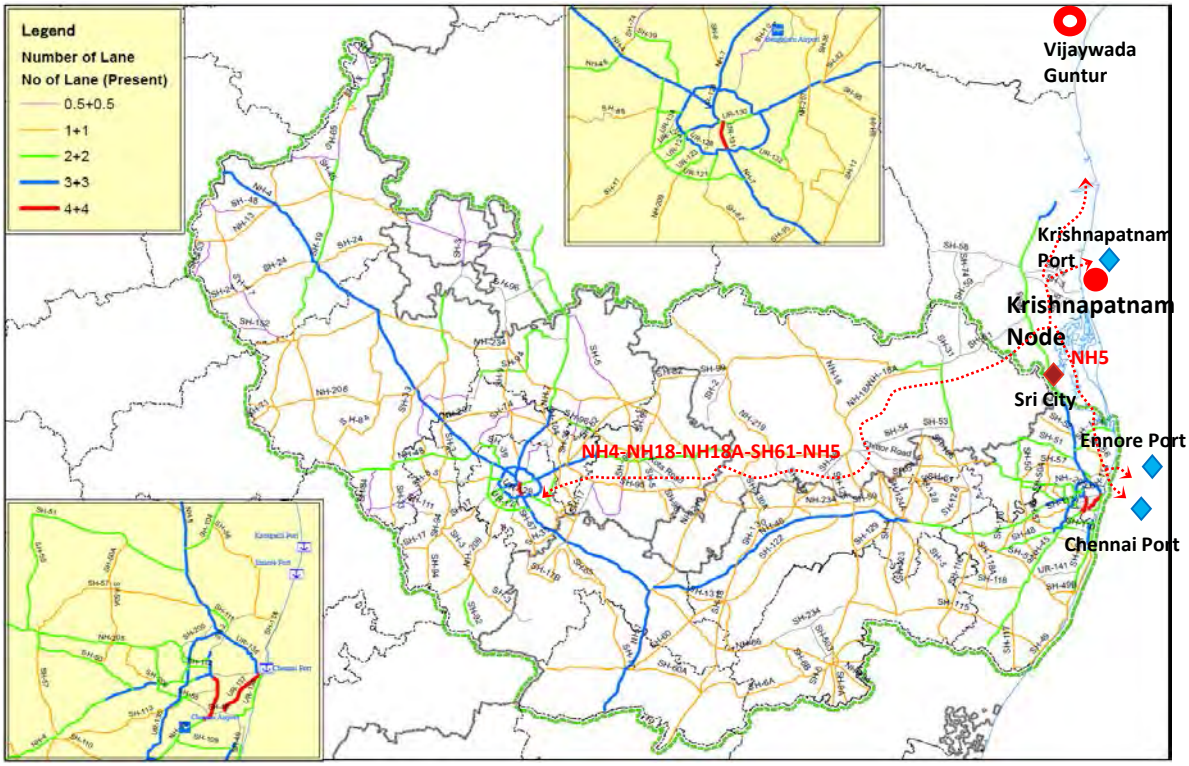
7 Infrastructure Development Plan

7.1 Roads and Public Transport

7.1.1 Sector Overview

Major industrial linkage to/from Krishnapatnam node will be developed with Bengaluru, Chennai, Vijaywada, Guntur, Nellore, Chennai Port, Ennore Port, and Sri City and corresponding roads to the linkages are delineated as shown in Figure 6-1. Present lane numbers of the roads on linkages are four or six on linkages with Chennai, Vijaywada, Guntur, Sri City, Chennai Port, and Ennore Port. However, there are some sections which are given only two lanes on linkages with Bengaluru.



Source: JICA Study Team

Figure 7.1: Number of Lanes on Major External Linkage (Krishnapatnam)

Linear distances from Krishnapatnam nodes to major destinations which are related to industrial activities of Krishnapatnam nodes are summarized in Table 7-1.

Table 7.1: Distance from Nodes

From	Krishnapatnam Node			
To /Linear Distance(km)	Chennai	136	Nellore	33
	Bengaluru	310	Chennai Port	119
	Vijaywada	256	Ennore Port	109
	Guntur	226	Sri City	77

Source: JICA Study Team

Land demands and population demands of Krishnapatnam Node in three phases are forecasted by the JICA Study Team as shown in Table 6.5 and Table 7.2, respectively.

Table 7.2: Population Demand Forecast in Krishnapatnam Node

	Phase-1	Phase-2	Phase-3
Working Population	97,336	243,849	582,706
Residential Population	33,408	83,695	200,000

Source: JICA Study Team

Currently the Krishnapatnam port is accessed from the west by a 4 lane road. The port has acquired land between road and rail, to permit expansion of both. According to discussion result with Krishnapatnam Port Company Limited held on 26 June 2014, accesses from south is being proposed (6 lane road) running from Naidupet (NH 5) via Kota and new industrial park to Krishnapatnam Port with length of about 50 km.

Development issues are selected with consideration of development vision discussed in Chapter 5.3 and envisioned future road and traffic conditions of Krishnapatnam node, such as public transport promotion, smooth transit in node, segregation of cargo traffic, and environmental conservation. Node development plan is examined based on those issues.

7.1.2 *Demand Supply Analysis for External Node Infrastructures*

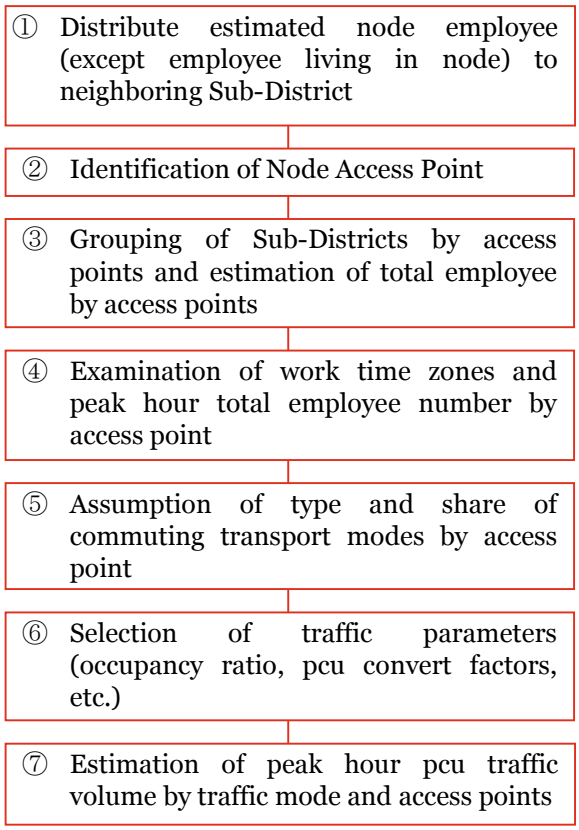
General

Traffic demand from/to node is predicted to examine capacity of node access roads and rail. Commuter traffic and cargo traffic are subjected to prediction of the traffic demand. Prediction of the traffic demand and capacity examination is made for each phases.

Methodology

Commuter Traffic Demand

Traffic prediction method for the commuter traffic is explained below:

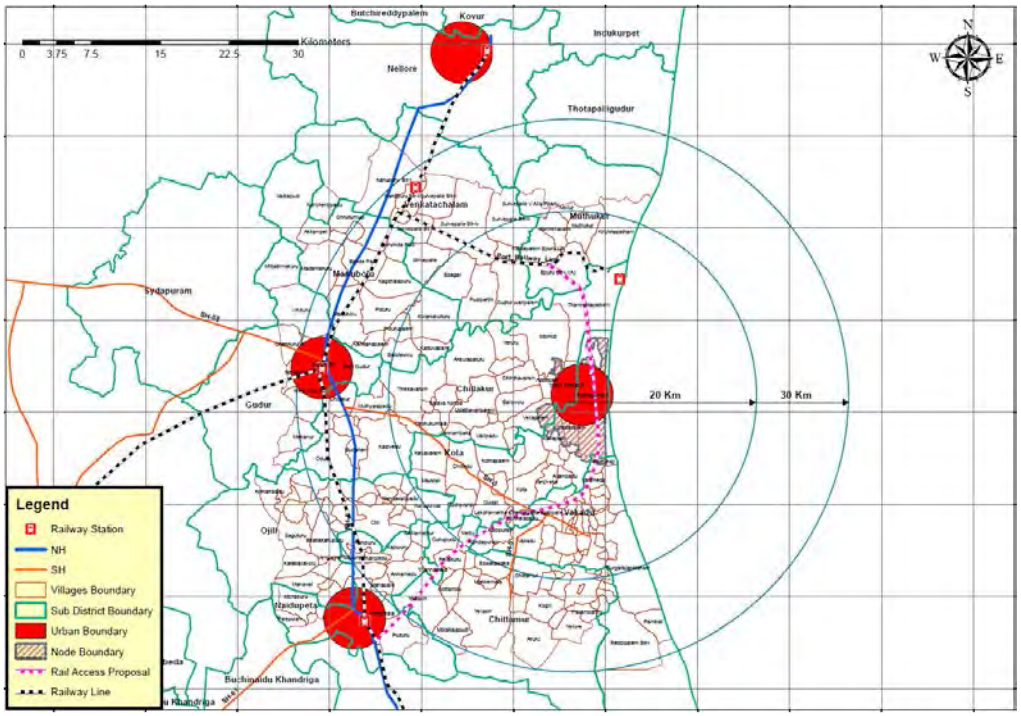


Source: JICA Study Team

Figure 7.2: Work Flow for Commuter Traffic Demand Estimate

Distribute estimated node employee (except employee living in node) to neighboring Sub-District:

Estimated node employee in foregoing chapter (except employee living in node) is distributed to neighbouring sub-district in considering of urbanization trend and population frame of sub-districts. Sub-districts within about 30km from node centre are selected for the distribution. Urbanization trend and the distribution result to sub-district are shown in Figure 7.3 and Table 7.3, respectively.



Source: JICA Study Team

Figure 7.3: Envisaged Direction of Urbanization

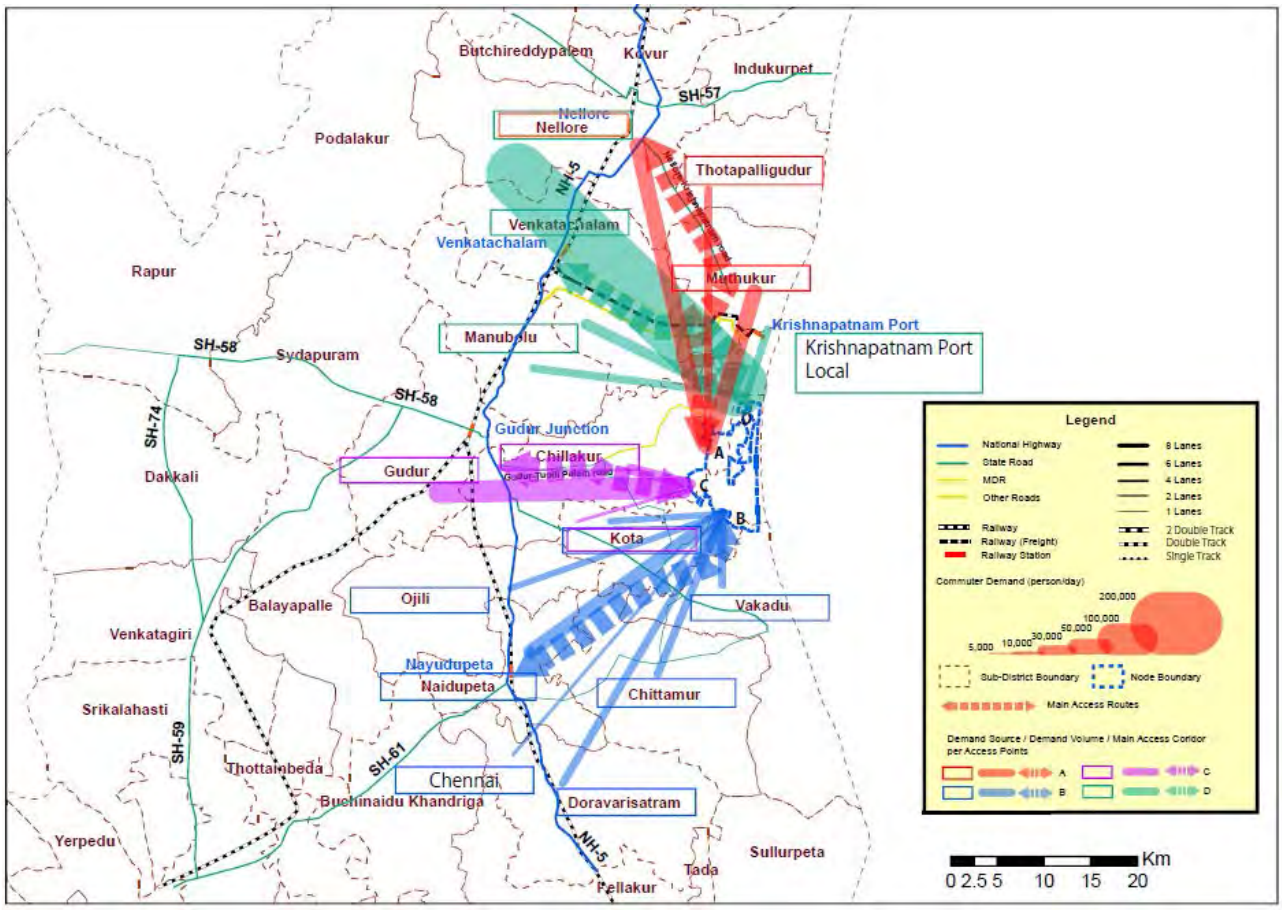
Table 7.3: Distribution of Node Employee to Vicinal Sub-Districts

Node	Item			Unit	Year		
					2019	2024	2034
Krishnapatnam	Area	Residential		Acre	187	469	1,120
		Whole		Acre	1,300	3,258	7,785
	Population	Residential		person	33,398	83,699	200,000
		Employee (Res.)		person	7,260	18,196	43,478
		Employee (Non-Res.)	**Sub-Districts**				
			Muthukur	person	4,739	11,877	28,380
			Venkatachalam	person	4,739	11,877	28,380
			Manubolu	person	3,475	8,710	20,812
			Chillakur	person	4,739	11,877	28,380
			Kota	person	4,739	11,877	28,380
			Ojili	person	2,844	7,126	17,028
			Naidupeta	person	6,319	15,836	37,841
			Chittamur	person	3,791	9,502	22,704
			Vakadu	person	3,475	8,710	20,812
			Thotapalligudur	person	3,791	9,502	22,704
			Nellore	person	34,754	87,099	208,123
			Gudur	person	9,478	23,754	56,761
			Doravarisatram	person	3,159	7,918	18,920
		Employee total		person	97,305	243,861	582,706

Source: JICA Study Team

Identification of node access points

Four node access points (A to D) are identified based on sub-districts which are distributed node commuter, existing roads and rail, and land use plan in node as shown in Figure 7.4. Colored solid lines express commuter volume between sub-district and node. Colored dotted line expresses access route from sub-districts to access points.



Source: JICA Study Team

Figure 7.4: Identification of Node Access Point

Grouping of sub-districts by access points and estimation of total employee by access points

As hinterlands of each access points, sub-district are categorized into each access points and total employee by access points are estimated as shown in Table 7.4. Some sub-districts distribute employee to two access points due to positional property.

Table 7.4: Grouping of Node Employee by Access Points

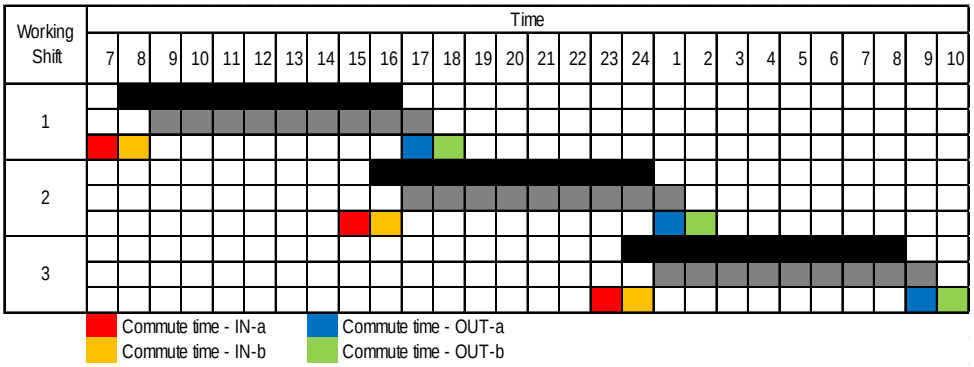
Sub-District	Year											
	2019				2024				2034			
	A	B	C	D	A	B	C	D	A	B	C	D
Muthukur	4,739				11,877				28,380			
Venkatachalam				4,739				11,877				28,380
Manubolu				3,475				8,710				20,812
Chillakur			4,739				11,877				28,380	

Sub-District	Year											
	2019				2024				2034			
	A	B	C	D	A	B	C	D	A	B	C	D
Kota		3,159	1,580			7,918	3,959			18,920	9,460	
Ojili		2,844				7,126				17,028		
Naidupeta		6,319				15,836				37,841		
Chittamur		3,791				9,502				22,704		
Vakadu		3,475				8,710				20,812		
Thotapalligudur	3,791				9,502				22,704			
Nellore	6,951			27,803	17,420			69,679	41,625			166,498
Gudur			9,478				23,754				56,761	
Doravarisatram		3,159				7,918				18,920		
Total	15,481	22,748	15,797	36,018	38,799	57,010	39,590	90,266	92,709	136,226	94,601	215,691
	90,044				225,665				539,228			

Source: JICA Study Team

Examination of work time zones and peak hour total employee number by access point

Three work time zones in a day is assumed to introduce in node and hourly work time zones in consideration of commuting time dispersion are proposed as shown in Figure 7.5. Peak hour total employee number is estimated based on the work time zones for each access points as shown in Table 7.5.



Source: JICA Study Team

Figure 7.5: Proposed Work Time Zones

Table 7.5: Number of Node Employee in Peak Hour

Year											
2019				2024				2034			
A	B	C	D	A	B	C	D	A	B	C	D
2,580	3,791	2,633	6,003	6,466	9,502	6,598	15,044	15,452	22,704	15,767	35,949

Source: JICA Study Team

Assumption of type and share of commuting transport modes by access point

Motor-cycle, Car(including para-transit), and Bus are selected as commuting transport mode and share of 20%, 20%, 60% are assumed as basic share of commuting transports. Mass Transit System, such as BRT, LRT, and Rail is selected, in case that traffic demand exceeds capacity of road transports.

Selection of traffic parameters (occupancy ratio, pcu convert factors, etc.)

Traffic parameters, such as occupancy ratio and pcu convert factors are selected in consideration of practical example in India as shown in Table 7.6.

Table 7.6: Traffic Parameters

Vehicle Type	Occupancy Ratio	PCU Convert Factor
MC	1.2	0.5
Car	2.0	1.0
Bus	60	3.0
BRT	60	-
LRT	1,500	-
Railway	2,000	-

Source: JICA Study Team

Estimation of peak hour pcu traffic volume by traffic mode and access points

Peak hour pcu commuter traffic volume are estimated based on peak hour commuter number, commuting transport mode, share of commuting transport mode, and traffic parameter for each access points.

Freight Traffic Demand

Traffic prediction method for the cargo traffic is explained below:

① Identification of input materials and output products by industry, Assumption of origins and destinations, packing type, and transport mode for input materials and output products

② Estimation of input materials and output products volumes based on area of each industries and basic unit of area-output

③ Estimation of input materials and output products by origin and destination, access points

④ Setting of peak hour ratio for cargo traffic and estimation of peak hour cargo traffic by access points

⑤ Selection of traffic parameters (average load by vehicle type, pcu convert factors, etc.)

⑥ Estimation of peak hour pcu traffic volume by traffic mode and access points

Source: JICA Study Team

Figure 7.6: Work Flow for Freight Traffic Demand Estimate

Identification of input materials and output products by industry, Assumption of origins and destinations, packing type, and transport mode for input materials and output products

Kinds of Input materials and output products are identified for each industry in node. Origin and destinations, type of cargo package, and mode of cargo transport are assumed based on practical example in India. Detailed explanation is mentioned in Section 7.4.2 Estimation of Input Materials and Output Products.**Estimation of input materials and output products volumes based on area of each industries and basic unit of area-output**

Volume of input materials and output products are estimated based on area of each industries and basic unit between area and output. Detailed explanation is mentioned in Section 7.4.2 Estimation of Input Materials and Output Products.

Estimation of input materials and output products by origin and destination, access points

Cargo traffics by road transport are totalized per access points with consideration of origin and destination. Result of estimation per access points is shown in Table 7.7.

Table 7.7: Annual Cargo Volume by Access Point

Categories	Origin / Destination	Access Point	Year			
			2019	2024	2029	2034
INBOUND CONTAINER (TEU/year)	-	-	-	-	-	-
OUTBOUND CONTAINER(TEU/year)	K. Port	D	6,144	10,550	18,117	31,110
EMPTY CONTAINER(TEU/year)	K. Port	D	11,827	20,309	34,874	59,885
INBOUND BULK(ton/year)	K. Port	D	92,192	158,310	271,847	466,810
	Local	D	284,583	488,680	839,151	1,440,973
OUTBOUND BULK (ton/year)	Chennai	B	187,197	321,451	551,989	947,865
	Chennai Airport	B	3,451	5,927	10,177	17,476

Source: JICA Study Team

Setting of peak hour ratio for cargo traffic and estimation of peak hour cargo traffic by access points

Peak hour cargo traffic volume per access points are estimated based on annual working days (260 days) and peak hour ratio (0.2) as shown in Table 7.8.

Table 7.8: Peak Hour Cargo Volume by Access Point

Categories	Unit	Year											
		2019				2024				2034			
		A	B	C	D	A	B	C	D	A	B	C	D
Container	TEU/hour	0	0	0	14	0	0	0	24	0	0	0	70
Bulk	ton/hour	0	147	0	290	0	252	0	498	0	743	0	1,468

Source: JICA Study Team

Selection of traffic parameters (average load by vehicle type, pcu convert factors, etc.)

Traffic parameters such as average load per vehicle type and pcu convert factors are selected in consideration of practical example in India as shown in Table 7.9.

Table 7.9: Traffic Parameters

Vehicle Type	Load Ratio	PCU Convert Factor
Truck	4 ton/vehicle	3.0
Trailer	2 TEU/vehicle	4.5

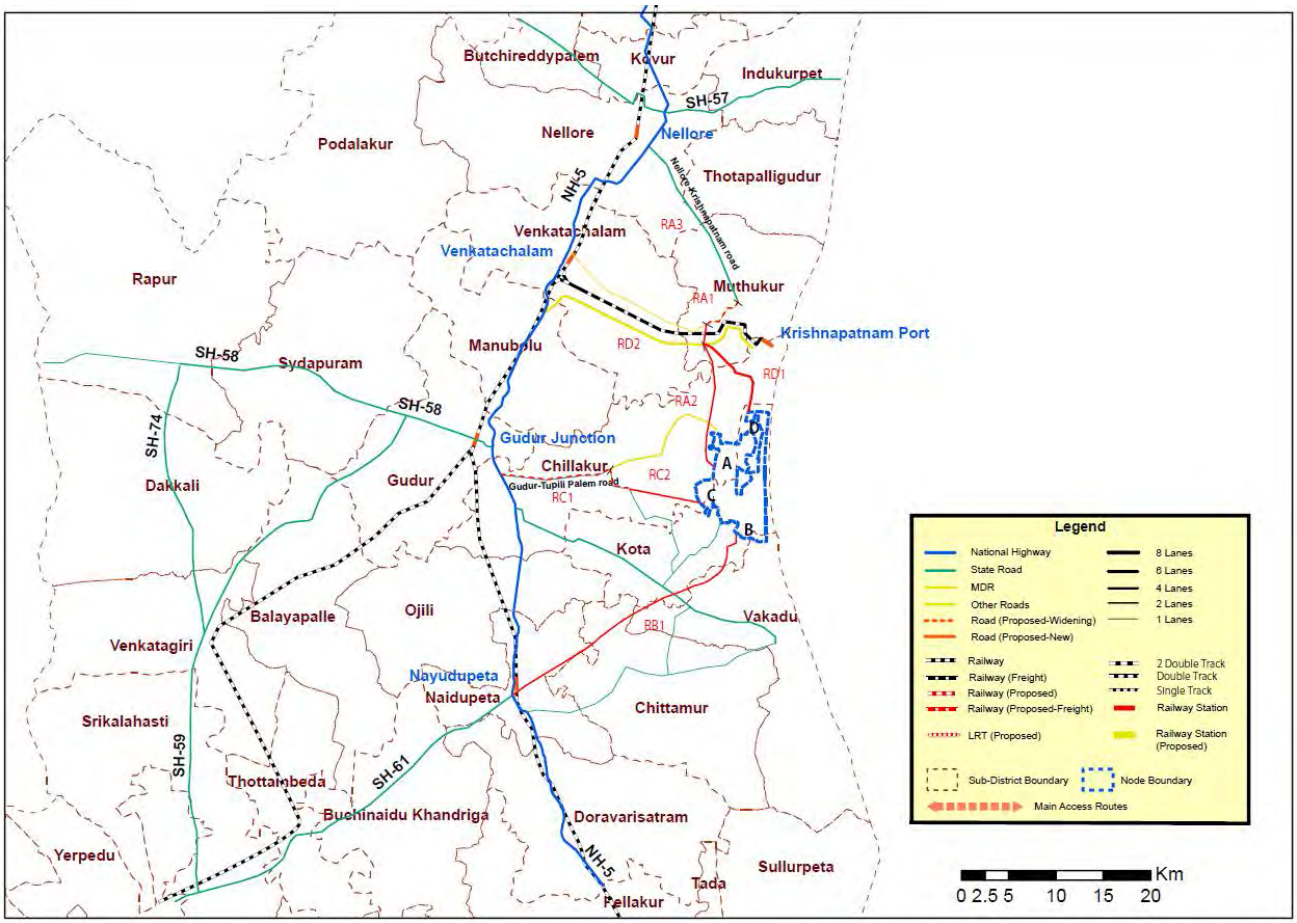
Source: JICA study team

Selection of traffic parameters (average load by vehicle type, pcu convert factors, etc.)

Peak hour pcu cargo traffic volume are estimated based on peak hour cargo volume, transport mode, share of cargo transport mode, and traffic parameter for each access points.

Assumed Access Infrastructure to Node

① Main access roads connecting between sub-districts which are provided node commuters and access points is selected from existing roads with proposed new roads as shown in Figure 7.7. RA1 to RA3 are access route for access point A, RB1 is access route for access point B, RC1 to RC2 are access route for access point C, and RD1 to RD2 are access route for access point D.



Source: JICA Study Team

Figure 7.7: Access Roads to Krishnapatnam Node by Access Points

② Road capacity of the main access roads is estimated as shown in Table 7.10. Following link capacity (DSV – LOS-B) of 1, 2, 4 (Dual-2 - 2x2), 6 (Dual-3 - 2x3), and 8 (Dual-4 - 2x4) lanes road facilities are considered for assessing the traffic on a link/section:

- T1 – 1,800 PCUs
- T2 – 17,500 PCUs
- T4 – 45,000 PCUs
- T6 – 60,000 PCUs
- T8 – 85,000 PCUs

Road capacity of one direction is applied for demand supply gap analysis in next section, since one direction of commuter traffic on road is dominant in peak hour. Peak hour traffic ratio is selected 10% based on practical example in India. As for share of traffic which is not related to node on access roads is assumed 10% in consideration of limited other destination through access roads.

Table 7.10: Road Capacity of Main Access Roads

Access Point	Main Access Roads	Status	Number of Lanes	Road Capacity (pcu per direction)
A	RA1	Existing	1	1,800
	RA2	Proposed	-	
	RA3	Existing	2	17,500
B	RB1	Proposed	-	
C	RC1	Existing	1	1,800
	RC2	Proposed	-	
D	RD1	Proposed	-	
	RD2	Existing	4	45,000

Source: JICA study team

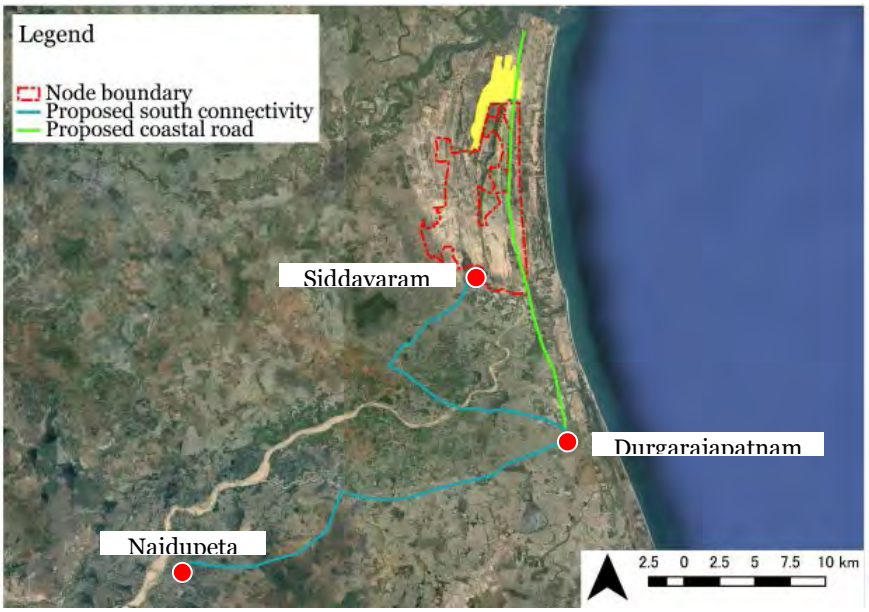
③ Railway capacity of main access route is set as shown in Table 7.11. As for share of passenger traffic which is not related to node on public transport is assumed 10% in consideration of node position.

Table 7.11: Capacity and Cost of Public Transport

Type	Metro	LRT	Railway	Mono Rail AGT	BRT	BUS
PPHPD (Passengers per hour per direction)	- 60,000	- 30,000	- 30,000	- 15,000	- 8,000	- 6,000
Construction Cost (Million USD/km)	30-50 (Viaduct)	30-50	10-20	30-50	6-13	-

Source: JICA study team

Regarding external road connectivity to south (to Naidupeta), following alignment is proposed through discussion with nodal agency. This road development is expected to expand existing road, not to develop new road to minimize land acquisition cost and to make development period shorter.

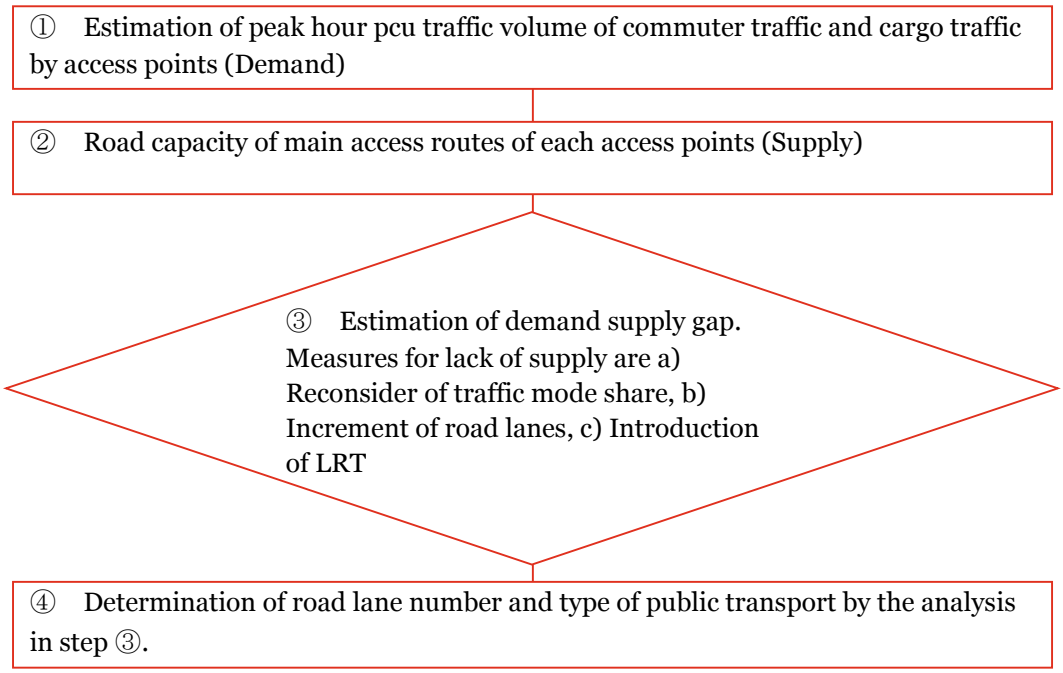


Source: JICA Study Team

Figure 7.8: External Road Connectivity from Siddavaram to Naidupeta via Durgarajapatnam

Demand Supply Analysis

Based on traffic demands of each access point estimated in foregoing section, necessary capacity of road and selection of public transport are carried out in accordance with analysis flow shown in Figure 7.8.



Source: JICA Study Team

Figure 7.9: Work Flow for Demand Supply Analysis

Demand supply gap of main access routes of each access points is estimated. Measures for lack of supply are examined to main access routes which does not satisfy demand in accordance with Figure 7.8. As a result,

introduction of LRT is proposed for access route of access point D because V/C is 1.91 in long term under 8 lanes road capacity without introduction of public transport and development of more than 8 lanes road is not realistic. Type of public transport is selected in accordance with capacity of public transport shown in Table 7.11 based on 16,200 persons commuter demand of access point D by public transport. Result of demand supply analysis for all access points are shown in Table 7.12.

Table 7.12: Result of Demand Supply Analysis by Access Points

No.	Mode	Unit	Remarks	Year											
				2019				2024				2034			
				A	B	C	D	A	B	C	D	A	B	C	D
1	Modal Share														
	M/C	%		20	20	20	20	20	20	20	20	20	20	20	5
	Car	%		20	20	20	20	20	20	20	20	25	40	25	25
	Bus	%		60	60	60	60	60	60	60	60	55	40	55	25
	LRT	%		0	0	0	0	0	0	0	0	0	0	0	45
2	Converted Commuter Traffic Volume														
	M/C	pcu/hour		215	316	219	500	539	792	550	1,254	1,288	1,892	1,314	749
	Car	pcu/hour		258	379	263	600	647	950	660	1,504	1,931	4,541	1,971	4,494
	Bus	pcu/hour		77	114	79	180	194	285	198	451	425	454	434	449
	LRT	train/hour	1500 commuter /train	0	0	0	0	0	0	0	0	0	0	0	11
3	Converted Cargo Traffic Volume														
	Trailer	pcu/hour		0	0	0	31	0	0	0	53	0	0	0	157
	Truck	pcu/hour		0	110	0	217	0	189	0	373	0	557	0	1,101
4	Number of Lanes														
	Road			**2**	**2**	**2**	**4**	**2**	**4**	**2**	**4**	**4**	**8**	**4**	**8**
5	Capacity														
	Road	pcu/day	One direction	17,500	17,500	17,500	45,000	17,500	45,000	17,500	45,000	45,000	85,000	45,000	85,000
	Road	pcu/hour	peak ratio: 0.1	1,750	1,750	1,750	4,500	1,750	4,500	1,750	4,500	4,500	8,500	4,500	8,500
	Road	pcu/hour	Occupancy ratio: 0.1	1,575	1,575	1,575	4,050	1,575	4,050	1,575	4,050	4,050	7,650	4,050	7,650
	LRT	train/hour		0	0	0	0	0	0	0	0	0	0	0	20
	LRT	train/hour	Occupancy ratio: 0.1	0	0	0	0	0	0	0	0	0	0	0	18
6	Demand Supply Gap (V/C)														
	Roads			**0.35**	**0.58**	**0.36**	**0.38**	**0.88**	**0.55**	**0.89**	**0.90**	**0.90**	**0.97**	**0.92**	**0.91**
	LRT			**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.60**

Source: JICA Study Team

7.1.3 *Framework for Infrastructure Development for Internal Node Development*

Development Vision

Vision for node development is discussed in section 6.3 and followings are expected to node as new industrial and urban core.

- *Center of Manufacturing Trade*
- *Success model of self-reliant Node*
- *Indian R&D Center*
- *Provider of high skilled labors*
- *Employment Generator*

Development of node with world standard quality to facilitate investment of international industrial firms is required to realize above visions. Provision of following values to investors is also important. Infrastructure development is dominant in node development investment and development concept is essential to determine efficiency and convenience of node.

- *Efficient and Stable Infrastructure*
- *One Stop Service*
- *Quick and Easy Trouble Shooting*
- *Special Incentives*

Since global issues of energy conservation and environmental conservation has been common issues of development and technical innovation especially IT technology, advanced technologies related to eco-friendly has been introduced into development. Concept of "Smart City" is examined in India and introduction of public transport, road debottlenecking, development of pedestrian and cyclist facilities are proposed for road traffic sector as shown in Table 7.13. Benchmarks for smart city development in Transport sector is also proposed in Table 7.14.

Table 7.13: Three Pronged Approach of Smart City Scheme

Category	Three Pronged Approach
Urban Mobility	1. Improvements in public transport – Metro Rail, BRT, LRT, Monorail, Trams etc. 2. Improvements in infrastructure of other motor vehicles – ring roads, bypasses, underpasses, elevated roads, improvements in the existing road ways 3. Improvements in infrastructure for walking, cycling and waterways

Source: Draft Concept Note on Smart City Scheme 2014.12.03

Table 7.14: Benchmarks for Smart Cities

Parameter	Benchmarks
Transport	1. Maximum travel time of 30 minutes in small & medium size cities and 45 minutes in metropolitan areas 2. Continuous unobstructed footpath of minimum 2m wide on either side of all street with RoW 12m or more 3. Dedicated and physically segregated bicycle tracks with a width of 2mor more, one in each direction, should be provided on all streets with carriageway larger than 10m (not ROW) 4. High quality and high frequency mass transport within 800m(10-15 minute walking distance) of all residences in areas over 175persons / ha of built area 5. Access to para-transit within 300m walking distance.

Source: Draft Concept Note on Smart City Scheme 2014.12.03

Development Issues

① Promotion of Public Transport

East-West and North-South distances of Krishnapatnam Node are about 7km and about 13km, respectively. And, travelling in node is basically undertaken by vehicle traffic. However, promotion of public transport, development of pedestrian and cyclist facilities, and development of transfer facilities among different transport facilities are essential to restraint of private traffic from the aspect of environmental conservation and alleviation of traffic congestion.

② Smooth Transit in Node

Development of efficient public transport and debottlenecking of road network are essential to ensure smooth travel and just in time service in node. Efficient networking and good accessibility to station of public transport are important issue on public transport development. Moreover, efficient traffic control at intersections is important to prevent bottleneck on road network.

③ Segregation of Cargo Traffic

Heavy vehicle for cargo traffic causes big impact on traffic flow and road side environment (noise, vibration), due to mechanical characteristic of the vehicle. Segregation measures on road structure and road network are essential to alleviate above impacts.

④ Environmental Conservation

Environmental conservation measures such as introduction of low-emission type vehicle into public transport system should be promoted to respond environmental related global issues.

Development Concept

Based on development vision and development issues discussed in foregoing section, “Clean & Smart” is introduced as node development concept. Based on this development concept, eco- friendly transport system

such as public transport system and pedestrian and cyclist facilities should be promoted. Transfer facilities among public transport facilities, and pedestrian and cyclist facilities should be promoted. Hierarchic road network and road structure considering segregation of cargo traffic should be promoted.

Planning Policy

Road Network Planning

A proper road network contributes to the efficient development of an industrial and urban development area. Since road network would play an essential role in various industrial and urban activities, road network plan should be developed base on land use condition and environmental conditions besides the transport plan. Road network plan has principally taken into account network pattern, road hierarchy, and road density in the process of developing the road network plan.

Network Pattern

Network patterning is as known effective method in network planning. In this study, road network adopts grid patterns because that zoning and blocking of nodes are basically rectangular and this land-use characteristic is suitable for the pattern.

Road Hierarchy

To develop a proper road network, a systematic and hierarchical functional classification is necessary. The hierarchical classification of functions is composed of expressways, primary roads, secondary roads, and tertiary roads.

Primary Road System: The primary road system services the major portions of trips entering and leaving industrial and urban areas as well as the majority of throughway travel that wants to bypass the city center. In addition, significant intra-urban travel, such as between node centre and outlying residential areas, between industrial zone and logistic center, is served by primary road.

Secondary Road System: The secondary road system interconnects with and augments the primary road system. It provides services to travels with moderate trip lengths at a somewhat lower level of travel mobility than primary roads. This system also distributes travel to geographic areas that are smaller than those identified with those of higher road systems. Secondary roads must serve not only vehicular traffic but also various transportation and nontransportation activities.

Tertiary Road System: The tertiary road system aims to provide access to areas located along the roads and to serve not only vehicular traffic but also nonmotorized vehicle and pedestrian traffic as well as roadside nontransportation activities. Some urban streets that have commercial frontage serve fairly substantial volumes of traffic. However, this traffic is of terminal in nature; thus, it does not provide movement throughout the area.

Road Density

Road density is a key index of the road network's appropriateness for keeping a balance with land-use conditions. Target road densities corresponding to types of land use have been introduced in various existing manuals.

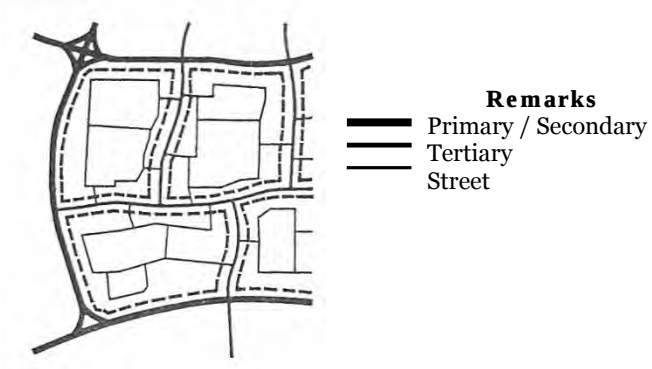
Table 7.15: Example of Target Road Density in Urban Area

Land Use	Target Road Density (km/km²)
Residential	4
Commercial	6
Semi-Industrial	2
Industrial	1

Source: Ministry of Construction, Japan

Road Network by Grid Pattern

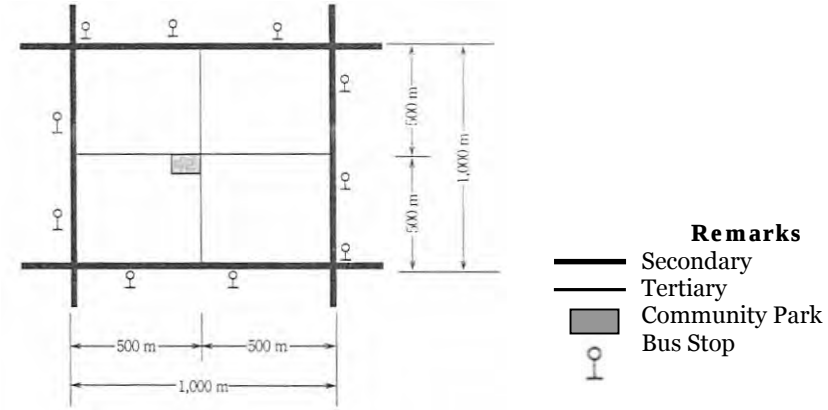
Role of the local roads which categorized as tertiary road is to provide access to trip origin/destination point such as factory, office, school, market and residence to/from upper hierarchy road. Therefore appropriate coordination on the local road network planning in accordance with land use and Primary/secondary road network is essential. Figure 7.9 shows basic concept for establishment of road network pattern with kind of road hierarchy. Hence areas which are surrounded by the road are formed as a community block; scale and shape of the block are considered on the road network establishment.



Source: JICA Study Team

Figure 7.10: Industrial and Urban Road Hierarchy

Figure 7.10 shows standard urban road network segment on road network plan.

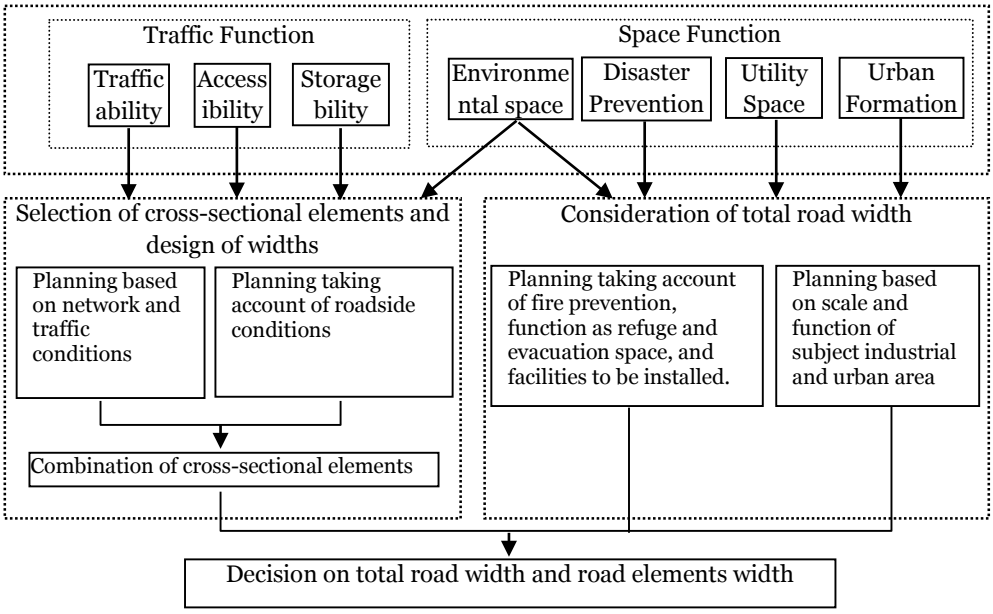


Source: JICA Study Team

Figure 7.11: Standard for Industrial and Urban Road Network Segment

Road Planning

Besides the road network planning, due consideration to road function both in traffic and space is essential in cross-section planning because urban roads would play a role not only as facilities for traffic but also as space for varied purposes. Especially, the space function of medians, shoulders, sidewalks, and service roadways was taken into account in harmony with relevant land-use urban plan.



Source: JICA Study Team

Figure 7.12: Concept of Cross-section Planning Based on Road Functions

Key elements of the urban design guidelines, such as design speeds and widths of typical cross-sectional elements, are considered and proposed as follows:

Design Speed

Design speed is the maximum speed for safe travel that can be maintained for a specified section of a road. The design speed is determined with respect to the terrain, adjacent land use, type of road, and the design speed of adjoining sections. The design speed will directly affect many geometric elements, like the horizontal and vertical alignments, sight distance, provision of super elevation, etc.

Examination of Typical Cross-sections

Cross-sectional elements are proposed with consideration of road functions as shown in Figure 7.10 above. Basic policy for planning of cross-section elements is briefly explained as follows:

Lane Width: Since lane width has the largest effects on running speeds and comfortability levels, the appropriate lane width should be considered when determining design speed.

Median: It is considered that the wider the median is, the higher the road functions become. Also, when a vehicle loses control, it is easily controlled if the median is wider, thereby avoiding serious accidents.

Shoulder: Taking into account the relationship of functionally classified road systems to traffic mobility and land access, it can be said that urban tertiary roads has a relatively higher land access function, while urban primary roads provide a higher level of mobility for throughway movement.

Sidewalk: A sidewalk, which is physically separated from motorized traffic by a curb, consists of the walking space and the lateral space for street lightings, traffic barriers, and other street hardware. The minimum width for a sidewalk should be 1.0m. Consideration of necessary pedestrian walking space was based on the necessary space between pedestrians.

Planted Strip: A planted strip is part of a sidewalk, providing aesthetic elements and serving as buffer strip. The width of a planted strip between the sidewalk and travelled way curb, if provided, should be a minimum of 2.0m to allow maintenance activities.

Road Safety

Major road accidents on urban area are speeding, collision at intersection, and collision between vehicle and pedestrian and cyclist. Collision between heavy freight vehicle and other vehicle is likely to happen in node, since share of freight traffic is high on node traffic and different vehicle characteristics between heavy vehicle and ordinary vehicles. In addition to enforcement and education measures for road traffic accident mitigation, infrastructure measures for above accidents are effective. Countermeasures for above road accidents by infrastructure are summarized in Table 7.16 based on accident analysis and those measures will be introduced into internal node development plan.

Table 7.16: Counter Measures for Road Safety

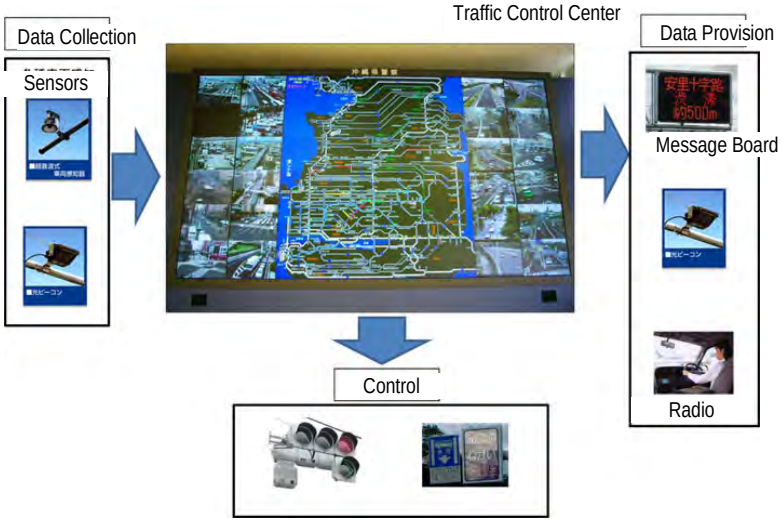
Accident Type	Countermeasures by Infrastructure
Speeding	- Speed Hump
Collision at Intersection	- Controlled Traffic Signal - Street Light
Collision between vehicle and pedestrian･cyclist	- Controlled Traffic Signal - Mount up footpath - Street Light
Collision between heavy freight vehicle and other vehicles	- Designation of Passage Lane for freight vehicle

Source: JICA Study Team

Intersections

Grade separated intersection is generally applied to high traffic crossing with more than 4 lanes roads. In this plan, grate separation is applied to crossing between node access road and express national highway. At-grade intersection is basically applied at other intersections on node access roads.Intersection in node is basically at-grade except railway crossing due to small traffic in node and effective utilization of land.

There are more than 100 at-grade intersections in node and the intersections are located on grid line. Therefore, coordinated intersection control by coordinated traffic signal system with control centre is desirable to ensure efficient traffic control. This system has scalable for increment of number of traffic signal and traffic sensors.



Source: Okinawa Prefectural Police HP

Figure 7.13: Integrated Traffic Control System

Public Transport

Bus System

Bus system is introduced as main public transport system in node in consideration of scale of node area and node population.

Bus Network Plan : Bus network in node should be considered in consideration of transfer between commuting bus from outside of node and node internal circulation bus, and development area in each development phase. However, final decision will be made by bus operator based on road network, bus lines, frequency, bus allocation plan, and etc.

Bus Terminal and Bus Stop Plan : Bus terminal should be planned as transfer facility between commuting bus from outside of node and node internal circulation bus. Bus depot should be planned for maintenance and waiting of bus. Bus stop should be installed every 500m along road to keep 5 minutes walking sphere.

LRT System

LRT of mass transit system is introduced for access rout of access point D in long term to accommodate estimated huge commuter from Nellore.

Route : Route of LRT start from Venkatachalam station of Indian Railway to central area of node through access point D. Space between existing freight railway and Krishnapatnam road is assumed as space for LRT.

Station Position : Station interval of 500m in node and 1,500m at out of node are basic criteria, and station position at out of node should be finalized based on possible passenger number within LRT corridor (1km on both sides).

7.1.4 *Design Conditions*

Road Design

Following Indian design standard is basically applied to road and road related facility design and international standard is adopted when there is no stipulation in Indian design standard.

- IRC 86:1983 GEOMETRIC DESIGN STANDARDS FOR URBAN ROADS IN PLAINS
- IRC 106:1990 GUIDELINES FOR CAPACITY OF URBAN ROADS IN PLAINS
- IRCRC 64:1990 GUIDELINES FOR CAPACITY OF ROADS IN RURAL AREAS
- IRC 73:1980 GEOMETRIC DESIGN STANDARDS FOR RURAL HIGHWAYS

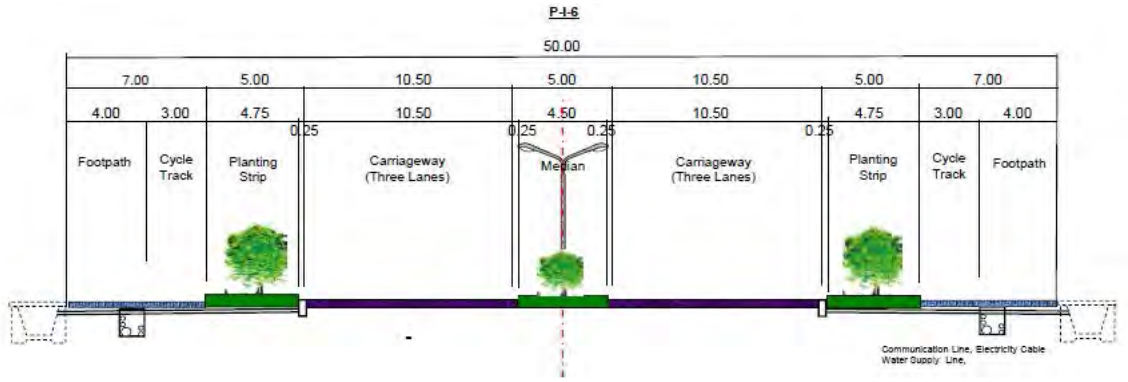
Proposed elements of typical cross sections in this plan are shown in Table 7.17 and Figure 7.13 to Figure 7.30. Figure 7.14, Figure 7.17, and Figure 7.20 show typical cross section of primary road in transitional period. Transitional typical cross sections aim to secure land for widening and efficient widening construction.

Road lighting is installed all type of road and surface drainage water on road area is discharged to out of road area. Utilities such as water supply line, electric cable, and communication line will be accommodated under footpath and concrete box for accommodating above utilities is planned to install on primary road in consideration of efficient maintenance.

Table 7.17: Elements of Proposed Typical Cross Sections

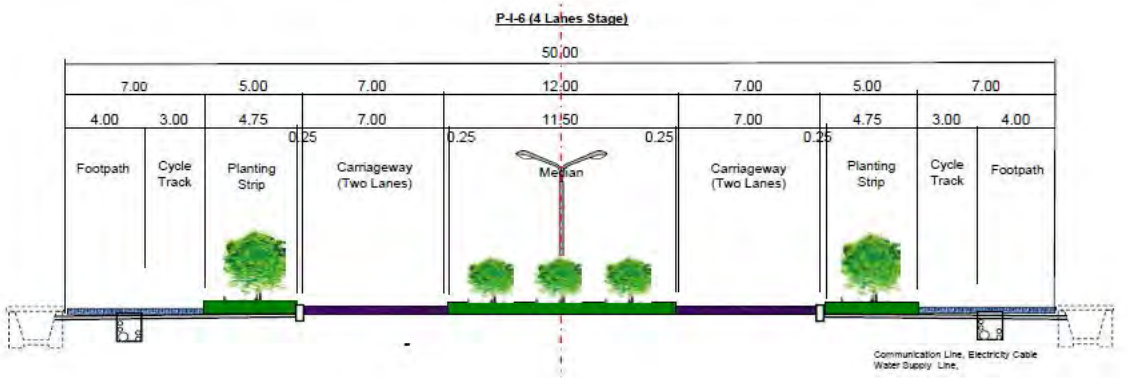
Classification	Type	Earthwork Section																	
		Foot Path	Planting Strip	Parking	Cycle Track	Service Road	Marginal Strip	Planting Strip	traveled way	median	traveled way	Planting Strip	Marginal Strip	Service Road	Cycle Track	Parking	Planting Strip	Foot Path	Total
Primary	P-I-6	4.00	0.00	0.00	3.00	0.00	0.00	5.00	3.50 × 3	5.00	3.50 × 3	5.00	0.00	0.00	3.00	0.00	0.00	4.00	50.0
	P-I-4	4.00	0.00	0.00	3.00	0.00	0.00	5.00	3.50 × 2	5.00	3.50 × 2	5.00	0.00	0.00	3.00	0.00	0.00	4.00	43.0
	P-6	4.00	0.00	0.00	3.00	0.00	0.00	2.00	3.50 × 3	5.00	3.50 × 3	2.00	0.00	0.00	3.00	0.00	0.00	4.00	44.0
	P-4	4.00	0.00	0.00	3.00	0.00	0.00	2.00	3.50 × 2	5.00	3.50 × 2	2.00	0.00	0.00	3.00	0.00	0.00	4.00	37.0
	P-6-R	4.00	0.00	2.50	2.00	3.50	0.50	2.00	3.50 × 3	5.00	3.50 × 3	2.00	0.50	3.50	2.00	2.50	0.00	4.00	55.0
	P-4-R	4.00	0.00	2.50	2.00	3.50	0.50	2.00	3.50 × 2	5.00	3.50 × 2	2.00	0.50	3.50	2.00	2.50	0.00	4.00	48.0
Secondary	S-4	4.00	0.00	0.00	2.50	0.00	0.00	2.00	3.50 × 2	3.00	3.50 × 2	2.00	0.00	0.00	2.50	0.00	0.00	4.00	34.0
	S-4-R	4.00	0.00	2.00	2.00	3.50	0.50	2.00	3.50 × 2	3.00	3.50 × 2	2.00	0.50	3.50	2.00	2.00	0.00	4.00	45.0
Tertiary	T-4	2.50	0.00	0.00	2.50	0.00	0.00	0.00	3.50 × 2	1.50	3.50 × 2	0.00	0.00	0.00	2.50	0.00	0.00	2.50	25.5
	T-2-R	3.00	1.00	2.50	0.00	0.00	0.00	0.00	3.50 × 1	0.00	3.50 × 1	0.00	0.00	0.00	0.00	2.50	1.00	3.00	20.0
Classification	Type	Bridge Section																	
					Parapet	Foot Path	Parking	Cycle Track	traveled way	median	traveled way	Cycle Track	Parking	Foot Path	Parapet				Total
Primary	P-6				0.50	2.50	0.00	2.50	3.50 × 3	2.00	3.50 × 3	2.50	0.00	2.50	0.50				34.0
	P-4				0.50	2.50	0.00	2.50	3.50 × 2	2.00	3.50 × 2	2.50	0.00	2.50	0.50				27.0
Secondary	S-4				0.50	2.50	0.00	2.50	3.50 × 2	1.50	3.50 × 2	2.50	0.00	2.50	0.50				26.5
Tertiary	T-4				0.50	2.00	0.00	2.00	3.50 × 2	1.50	3.50 × 2	2.00	0.00	2.00	0.50				24.5
	T-2				0.50	2.00	2.50	0.00	3.50 × 1	0.00	3.50 × 1	0.00	2.50	2.00	0.50				17.0

Source: JICA Study Team



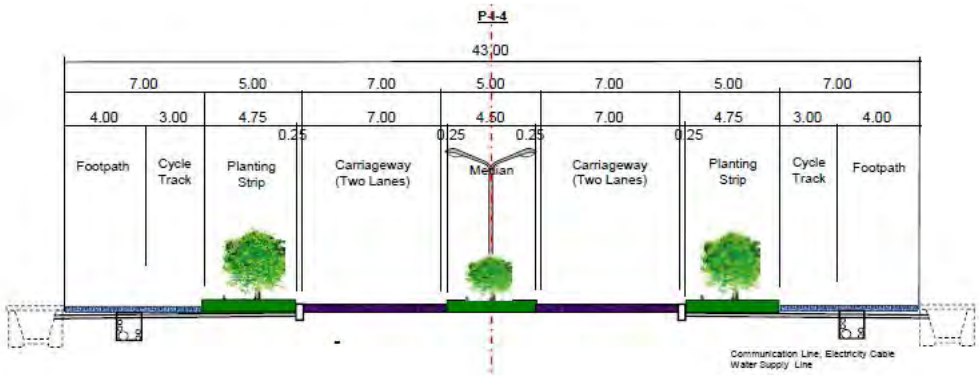
Source: JICA Study Team

Figure 7.14: Proposed Typical Cross Section (Primary-Industry-6Lanes)



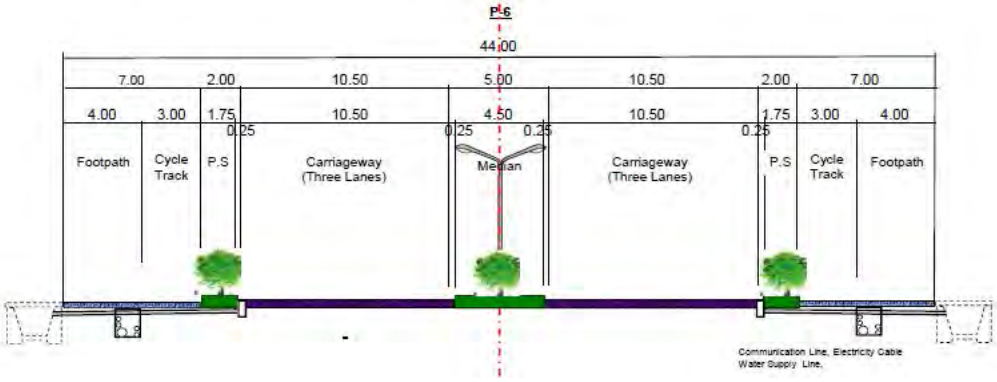
Source: JICA Study Team

Figure 7.15: Proposed Typical Cross Section (Primary-Industry-4Lanes-Stage)



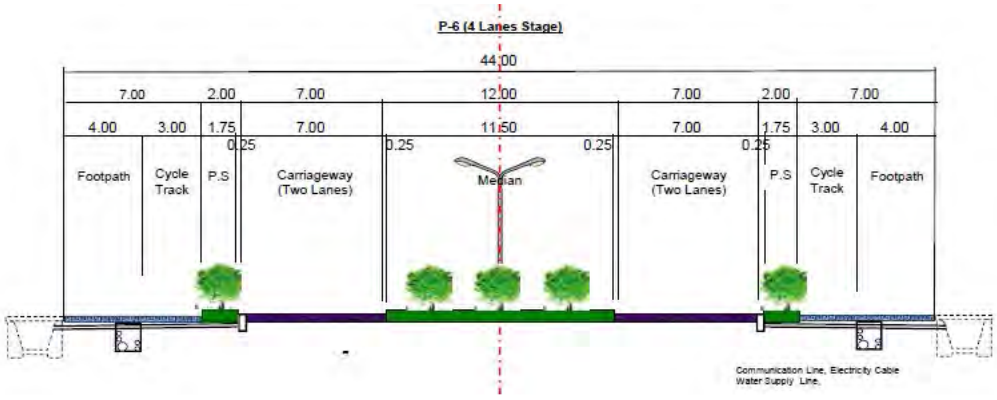
Source: JICA Study Team

Figure 7.16: Proposed Typical Cross Section (Primary-Industry-4Lanes)



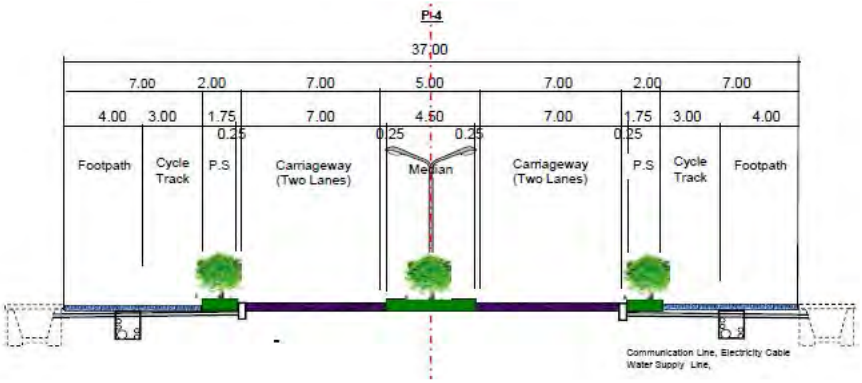
Source: JICA Study Team

Figure 7.17: Proposed Typical Cross Section (Primary-6Lanes)



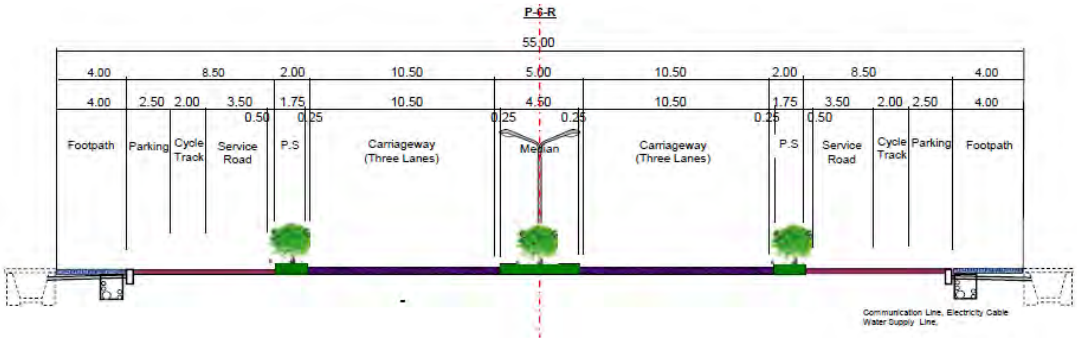
Source: JICA Study Team

Figure 7.18: Proposed Typical Cross Section (Primary-6Lanes-Stage)



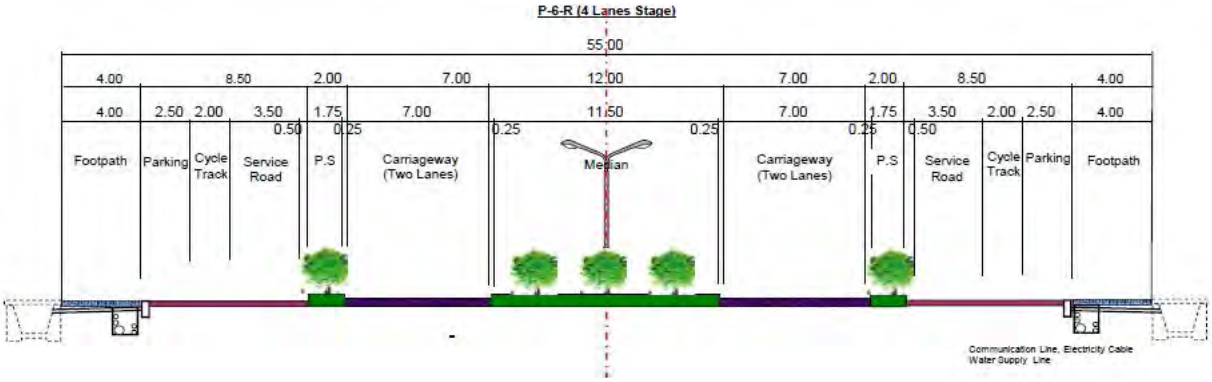
Source: JICA Study Team

Figure 7.19: Proposed Typical Cross Section (Primary-4 Lanes)



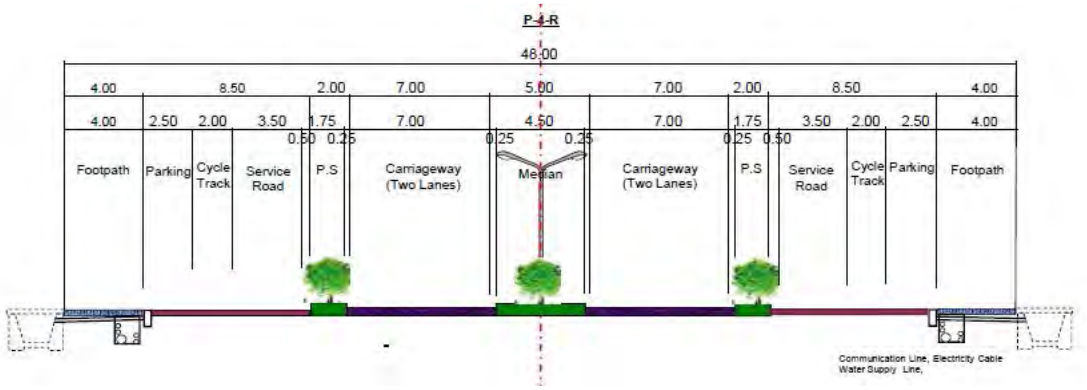
Source: JICA Study Team

Figure 7.20: Proposed Typical Cross Section (Primary-Residential-6 Lanes)



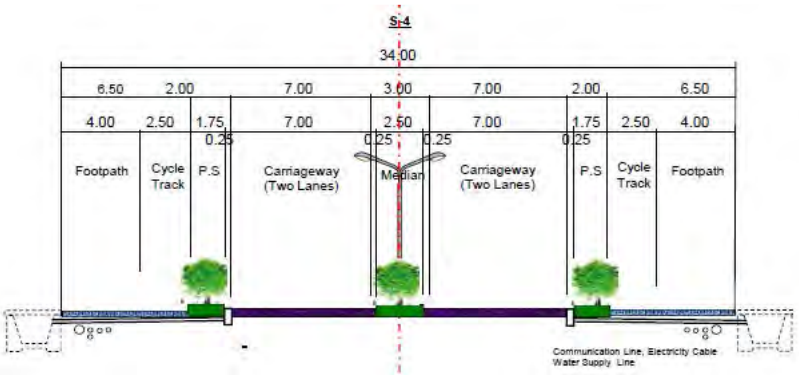
Source: JICA Study Team

Figure 7.21: Proposed Typical Cross Section (Primary-Residential-6 Lanes-Stage)



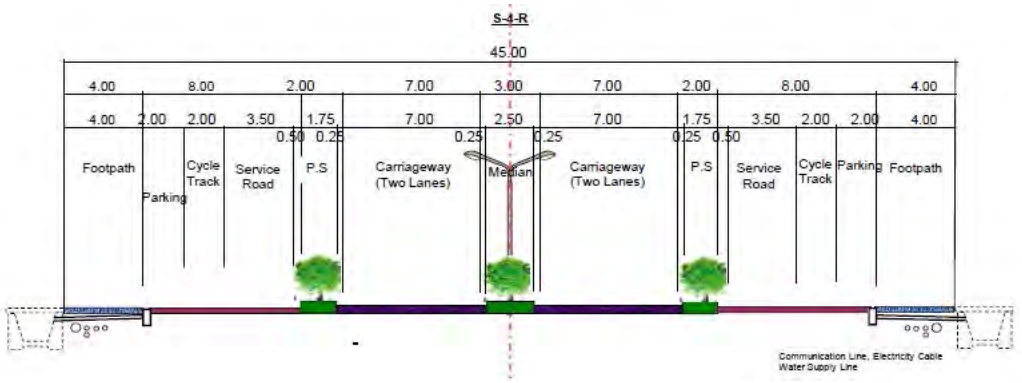
Source: JICA Study Team

Figure 7.22: Proposed Typical Cross Section (Primary-Residential-4 Lanes)



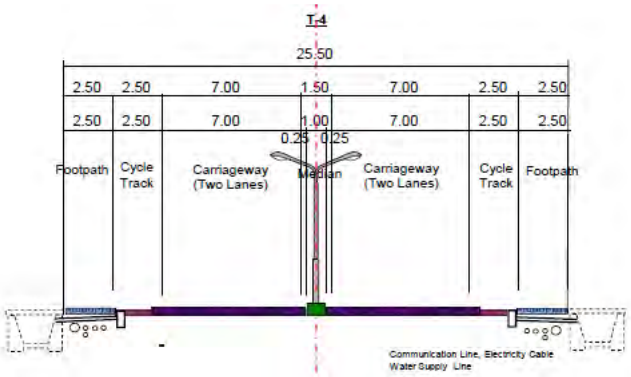
Source: JICA Study Team

Figure 7.23: Proposed Typical Cross Section (Secondary-4 Lanes)



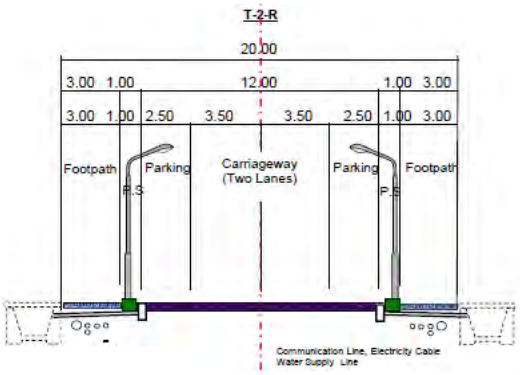
Source: JICA Study Team

Figure 7.24: Proposed Typical Cross Section (Secondary-Residential-4 Lanes)



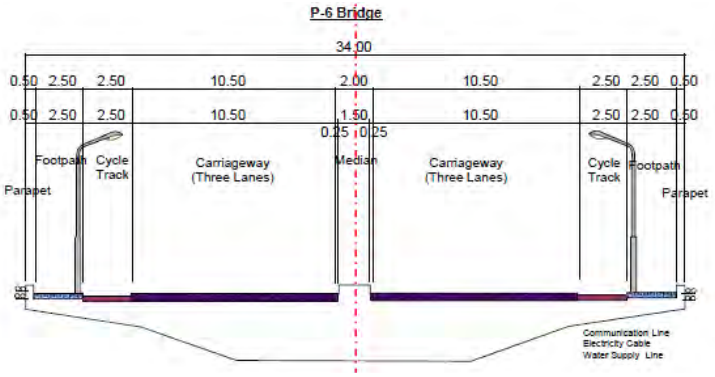
Source: JICA Study Team

Figure 7.25: Proposed Typical Cross Section (Tertiary-4 Lanes)



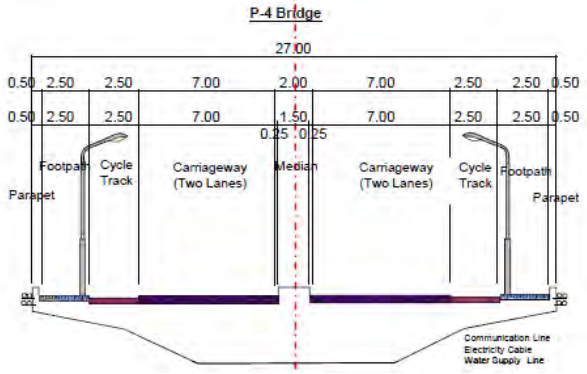
Source: JICA Study Team

Figure 7.26: Proposed Typical Cross Section (Tertiary-Residential-2 Lanes)



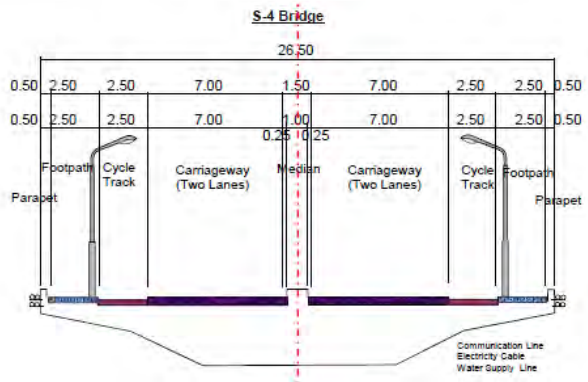
Source: JICA Study Team

Figure 7.27: Proposed Typical Cross Section (Primary-6 Lanes)



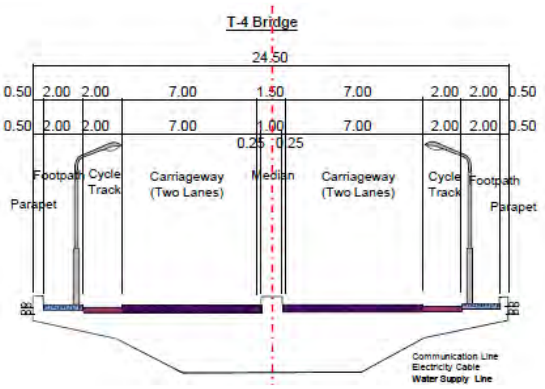
Source: JICA Study Team

Figure 7.28: Proposed Typical Cross Section (Primary-4 Lanes)



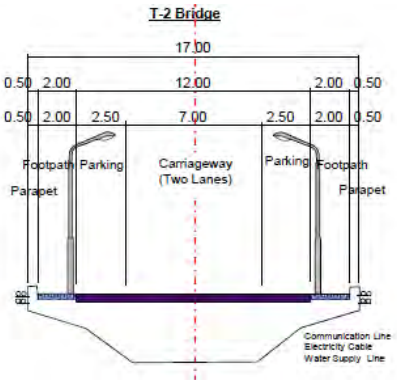
Source: JICA Study Team

Figure 7.29: Proposed Typical Cross Section (Secondary-4 Lanes)



Source: JICA Study Team

Figure 7.30: Proposed Typical Cross Section (Tertiary-4 Lanes)



Source: JICA Study Team

Figure 7.31: Proposed Typical Cross Section (Tertiary-2 Lanes)

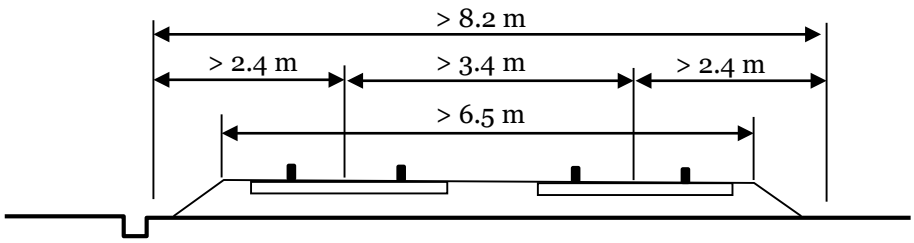
Public Transport

Bus System

Bus Terminal : Bus terminal consists of vehicle related facilities, passenger related facilities, management related facilities, and service related facilities. Length and width of platform area is more than 12m and 3m, respectively. Number of platform is 10 locations and total area is 5,000m2.
Bus Depot: Bus depot consists of vehicle related facilities and management facilities, and total area is 10,000m2.
Bus Stop: Type of bus stop is bus bay type and pavement area is 125m2.

LRT System

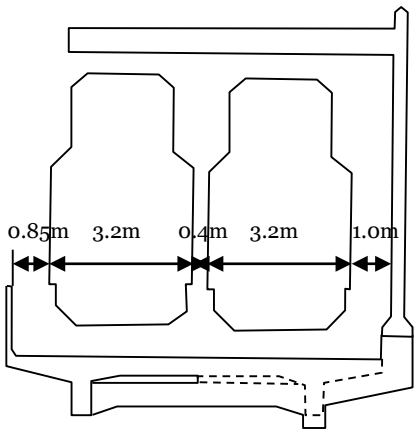
ROW in Embankment Section : Proposed dimensions of ROW in embankment section is shown in Figure 7.31.



Source: JICA Study Team

Figure 7.32: Proposed Typical Cross Section of LRT (Embankment Section)

ROW in Bridge Section : Proposed dimensions of ROW in bridge section is shown in Figure 7.32.



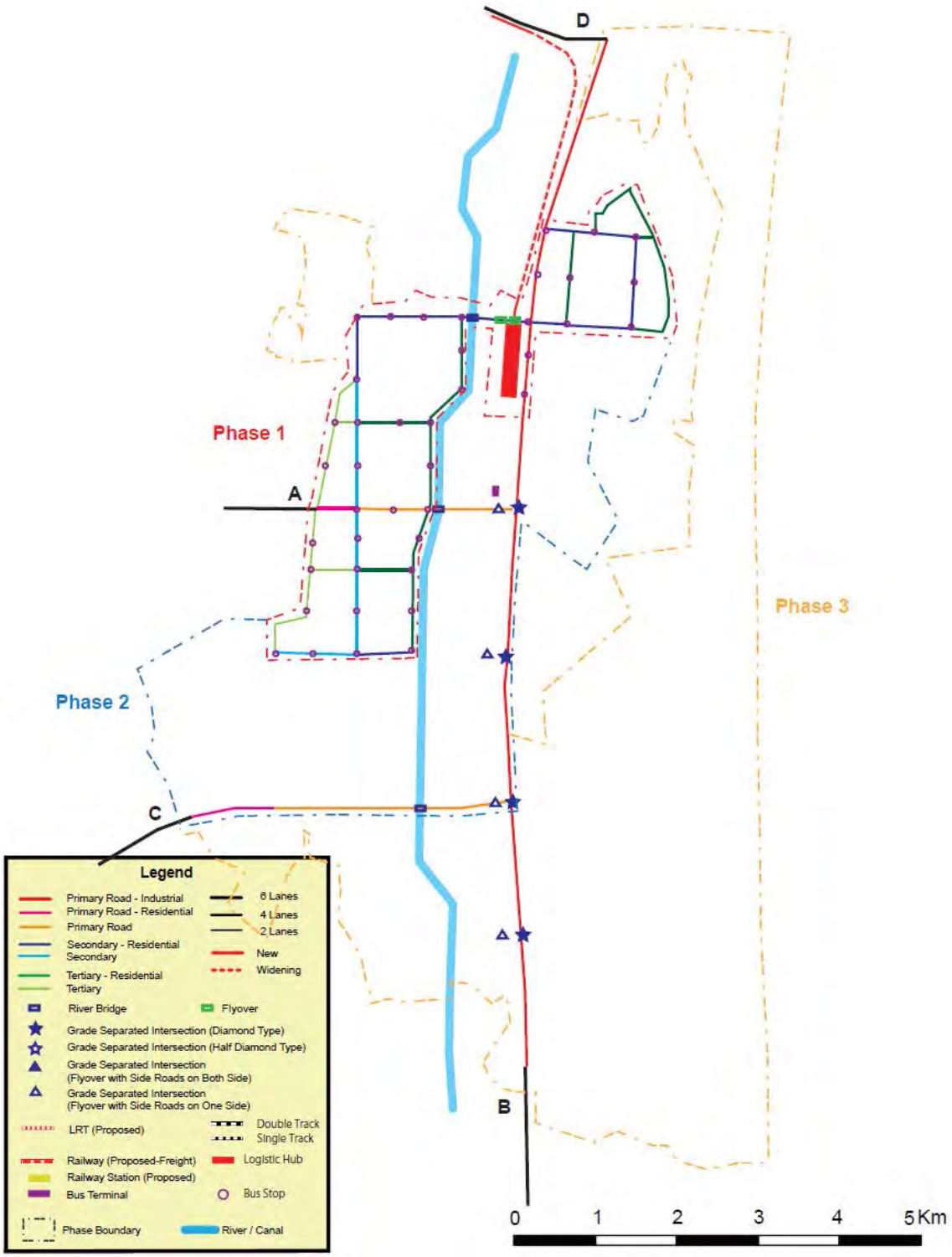
Source: JICA Study Team

Figure 7.33: Proposed Typical Cross Section of LRT (Bridge Section)

7.1.5 *Development Plan*

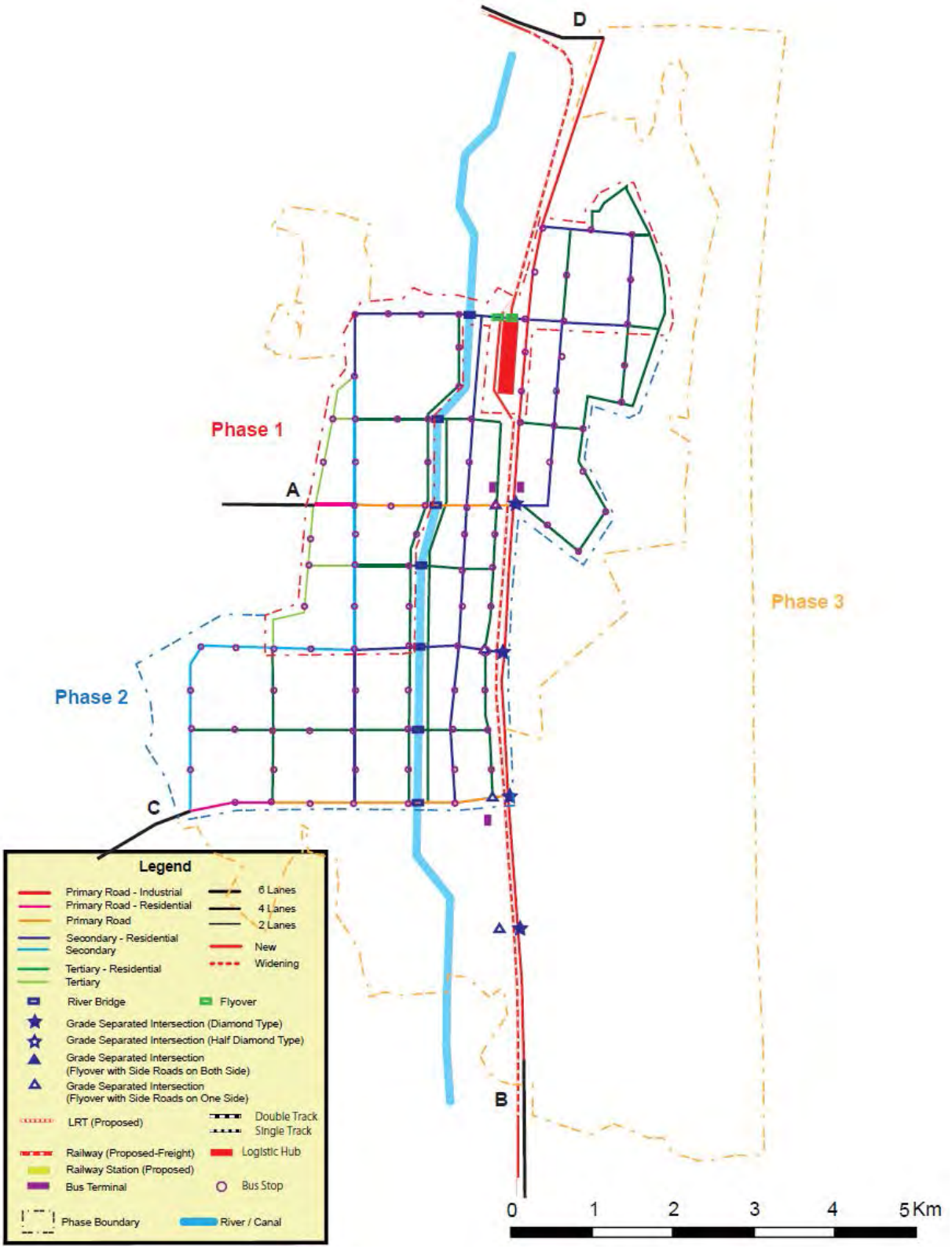
Internal Node Development

Based on planning policy and design conditions and existing road and rail development plans, internal node development plans for each phase are proposed as shown in Figure 7.33 to Figure 7.35.



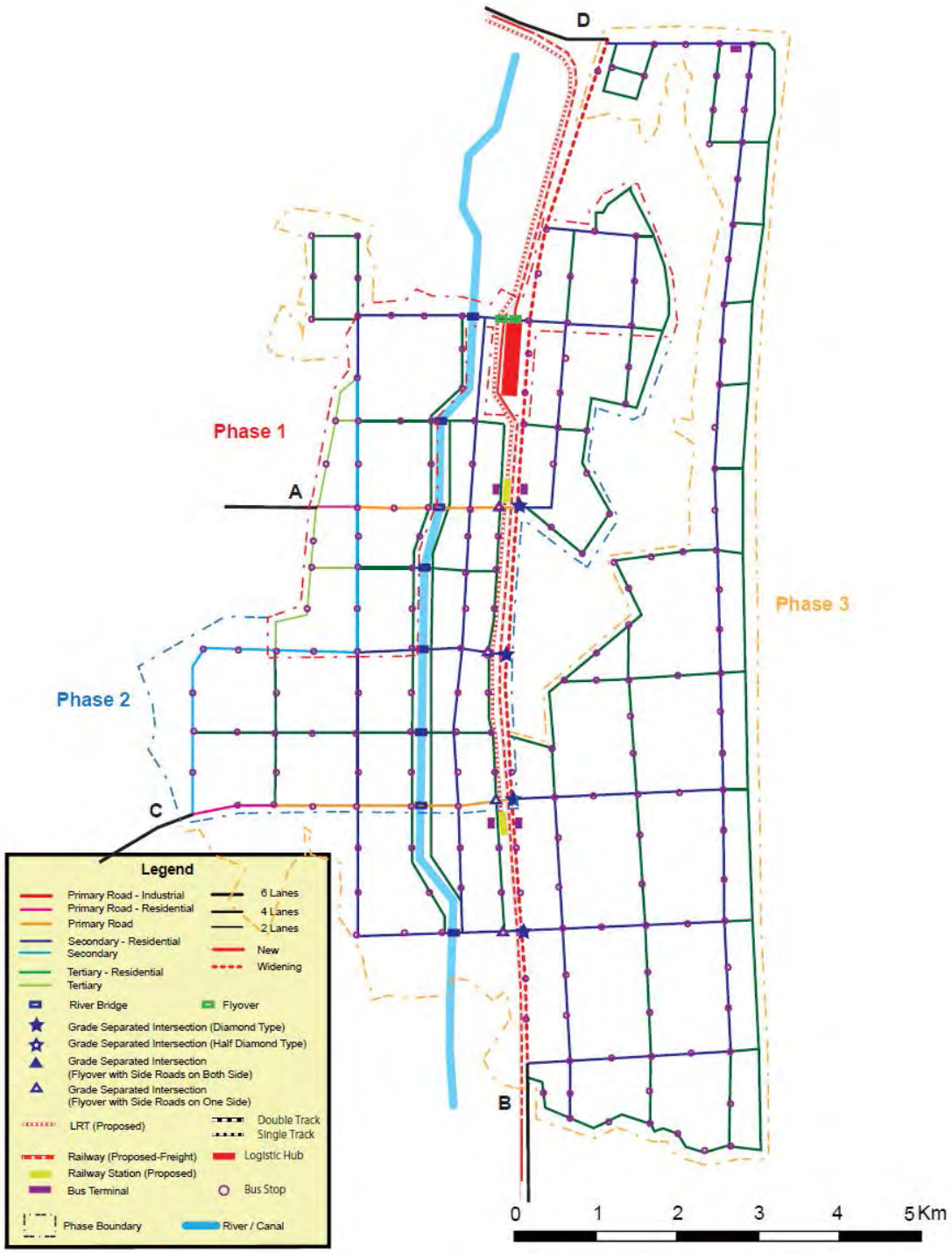
Source: JICA Study Team

Figure 7.34: Road and Public Transport Facilities Development Plan in Internal Krishnapatnam Node (Phase 1)



Source: JICA Study Team

Figure 7.35: Road and Public Transport Facilities Development Plan in Internal Krishnapatnam Node (Phase 2)

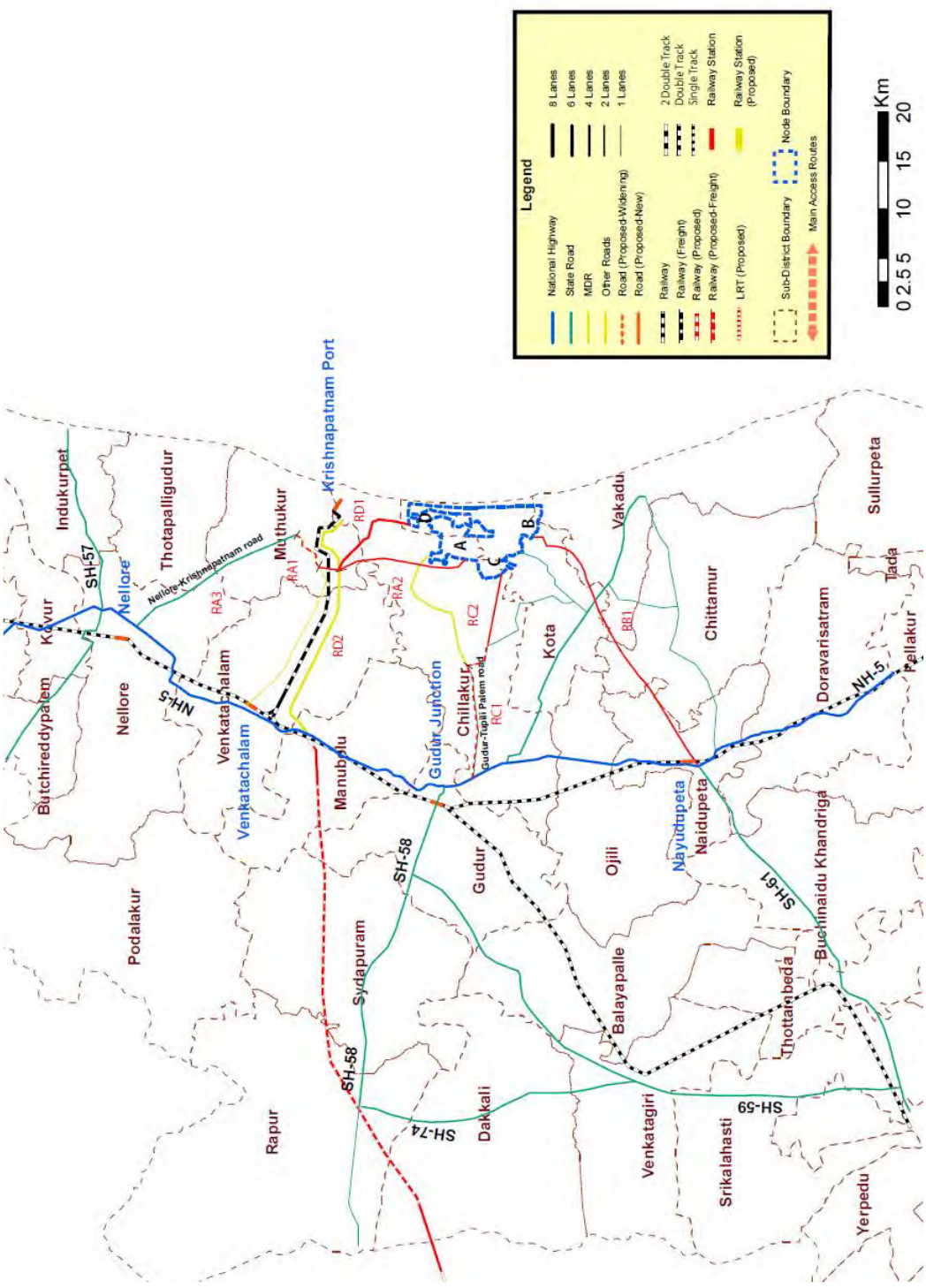


Source: JICA Study Team

Figure 7.36: Road and Public Transport Facilities Development Plan in Internal Krishnapatnam Node (Phase 3)

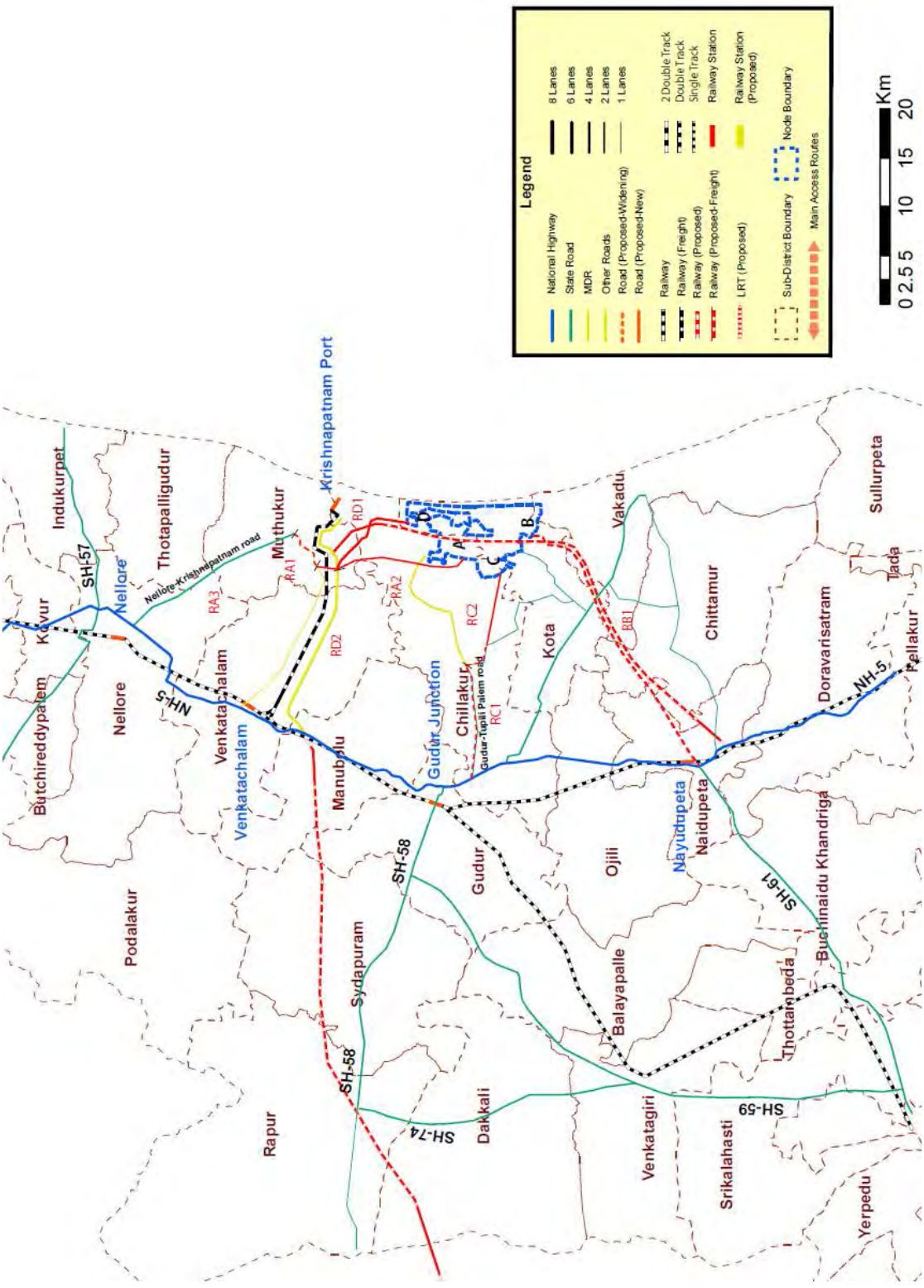
External Node Development

Based on demand supply analysis result and existing road and rail development plans, external node development plans for each phase are proposed as shown in Figure 7.36 to Figure 7.38.



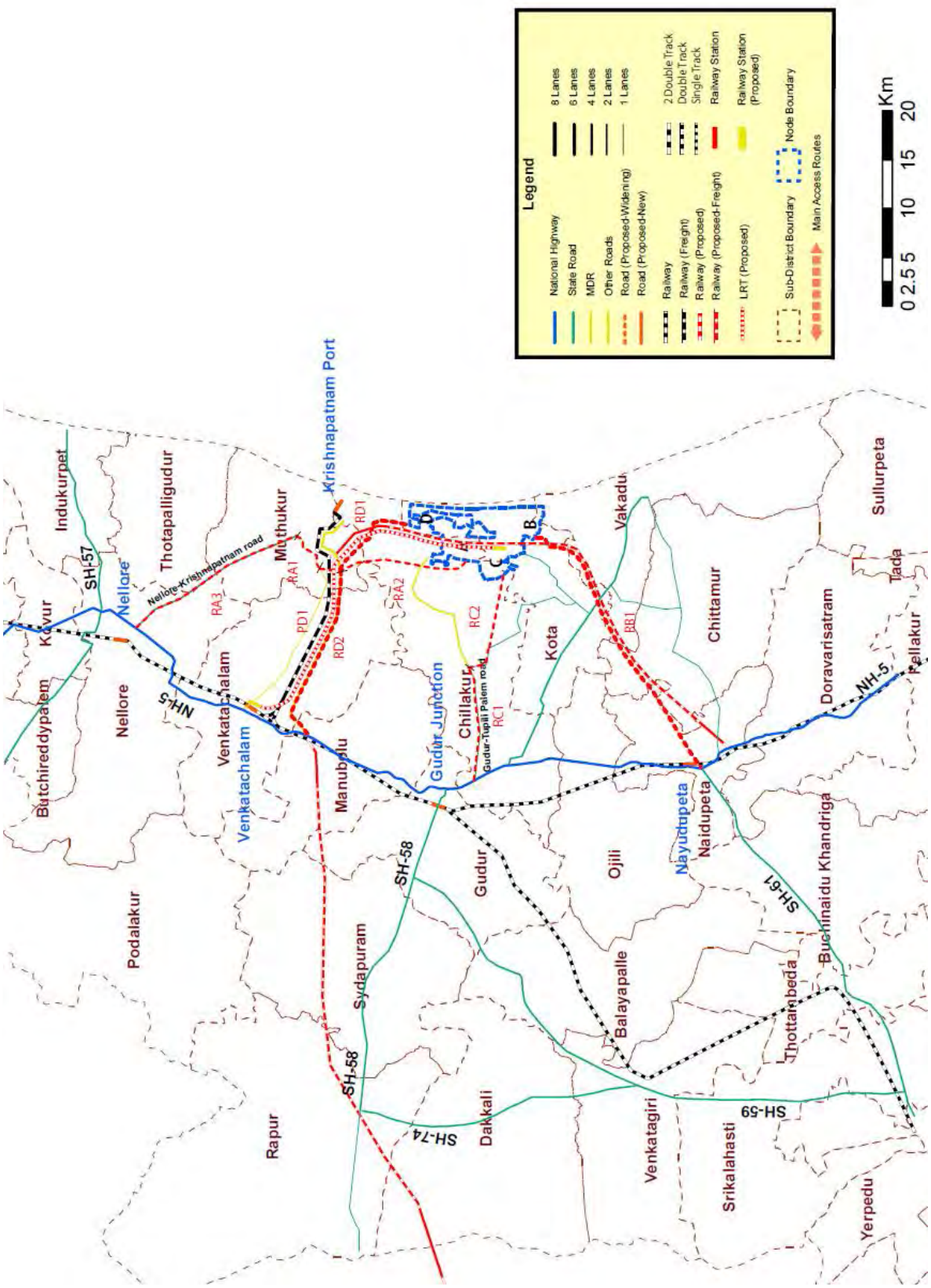
Source: JICA Study Team

Figure 7.37: Road and Public Transport Facilities Development Plan in External Krishnapatnam Node (Phase 1)



Source: JICA Study Team

Figure 7.38: Road and Public Transport Facilities Development Plan in External Krishnapatnam Node (Phase 2)



Source: JICA Study Team

Figure 7.39: Road and Public Transport Facilities Development Plan in External Krishnapatnam Node (Phase 3)

7.1.6 *Implementation Plan (Development Schedule)*

Internal Node Development

Based on proposed internal node development plan and identified projects, implementation plan for internal node development is proposed as shown in Table 7.18. Annual investment expenditure and total investment cost in each phase are also shown in Table 7.18.

Table 7.18: Implementation Plan for Internal Node

Item	Description		Phase 1 (2014-2018)					Phase 2 (2019-2023)					Phase 3 (2024-2033)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
1. Internal Road Works	1) Primary Roads	a) 6 Lanes from 4 Lanes (ROW=44m)																				
		b) 4 Lanes (ROW=37m)				3,290																
		c) Type-Industrial 6 Lanes from 4 Lanes (ROW=50m)															516	516	516			
		d) Type-Industrial 4 Lanes (ROW=43m)			3,655	3,655	3,655															
		e) Type-Residential 6 Lanes from 4 Lanes (ROW=55m)																				
		f) Type-Residential 4 Lanes (ROW=48m)			1,520																	
	2) Secondary Roads	a) 4 Lanes (ROW=34m)				2,243	2,243				5,980	5,980							5,428	5,428	5,428	5,428
		b) Type-Residential 4 Lanes (ROW=45m)				3,960					2,610											
	3) Tertiary Roads	a) 4 Lanes (ROW=25.5m)				2,600	2,600		4,238	4,238	4,238	4,238						4,310	4,310	4,310	4,310	4,310
		b) Type-Residential 2 Lanes (ROW=20m)					1,920				1,160											
Total																						
2. Intersection Works	1) At-Grade Intersection (signalized)	a) Cross Type (6*4)				45																
		b) Cross Type (6*2)																				
		c) Cross Type (4*4)				200	200				150	150									163	163
		d) Cross Type (4*2)				18																
		e) Cross Type (2*2)																				
		f) T-Type (6*4)				216																
		g) T-Type (6*2)																				
		h) T-Type (4*4)				90	90				70	70									290	290
		i) T-Type (4*2)					14															
		j) T-Type (2*2)					16															
	2) Grade-separated intersection	a) Diamond Type			1,850	1,850	1,850															
		b) Half Diamond Type			740	740																
		c) Flyover with side roads on both sideType																				
		d) Flyover with side roads on one side Type			667	667	667															
		e) Flyover with side road on one side Type																				
Total																						
3. River Bridge Works	1) On Primary Road	a) 6 Lanes (W=34m)																				
		b) 4 Lanes (W=27m)			2,142	2,142	2,142															
	2) On Secondary Road	4 Lanes (W=26.5m)			835	835	835	626	626	626	626							626	626	626	626	
	3) On Tertiary Road	a) 4 Lanes (W=24.5m)						1,158	1,158	1,158	1,158											
		b) 2 Lanes (W=17m)																				
Total																						
4. Flyover Bridge Works	1) On Primary Road	a) 6 Lanes (W=34m)																				
		b) 4 Lanes (W=27m)																				
	2) On Secondary Road	4 Lanes (W=26.5m)			212	212	212															
	3) On Tertiary Road	a) 4 Lanes (W=24.5m)																				
		b) 2 Lanes (W=17m)																				
Total																						
5. Road Facilities	1) Street Light	a) Dual bulb Type (High-pressure sodium lamp)				675	675			607	607	607										2,525
		b) Single bulb Type (High-pressure sodium lamp)					253					153										
	2) Traffic Light	1) Cross Type Intersection				450	450					600									325	325
		2) T-Type Intersection				360	360					280									580	580
	3) Central Traffic Light Control System					300																
	4) Utilies Box	h: 1.5mx w: 1.5m, both sides of road, Primary Road only			7,680	7,680	7,680															
Total																						
6. Internal Public Transport Facilities Works	1) Bus Terminal	10 Busbays with 5,000m2					1,300					2,600										2,600
	2) Bus stop	Bus bay type (A=125m2) x both side			137	137	137				260	260							500			500
	3) Bus Depot	10,000m2					800					1,600										1,600
	4) LRT	Venkatachalam - Node													15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000
Annual Total (INR Lakh)			0	0	19,437	32,363	28,098	1,784	6,021	6,626	16,858	16,538	0	0	15,000	15,000	15,516	20,452	26,380	25,364	26,721	33,320
Phase Total (INR Lakh)			79,899					47,829					177,752									

Source: JICA Study Team

External Node Development

Based on proposed external node development plan and identified projects, implementation plan for external node development is proposed as shown in Table 7.19. Annual investment expenditure and total investment cost in each phase are also shown in Table 7.19.

Table 7.19: Implementation Plan for External Node

Item	Description		Phase 1 (2014-2018)					Phase 2 (2019-2023)					Phase 3 (2024-2033)									
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
7. External Road Works	1) RA1	P1: Widening 1L-2L, P2: -, P3: Widening 2L-4L					567															756
	2) RA2	P1: New 2L, P2: -, P3: Widening 2L-4L			2,040	2,040	2,040													680	680	680
	3) RA3	P1: Widening 2L-4L, P2: -, P3: Widening 4L-6L			768	768	768													768	768	768
	4) RB1	P1: New 2L, P2: Widening 2L-4L, P3: Widening 4L-8L			3,840	3,840	3,840			1,280	1,280	1,280								2,560	2,560	2,560
	5) RC1	P1: Widening 1L-2L, P2: -, P3: Widening 2L-4L				698	698														930	930
	6) RC2	P1: New 2L, P2: -, P3: Widening 2L-4L					2,700															900
	7) RD1	P1: New 4L, P2: -, P3: Widening 4L-8L			1,900	1,900	1,900													760	760	760
	8) RD2	P1: -, P2: -, P3: Widening 4L-8L																			2,064	2,064
8. External Public Transport Facilities Works	1) Railway																					
	2) LRT	Venkatachalam - Node													36,250	36,250	36,250	36,250	36,250	36,250	36,250	36,250
9. Major River Bridge Works	1) Road Bridge	6 Lanes (W=34m), 4 Lanes (W=27m)			10,965	10,965	10,965															
	2) LRT Bridge	W=10m													900	900	900	900				
10. Flyover Bridge Works																						
Annual Total (INR Lakh)			0	0	19,513	20,211	23,478	0	0	1,280	1,280	1,280	0	0	37,150	37,150	37,150	37,150	36,250	41,018	44,012	45,668
Phase Total (INR Lakh)			63,201					3,840					315,548									

Source: JICA Study Team

7.1.7 *Cost Estimate*

Based on proposed internal and external node development plans and identified projects, broad cost estimate is carried out for internal and external node development plans as shown in Table 7.20.

Table 7.20: Cost Estimate for Internal and External Node Infrastructures

Item	Description		Unit	Unit Rate	Phase 1(2014-2018)		Phase 2 (2019-2023)		Phase 3 (2024-2023)		Total
					Quantity	Cost	Quantity	Cost	Quantity	Cost	
				(INR Lakh)		(INR Lakh)		(INR Lakh)		(INR Lakh)	(INR Lakh)
ROAD AND PUBLIC TRANSPORT WORKS											
1. Internal Road Works	1) Primary Roads	a) 6 Lanes from 4 Lanes (ROW=44m)	km	120	0.0	0	0.0	0	0.0	0	0
		b) 4 Lanes (ROW=37m)	km	700	4.7	3,290	0.0	0	0.0	0	3,290
		c) Type-Industrial 6 Lanes from 4 Lanes (ROW=50m)	km	120	0.0	0	0.0	0	12.9	1,548	1,548
		d) Type-Industrial 4 Lanes (ROW=43m)	km	850	12.9	10,965	0.0	0	0.0	0	10,965
		e) Type-Residential 6 Lanes from 4 Lanes (ROW=55m)	km	120	0.0	0	0.0	0	0.0	0	0
		f) Type-Residential 4 Lanes (ROW=48m)	km	950	1.6	1,520	0.0	0	0.0	0	1,520
	2) Secondary Roads	a) 4 Lanes (ROW=34m)	km	650	6.9	4,485	18.4	11,960	33.4	21,710	38,155
		b) Type-Residential 4 Lanes (ROW=45m)	km	900	4.4	3,960	2.9	2,610	0.0	0	6,570
	3) Tertiary Roads	a) 4 Lanes (ROW=25.5m)	km	500	10.4	5,200	33.9	16,950	43.1	21,550	43,700
		b) Type-Residential 2 Lanes (ROW=20m)	km	400	4.8	1,920	2.9	1,160	0.0	0	3,080
Total					46	31,340	58.1	32,680	89.4	44,808	108,828
2. Intersection Works	1) At-Grade Intersection (signalized)	a) Cross Type (6*4)	Location	45	1	45	0	0	0	0	45
		b) Cross Type (6*2)	Location	35	0	0	0	0	0	0	0
		c) Cross Type (4*4)	Location	25	16	400	12	300	13	325	1,025
		d) Cross Type (4*2)	Location	18	1	18	0	0	0	0	18
		e) Cross Type (2*2)	Location	10	0	0	0	0	0	0	0
		f) T-Type (6*4)	Location	36	6	216	0	0	0	0	216
		g) T-Type (6*2)	Location	28	0	0	0	0	0	0	0
		h) T-Type (4*4)	Location	20	9	180	7	140	29	580	900
		i) T-Type (4*2)	Location	14	1	14	0	0	0	0	14
		j) T-Type (2*2)	Location	8	2	16	0	0	0	0	16
	2) Grade-separated intersection	a) Diamond Type	Location	1,850	3	5,550	0	0	0	0	5,550
		b) Half Diamond Type	Location	1,480	1	1,480	0	0	0	0	1,480
		c) Flyover with side roads on both sideType	Location	550	0	0	0	0	0	0	0
		d) Flyover with side roads on one side Type	Location	500	4	2,000	0	0	0	0	2,000
		e) Flyover with side road on one side Type	Location	480	0	0	0	0	0	0	0
Total						9,919		440		905	11,264
3. River Bridge Works	1) On Primary Road	a) 6 Lanes (W=34m)	sq.m	0.45	0	0	0	0	0	0	0
		b) 4 Lanes (W=27m)	sq.m	0.45	14,280	6,426	0	0	0	0	6,426
	2) On Secondary Road	4 Lanes (W=26.5m)	sq.m	0.45	5,565	2,504	5,565	2,504	5,565	2,504	7,513
	3) On Tertiary Road	a) 4 Lanes (W=24.5m)	sq.m	0.45	0	0	10290	4,631	0	0	4,631
		b) 2 Lanes (W=17m)	sq.m	0.45	0	0	0	0	0	0	0
Total						8,930		7,135		2,504	18,569
4. Flyover Bridge Works	1) On Primary Road	a) 6 Lanes (W=34m)	sq.m	0.4	0	0	0	0	0	0	0
		b) 4 Lanes (W=27m)	sq.m	0.4	0	0	0	0	0	0	0
	2) On Secondary Road	4 Lanes (W=26.5m)	sq.m	0.4	1,590	636	0	0	0	0	636
	3) On Tertiary Road	a) 4 Lanes (W=24.5m)	sq.m	0.4	0	0	0	0	0	0	0
		b) 2 Lanes (W=17m)	sq.m	0.4	0	0	0	0	0	0	0
Total						636		0		0	636
5. Road Facilities	1) Street Light	a) Dual bulb Type (High-pressure sodium lamp)	pole	1	1,350	1,350	1,822	1,822	2,525	2,525	5,696
		b) Single bulb Type (High-pressure sodium lamp)	pole	0.8	317	253	191	153	0	0	407
	2) Traffic Light	1) Cross Type Intersection	Location	50	18	900	12	600	13	650	2,150
		2) T-Type Intersection	Location	40	18	720	7	280	29	1,160	2,160
	3) Central Traffic Light Control System		l.s	300	1	300	0	0	0	0	300
	4) Utilies Box	h: 1.5mx w: 1.5m, both sides of road, Primary Road only	km	1200	19	23,040	0	0	0	0	23,040
Total						26,563		2,855		4,335	33,752
6. Internal Public Transport Facilities Works	1) Bus Terminal	10 Busbays with 5,000m2	Location	1300	1	1,300	2	2,600	2	2,600	6,500
	2) Bus stop	Bus bay type (A=125m2) x both side	Location	10	41	410	52	520	100	1,000	1,930
	3) Bus Depot	10,000m2	Location	800	1	800	2	1,600	2	1,600	4,000
	4) LRT	Venkatachalam - Node	km	10000	0	0	0	0	12	120,000	120,000
Total						2,510		4,720		125,200	132,430
Grand Total (Internal Node)						79,899		47,829		177,752	305,480
7. External Road Works	1) New Construction	a) 6 Lanes	km	780	0	0	0	0	0	0	0
		b) 4 Lanes	km	600	10	5,700	0	0	0	0	5,700
		c) 2 Lanes	km	360	57	20,340	0	0	0	0	20,340
	2) Widening	a) 6 Lanes to 8 Lanes	km	120	0	0	0	0	0	0	0
		b) 4 Lanes to 8 Lanes	km	240	0	0	0	0	58.7	14,088	14,088
		c) 4 Lanes to 6 Lanes	km	120	0	0	0	0	0	0	0
		d) 2 Lanes to 6 Lanes	km	240	0	0	0	0	0	0	0
		e) 2 Lanes to 4 Lanes	km	120	0	0	32	3,840	65.5	7,860	11,700
		f) 1 Lanes to 4 Lanes	km	180	0	0	0	0	0	0	0
		g) 1 Lanes to 2 Lanes	km	90	22	1,962	0	0	0	0	1,962
Total					88	28,002	32	3,840	124	21,948	53,790
8. External Public Transport Facilities Works	1) Railway		km	600	0	0	0	0	0	0	0
	2) LRT	Venkatachalam - Node	km	10000	0	0	0	0	29	290,000	290,000
Total						0		0		290,000	290,000
9. Major River Bridge Works	1) Road Bridge	6 Lanes (W=34m), 4 Lanes (W=27m)	sq.m	0.45	73,100	32,895	0	0	0	0	32,895
	2) LRT Bridge	W=10m	sq.m	0.45	0	0	0	0	8,000	3,600	3,600
Total						32,895		0		0	36,495
10. Flyover Bridge Works			sq.m	0.4	0	0	0	0	0	0	0
Total						0		0		0	0
Grand Total (External Node)						60,897		3,840		311,948	376,685
Grand Total (Internal and External Node)						140,796		51,669		489,700	682,165

Note:

- Internal road work costing is done for road portion only above the formation level
- Road work cost includes cost of sub base, base, surface courses, median, culverts, minor bridges, drainage, footpath, marking, planting zone etc.

Source: JICA Study Team

Maintenance cost for annual and phase period is estimated as shown in Table 7.21.

Table 7.21: Operation Cost Estimate for Internal Node Infrastructures

Item	Description		Unit	Charges	Phase 1(2014-2018)		Phase 2 (2019-2023)		Phase 3 (2024-2023)		Total
					Annual	Phase Total	Annual	Phase Total	(INR Cr.)	Phase Total	
				(%)	(INR Lakh)	(INR Lakh)	(INR Lakh)	(INR Lakh)	(INR Lakh)	(INR Lakh)	(INR Lakh)
ROAD AND PUBLIC TRANSPORT WORKS											
1. Internal Road Works	1) Primary Roads	Routine maintenance (pot hole repair every year), periodic maintenance (overlay each 5 years)	l.s.	1.0	158	789	158	789	173	866	2,444
	2) Secondary Roads		l.s.	1.0	84	422	230	1,151	447	2,236	3,809
	3) Tertiary Roads		l.s.	1.0	71	356	252	1,262	468	2,339	3,957
2. Road Facilities	1) Street Light		l.s.	5.0	80	401	179	894	305	1,526	2,821
	2) Traffic Light		l.s.	2.5	41	203	63	313	108	539	1,054
	3) Central Traffic Controll Center		l.s.	5.0	15	75	15	75	15	75	225
3. Internal Public Transport Facilities Works	1) LRT		l.s.	1.5	0	0	0	0	1,800	9,000	9,000
Total					449	2,245	897	4,483	3,316	16,581	23,309

Source: JICA Study Team

7.2 *Railways*

7.2.1 *Sector Overview*

The connection of the proposed manufacturing nodes to the railway network will be essential for their commercial viability and competitiveness. Such connections can only be achieved through the development of multimodal transfer terminals, or "Logistics Hubs" within the nodes.

These Logistics Hubs, which are evaluated in detail in the Logistics section of the Final Report, will facilitate the transfer of cargo between road and rail, as well as the handling, storage and, where necessary, customs clearance, of containerized and break-bulk cargo. *They are also the only practical means by which rail can access each node.* Thus the development of the railway network to support the long term viability of the nodes is intertwined with the development of the logistics hubs.

For the Krishnapatnam node, the objective will be to connect the node to the railway network via the existing 19 km double tracked electrified railway line which runs to Krishnapatnam Port from Venkatachalam station on the Chennai-Nellore mainline. The capacity of the port access line, which is equipped with automatic block signalling, is estimated by the port operating company at 60 trains per day in each direction, but could be as much as 80 trains per day in each direction. Current utilization stands at only about 10 trains per direction per day, or about 17% of estimated capacity.

The rail capacity analysis completed as part of Interim Report 2 indicates that even if traffic growth on the port access line reached the BIS level (weighted average of 9.86% per annum), the number of trains operating on the line would barely have reached 60 in each direction by 2032/33, by which time it might be expected that capacity improvements would guarantee a daily throughput of 80 trains per direction day.

All trains operating on the port access line are freight trains, the majority of them coal trains, each consisting of 59 wagons and with an average payload of 3,776 tonnes. The addition of rail traffic generated by the proposed manufacturing node would not cause capacity problems on the port access line since in the final forecast year the number of trains in and out of the node will total only 2 trains per day in each direction.

By contrast, the line capacity analysis undertaken in Interim Report 2 indicated that growth at the accelerated rate of 9.86 per annum (the BIS case) would very quickly absorb the available line capacity on the two track mainline between Nellore and Gudur, leading to the necessity of constructing a third and fourth track within the next 14 years. However some of the pressure on capacity on this section may be relieved by the diversion of some freight trains to the Obulavaripalli - Venkatachalam Line after its completion.

The rail connection to the Krishnapatnam node will be achieved by the construction of a 13.5 km access line (single track, but fully signalled and electrified). This line would separate from the Port Access mainline somewhere before the entrance to the port marshalling yard. A preliminary layout diagram for this access line is given in Section 7.2.2 below.

7.2.2 *Principles for design of rail nodal accesses*

The need to apply efficient railway operating practices will be a major determinant of the size and layout both of the nodal access lines and the logistics hubs. The involved principles are common across all three nodes and were discussed in Annexure 7.2 on Design Methodology for Access Lines and Logistics Hubs.

Foremost among these needs are:

- the need to operate long freight trains between the nodes and designated origins or destinations;
- the need to maintain the integrity of these trains (by banning their break-up or re-marshalling at enroute stations);
- the need to use electric traction for the haulage of these trains; and

- the need to limit enroute delays to technical stops for crew changes or other operational purposes.

These are principles which are already widely applied by Indian Railways, and they need to be observed in the design of railway accesses to the nodes and in the design of logistics hubs.

As is the case with the other nodes, Krishnapatnam can be expected to generate only two types of rail traffic*: containers and break-bulk steel*. The composition and lengths of container and steel trains are given in Table 7.22 below.

Table 7.22: Krishnapatnam Node - Train Composition and Length

Train Type	Vehicle Type	No. in consist	Length over couplers (metres)	Overall length (metres)
Containers	WAG 9 electric loco	1	20.50	20.50
	BLCA container flat	45	14.63	658.13
	Brake van	1	15.00	15.00
	Total			693.63
Steel	WAG 9 electric loco	1	20.50	20.50
	BFNS steel wagon	45	14.72	662.22
	Brake van	1	15.00	15.00
	Total			697.72

The use of electric locomotives will require that full length trains are pushed back, rather than pulled, into the hubs, because the operation of high lift cargo handling equipment prevents the complete overhead wiring of the loading/unloading sidings within the hubs. For this purpose, long reception sidings must be provided outside the hubs to permit locomotives to run around and push back their trains.

In all cases, two such reception sidings will be provided, in addition to the running line, in order to accommodate two trains at a time. The average railway traffic density at Krishnapatnam is projected at 2 trains in and 2 trains out per day, with little probability that two trains would occupy the sidings at the same time, but two siding tracks will be provided in order to allow for future traffic. Based on the train specifications in Table 7.22, the length of the siding tracks between turnouts (switches) will be 752 metres, which will accommodate the train lengths plus some allowance for braking.

7.2.3 *Features of rail nodal access design at Krishnapatnam*

The Krishnapatnam logistics hub will be located near the northern boundary of the node. It will be rail connected by a single track electrified access line which will separate from the Venkatachalam-Krishnapatnam Port line about 4km to the west of the port. From its junction with the mainline to the entrance to the proposed logistics hub, the nodal access line will have a length of 13.5 km.

The two reception sidings, to be provided either side of the running line, will be located just outside the hub boundary. Care was taken to ensure sufficiently wide curve radii on the approach to the node, consistent with the operation of long and heavy trains. It will be observed that the tightest curve on the line is 1,831 metres.

The layout of the access line, showing its relationship to the logistics hub and the reception sidings is given in Figure 7.40..

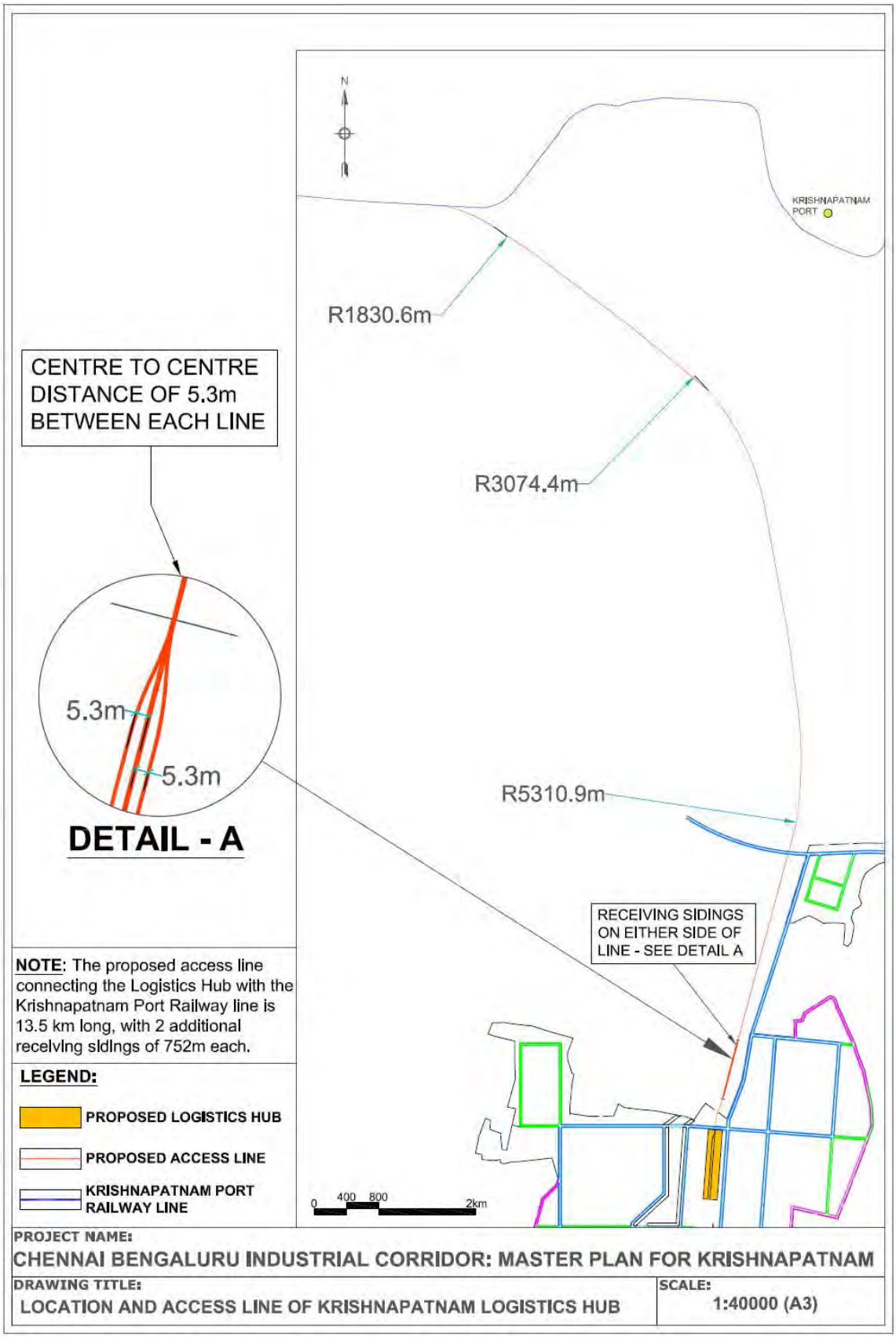


Figure 7.40: Krishnapatnam Node – Layout of proposed rail access line and reception sidings

7.2.4 *Expected difficulty of construction*

A recent inspection of the site of the node revealed no particular difficulties for construction of the access line. As shown in Figure 7.41 and Figure 7.42 エラー! 参照元が見つかりません。, the terrain surrounding the site of the Krishnapatnam node is flat and sufficiently above the water table to allow railway construction without difficulty.

Figure 7.41: Krishnapatnam Node - View facing North

Figure 7.42: Krishnapatnam Node - View facing South

7.2.5 *Demand Forecast*

The demand forecast for Krishnapatnam as in the case of the other two nodes, was based on input/output forecasts prepared by the Industry Planning team.

below presents the forecasts of the rail modal volume and share used as a basis for scaling the rail facilities at Krishnapatnam.

Table 7.23: Krishnapatnam Node – Forecast Rail share of container and break bulk freight volume

Traffic category	2017/18	2022/23	2027/28	2032/33
Containers				
- Loaded inbound (TEU)	528	907	1,557	2,674
- Loaded outbound (TEU)	12,355	21,216	36,431	62,559
- Empty Inbound (TEU)	11,827	20,309	34,874	59,885
Total	24,710	42,431	72,862	1,25,118
Containers - rail volume				
- Loaded inbound (TEU)	528	907	1,557	2,674
- Loaded outbound (TEU)	6,211	10,665	18,314	31,449
- Empty Inbound(TEU)	0	0	0	0
Total	6,739	11,572	19,872	34,123
Containers - rail share (%)				
- Loaded inbound (TEU)	100%	100%	100%	100%
- Loaded outbound (TEU)	50%	50%	50%	50%
- Empty Inbound (TEU)	0%	0%	0%	0%
Total	27%	27%	27%	27%
Breakbulk				
- Inbound (tonnes)	4,68,967	8,05,300	13,82,845	23,74,594
- Outbound (tonnes)	1,90,649	3,27,378	5,62,167	9,65,341
Total	6,59,615	11,32,678	19,45,012	33,39,935
Breakbulk - rail volume				
- Inbound (tonnes)	92,192	1,58,310	2,71,847	4,66,810
- Outbound (tonnes)	0	0	0	0
Total	92,192	1,58,310	2,71,847	4,66,810
Breakbulk - rail share %				
- Inbound	20%	20%	20%	20%
- Outbound	0%	0%	0%	0%
Total	14%	14%	14%	14%
Petrochemicals - inbound pipeline	77,012	1,32,243	2,27,084	3,89,945

A key feature of these forecasts is that inbound empty container volumes are expected to comprise nearly 50 per cent of annual TEU volumes. This is due to the extreme imbalance between flows of loaded containers, with loaded inbound containers representing only a small fraction of loaded outbound. While it is likely that a large proportion of outbound freight will be transported from the node in containers, only a small volume of inputs, comprising raw cotton from Nagpur for textile production, will be transported in containers. Thus there will be a need to re-position empty containers for re-loading in the node.

It is likely that Krishnapatnam Port will provide a source of empty containers since its imports of loaded containers will exceed its exports (in other words, the opposite of the container balance expected in the node). The proximity of the port to the node suggests that all re-positioned containers would be carried by road.

A relatively high share (40%) of Krishnapatnam's output is expected to be exported through the port, suggesting that a high percentage of outbound containers will be carried to the port by road. The rail share of outbound containers will be maintained at about 50% by the dominance of rail in the long haul transportation of containers to domestic destinations. Outbound break-bulk volumes from Krishnapatnam are expected to be relatively high owing to the concentration of output volume moved by road to Chennai and other short haul destinations.

Rail will transport (in break-bulk form) 50% of the steel input tonnage to the node, probably from Bellary. The other 50% which is not reflected in the above table since it would by-pass the logistics hub would be transported

by road from Krishnapatnam Port. Road will have the major share of inbound break-bulk tonnage, since it will dominant the transport of food grains for the food processing industry, all from local sources. Realization of the above forecast TEU and break-bulk tonnage volumes for rail will translate, on average, to one outbound container train, and one inbound and one outbound steel train, per day by 2032/33.

7.2.6 *Cost estimate*

Connection of Krishnapatnam node to the rail network will require construction of an electrified access line (running from the existing Venkatachalam-Port mainline) with reception sidings for an overall length of 15.0 track km.

The unit construction cost of single electrified line, equipped with automatic block signalling, was estimated at Rs. 53 million per km. This cost was derived from the quoted costs of recent new line construction projects. The overall cost, at current prices, of the access line and reception sidings would therefore be Rs.795.21 million as shown in Table 7.24 below.

Table 7.24: Krishnapatnam Node - Capital Cost for construction of Access Lines

Access Line	
Length (km)	13.500
Unit construction cost (million Rs/km)	53.00
Total cost (million Rs)	**715.50**
Reception sidings	
Length (km)	1.504
Unit construction cost (million Rs/km)	53.00
Total cost (million Rs)	**79.71**
TOTAL	
Length (km)	15.004
Unit construction cost (million Rs/km)	53.00
Total cost (million Rs)	**795.21**

7.2.7 *Development plan*

Construction of the access track should be completed in time to allow trains to run to and from the Tumkur node in early 2018, coinciding with the scheduled commencement of manufacturing activity. It should be possible to carry out the construction works within the two year period 2015/16-2016/17.

As indicated in Annexure B of this report which discusses the principles to be applied to rail and logistics hub development, the responsibility for financing the construction of the access lines and reception sidings should rest with the SPV company which will develop the node.

The investment in the construction of these facilities could be recovered in the land rent to be paid by the hub operator who would also be responsible for organizing rail transport, for paying haulage charges to IR and possibly also for investment in container wagons. The hub operator in turn would pass on these costs to freight customers in the form of consolidated rail haulage charges.

To demonstrate how such a system would work, an assessment was made of the components of these consolidated charges. Although the rate of land rent has yet to be determined, it was assumed that this would be set at a level which would at least recover the track capital and maintenance costs, as shown in Table 7.24 and Table 7.25 below.

Table 7.25: Krishnapatnam Node - Recovery of railway capital, haulage and maintenance charges for Containers

Charge component	2017/18	2022/23	2027/28	2032/33
Net haulage charge - containers (Rs. per ntk)	1.0200	1.0200	1.0200	1.0200
Investment in access line and reception sidings (Rs. per ntk)*	0.0654	0.0381	0.0222	0.0129
Access track maintenance (Rs. per ntk)*	0.0571	0.0451	0.0382	0.0342
Container wagon investment (Rs. per ntk)	0.0210	0.0194	0.0174	0.0175
Container wagon maintenance (Rs. per ntk)	0.0143	0.0132	0.0118	0.0119
Total charge (Rs. per ntk)	**1.1779**	**1.1359**	**1.1096**	**1.0966**
Sources: (1) MOR Statistical Statements				
(2) Consultant's Train Cost Model				
* Calculated across total ntk generated by the node (containers plus steel)				

Table 7.26: Krishnapatnam Node – Recovery of railway capital, haulage and maintenance charges for Steel

Charge component	2017/18	2022/23	2027/28	2032/33
Net haulage charge - steel (Rs.per ntk)	1.1900	1.1900	1.1900	1.1900
Investment in access line and reception sidings (Rs.per ntk)*	0.0654	0.0381	0.0222	0.0129
Access track maintenance (Rs. per ntk)*	0.0571	0.0451	0.0382	0.0342
Total charge (Rs. per ntk)	**1.3125**	**1.2732**	**1.2504**	**1.2371**
Sources: (1) MOR Statistical Statements				
(2) Consultant's Train Cost Model				
* Calculated across total ntk generated by the node (containers plus steel)				

In the case of steel traffic, IR is responsible for the supply and maintenance of wagons. Hence the only addition to haulage charges to be paid by steel customers would be the rate per net tonne-km necessary to recover access track capital and maintenance costs.

7.3 *Logistics*

7.3.1 *Sector Overview*

The establishment within each node of intermodal transport terminals, or Logistics Hubs, will be an important part of a strategy to minimize the logistics costs and maximize the competitiveness of the manufacturing enterprises within the nodes. These Logistics Hubs will facilitate the transfer of cargo between road and rail, as well as the handling, storage and, where necessary, customs clearance, of containerized and break-bulk cargo. They are also the only practical means by which rail can access each node. The same is not true of road transport which can access individual manufacturing establishments within the nodes, via a dense network of local roads which will be provided in each node. Thus, rail connections to the nodes are inextricably linked to the operation of Logistics Hubs and will to a large extent determine the component facilities and layouts of the latter.

By facilitating the transfer of cargo between road and rail, the hubs will blend the capacities of each mode to minimize transport costs over relatively short and long distances respectively. It is expected that the logistics hubs will be designed to handle only container and break-bulk cargo, or in other words, cargo which can be moved in unitized lots (containers, pallets, or bundles).

7.3.2 *Principles for design of logistics hubs*

In all cases, logistics hubs will be located as close as possible to the geographic centre of the manufacturing industries to be established in the node.

The central feature of each node will be a set of railway sidings for the loading/unloading of containers and the unloading of break-bulk steel. In the Krishnapatnam hub, it is proposed to have one track for the loading/unloading of containers and one for the unloading of steel. These tracks must allow for the receipt and dispatch of full length unit trains running between a single origin and a single destination, without being broken up or re-marshalled.

Standard trains lengths are 694 metres (an electric locomotive plus 45 BLCA wagons and a brakevan) for container trains and 698 metres (an electric locomotive plus 45 BFNS wagons and a brakevan) for steel trains. Accordingly, the clear standing length required in the loading/unloading tracks is 700 metres. In the Krishnapatnam hub it will be necessary to install overhead wiring in the first 154 metres of lead track into the steel siding and about 150 metres into the container siding, to allow electric locomotives to push their trains into the loading/unloading tracks.

The steel and container handling areas will be separated by a chain link fence, and provided with their own security controlled entrances.

In the Krishnapatnam hub, a paved container yard will be provided on one side of the container siding track to allow the discharge and loading of wagons by reach-stacker equipment. The track would be embedded in pavement to allow cargo handling equipment to work both sides of a train at the same time, if in future it becomes necessary to add a second track. In the steel handling area, a single storage yard will be provided adjacent to the steel siding track and an internal road. The siding track would also be embedded in pavement although top lifting forklifts will work on one side of the train at a time.

In the case of both container and steel trains, handling equipment would work along a frontage of 600 metres. The CY and steel storage areas are assumed to be dimensioned with lengths of 600 metres and 400 metres respectively. Their widths are determined by the projected cargo volume in the last year of the forecast period (2032/33).

As in the case of the other nodes, in Krishnapatnam, the required capacity of the CY was determined as a function of average container dwell times and peak arrival rates in the final forecast year, as well as the number

of container tiers in the stacks. With an assumption of 3 high stacking of loaded containers 5 high stacking of empty containers, the required number of ground-slots was calculated as 234 TEU.

The CY configuration best corresponding to this requirement is 27 stacks each with a ground area of 4 x 3 TEU, equivalent to 178 square metres. Each stack will be separated by a 13 metre aisle for the operation of reach-stackers. The overall dimensions of the CY will be 600 m x 18.3 m = 10,980 m². In the Krishnapatnam hub, the container stacks will be 3 TEU deep, giving a width of 18.3 metres.

Roadways will be provided on either side of the rail sidings to allow direct transfer of containers and steel between wagons and road trailers or trucks. The width of these roadways will be 15 metres, sufficient to permit trucks and trailers to pass sections where reach-stackers or toplifters are working.

Other facilities to be provided within each hub include: a Container Freight station (CFS -for the stuffing/unstuffing and of containers and for customs inspection of container cargo); a long term warehouse for storage of cargo beyond the free period of 3 days; a two storey administration building with additional space for rental by service providers, such as freight forwarders; a trailer park; a workshop for the container repair and for the maintenance of cargo handling equipment; a railway maintenance store, and gatehouses (for security at both entrances to the hub).

The design of the CFS is based on the assumption that it will handle 40% of the CY throughput of loaded TEU – i.e. that 40% of the loaded TEU volume will be stuffed or unstuffed in the CFS (the balance of 60% being handled at factories located within the node). The area of the CFS will be determined by the number of TEU expected to be handled within the turn time of the container stacks in the final forecast year multiplied by a discharged cargo area of 29.7 metres per TEU, with the addition of 20% for forklift movement areas.

Since the long term warehouse was expected to store about half of the CFS cargo volume, the area of the warehouse was estimated to be half that of the CFS.

7.3.3 *Demand forecast*

The nodal cargo forecasts were further broken down to derive forecasts for the CFS and warehouse components of the logistics hub, as shown in Table 7.27 below.

Table 7.27: Krishnapatnam Logistics hub - Throughput

Category	2017/18	2022/23	2027/28	2032/33
Loaded inbound (TEU)	528	907	1557	2674
Empty inbound (TEU)	11827	20309	34874	59885
Loaded outbound (TEU)	12355	21216	36431	62559
Empty outbound (TEU)				
Total (TEU)	24710	42431	72862	125118
CFS t/put (40% of loaded container volume)-TEU	5153	8849	15195	26093
Breakbulk handling in CFS - inbound tonnes	3063	5260	9032	15510
Breakbulk handling in CFS - outbound tonnes	97866	168053	288577	495538
Steel handling in CY -tonnes	92192	158310	271847	466810
Sub-total (Tonnes)	193121	331623	569456	977859
Overtime storage volume in CFS and steel yard (5% of total tonnage)	9656	16581	28473	48893
Other L.T. storage volume (20% of CFS volume)	20186	34663	59522	102210
Reefer storage volume (50% of L.T. storage volume)	10093	17331	29761	51105

In particular, it was assumed that:

- 40% of the CY throughput of loaded TEU will be stuffed or unstuffed in the CFS;
- Long term warehouse storage volume (Cubic metres) will represent about 20% of total break-bulk volume handled in the CFS;

- Reefer storage volume will represent half of the Long Term warehouse storage volume.

7.3.4 *Features of Krishnapatnam logistics hub design*

The proposed layout of the Krishnapatnam logistics hub is given in Figure 7.42. The design assumptions and specifications are indicated in Table 7.28 below.

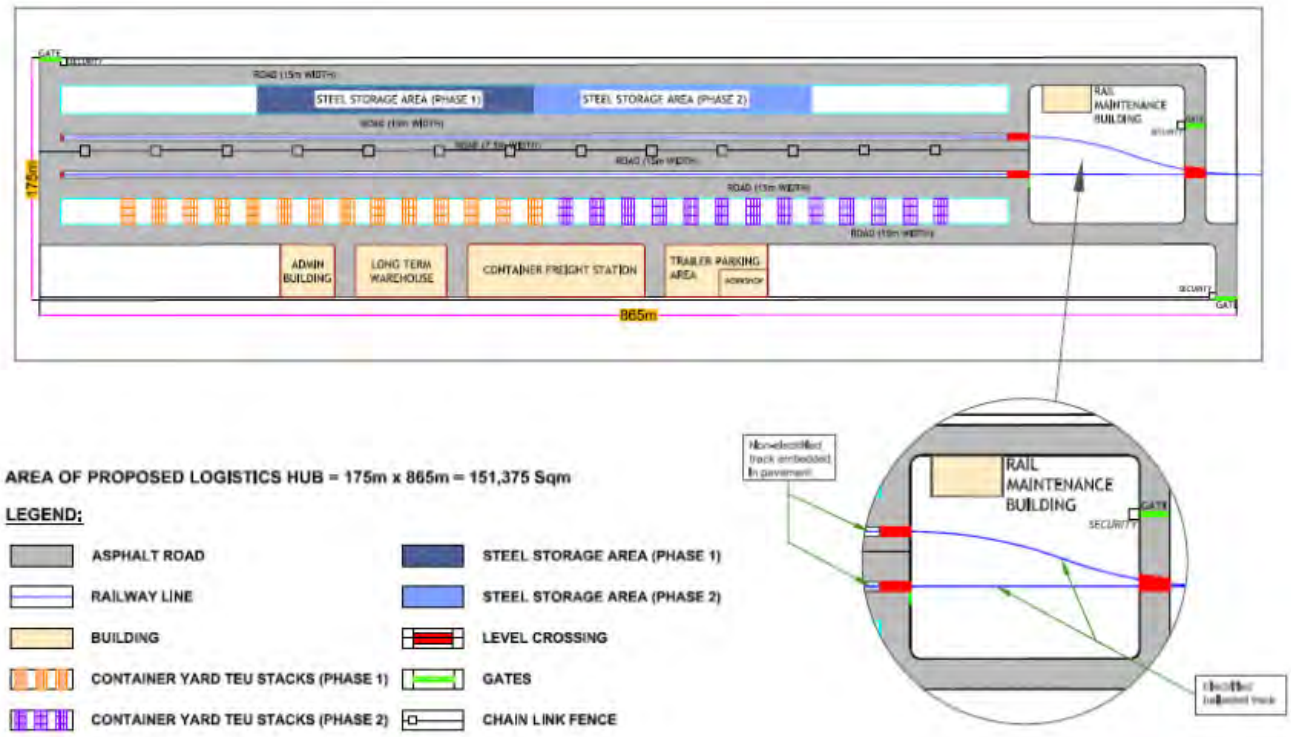


Figure 7.41: Krishnapatnam Logistics Hub - Layout

Table 7.28: Krishnapatnam Logistics Hub - Specifications

Areas of hub components (square metres)	
Container Yard (CY) (10,980 x 1)	10,980
Steel storage yard	8,000
Container Freight Station (CFS)	4,848
Long Term Warehouse	2,500
Trailer Park (including W/shop and Security)	2,800
Administration Building	1,500
Rail Maintenance Store	700
Rail sidings	7,669
Internal roads	68,394
Not utilised	43,984
TOTAL	**151,375**
CY specifications/productivity	
Ground slots (No.)	325
Average stack height (TEU)	3.96
Capacity (TEU)	1,286
Container dwell times (days) :	
Loaded outbound	1.5
Loaded inbound	3.0
Empty inbound	3.0
Peak arrival factor	120%

7.3.5 *Cost and revenue estimates*

(i) Capital cost estimates

Cargo handling equipment productivity rates and unit purchase costs were obtained from similar projects in India in order to calculate the physical requirement and cost of equipment acquisition, Similarly, unit construction costs were obtained from comparable projects in India for application to the areas of the different hub components in order to estimate the Civil Work cost of the hub construction. These cost estimates, together with an indication of sources, are given in Table 7.29 below.

Table 7.29: Krishnapatnam Logistics Hub - Capital Cost Estimates

	Phase 1			*Phase 2*			*Total*		
Item	**Area (Sqm) (or) Length (m)**	**Cost per sqm (or) per km (Rs.)**	**Total cost (mn Rs.)**	**Area (Sqm) (or) Length (m)**	**Cost per sqm (or) per km (Rs.)**	**Total cost (mn Rs.)**	**Area (Sqm) (or) Length (m)**	**Cost per sqm (or) per km (Rs.)**	**Total cost (mn Rs.)**
Land rent (TBD)	-	-	-	-	-	-	-	-	-
CY & internal roads	79,684	2,047.51	163.15	9,490	2,047.51	19.43	89,174	2,047.51	182.58
Railway sidings (a)			104.32			-			104.32
- paved area	6,300	4,000	25.20	-	4,000	-	6,300	4,000	25.20
- length embedded	1,400	450,00,000	63.00	-	450,00,000	-	1,400	450,00,000	63.00
- length electrified plus ballasted	304	530,00,000	16.12	-	530,00,000	-	304	530,00,000	16.12
Buildings									
- Admin Building	1,500	19,625.41	29.44				1,500	19,625.41	29.44
- CFS	4,848	13,083.61	63.43				4,848	13,083.61	63.43
- L.T. warehouse	2,500	21,587.95	53.97				2,500	21,587.95	53.97
Security/gatehouse	300	13,083.61	3.93				300	13,083.61	3.93
Workshop	700	18,317.05	12.82				700	18,317.05	12.82
Railway maint.store	700	18,317.05	12.82				700	18,317.05	12.82
Sub-total (Buildings)			176.41			-			176.41
Utilities			27.92			1.22			29.14
Sub-total (Bldgs and Infra)			*471.80*			*20.65*			*492.45*
Equipment	**No. (units)**	**Cost per unit (mn Rs)**		**No. (units)**	**Cost per unit (mn Rs)**		**No. (units)**	**Cost per unit (mn Rs)**	
Reachstackers (b)	2	30.00	60.00		30.00	-	2	30.00	60.00
Forklifts for CFS	4	1.01	4.05	6	1.01	6.08	10	1.01	10.13
HD Forklifts	3	6.08	18.23		6.08	-	3	6.08	18.23
Prime movers and trailers (c)	2	3.38	6.75	1	3.38	3.38	3	3.38	10.13
Weighing scales	2	0.61	1.22		0.61	-	2	0.61	1.22
Pallet trolleys	7	0.04	0.26	8	0.04	0.29	15	0.04	0.55
Conveyors			6.34						6.34
Racking system			0.86						0.86
Sub-total			*97.71*			*9.74*			*107.45*
Misc.fixed assets									
Consultancy fee (3%)			17.09			0.91			18.00
Contingency (4%)			22.78			1.22			24.00
Total			***609.37***			***32.53***			***641.90***

Sources for costs

a) Ministry of Railways (Adviser Infrastructure) 13/11/2014

b) Cost of Hyster TIL reach stacker from CONCOR 03/07/2014

c) Second hand prices from OLX.in

All other prices and rates are from the "Emerging Kerala 2012 Logistics Park proposal"

The construction of the hub will be phased. During Phase 1, from 2015/16 – 2025/26 half of the steel yard, the entire steel siding, half of the container yard, the entire container siding, and all buildings will be constructed. In Phase 2, from 2026/27 – 2032/33, the remaining halves of the steel yard and of the container yard will be added. Equipment will be added when justified by demand.

(ii) Capital expenditure profile

The capital expenditure profile for the project, which reflects the phasing of the Civil Works cost as explained below:

Table 7.30: Krishnapatnam Logistics Hub - Capital Expenditure Profile (2014 constant prices)

Units: Million Rs.

Year	Fixed assets	Cargo handling equipment	Net outflow	Consultancy fee (3% of net outflow)	Contingency allowance (4% of net outflow)	Total Consultancy and Contingency	Gross outflow
2015/16	235.90	0.00	235.90	7.08	9.44	16.51	252.41
2016/17	235.90	93.17	329.07	9.87	13.16	23.04	352.11
2017/18	0.00	0.04	0.04	0.00	0.00	0.00	0.04
2018/19	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2019/20	0.00	0.04	0.04	0.00	0.00	0.00	0.04
2020/21	0.00	1.01	1.01	0.03	0.04	0.07	1.08
2021/22	0.00	3.38	3.38	0.10	0.14	0.24	3.61
2022/23	0.00	0.04	0.04	0.00	0.00	0.00	0.04
2023/24	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2024/25	0.00	0.04	0.04	0.00	0.00	0.00	0.04
2025/26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2026/27	20.65	2.10	22.75	0.68	0.91	1.59	24.34
2027/28	0.00	1.05	1.05	0.03	0.04	0.07	1.12
2028/29	0.00	3.41	3.41	0.10	0.14	0.24	3.65
2029/30	0.00	1.09	1.09	0.03	0.04	0.08	1.16
2030/31	0.00	0.04	0.04	0.00	0.00	0.00	0.04
2031/32	0.00	2.06	2.06	0.06	0.08	0.14	2.21
2032/33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2033/34	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2034/35	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2035/36	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2036/37	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	**492.45**	**107.45**	**599.90**	**18.00**	**24.00**	**41.99**	**641.90**

Phase 1

Phase 2

(iii) O&M costs

Operating and maintenance costs for the hub include: the wages costs of operating staff, the salary costs of administrative and management staff, and the maintenance costs of fixed assets (pavements, railway sidings, and buildings) and equipment. For the estimation of wages and salaries cost, the staff ratios to throughput for a comparable project in India were used to calculate the numbers of staff in each category. The resulting workforce numbers were then multiplied by unit wage and salary costs from the same source to derive the total wages and salary costs for the hub.

The maintenance costs of fixed assets and equipment were calculated as a percentage of the cumulative investment in each category. For this purpose 1% was assumed for fixed assets and 2% for cargo handling equipment.

The resulting stream of wages and salaries and maintenance costs over the forecast period to 2032/33 is given inTable 7.31 and Table 7.32 respectively.

Table 7.31: Krishnapatnam Logistics Hub - Estimates of Wage and Salary Costs (2014 values)

Year	Total operating staff (No.)	Annual Wages Cost (Mn Rs.)	Total salaried staff (No.)	Annual Salary Cost (Mn Rs.)	Total Salaries plus wages (Mn Rs.)
2015/16					
2016/17					
2017/18	84	11.67	22	10.33	22.00
2018/19	84	11.67	22	10.33	22.00
2019/20	84	11.67	22	10.33	22.00
2020/21	84	11.67	22	10.33	22.00
2021/22	93	12.92	24	11.27	24.19
2022/23	99	13.76	26	12.21	25.96
2023/24	99	13.76	26	12.21	25.96
2024/25	99	13.76	26	12.21	25.96
2025/26	99	13.76	26	12.21	25.96
2026/27	99	13.76	26	12.21	25.96
2027/28	108	15.01	28	13.15	28.15
2028/29	117	16.26	30	14.08	30.34
2029/30	123	17.09	32	15.02	32.12
2030/31	132	18.34	34	15.96	34.31
2031/32	132	18.34	34	15.96	34.31
2032/33	141	19.60	36	16.90	36.50
2033/34	141	19.60	36	16.90	36.50
2034/35	141	19.60	36	16.90	36.50
2035/36	141	19.60	36	16.90	36.50
2036/37	141	19.60	36	16.90	36.50
TOTAL		311.44		272.29	583.74
Unit Wages Cost (per annum), Rs.			1,38,975		
Unit Salaries Cost (p.a.), Rs.			4,69,473		

Table 7.32: Krishnapatnam Logistics Hub - Estimates of Fixed Asset and Equipment Maintenance Costs (2014 values)

Year	Fixed asset cumulative investment (Mn Rs.)	Cost of fixed asset repair and maintenance. (Mn Rs.)	Equipment cumulative investment (Mn Rs.)	Cost of equipment repair and maintenance. (Mn Rs.)
2015/16				
2016/17				
2017/18	471.80	4.72	93.17	1.86
2018/19	471.80	4.72	93.21	1.86
2019/20	471.80	4.72	93.21	1.86
2020/21	471.80	4.72	93.25	1.86
2021/22	471.80	4.72	94.26	1.89
2022/23	471.80	4.72	97.63	1.95
2023/24	471.80	4.72	97.67	1.95
2024/25	471.80	4.72	97.67	1.95
2025/26	471.80	4.72	97.71	1.95
2026/27	471.80	4.72	97.71	1.95
2027/28	492.45	4.92	99.81	2.00
2028/29	492.45	4.92	100.85	2.02
2029/30	492.45	4.92	104.27	2.09
2030/31	492.45	4.92	105.35	2.11
2031/32	492.45	4.92	105.39	2.11
2032/33	492.45	4.92	107.45	2.15
2033/34	492.45	4.92	107.45	2.15
2034/35	492.45	4.92	107.45	2.15
2035/36	492.45	4.92	107.45	2.15
2036/37	492.45	4.92	107.45	2.15
TOTAL		96.43		40.17
R&M cost % of cum. inv.-fixed assets			1.0%	
R&M cost % of cum. inv.-equip.			2.0%	

(ii) *Revenue*

Revenue rates for each services provided within the logistics hub were obtained from a comparable project in India. These were escalated to 2014 values and then applied to the relevant throughput values to derive annual revenue amounts. The following revenue assumptions were made.

- Av. No. lifts/TEU (Assume 40% require 1 lift and 60% require 2 lifts) = 1.6
- Average cargo storage beyond 3 days (days) = 2
- Average cold storage, days = 7
- Charge per lift (Rs. per TEU) = 500
- Stuffing/unstuffing (Rs. per TEU) = 1500
- Break bulk handling (Rs. per tonne) = 116.99
- Overtime CFS storage (Rs. per tonne per day beyond 3 days) = 175.48
- Office lease rental (Rs. per square metre per month) = 314.81
- Cold storage rental (Rs. per cubic metre per day) = 20.66
- Warehouse rental (Rs. per square metre per year) = 3022.14
- Area available for warehouse rental, square metres = 3750

The calculation bases and resulting revenue flows are given in Table 7.33 below.

Table 7.33: Krishnapatnam Logistics Hub - Estimated Revenue Flows (2014 values)

Fiscal years	CY volume	No. of lifts pa	CY container lifting revenue, Mn Rs.	CFS stuffing/ unstuffing volume. TEU	CFS revenue, Mn Rs.	Break bulk handling volume, tonnes	Break bulk handling revenue, Mn Rs.	Overtime storage volume, tonnes	Warehouse storage revenue, Mn Rs,	Cold storage revenue, Mn Rs.	Warehouse rental space, Sqm	Warehouse rental income, Mn Rs.	Office rental space, Sqm	Office rental income, Mn Rs.	Total Revenue Mn Rs.
2017/18	24710	39536	19.77	5153	7.73	193121	22.59	9656	3.39	1.46	3750	11.33	500	1.89	68.16
2018/19	28254	45207	22.60	5892	8.84	220821	25.83	11041	3.87	1.67	3750	11.33	600	2.27	76.42
2019/20	31798	50878	25.44	6632	9.95	248522	29.07	12426	4.36	1.88	3750	11.33	700	2.64	84.68
2020/21	35343	56548	28.27	7371	11.06	276222	32.31	13811	4.85	2.09	3750	11.33	800	3.02	92.93
2021/22	38887	62219	31.11	8110	12.16	303922	35.55	15196	5.33	2.30	3750	11.33	900	3.40	101.19
2022/23	42431	67890	33.95	8849	13.27	331623	38.80	16581	5.82	2.51	3750	11.33	1000	3.78	109.45
2023/24	48518	77628	38.81	10118	15.18	379190	44.36	18959	6.65	2.87	3750	11.33	1100	4.16	123.36
2024/25	54604	87366	43.68	11388	17.08	426756	49.92	21338	7.49	3.22	3750	11.33	1200	4.53	137.27
2025/26	60690	97104	48.55	12657	18.99	474323	55.49	23716	8.32	3.58	3750	11.33	1300	4.91	151.18
2026/27	66776	106842	53.42	13926	20.89	521889	61.05	26094	9.16	3.94	3750	11.33	1400	5.29	165.09
2027/28	72862	116580	58.29	15195	22.79	569456	66.62	28473	9.99	4.30	3750	11.33	1500	5.67	179.00
2028/29	83313	133301	66.65	17375	26.06	651137	76.17	32557	11.43	4.92	3750	11.33	1560	5.89	202.46
2029/30	93764	150023	75.01	19554	29.33	732817	85.73	36641	12.86	5.54	3750	11.33	1620	6.12	225.92
2030/31	104215	166745	83.37	21734	32.60	814498	95.28	40725	14.29	6.16	3750	11.33	1680	6.35	249.39
2031/32	114666	183466	91.73	23914	35.87	896178	104.84	44809	15.73	6.77	3750	11.33	1740	6.57	272.85
2032/33	125118	200188	100.09	26093	39.14	977859	114.40	48893	17.16	7.39	3750	11.33	1800	6.80	296.31
2033/34	125118	200188	100.09	26093	39.14	977859	114.40	48893	17.16	7.39	3750	11.33	1800	6.80	296.31
2034/35	125118	200188	100.09	26093	39.14	977859	114.40	48893	17.16	7.39	3750	11.33	1800	6.80	296.31
2035/36	125118	200188	100.09	26093	39.14	977859	114.40	48893	17.16	7.39	3750	11.33	1800	6.80	296.31
2036/37	125118	200188	100.09	26093	39.14	977859	114.40	48893	17.16	7.39	3750	11.33	1800	6.80	296.31
Total (20 years)			1221.14		477.50		1395.61		209.34	90.15		226.66		100.49	3720.89

Source: Emerging Kerala 2012 Logistics Park proposal

(iii) *Revenue and O&M cost comparison*

The comparison of the revenue and O&M cost streams, shown in Table 7.34, indicates a healthy surplus of revenue over costs for the Krishnapatnam Logistics Hub.

Table 7.34: Krishnapatnam Logistics Hub - Comparison of Revenue with O&M costs

Year	Wage costs (operating labour) Mn Rs.	Salary costs (admin and customs personnel) Mn Rs.	Fixed asset repair and maintenance, Mn Rs.	Equipment repair and maintenance, Mn Rs.	Administrative overhead, Mn Rs.	Total O&M cost, Mn Rs.	Total revenue, Mn Rs.	Net revenue, Mn Rs.
2017/18	11.67	10.33	4.72	1.86	5.72	34.30	68.16	33.86
2018/19	11.67	10.33	4.72	1.86	5.72	34.30	76.42	42.12
2019/20	11.67	10.33	4.72	1.86	5.72	34.30	84.68	50.37
2020/21	11.67	10.33	4.72	1.86	5.72	34.30	92.93	58.63
2021/22	12.92	11.27	4.72	1.89	6.16	36.95	101.19	64.24
2022/23	13.76	12.21	4.72	1.95	6.53	39.16	109.45	70.29
2023/24	13.76	12.21	4.72	1.95	6.53	39.16	123.36	84.20
2024/25	13.76	12.21	4.72	1.95	6.53	39.16	137.27	98.11
2025/26	13.76	12.21	4.72	1.95	6.53	39.16	151.18	112.01
2026/27	13.76	12.21	4.72	1.95	6.53	39.16	165.09	125.92
2027/28	15.01	13.15	4.92	2.00	7.02	42.09	179.00	136.91
2028/29	16.26	14.08	4.92	2.02	7.46	44.74	202.46	157.72
2029/30	17.09	15.02	4.92	2.09	7.83	46.95	225.92	178.97
2030/31	18.34	15.96	4.92	2.11	8.27	49.61	249.39	199.78
2031/32	18.34	15.96	4.92	2.11	8.27	49.61	272.85	223.24
2032/33	19.60	16.90	4.92	2.15	8.71	52.28	296.31	244.03
2033/34	19.60	16.90	4.92	2.15	8.71	52.28	296.31	244.03
2034/35	19.60	16.90	4.92	2.15	8.71	52.28	296.31	244.03
2035/36	19.60	16.90	4.92	2.15	8.71	52.28	296.31	244.03
2036/37	19.60	16.90	4.92	2.15	8.71	52.28	296.31	244.03
TOTAL (20 YEARS)	311.44	272.29	96.43	40.17	144.07	864.40	3720.89	2856.49
Admin overhead rate		20%						

7.3.6 *Development plan*

Construction of the logistics hub should be completed to coincide with the commencement of manufacturing activity in early 2018. Construction would be undertaken within the two year period 2015/16-2016/17 and initial equipment acquisition within 2016/17.

Responsibility for construction would rest with the hub operator selected by a process of competitive bidding. Financing of the project with an initial capital cost estimated at Rs.641.90 million would be provided from equity funds (60%) and a Japanese ODA loan (40%).

7.4 *Power*

7.4.1 *Sector Overview*

The historical trend of power requirement in the three states – Karnataka, Andhra Pradesh and Tamil Nadu was analyzed. Electricity demand forecasts for the Business as Usual (BAU) scenario was made based on the latest 18th EPS (Electric Power Survey). The EPS used the base year of FY 2009-10, deviations from the actual data observed for the years FY 2011 to FY 2013 were revised. With a massive investment coming up in the Chennai Bangalore Industrial Corridor (CBIC), accelerated scenario was also considered. Further the electricity demand was classified for each state across domestic, commercial, industrial, agricultural, transportation and miscellaneous. Upcoming power projects were analyzed to estimate the supply of power in short term in three states. Demand and supply gap was analyzed with focus on capacity addition plans to assess the power position of the states.

Table 7.35: Demand and supply gap analysis in the various scenarios

Scenario	Year	Demand (MW)	Supply (MW)	Gap (MW)
Current	FY2013-14	35,223	27,310	7,913
Short Term	FY2017-18	42,548	50,680	(8,132)
Mid Term	FY2022-23	64,324	-	13,644
Long Term	FY2032-33	147,948	-	97,268

It is imperative that the generation growth required for the plant be matched with corresponding growth in distribution and transmission sector. The transmission infrastructure development plans comprise of plans for meeting the generation capacity additions, system strengthening, reducing congestion, establishing point to point evacuation links from generating plants etc. Karnataka's state transmission utility, KPTCL added 31,539 km of transmission lines in FY 13 and proposes to add a similar quantum in the short term. The state transmission utility of Tamil Nadu, TANTRANSCO has planned for approximately USD 1,667 million of transmission investment over the next 2 years. Andhra Pradesh's state transmission utility, AP Transco, has undertaken various system strengthening and augmentation projects in the recent past, with a capital expenditure of more than USD 817 million over the past 4 years.

To support the growing power requirement of the state, AP power distribution companies (APEPDCL and APSPDCL) have constantly endeavored to increase their sub-transmissions and distribution capacity in-line with load requirements. In addition to planned capital expenditure to meet the present power scenarios, new capacity enhancements are planned to provide reliable and uninterrupted supply in line with the states promise of providing 24x7 power supply to all domestic consumer. As part of the sub transmission network strengthening and capacity augmentation, additional infrastructure is planned to be commissioned in the next five years at a cost of INR 6,542 Cr. With the overall objective of reducing technical losses in the distribution system to below 7% in all towns and Mandal HQs, various initiatives are planned at a cost of INR 343 Cr.[36]

7.4.2 *Framework of Infrastructure*

Needs of a consumer

In order to design a robust city power infrastructure from ground's up, it is critical that we understand the needs of the prospective consumers that would be based out of the upcoming node. For example, in large industries like textile, automobiles etc. energy forms almost 20-25% of the total operating costs (second only to raw material costs). In such a case, the attractiveness of the node to industrial consumers would primarily depend on continuous availability of quality and cost-effective electricity. This section captures key consumer

[36] http://powermin.nic.in/upload/pdf/joint_initiative_of_govt_of_india_and_andhrapradesh.pdf

expectations from power supply perspective. *(Source: Primary interactions with state industrial associations, 2014):*

1. Reliability: A consumer establishing a base in the node would need round the clock electricity so as to avoid usage of local back-up power supply sources like diesel sets etc. that would increase consumer' capital burden and also have a higher environmental impact. The design philosophy is built around the objective that all consumers in the node will have access to round the clock quality power.

2. Quality: Many industries like textile, telecom etc. use sensitive voltage regulated equipment. In case the power supply from the utility is of poor quality (voltage instability, interruptions etc.), the life of such equipment can be affected. In such cases, installations of voltage regulators/UPS etc. are additional capital costs that the consumers' needs to incur. Hence, ensuring the quality of supply for all consumers has been a key consideration in the infrastructure design.

3. Affordability: The desired levels of reliability and efficiency have to be balanced through optimum pricing of the electricity that is within industry benchmarks. The consumer would want electricity tariffs that are affordable for the overall business operations. The high costs can prompt consumers to look for open access procurement making the present distribution network plans redundant. In extreme situations, this could also lead to consumer relocation to a more favorable node/area. The overall cost of electricity is dependent on a number of external and internal factors and is under regulatory purview. However, from a design perspective, there has been a constant focus on avoiding unnecessary capital expenditure without impacting the other design considerations.

4. Safety: Equipment failures are one of the most prevalent reasons for hazards to consumer property/life. A consumer would want, in all cases, that the network should have automatic procedures to protect him from hazards like fire/short circuits etc.

5. Customer Service: A consumer wants that the utility should be responsive to his queries/problems. In the present system of private utilities in metros like Delhi, consumers are aware of the best practices in customer management like internet based payment, grievance management cells, pre-payment discount based billing, independent kiosks for customer grievance resolutions etc. It would be the expectations of all consumers coming into the node that these basic facilities should be provided from the distribution utility.

6. Sustainability: Nowadays the element of sustainability forms an integral part of all power systems design. This means that the power generation /transmission/distribution should be done in a manner to have least carbon consumption. For generation it may mean installing more renewable based plants. However for transmission it may mean effective voltage level regulation or for distribution it can mean installation of smart grid for consumers and keeping losses within prescribed limits.

Needs from power systems

Corresponding to these consumer needs, a power system would need to have the following features:-

1. Redundancy of operations – As consumer needs dictate that the system should be available round the clock enough redundancy in the operations needs to be built in for supply assurance. For transmission it can mean designing the system such that for every line failure, the system can assure power to affected consumers via 2 different routes (N-2 principle) or for distribution it may mean ring main interconnections of feeders as well as sub stations.

2. Maximum efficiency– The system should have minimal losses for the node. Considering the transmission and distribution loss levels in the country exceed 25% on an average across utilities *(Source: "The Performance of State Power Utilities for the years 2010-11 to 2012-13", PFC report),* the node should target maximum increase in efficiency. We have seen utilities like TPDDL and BSES have been able to reduce Aggregate Technical and commercial losses to less than 11% in large area like Delhi. Considering that we are using new equipment and smart technology for implementation in the node, the target for the node should be to achieve at least 8-10% losses in the phase II.

3. Integration with multiple sources of supply: The proposed power system would need to seamlessly integrate with the in-node distributed renewable energy sources. With the envisioned increase of renewable energy share in India's power generation, there would be similar renewable capacity additions within the proposed node and hence integration issues would be of prime importance. It is therefore essential to preemptively address any such issues during the design stages itself. Introduction of smart distribution control systems would provide the much needed flexibility to manage the entire power value chain.

4. Integrate operations on IT platform for maximum efficiency: With the development of power systems, the power grid within a control area, becomes much more complicated due to increasing number of nodes and renewable energy interconnections. An integrated power system control center is essential in maintaining system reliable and security operations. Use of latest information and communication technologies would provide a platform to enhance the functions and performance of power system control center. Smart power dispatch concept will be the trend of future control center development. This needs to be enabled in the current design of the node.

5. Transmission system stability: Majority portion of the investment in India's transmission sector are directed towards construction of new transmission lines and substation. Whereas spending towards the improvement of the stability of the system is low. It is our expectation that the state power transmission company would increase the investment in the region surrounding the node, which shall improve the quality of the electricity transmission and efficiency.

Needs from generators

Corresponding to consumer as well as power system features the power generators would need the following features:-

1. Operational Flexibility: Conventional power plants supplying power to the node should be able to cater to variations in demand and use of renewable source integrated into the grid. This would mean running at varying loads as per the use of energy by industries and other consumers.

2. Energy Efficiency: The design of the power plant should make generation fuel efficient at any load. This would mean getting more energy from the same amount of fuel and ensuring sustainability of power generation.

3. Fuel flexibility: Power generation plants should be designed in a way that cascading plants can lead to use of multiple sources of generation including gaseous and liquid fuels, including biofuels. Smart plants should be able to switch from one fuel to another without stopping.

7.4.3 *Design Conditions*

Considering the varying stakeholder expectations, the infrastructure design conditions have been prescribed upfront for the various network components.

Grid Substation

The grid substation design can broadly be segregated across primary and secondary equipment base. While primary equipment would be on the input side, the secondary equipment on the distribution side of the substation.

Primary equipment

The key design expectations from the substation primary equipment will cover the following:

1. Reliability: Controllability of power transfer, high efficiency, improvement in carrying capacity, increased situational awareness, redundancy improvement.

2. Safety: Limitation of touch and step potential (voltage), risk of fire or explosion, avoidance of unauthorized users or intrusion by continuous surveillance, and seismically qualified equipment.

3. Environmental impact: Site-adapt aesthetic, lowering above-ground level, limitation of electromagnetic and electric field, low level of noise emission, and use of waste recycling.

4. Flexibility: Plug-and-play design, integrated compact design, low level of maintenance and easier operation.

5. Footprint: minimum technical losses as possible.

6. Costs: low cost equipment, minimized life-cycle cost.

Secondary equipment

The secondary equipment design will mainly focus on the following criteria:

1. Reliability: Secondary equipment should be integrated and compact. The secondary functions should have extensive communication, typically done using fiber optics, coaxial cables and wireless means. The protections devices should be available as redundant systems which can work independently of each other.

2. Interoperability: the implementation of IEDs should allow seamless communication within secondary system, as well as interfacing to network management system. The communication protocols should allow for interoperability between different IEDs that communicate among themselves

3. Controllability: improved local manual and automatic functions, achieve high speed response in real-time.

4. Re-configurability: future changes, upgrades and retrofits are simplified and can be done with minimal time and effort (manpower).

5. Economic Benefits: green-field substation design should take into account energy market participation, profit optimization and system operation risk reduction in a combined consideration.

With the focus on the above needs and CERC and state regulatory guidelines, following conditions would have to fulfill by the proposed system design.

Distribution network

In distribution, the location of the sub stations should be such that it caters to the rising demand of the node in an efficient manner. Technical considerations of the state dictate that any 11kV line should not exceed 5-10 Kms in length. Similar is the consideration in case of LT level line which can't exceed more than 500 meters to enable technical losses reduction for the state. This dictates the location of the sub stations to be nearer to the consumption point.

Distribution networks in India incur a loss of more than 10% on electricity transmission from nearest distribution sub-station to the consumption point. This is the key reason that metropolitan cities are now moving to underground systems for transmission of electricity. From a design perspective, the key to designing an ideal smart network is to meeting the consumer needs from the infrastructure. Based on the consumer needs in Section 2 (Design Philosophy), a distribution network needs to have the following features for success:-

1. Easy maintenance – Distribution networks are prone to outages due to local constraints. In such systems, the ability of the utility to easily maintain the system is one of the prime criteria for new system installations.

2. Stability - Indian power sector is experiencing a rapid growth in the renewable energy share, especially from solar and wind sources. For this node, while wind energy would not be generated inside the node,

there are possibilities of solar based distributed generation across the geographic spread of the node. It therefore becomes essential to utilize the unpredictable renewable supply, both from inside the node and outside, while balancing the expectation of reliability and cost. As already mentioned earlier, smart grid interventions would need to be implemented for better integration.

3. Fast installation and operation – Ease of installation and operation of the system is also an important criterion for designing the distribution network.

4. Maintains the ambience of the node – With development of infrastructure, the ambience of the node also is a criterion for selection of any distribution network.

5. Can be automatically controlled via a control center – With multiple utilities integrating, power systems should also be able to integrate with the system and controlled via a common control center.

On these parameters, underground distribution networks are assessed:-

Advantages of underground distribution network	Disadvantages of underground distribution network
Joint-Use – Underground utilities can utilize a joint-use trench and reduce the overall construction costs of a project. A single trench commonly shared by all utilities will result in lower construction costs. Customer installed conduit, duct bank and manholes can also reduce the cost to install utilities underground.	**Costs** – Underground utilities have higher installation costs typically in the range of 1.5 times to 2 times the overhead cables. However with sharing across utilities the cost can come down when considering the Lifecycle cost.
Increased Public Safety – Burying utilities can reduce the potential for fatalities and injuries as well as outages as a result of contact with overhead conductors. In addition, burying utilities can eliminate the potential for fatalities and injuries as a result of collisions of vehicles	**Cable Failures/Repair Costs** – It is more difficult and time consuming to repair subsurface utilities. Also, Property owners provide unauthorized screening of pad-mounted equipment and underground cables.
Aesthetics – A primary reason to bury overhead utilities is aesthetic. Aesthetic benefits include increased property values by preserving the natural beauty of the land, more attractive streetscapes with greater pedestrian activity, and a better quality of life. The one time investment of undergrounding produces aesthetic rewards for generations. Undergrounding results in fewer poles and improved pedestrian access.	**Excavation** – Disruption in service can occur as private property or lawns are excavated. However this may not be applicable green field projects.

Figure 7.42: Underground distribution network: Characteristics

From the assessment, underground distribution networks present a better case for the node as compares to conventional distribution network. It is operated through a RMU (Ring Main unit) which is an individual switchgear unit to handle medium level distribution. This is placed on top of a tray which is feeding the incomers for the distribution network. The outcomers from the RMU are being fed into the consumer transformers for consumption. Please refer to the annex on the illustrative diagrams of the network for the node.

The distribution network will follow the following design conditions in line with the industry standards:

1. Maximum loading for the substations is considered as 80%, remaining 20% would be as spare capacity, thus increasing operational flexibility

2. 'Ring Main Unit' designing is considered while designing the distribution network, which would increase reliability

3. Underground cabling system would ensure safety against storms and other environmental problems. It would also increase the aesthetics and looks

4. Monitoring and automation thorough SCADA, load balancing and fault monitoring activities would be some of the key design conditions

5. The technical losses, for the various network component, will follow the following norms:

Table 7.36: Loss level for the node power network

System level	Loss % (Min-Max)
Step-up transformers & EHV transmission system	0.5% - 1.0%
Transformation to intermediate voltage level, transmission system & step down to sub-transmission voltage level	1.5% - 3.0%
Sub-transmission system & step-down to distribution voltage level	2.0% - 4.5%
Distribution lines and service lines	3.0% - 7.0%
Total	**7.0% - 15.5%**

The overall network design has been done based on the aforementioned design principles.

7.4.4 *Demand Forecast*

Existing gap in infrastructure

The demand is estimated to be spread across three key categories – Industrial, Domestic and Others including lighting, commercial etc. The table below demonstrates phase I, phase II and Phase III power demand estimate for the node.

Table 7.37: Power demand estimates for various years, PwC analysis

Category	FY 2017	FY 2019	FY 2022	FY 2025	FY 2028	FY 2031	FY 2033
Industrial (MW)	20.82	62.47	124.94	187.41	249.88	312.34	353.99
Residential (MW)	2.24	7.60	18.30	33.06	53.10	79.95	102.58
Others (MW)	4.90	14.69	29.37	44.06	58.74	73.43	83.22
Total expected demand (MW)	27.95	84.75	172.61	264.53	361.72	465.72	539.79
Diversity Factor (DF)*	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Maximum demand (MD)	19.57	59.33	120.83	185.17	253.20	326.01	377.85

From the estimates in phase I around 28 MW of demand is expected in the node. However, in phase II this demand is expected to increase to 230 MW. This is due to rise in industries and corresponding domestic demand coming up in the region. In Phase III the demand is expected to stabilize around 540 MW for the region as industry growth in the node also stabilizes. Assumptions made for the forecasting of the demand are mentioned in Appendix.

Considering the supply numbers, existing sub stations have minimal spare capacity for any load coming from new industry growth. Hence, due to the segmented nature of the available capacities across sub stations, it is imperative that the node creates fresh infrastructure in order to sustain for coming 20 years.

Table 7.38: Gap assessment for the node

Category	FY 2017	FY 2019	FY 2022	FY 2025	FY 2028	FY 2031	FY 2033
Maximum demand (MD)	19.57	59.33	120.83	185.17	253.20	326.01	377.85
Total available capacity as per existing infrastructure (MW)	5.50	5.50	5.50	5.50	5.50	5.50	5.50
Usable capacity for the node	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Demand for which system needs to be designed (MW)	19.57	59.33	120.83	185.17	253.20	326.01	377.85

In phase II it would be required power infrastructure to cater to the demand of almost 165 MW. This will increase to 378 MW in phase III.

Table 7.39: Scenarios for design gap (MW), PwC analysis

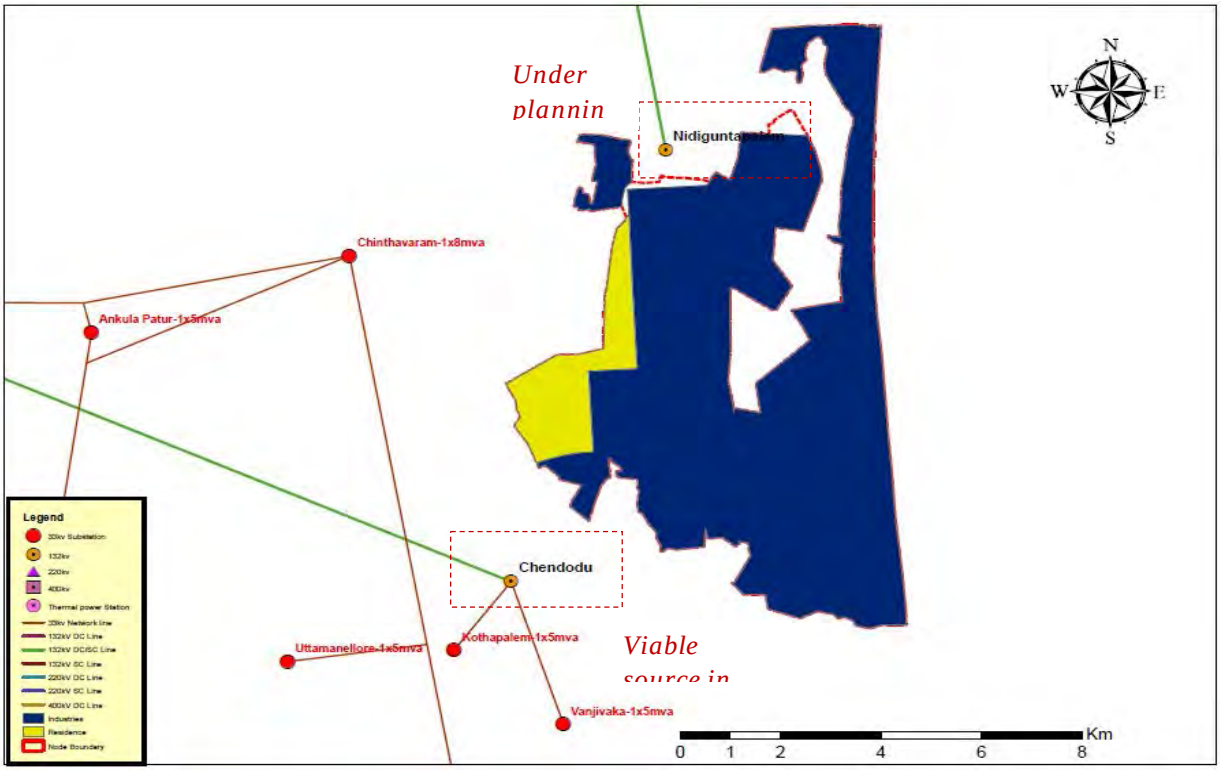
Category	Total Demand (MW)	Maximum gap for system design (MW)
Phase I (2019)	84.75	59.33
Phase II (2024)	233.37	163.36
Phase III (2032)	539.79	377.85

Considering the philosophy for design, it would be required to have varying strategies for meeting existing and upcoming demand. In phase I considering that the expected demand is close to 85 MW, this can be met by present system of the utilities with marginal outside additions. However, in phase II and III, it would be required to have sizable additions from outside in order to ensure round the clock power to the node.

7.4.5 *Development Plan*

Available sources for meeting the gap

Considering technical considerations (length of 11kV feeders), only two substations (Chendodu- 132kV 2x 150 MVA S/S and proposed Nidiguntapalem- 132kV 2x150 MVA) form a viable source of power for the node. However, considering that Nidiguntapalem S/S is under planning phase currently, we expect Chendodu S/S to meet the bulk of existing requirements of the node.



However, when we assess the current loading of the sub-station (Chendodu-132kV, 5MVA S/S), we see that only 33% of the S/S is available currently for the node demand.

Table 7.40: Available capacity for the node

Name of the substation	PTR Capacity (MVA)	Peak Loading (MVA)	Available Capacity (MVA)	Available Capacity (MW)
Chendodu – 132kV 5 MVA	1 X 150 MVA	84	63	50.40

This would be insufficient for phase II and hence would need up gradation from the transmission utility. This would be critical in the phase II plan for meeting power demand in the node.

In the phase II, with augmentation of the Chendodu S/S and upcoming Nidiguntapalem- 132kV, entire Phase II demand can be met. This would also be sufficient for phase III demand. However, the transmission utility should ensure that the timelines of the project can be met and adequate arrangements can be made for allocation of capacity for the node.

Sub-station requirement

For the distribution network, the additional sub stations should ensure that the power availability is ensured for the consumers. Hence, the S/S should be able to meet the upcoming demand in medium as well as phase III. Typically, we have distribution substations in the range of 33kV/11kV with capacities varying from 2x8 MVA capacity of handling load. Taking this in mind, we can design the optimal number of distribution sub stations required for meeting the demand.

Table 7.41: Distribution sub-station requirement (Nos.)

Characteristics	2016-19	2020-24	2025-32
Total demand expectation for system design (MW)	59.33	163.36	351.56
System design for 80% loading condition in the node	74.16	204.20	439.45
System power factor	0.80	0.80	0.80
Total installed capacity (MVA)	92.70	255.24	549.31
Capacity of each distribution sub-station (MVA)	16	16	16
Additional distribution sub-station requirement (Nos.)	6	10	18

Also, considering the high demand coming in the region, we also propose installation of a Main Receiving Sub Station (MRSS) in the region that would feed the other distribution sub stations. This would be based on GIS based technology and would be owned and operated by transmission utility of the state.

Table 7.42: Transmission sub-station requirement (Nos.)

Characteristics	Phase I	Phase II	Phase III
Total installed capacity (MVA)	92.70	255.24	549.31
Current Transmission Capacity with augmentation of Chendodu S/S (MVA)	20	20	20
Proposed addition in transmission capacity (MVA)	0	300	600
Key characteristics of transmission S/S	2 X 150 MVA, 220/ 33 kV Gas Insulated Sub-station for the region		

The plan for distribution and transmission capacity augmentation would ensure that for any consumer (industry/commercial/domestic/other) the node would have adequate infrastructure for ensuring the availability of electricity. This MRSS (Main Receiving Substation) would either be fed through a direct 220 kV line from the generation station or would be fed from a new designed transmission sub-station outside the node.

Location and tapping points

In distribution, the location of the sub stations should be such that it caters to the rising demand of the node in an efficient manner. Technical considerations of the state dictate that for any 11kV line should not exceed 5-10 Kms in length. Similar is the consideration in case of LT level line which can't exceed more than 500 meters to enable technical losses reduction for the state. This dictates the location of the sub stations to be near the consumption point.

For the purpose of the designing, each sub-station should be able to handle 20 MVA load from upcoming demand. These sub stations are located as per the following characteristics:-

1. The location needs to be close to higher demand areas of the node (typically industries)
2. The locations should be optimized to ensure that internal network is minimized for cost optimization
3. The phasing of the sub stations should be such that tapping points are covered initially and then progressively, we can look into flow of demand into the node to ensure optimality in design.

Further, the locations of the sub stations have been proposed based on the available spare capacity in the existing transmission network as below:-

1. In the phase I, the input flow would be from the Chendodu 132 kV S/S into the proposed sub-station S-6 for fulfilling phase I demand of the node.

2. In the phase II, the 132kV feeder from Chendodu S/S as well as 132kV from proposed Nidiguntapalem (2x150 MVA) would feed the Main Receiving Sub Station (MRSS) in the node which in turn would feed 33/11kV sub stations.

3. In the phase III, the 132kV feeder from Chendodu S/S as well as 132kV from developed Nidiguntapalem (2x150MVA) would feed the Main Receiving Sub Stations (MRSS) in the node which in turn would feed 33/11kV sub stations as well as newly developed sub stations.

The following is proposed to be the input-output characteristics of the feeders from S/S in the node:-

Table 7.43: Line characteristics (I/O configurations)

Sub Station	Input	Output
Chendodu (132kV , 2X 150 MVA transmission S/S)	Gudur S/S, 132kV DC/SC Line	MRSS bay (132kV S/C Line)
Nidiguntapalem (132kV, 2x150 MVA transmission S/S)	Brahmadevam S/S , 132kV, DC/SC Line	MRSS bay (132kV S/C Line)
Main Receiving Sub Station (MRSS) within the node	Chendodu, Nidiguntapalem S/S-132kV	Distribution S/S (S1 to S34) – 33kV
Sub-Stations (1-34)	MRSS Bay (33kV) Chendodu, Nidiguntapalem S/S-132kV	5 X 11kV feeder for consumers

The following section describes the interconnections diagrammatically for reference. The subsequent pictorials show indicative locations of the proposed substations across the short (phase I), medium (phase II) and long term (phase III) in line with the proposed demand growth.

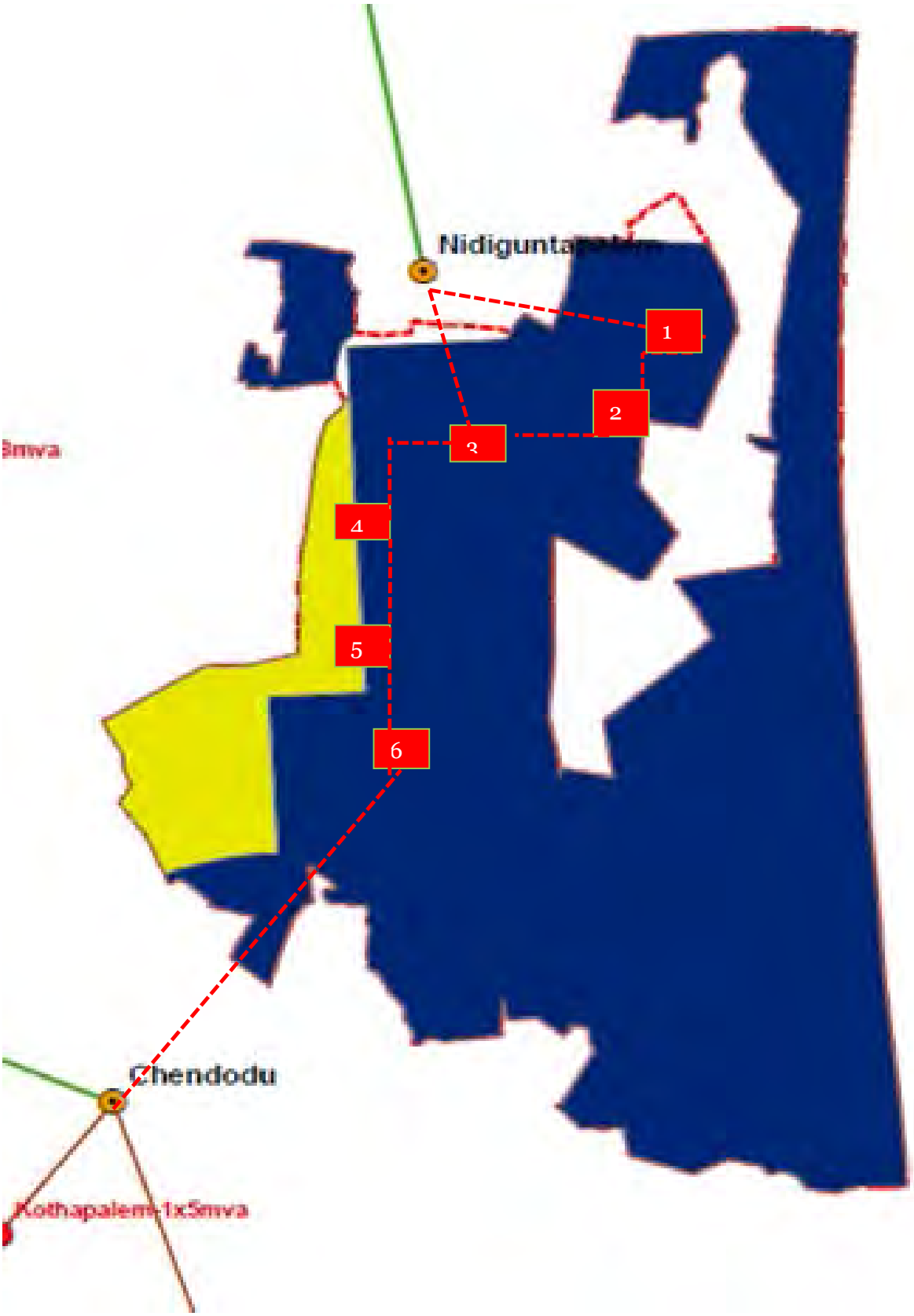


Figure 7.44: Sub-station locations for Phase I

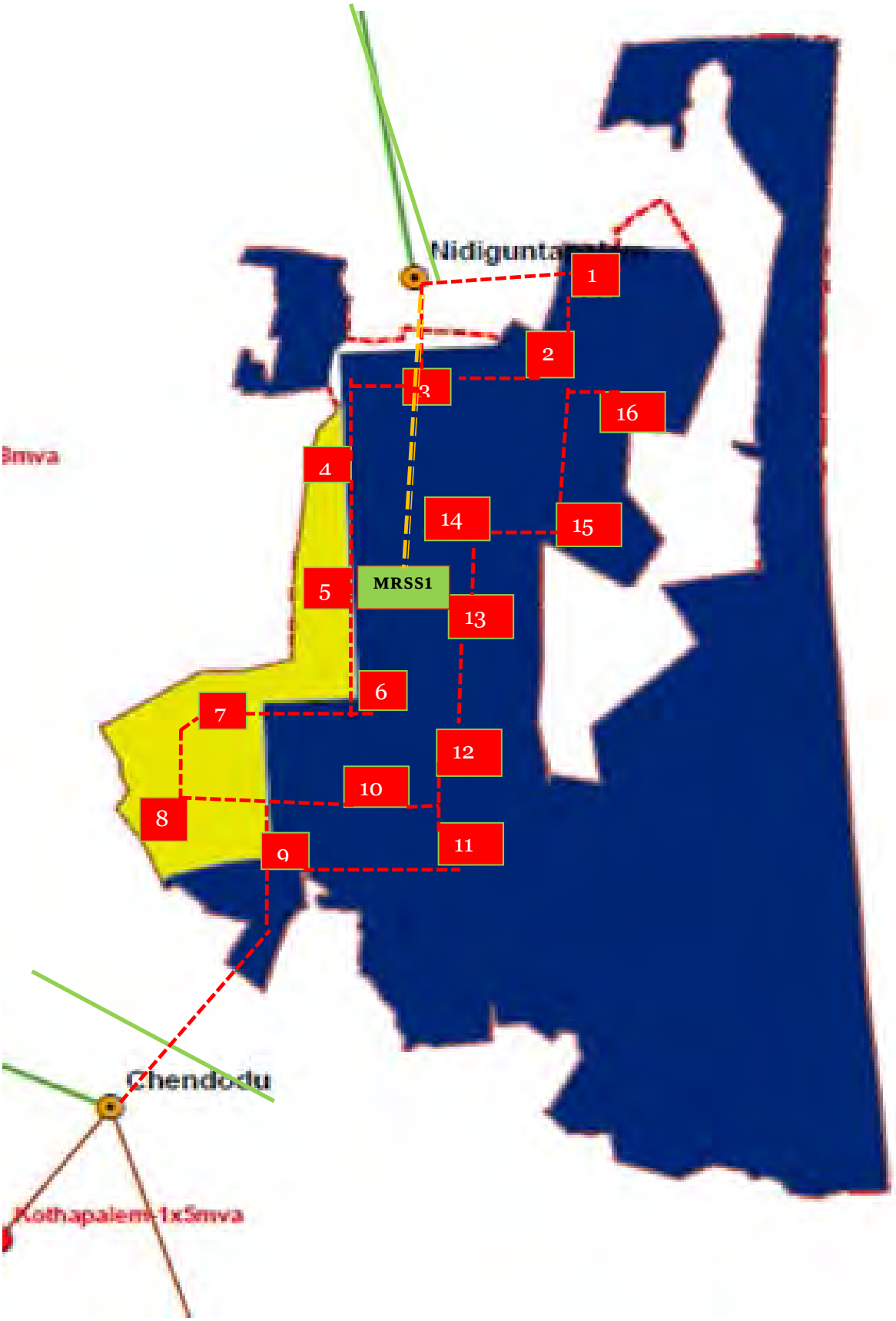


Figure 7.45: Sub-station locations for Phase II

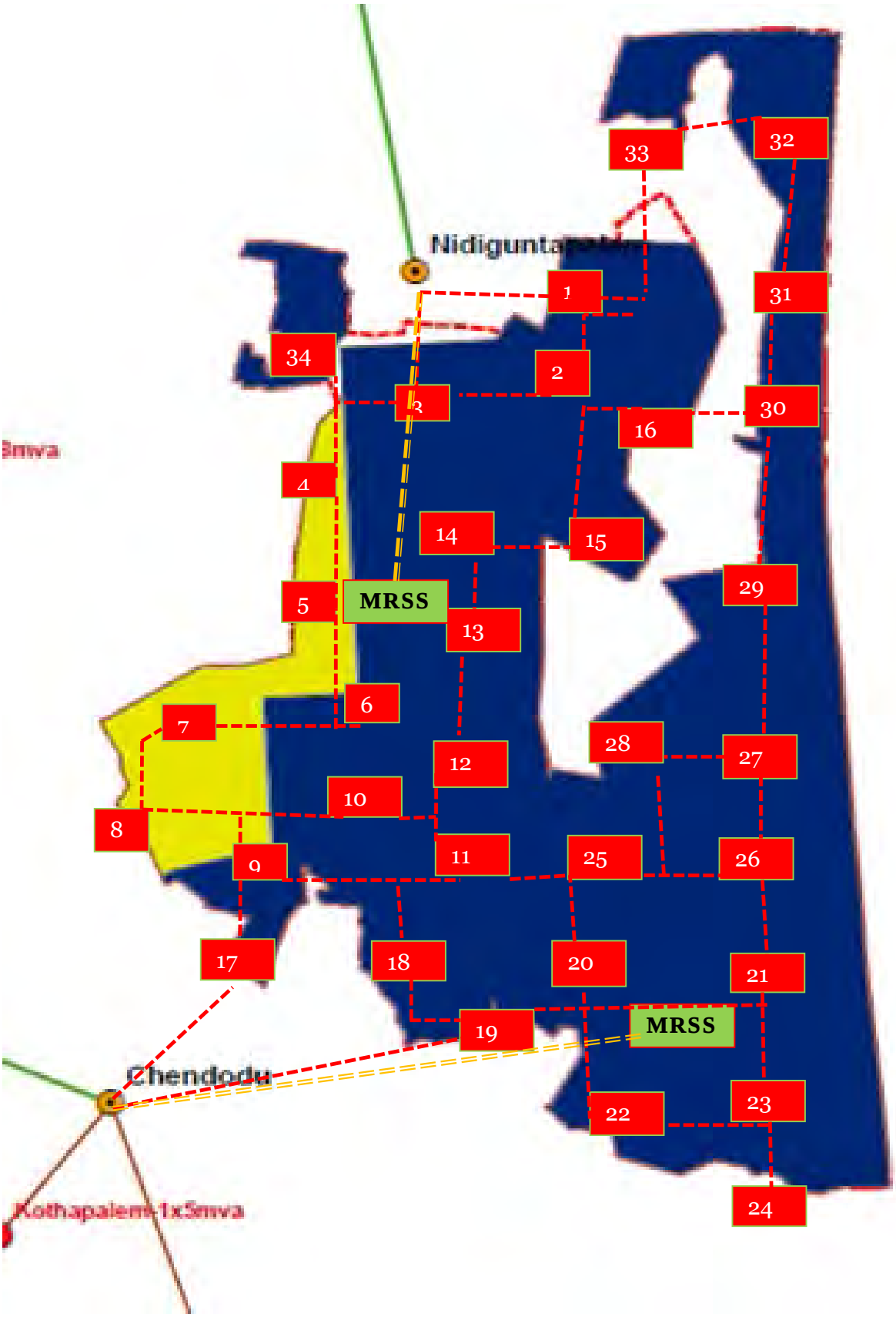


Figure 7.46: Sub-station locations for Phase III

The figures above shows the proposed locations of the sub stations for optimal energy distribution for consumers. The Main Receiving Sub Stations (MRSS) for the node will act as transmission interface for the node and would be connected to a transmission sub-station in the vicinity of the node by transmission utility. In the phase III we will have 18 more sub stations coming up in the area. The locations of these stations would be dependent upon the demand growth post the phase II. Hence, it would not be possible to ascertain with certainty the locations of these 18 sub stations in the present assessment. However tentative locations are proposed in this report.

Land requirement for proposed substations

The land requirement of the sub stations can be determined by taking standard area requirement per sub-station. As per industry norms, the following is the land requirement for sub stations:-

Table 7.44: Standard land requirement for sub-stations

Characteristics	Area requirement (Sq. Mts.)
Distribution sub-station (33/11kV) – 1 X 20 MVA	2020
Transmission receiving sub-station- 2x150MVA, 220/33kV GIS Based sub-station	24,280

As per the sub –station requirement, we see that the land requirement for distribution and transmission infrastructure would be as follows:-

Table 7.45: Land requirement for sub stations

Characteristics	Phase I	Phase II	Phase III
Additional Distribution infrastructure	12,120	20,200	36,360
Additional Transmission infrastructure	0	24,280	24,280
Incremental land requirement from distribution and transmission perspective	12,120	44,480	60,640
Cumulative land requirement	12,120	56,600	1,17,240

In the phase I we would need close to 12,120 Sq. mt. of area for the distribution infrastructure. This would increase to close to 56,600 Sq. mt. of area for distribution and transmission infrastructure in the phase II and stabilize to 1,17,240 Sq. mt. in the phase III.

Input/output line interconnections

Based on the design philosophy, underground networks are chosen for implementation on the nodes on primary roads. These networks would be in the form of 11kV feeders from substations to consumer end. The network would flow along with road sides. Based on the master plan, primary roads have been chosen for 11kV main feeders as well as distribution transformers. On secondary roads, lower voltage lines like 440V etc. are being proposed. The actual route of these secondary road lines will be dependent upon the distribution utility and the actual node infrastructure development. The map below shows the proposed distribution network superimposed on the master plan for road. This also details down the key feeders from each sub-station. Kindly note that in underground networks, electricity lines are kept separate from with gas lines for safety reasons.

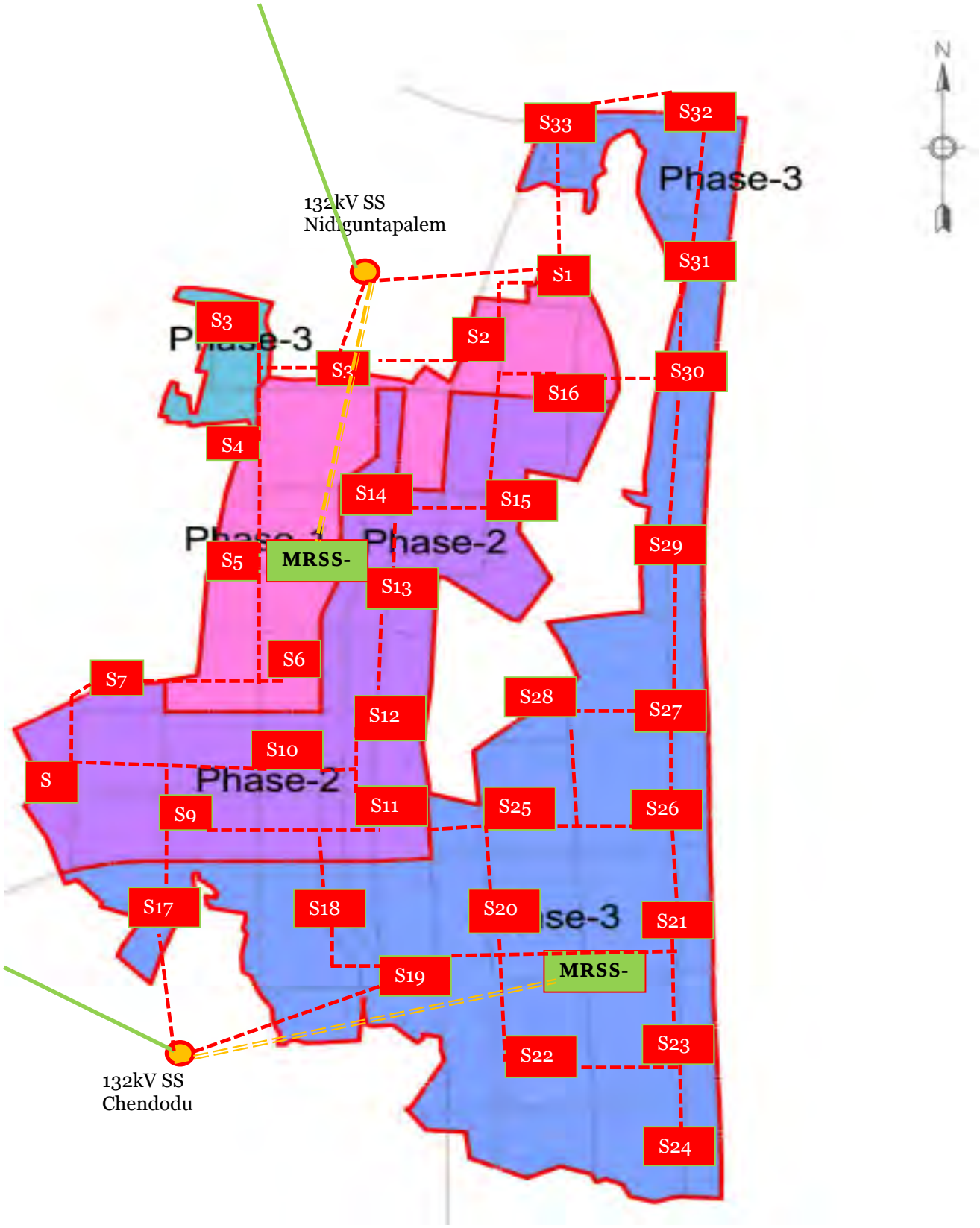


Figure 7.47: Proposed distribution network for the node superimposed on master plan for roads

7.4.6 *Recommendations on generation*

It is important to understand that generation unlike transmission /distribution is non location specific. This means that any plant based in Andhra Pradesh can supply power to the node provided it has spare capacity and has transmission evacuation availability. Considering this, generation has been segmented into two key parts- In node generation and procured generation. In node generation is the energy that has been generated in the node itself for the consumption of the node. Typically this would be from captive renewable plants developed by industries at the time of commissioning. Procured generation would be generated by a power plant outside the node and electricity thus generated would be supplied via transmission S/S at the periphery of the node into MRSS. Below section details each and assessing feasibility of adequate generation for consumption:-

In node generation

At the present node doesn't have any planned conventional power projects coming up in the phase I/II, captive renewable generation that consumers install in industries/homes would also be used.

RE consists of 12.6% of the supply in India and almost 70% are from wind power and that under "Strategic Plan for New and Renewable Energy Sector for the Period 2011-17" of MNRE, this would double until the end of 2016 with increasing role of wind and solar. However there are some technical limitations on extent to which such distributed generation can be viable in a closed loop system. Central Electricity Authority in its LGBR report, 2014 states that for stability of the grid in a region, the renewable should not exceed 18% of the total generated units. Also, seasonal nature of the renewable energy also poses limitations on continuous process industries in the region. Taking CEA standards for the node *(Assumption: Node being a close environment)*, 18% of the total generation would be coming from renewable energy.

Table 7.46: Renewable energy source: Expected capacity addition (MW)

Category	Total Demand (MW)	Maximum Installed Capacity from Renewable Energy Sources (MW)*
Phase I (2019)	84.75	15.35
Phase II (2024)	233.37	42.29
Phase III (2032)	539.79	97.82

* Renewable energy source generate 1.4 MU /MW/annum as compared to 7 MU/MW/annum from conventional energy sources. Taking this into account, maximum installed capacity from renewable energy has been estimated.

These power plants would be connected at 11kV voltage levels with the distribution S/S or would be consumed directly by industries at the point of consumption.

Procured generation

From the generation perspective for ensuring that the node has reliable round the clock power, the transmission sub stations of Chendodu (132kV, 2X150 MVA) and proposed Nidiguntapalem (132kV, 2X150 MVA) are to be energized with adequate capacity for the node. These sub stations currently are connected to the Southern grid and hence are fed by plants across the southern grid. Looking at the current generation position of the state, we see that in the phase I the state plants would have spare capacity for feeding the node. However, in the phase II/III, additional capacity would be needed for meeting the state demand.

Considering the nature of electricity procurement, it may not be possible to judge the availability of electricity for the node. Hence, we need to look at the entire region:-

Table 7.47: Gap analysis for the node area.

Scenario	Total Demand (MW)	Supply (MW)	Gap (MW)
FY 2016	42,548	50,680	NA
FY 2022	64,324	-	13,644
FY 2032	147,948	-	97,268

It may not be feasible for the report scope to cover the entire regional energy gap, but some new developments like integration of southern grid to national grid and increase of base load capacity in the region are making it easier for the region to provide power to consumers.

Some upcoming power plants which are viable sources of power for the node:-

1. Sri Damodaram Sanjeevaiah Thermal Power Station is located in Nelatur Village, near Krishnapatnam and at a distance of 23 km from Nellore city of Andhra Pradesh. The power plant is one of the coal-based power plants of Andhra Pradesh Power Development Company Limited (APPDCL). It is the Special Purpose Vehicle (SPV), a joint venture company of APGENCO (with 50% equity) and IL AND FS (50% equity) partnership. The proposed capacity of plant is 1600 MW. The project is under construction and likely to be completed by the end of 2014. The Power station is designed for blended coal in the ratio of 70% washed domestic coal from Talcher Coalfield to 30% imported coal.

2. Thermal Powertech Corporation India Ltd., (TPCIL)(Joint venture between Hyderabad-based Gayatri Energy Venture Pvt. Ltd (GEVPL), a wholly-owned subsidiary company of Gayatri Projects ltd. and Singapore-based Sembcorp Utilities, a wholly-owned subsidiary of Sembcorp Industries Ltd) plans to build, own and operate a 1,320-megawatt (2x660MW units) coal-fired coastal power plant in Nellore District of Andhra Pradesh, India.

For the node to ensure that power is available for the consumers, the following aspects need to be tackled:-

1. High priority of dispatch from existing generation plants should be maintained for the node. This is managed by APTRANSCO.

2. Allowance of open access to the node at transmission level to ensure the procurement for adequate power for the node. Managed by APTRANSCO.

3. Central thermal power companies can also be approached for ensuring that a fixed quantum of electricity can be provided to the node in the phase II/III.

7.4.7 *Operational Plan*

This operational plan provides the basic objectives, relevant stakeholder participation framework and the key steps in order to ensure seamless and reliable power to the consumer base of the node.

Objectives for the operational plan:

- **Access to all:** providing electricity availability to all categories of consumers;
- **24 X 7 reliable supply**: ensuring round-the-clock electricity supply for all strata of consumers;
- **Quality power as per specified norms:** delivering the power in accordance to the defined specification;
- **Affordable to all consumers in the node:** offering the power at optimized cost to all the consumers within the node area.

These objectives can only be realized with the help of detailed plan of action which encompasses the participation of all the stakeholders

The following steps as necessary for achieving the above mentioned objectives are:	*Relevant Stakeholders*
Meticulous planning: A detailed blueprint for power distribution and transmission network and infrastructure needs to be drawn out for identifying the required interventions that shall be required within the node. Also, with respect to the demand estimation of the node a power procurement plan needs to be developed which shall also form an essential input for the power distribution and transmission design layouts.	• Utility Planning Division, • Layout and Design Engineering Firms • Policy Makers • State Government
Execution & Commissioning: Time bound asset construction and commissioning is very important in order to deliver the project and adhere to the timelines as envisaged during the planning phase. This would require a fair amount of participation from the execution team of the utilities, vendors and the procurement and commissioning partners.	• Utility Commissioning Team, • Engineering & Procurement Firms • Vendors
Efficient distribution & retail supply: Discom would be the interface between the end consumers and sector stakeholders on one end of the value chain while interfacing with the generation sources as well as the inter-state and intra-state transmission network on the other end. In order to achieve this, following needs to be done • Appropriate load forecasting techniques with optimized power procurement plan is required for supply and distribution of power. • Integration of the core business operations of the Discom that would draw real time data from sensors and energy meters installed across various medium and low voltage network nodes. This would also form a central control center which would be responsible for network operations and running analytics on real time business data. The business reports would be available online for all key stakeholders including regulators, government and other state and central government power entities.	• Utility Operations Team • Utility Commercial Team • State Regulatory Authority

Critical success factors:

- **Integration with other utilities:** Seamless integration with other utilities/applications that would be serving the node consumers. These utilities may be provided requirement based access to the Discom IT applications with an aim to enhance the overall customer service experience. The access can be either over internet or other relevant communication channels like mobile communication etc.
- **Integration with small scale renewable generation:** The utilization of renewable electricity generation sources can provide two fold benefits of meeting the electricity demand and also managing the carbon footprints. The focus has now started shifting towards small scale and distributed renewable generation sources installed at customer premise. The consolidated capacities of such sources can contribute significantly to a Discom's supply capacities subject to the Discom's capability to integrate these sources with its electrical grid.

- **Energy efficiency:** Managing the carbon foot prints without compromising on the real energy need is the challenge which can be overcome by adopting a proactive approach to energy efficiency. Promoting energy efficiency would require a two-fold approach:
  - Preemptive measures inculcated as part of the node design to ensure better utilization of electricity. This can be through standard specifications for equipment across high electricity consumption process/activities like water supply management etc.; policy mandates on constructing energy efficient buildings, promoting LED based public lighting that can have alternative electricity supply through integrated solar based generation units etc.
  - Reactive adjustments to the changing electricity requirement across various constituents of the smart city, including residents, during the operational stage. This is a continuous process which shall have a standard approach of identification of electricity intensive consumer/geographic segments and taking policy or operational initiatives to minimize unnecessary consumption or shift such consumptions during off-peak hours to smoothen the overall demand curve.
  -
- **Customer Empowerment:** It is imperative to develop a customer centric operating model for the Discoms to create a sustainable business environment. The empowerment would be through a number of initiatives such as:
  - Enhance customer awareness through better information sharing;
  - Be proactive in assessing customer expectations through predictive analysis of past behavior;
  - Bringing flexibility in business operations to promptly adapt to the changing customer needs;
  - Reach out to the customer through, new avenues like internet, mobile, social network etc., instead of making the customer reach out to the business;

- **Capital availability:** Availability of sufficient funds from the financial institutions is of the utmost importance for the success of the plan and eventually operating it sustainably thereafter.

- **Smart grid interventions:** The need for developing and operating the proposed distribution infrastructure on smart grid principles would require usage of smart electrical equipment and state-of-the art ICT solutions. Few solutions/interventions tailored for the node would be:-

  - Renewable energy control center: to better integration of renewable electricity supply with grid supply from conventional sources.

  - Installation of System Integrity Protection Scheme (SIPS): to detect abnormal system conditions, decide on possible course correction and take the best-fit corrective action wherever possible.

  - Advanced metering infrastructure: at consumer end for real time data assimilation from end consumers to assist in rational demand estimates and better supply management.

  - Integrated distribution management system (DMS): for integrated operations of the power value chain within the node. In this case, the value chain would comprise of primarily the distribution voltage levels.

Suggestions on prospective operational model for the node area

Distribution of power in a state/region is managed by the Discoms in the respective state/region. The priority of any specific area, within a Discom's licensee area, is almost similar across all regions owing to the Discom's universal service obligations. The Discom, should therefore, not be expected to provide any specific operational preference to the proposed node area in terms of maintaining round the clock supply of quality power and customer service.

It would therefore be preferred that the Discom should appoint a third party for undertaking the distribution of electricity in the proposed node area on behalf of the Discom. As per the Electricity Act, 2003, such entity will not be required to obtain separate license from the concerned State Electricity Regulatory Commission. In the India context, such models are in use in a number of urban areas and are referred to as 'input based franchisee (IBF) '.

The IBF is selected by competitive bidding and is responsible for maintenance, operation and upgrading of the distribution network. The IBF would also have the provision of procuring bulk power from the market, at competitive prices, subject to necessary approvals. The overall ownership of the franchisee area remains with the Discom but the IBF has to meet a certain minimum operational standards as specified in the contract between the Discom and the IBF.

Table 7.48: Comparison of operating frameworks

Comparison parameters	*Distribution Franchisee*	PPP Model	Utility based procurement
Asset ownership	• *Asset ownership remains with the utility* • *Private agency in the distribution franchisee area would be provided assets on lease for the years of operation*	• Asset ownership is transferred to the SPV created • A separate license is required for operation	• Assets owned by the distribution utility
Tariff	• *Tariff in line with state tariff* • *Concessional tariff might be applicable on power procurement*	• Tariff would be based on cost of power procurement by the licensee • Separate ARR would be filed by the utility	• State regulated tariff would be applicable on industries. No concessional tariff would be applicable. • Entire state's cross subsidy would be applicable on consumers
Political stability	• *Stable model as per current mode of operation*	• Non stable model of operation • Manpower concerns as the utility would have to withdraw manpower from the licensee area	• Stable model as current mode of operation
Complexity in operation	• *Moderate complexity in operation*	• Highly complex – Not operational in the country	• Limited as the model is based on current mode of operation
Performance standards	• *Separate performance standards (more robust that utility) would be applicable*	• State wise performance standards applicable	• State wise performance standards applicable
Capital Investment	• *Capital investment would be incurred by the private agency*	• Capital investment would be incurred by the SPV	• In domain of utility which are cash starved in target states • Also capital expenditure bound by ARR norms and can't be targeted for a particular node
Quality of supply	• *Focused approach by the private agency in reducing T&D losses as well as improve service*	• Focused approach by the private agency in reducing T&D losses as well as improve service	• Although utility can look for focused quality improvement in the node area, however it may not be feasible for the utility based models to provide round the clock power for the node

Table 7.49: Comparison of various DFs

Comparison parameters	Outsourcing	Revenue Franchisee	*Input based franchisee*
Responsibility	• Metering, billing, collection	• Revenue collection based on a given target	• *Supply onwards from input points; O&M; metering, billing, collection; release of new connections; capex*
Compensation and Bid Criteria	• Fixed fee	• Fixed fee with incentive	• *DF has right on revenue. Utility receives input rate. DF gets depreciated value of capex at the end of the contract*
Benefits	• Operational efficiency	• Collection efficiency	• *Operational & collection efficiency, reduced staffing, service improvement, technical efficiency*

Source: Policy Group Quarterly, 'Bhiwandi Electricity Distribution Franchisee Model: A Resolute step

Table 7.50: Contribution and benefits to Consumers, Discom and IBF

	Contribution	Benefits
Consumers	• Growth in consumption	• Improvement in services • Good quality and better available hours of power supply • Consumer delight • Reduction in cost of power
Licensee	• Distribution infrastructure establishment • Supplying power • Employee management	• AT&C Loss reduction • Collection efficiency improvement • Better control on the recovery of cost • Better maintenance of distribution system
Franchise	• Business management • Investments in improving system	• Financial gains • Consumer access

Table 7.51: Elements in the node

"In case [Name of the Utility] is unable to provide sufficient energy to meet the requirement of the franchise area, the franchisee may request [Name of the Utility] to source the energy, that is in deficit, from the open market."

-Clause 5.4.2, Standard Bidding Document for Input Based Urban Distribution Franchise, June 2012 MoP

"[Name of the Utility] shall also assist the Franchisee in obtaining information from [Name of the State Transmission Company] about the transmission capacity for power purchase."

-Clause 5.4.3, Standard Bidding Document for Input Based Urban Distribution Franchise, June 2012 MoP

Alternate power supply model: suggestion on prospects for captive power plant in the node area

In order to meet the energy demand, a dedicated conventional gas power plant can be setup in or around the node area.

Combined cycle gas power plants have various inherent advantages such as short gestation period, less space requirement, environment friendly native and easy to operate & control. There has been a steady progress in combustion turbine technology with availability of large capacity advanced class higher efficiency gas turbines in the range up to 330 MW ratings and single shaft machines. The performance of gas turbine technology has improved dramatically over the past.[37]

Conventional gas power plant would provide reliable power based on the availability of gas for generation. A gas thermal power plant with 300 MW (150 x 2) capacities would be required. In medium term 150 MW would be installed and long term it can be expanded based on the availability of gas to another 150 MW. Central government has plans to add 15,000 km new pipelines under National Gas Grid program, Kakinada-Chennai corridor (600 km) being one of them. This would pass through the Nellore district, close to the Krishnapatnam node and would connect the same to Krishna-Godavari Basin.

Currently gas power plants in India are running at low Plant Load Factor (PLF) due to scarcity of gas for power generation. Gas grid connected plants with the capacity of 9,845 MW received limited domestic gas and operated at an average PLF of 32.2% during the period of April 2014 to January 2015. Further 14,305 MW capacitiy had no supply of domestic gas and is classified as 'Stranded gas based plants'.[38]

Table 7.52: Driving factors and limitations of gas based power plants

Key Driving Factors	Limitations
• Short gestation period for plant installation • Less land area requirement • Environment friendly: cleaner emission • Easy to operate and control	• Gas shortage for power generation • Low PLF of current operational/installed power plants • Current non-availability of gas pipelines in the node area

7.4.8 *Risk Assessment*

Scope Risk

The basis of the power infrastructure design is the need or demand for the power. Further the demand has been forecasted based on the projection of the upcoming industries in the node area. Defining what power infrastructure is required would include uncertainties in business environment.[39]

If the industries don't come up in the phased manner or at the planned locations with minor variations then changes would have to be made in the master plan. Apart from power sourcing, transmission and distribution would also vary with the variations in the master plan.

Scope risks can be minimized and managed with savvy planning. Defining the project clearly, managing the changes in scope throughout the duration of the project, making use of risk registers to better manage risks, identifying the causative factors, and the appropriate responses to risky situations and developing greater risk tolerance in collaboration with the customer, would pay great dividends in the long run.

[37] http://www.cea.nic.in/reports/yearly/annual_rep/2004-05/chapter06.pdf
[38] http://powermin.nic.in/upload/Scheme_for_utilization_of_Gas_based_power_generation_capacity.pdf
[39] http://www.tutorialspoint.com/management_concepts/project_risk_categories.htm

Schedule Risk

Keeping to timeline would be one of the most difficult factors for the implementing agency. For example setting up a substation with latest technology would require importing key parts; this may be delayed due to logistics problems. Also external factors like cyclones, rains may delay the schedule of implementation

When formulating the critical path, ensure that any holidays that arise are in-built into the equation, so that realistic expectations are created, right from inception. Defining re-work loops too is also recommended, wherever possible. Sufficient buffer time would be required between phases to bride the delays in a particular phase. Also internal project milestones would be necessary to timely monitor the progress.

Resource Risk

People and funds are any project's main resource base. If the people are unskilled or incompetent to perform the task at hand, if the project is under-staffed from the beginning, or if key project members come on aboard far after the inception of the project, there is an obvious project risk that has ill-planned human resources as its base.

Similarly, from a financial perspective, if insufficient funds are provided to carry out the necessary tasks, be it relevant training programs for the people in question or be it inadequate investments in technology or required machinery, the project is doomed to fail from inception.

Estimating project costs accurately, allocating a suitable budget to meet these costs, not placing undue expectations on the capacity of the staff in question and avoiding burn-out at a later date are all factors that help minimize the project resource risk.

Technology Risk

The technologies used are relatively new in India. The smart city project is being viewed as a pilot project. The technologies suggested and proposed to be used may become obsolete or not technically/financially un-viable even during the phase of the project. This would pose significant risk.

Track on upcoming technologies would have to be done. Also strong technical partners would be required who would ensure backward compatibility of the new technologies with existing ones. This would require higher funding but would also ensure minimization of the risk.

Other risks

There are various other risks which pose threat to the project. This may include external risks arising from factors (exogenous variables, which cannot be controlled) such as economic factors (market risks, pricing pressure), natural factors (floods, earthquakes), and political factors (compliance and regulations of government).

7.4.9 *Investment and O&M Costs*

Phase I elements and costs

Table 7.53: Elements and costs for Phase I (current prices)

S.No.	Description	Quantity	Unit	Rate (Lacs)	Amount (INR Lacs)
A	33kV Incoming Overhead line				
i	From 132kV Nidiguntapatnam to Proposed Substation (S1 & S3)	20	KM	9.14	182.8

S.No.	Description	Quantity	Unit	Rate (Lacs)	Amount (INR Lacs)
B	33kV Underground Feeders from MRSS and interconnections between 33/11kV Substations				
	Installation of XLPE (E) 33KV insulated ISI marked and of approved make. Aluminum conductor armoured cables suitable for working voltage upto 33000 volts in existing masonry cable trench on M.S. cable trays for Substation inter connection				
i	Substation S1 to S2	8	KM	22	176
	Substation S2 to S3	8	KM	22	176
	Substation S3 to S4	8	KM	22	176
	Substation S4 to S5	8	KM	22	176
	Substation S5 to S6	8	KM	22	176
	for S/s interconnection	24	KM	22	528
C	33/11kV indoor Substation with following specifications	6	Nos.	500	3000
i	2x8MVA Power Transformer including 33kV and 11kV indoor breaker and SCADA				
D	11kV Underground Distribution system				
i.	Installation of XLPE(E) 11KV insulated ISI marked Aluminum conductor armoured cables suitable for working voltage upto 11000 volts in existing masonry cable trench on M.S. cable trays with 11kV Ring Main Unit (RMU) for HT connection and 11/0.430kV Package Substations for LT connection and street lighting	192	Km	38	7296
E	Cable trench for Cable laying	100	Km	5	500
	Total				**12,386**

In phase I and total cost of INR 12,386 lacs (Present Value) would be required.

Phase II elements and costs

Table 7.54: Elements and costs for Phase II (current prices)

S.No.	Description	Quantity	Unit	Rate (Lacs)	Amount (INR Lacs)
A	Main Receiving Substation (MRSS)				
	2x150MVA,132/33kV GIS Based Substation	1	Nos.	9000	9000
B	132kV Incomer line to MRSS From Nidiguntapalem	25	KM	58.04	1451.00
C	33kV Underground Feeders from MRSS and interconnections between 33/11kV Substations				
	Installation of XLPE(E) 33KV insulated ISI marked and of approved make.Aluminium conductor armoured cables suitable for working voltage upto 33000 volts in existing masonry cable trench on M.S. cable trays for Substation inter connection				
i	MRSS-1 to 33/11kV Substations (S1-S16)	128	KM	22	2816

	for S/s interconnection	40	KM	22	880
D	33/11kV indoor Substation with following specifications	10	Nos.	500	5000
I	2x8MVA Power Transformer including 33kV and 11kV inddor breaker and SCADA				
E	11kV Underground Distribution system				
i.	Installation of XLPE(E) 11KV insulated ISI marked Aluminum conductor armoured cables suitable for working voltage upto 11000 volts in existing masonry cable trench on M.S. cable trays with 11kV Ring Main Unit (RMU) for HT connection and 11/0.430kV Package Substations for LT connection and street lighting	320	Km	38	12160
F	Cable trench for Cable laying	200	Km	5	1000
	Total				**32,307**

In phase II and total cost of INR 32,307 lacs (Present Value) would be required.

Phase III elements and costs

Table 7.55: Elements and costs for Phase III (current prices)

S.No.	Description	Quantity	Unit	Rate (Lacs)	Amount (INR Lacs)
A	Main Receiving Substation (MRSS)				
	2x150MVA,132/33kV GIS Based Substation	1	Nos.	9000	9000
B	132kV Incomer line to MRSS From Chendodu	25	KM	58.04	1451.00
C	33kV Underground Feeders from MRSS and interconnections between 33/11kV Substations				
	Installation of XLPE(E) 33KV insulated ISI marked and of approved make. Aluminium conductor armoured cables suitable for working voltage upto 33000 volts in existing masonry cable trench on M.S. cable trays for Substation inter connection				
i	MRSS-1 to 33/11kV Substations (S17-S34)	144	KM	22	3168
	for S/s interconnection	74	KM	22	1584
D	33/11kV indoor Substation with following specifications	18	Nos.	500	9000
i	2x8MVA Power Transformer including 33kV and 11kV indoor breaker and SCADA				
E	11kV Underground Distribution system				

i.	Installation of XLPE(E) 11KV insulated ISI marked Aluminum conductor armoured cables suitable for working voltage upto 11000 volts in existing masonry cable trench on M.S. cable trays with 11kV Ring Main Unit (RMU) for HT connection and 11/0.430kV Package Substations for LT connection and street lighting	576	Km	38	21888
F	Cable trench for Cable laying	200	Km	5	1000
	Total				**47,091**

In phase III and total cost of INR 47,091 lacs (Present Value) would be required.

Cost escalations and O&M cost

Future value of the capital cost would be significantly higher. For estimation of the Future Value, we have considered the inflation rate of 6.9%[40] the average for the year 2010-14, till 2020 post which it is marginalized to 4%.

Table 7.56: Capital cost escalation (in INR lacs)

	Phase I	Phase II	Phase III
Capital cost	12,386	32,307	47,091
Capital cost with escalation	13,656	41,232	76,706

Operation and Maintenance (O&M) cost varies for distribution companies. For estimation of O&M cost, ratio of Tangible Assets (Gross Block) for APSPDCL for the year 2014 and the corresponding Repair & Maintenance cost for the distribution for 2014 has been considered which stands at 2%. The O&M cost for Phase I, II and III are expected to be in the same ratios. *Source: APSPDCL Balance sheet and P&L account dt. 31st March 2014*[41]

Table 7.57: O&M cost and net cash outflow for franchise (in INR lacs)

	2013	Phase I	Phase II	Phase III
Fixed Assets/Cumulative capital cost with escalation	6,06,470	13,656	41,232	76,706
O&M cost for entire phase	12,175	822	5,510	21,135
Total		14,478	46,742	97,841

Net Cash outflow for Phase I would be INR 14,478 Lacs, for phase II would be INR 46,742 Lacs, for phase III would be INR 97,841 Lacs.

[40] http://data.worldbank.org/indicator/NY.GDP.DEFL.KD.ZG/countries
[41] http://www.apspdcl.in/ShowProperty/SP_CM_REPO/Pages/Company%20Information/Annual%20Reports/FY%202013%20to%2014

7.5 *Water*

7.5.1 *Sector Overview*

In Nellore District, where Krishnapatnam Node is located, the existing water supply systems does not satisfy the target unit water provision set by the national standard. Unit water supply amount in the urban areas around the node is only 101 litter per day per capita (lpcd), while the target value is 135 lpcd. Major water resources for domestic use in Nellore District are groundwater and surface water. Water resources for industrial purposes in the district are also surface water (3.6 MLD: 16.8%) and groundwater (17.8 MLD: 83.2%).

Regarding sanitary conditions, there is no existing sewerage scheme with sewage treatment in the district, which needs to be improved especially in the Nellore Municipality, the capital of the district. As for the flood conditions, the node is located at low lying area which is affected by tide level.

In this section, the following items are studied in order to develop water infrastructures which will support the industrial activities and people's lives in Krishnapatnam Node:

i) Forecast of domestic water demand, industrial water demand, sewage generation and stormwater discharge in the node

ii) Determination of water resource balance to satisfy the domestic and industrial water demands

iii) Preparation of development plan of potable water supply system, non-potable water supply system, sewerage system, sewage recycle system and stormwater drainage system for the node

iv) Preparation of implementation plan to develop the water infrastructures

v) Preliminary cost estimation of the water infrastructures, including construction and operation and maintenance (O&M) costs

7.5.2 *Framework for Infrastructure Development*

To realize sustainable development of the Ponneri Node, stable water supply, good sanitary conditions, preservation of water environment and prevention of flood event are imperative. Development framework of water indrastructures including those for water supply, wastewater management and stormwater management are proposed as follows:

- 24 x 7 supply of water to 100% industries and households with direct water supply connection will be achieved.
- 100% connection of industries and households to sewer network and 100% coverage of primary and secondary treatment of the sewage will be achieved.
- 100% coverage of road network with stormwater drainage network will be achieved.
- Maximum utilization of water resources by water recycle for industrial uses will be achieved.

7.5.3 *Design Conditions*

Development Phases of Proposed Node

Krisnapatnam Node will be developed by three phases which are the short term (by 2018), the middle term (by 2023) and the long term (by 2033). Accordingly, the estimation of water demand and sewage generation will target at the years 2018, 2023 and 2033.

Relevant Technical Standards

The development plan of each infrastructure is based on the follwoing technical standard.

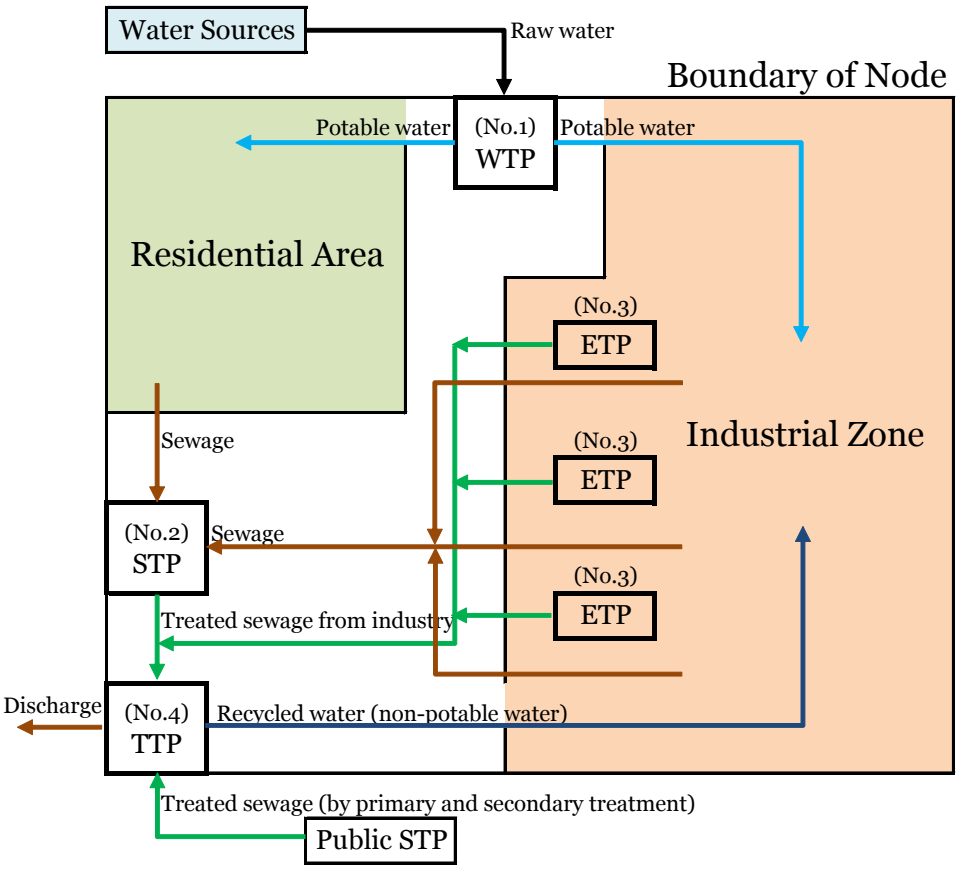
Table 7.58: Applicable Technical Standards for Water Infrastructure Plans

Type of Infrastructure	Technical Standard	Issuing Organization
Domestic water supply system	Manual on Water Supply and Treatment, May 1999	Central Public Health and Environmental Engineering Orgnization (CPHEEO), Ministry of Urban Development
Industrial water supply system		
Sewerage system	Manual on Sewerage and Sewage Treatment System, November 2013	CHEEO, Ministry of Urban Development
Stormwater drainage system	Guidelines on Urban Drainage, 2013	Indian Roads Congress, Ministry of Road Transfer & Highways
	Surface water drainage for low-income communities, 1991	World Health Organization
	Hand Book on Water Supply and Drainage, 1987	Bureau of Indian Standards

Source: JICA Study Team

7.9.1.1 Required Water Qualities

In the proposed node, several different kinds of water treatment facilities are necessary. The water quality standards to be applied to the treatment facilities depend on function or purpose of the treatment to be done in the facilities. Water flow diagram in Figure 7.49 presents functions of the water treatment facilities in the node and Table 7.58 show the water quality standards to be applied to the facilities according to their functions.



Source: JICA Study Team

Figure 7.48: Water Flow Diagram of the Node

Table 7.59: Applicable Water Quality Standards for the Target Facilities

No.	Target Facility	Applicable Water Quality Standards
1	Water Treatment Plant (WTP)	Indian Standard Specifications For Drinking Water
2	Sewage Treatment Plant (STP)	General Standard For Discharge Of Environmental Pollutants (Dischare to Inland Surface Water)
3	Industrial Effluent Treatment Plant (ETP) (To be introduced by each factory)	
4	Tertiary Treatment Plant (TTP) (Sewage Recycle Plant)	Standard for Recycled Water and Facilities Criterion in Japan

Source: JICA Study Team

Selection of the water quality standards to be applied are explained below:

1) WTP (Facility No.1 in Figure 7.49) will supply potable water to both the residential area and the industrial zone, thus the standard for drinking water should be applied.

2) STP (Facility No.2 in Figure 7.49) will treat the sewage collected from the residential area and the industrial zone by primary and secondary treatment. It will convey the treated sewage to TTP. Required treatment level in the STP are the same as those of usual public STP. Therefore, the effluent standard for discharging to inland surface water, which are applied to all usual STPs, are applied to the STP in the node.

3) ETP (Facility No.3 in Figure 7.49) will be introduced at each factory. Treated effluent at the ETP will be sent to TTP (Facility No.4 in Figure 7.49), which will also accept treated sewage from STP, to be recycled for industrial purposes. If ETP discharges untreatable materials at TTP, TTP can not meet the water quality required to the industrial water. To ensure the TTP's fuunction to provide industrial water, ETP should treat the industrial effluent to satisfy the same water quality level as that from STP. Therefore, the effluent standard for discharging to inland surface water will be applied to ETP.

4) TTP (Facility No.4) will receive the treated sewage and treat additionally to recycle the treated sewage for industrial processes, thus the recycled water should meet the water quality standard required for industrial water. However, there is not a well-suited water quality standard for industrial water in India. Therefore, the standard for recycled water and facilities criterion in Japan which is issued by Ministry of Land, Infrastructure, Transport and Tourism will be applied.

Each applicable regulation of water quality is described in Annex D.

7.5.4 *Demand Forecast*

The domestic water demand, the industrial water demand, the sewage generation and the stormwater discharge of Krishnapatnam Node are projected in order to estimate the requuired capacitiy and scale of each infrastructure.

Domestic Water Demand

The domestic water demand for the residential area is estimated with the follwoing formula:

(Domestic water demand for residential area) = (Target per capita water consumption) x (Target residential population)

Based on the Manual on Water Supply and Treatment prepared by CPHEEO, the target unit water consumption is classified into three levels as described in Table 7.59.

Table 7.60: Target Per Capita Water Supply Level

No.	Classification of towns / cities	Recommended Maximum Water Supply Level (LPCD)
1	Towns provided with piped water supply but without sewerage system	70
2	Cities provided with piped water supply where sewerage system is existing/contemplated	135
3	Metropolitan and Mega cities provided with piped water supply where sewerage system is existing/contemplated	150

Source: Manual on Water Supply and Treatment prepared Ministry of Urban Development

The proposed node will not be the Metropolitan or Mega city, however, both water supply system and sewerage system will be developed in the node, thus the node can be classified to the category No.2 and the target unit water consumption of the node is 135LPCD.

In addition, the domestic water demand for the industrial zone is estimated wth the following formula which is based on Manual on Water Supply and Treatment prepared by CPHEEO:

(Domestic water demand for industrial zone) = (Target per capita water consumption: 45LPCD) x (Target employed population)

According to the manual above, in addition, water demand should consider water loss or water leakage, which is allowed up to 15% by the manual. In this study, water leakage is assumed at 10% of the total water demand. Including the water leakage, domestic water demand for the residential area and the industrial zone are estimated as shown in Table 7.60.

Table 7.61: Domestic Water Demand of Krishnapatnam Node

Supply Destination	Unit Water Consumption (LPCD)	Year 2018		Year 2023		Year 2033	
		Population	Water Demand (MLD)	Population	Water Demand (MLD)	Population	Water Demand (MLD)
Residential People Excluding Employees	135	40,038	5.4	112,000	15.1	112,000	15.1
Employees from the inside of Node	135	31,348	4.2	88,000	11.9	88,000	11.9
Employees from the Outside of Node	45	0	0.0	37,426	1.7	494,706	22.3
Total			**9.6**		**28.7**		**49.3**
Including Water Loss			**10.7**		**31.9**		**54.8**

Source: JICA Study Team

Industrial Water Demand

The industrial water demand is estimated with the following formula:

(Industrial Water Demand) = (Industrial Land Demand) x (Water Consumption per Unit Industrial Area)

For the following reasons, the water consumption per unit industrial area is based on the Japanese standard value which is sourced from Japan Industrial Census (2011), and the planned water consumption value of Mahindra World City which is located near Chennai and is invested by many foreign companies:

- Many international companies from developed countries, including those from Japan, are expected to develop their businesses in the node. Hence unit water consumption in the node will reach to international level.

- Currently, the water productivity of Indian industries is 1/3 – 1/7 times smaller than that of Japan. Under the seriously water scarce conditions in the node, however, for the future the water productivity of industrial water in the proposed node is expected to be improved because Japanese manufacturers will try to achieve high water use efficiency by introduction of water-saving machineries or equipment, and instruction to the workers for utilize water as much as possible. Therefore, the unit consumption of industrial water in the proposed node is assumed to be improved to the Japanese level by the ultimate target year (2033).

- The developer of Mahindra World City has a plan to attract many foreign companies and investors, thus this will become a model of the proposed node.

Based on the above mentioned discussions, the industrial water demand of Krishnapatnam Node is estimated as described in Table 7.61.

Table 7.62: Industrial Water Demand of Krishnapatnam Node

Industrial Sector	Unit Industrial Water Demand	Year 2018		Year 2023		Year 2033	
		Land Area	Industrial Water Demand	Land Area	Industrial Water Demand	Land Area	Industrial Water Demand
	(MLD/Acre)	(Acre)	(MLD)	(Acre)	(MLD)	(Acre)	(MLD)
Metallurgy	0.0394	234	9.2	587	23.1	1,402	55.2
Medical Equipment	0.0043	65	0.3	163	0.7	389	1.7
Food Processing	0.0139	424	5.9	1,063	14.8	2,540	35.3
Textiles & Apparels	0.0312	76	2.4	190	5.9	453	14.1
Electrical Machinery	0.0029	212	0.6	532	1.5	1,270	3.7
Machinery	0.0025	65	0.2	163	0.4	389	1.0
Chemicals & Petrochemicals	0.0755	83	6.2	207	15.6	494	37.3
Pharmaceuticals	0.0043	12	0.0	29	0.1	69	0.3
Auto	0.0145	65	0.9	163	2.4	389	5.6
Computer, electronic and optical products	0.0087	65	0.6	163	1.4	389	3.4
Defence & Aerospace	0.0145	0	0.0	0	0.0	0	0.0
Total		**1,300**	**26.3**	**3,258**	**66.0**	**7,785**	**157.6**
Including Water Loss			**29.3**		**73.3**		**175.1**

Source: JICA Study Team

Sewage Generation

Based on the Manual on Sewerage and Sewage Treatment Systems prepared by CPHEEO, sewage generation is estimated to be 80% of water consumption. Therefore, the sewage generation of Krishnapatnam Node is calculated as presented in Table 7.63.

Table 7.63: Sewage Generation of Krishnapatnam Node

Generation Source	Sewage Generation (MLD)		
	Year 2018	Year 2023	Year 2033
Residential People Excluding Employees	4.3	12.1	12.1
Employees from the inside of Node	3.4	9.5	9.5
Employees from the Outside of Node	0.0	1.4	17.8
Total	**7.7**	**23.0**	**39.4**

Source: JICA Study Team

Industrial Effluent Generation

Generation of industrial effluent depends on the industry type. According to the Japan Industrial Census, the effluent generations vary from 10% to 70%, which are results of water recycle in each industry. In Krishnapatnam Node, effluent generation will be higher than the Japanese case because the study assumes that the industries in the node will mainly use central TTP instead of personal recycle system in each industry, as illustrated in Figure 7.49. Industrial effluent volume in the node is estimated as 70% of the industrial water consumption as presented in Table 7.64 for each phase.

Table 7.64: Industrial Effluent Generation of Krishnapatnam Node

Industrial Effluent	Effluent Generation (MLD)		
	Year 2018	Year 2023	Year 2033
Industrial Effluent	**18.4**	**46.2**	**110.3**

Source: JICA Study Team

Stormwater Discharge

(1) Stormwater Estimation

The storm runoff is that portion of the precipitation, which drains over the ground. Estimation of such runoff reaching the storm sewers therefore is dependent on the intensity, duration of precipitation, characteristics of the tributary area, and the time required for such flow to reach the storm water drain. The rational method is more commonly used based on the formula given below.

$Q = 10\ C\ i\ A$

Where,

Q: Runoff (m^3/hr)

C: Dimensionless runoff coefficient

i: Intensity of rainfall (mm/hr)

A: Area of drainage district (ha)

Source: "Manual on Sewerage and Sewage Treatment-Part-A", Ministry of Urban Development (MoUD)

(2) Imperviousness

When several different surface types or land use comprise the drainage area, a composite or weighted average value of the imperviousness runoff coefficient can be computed, such as:

$I = [(A_1I_1)+(A_2I_2)+.....+(A_nI_n)] / [A_1+A_2+.....+A_n]$

Where,

I: Weighted average imperviousness of the total drainage basin

A_1, A_2, A_n: Sub drainage areas

I_1, I_2, I_n: Imperviousness of the respective sub-areas

The percent imperviousness of the drainage area can be obtained from the records of a particular district. In the absence of such data, the Table: 7.65 below will serve as guide.

Table 7.65: Percentage of Imperviousness of Areas

Sl.No	Type of Area	Percentage of Imperviousness
1.	Commercial and Industrial Area	70-90
2.	Residential Area - High Density - Low Density	 61-75 35-60
3.	Parks and Undeveloped Areas	10-20

Source: Manual on Sewerage & Sewage Treatment Systems by Ministry of Urban Development

(3) Frequency of Storm

The frequency of storm for which the sewers are to be designed depends on the importance of the area to be drained. Commercial and industrial areas have to be subjected to less frequent flooding. The suggested frequency of flooding in the different areas is as follows -:

a) Residential Areas

   i) Peripheral areas twice a year

   ii) Central and comparatively high priced areas once a year

b) Commercial and high priced areas once in 2 years

As per World Health Organization (WHO) guidelines on Surface Water Drainage, a return period of five years is widely used to design primary drainage system in tropical cities.

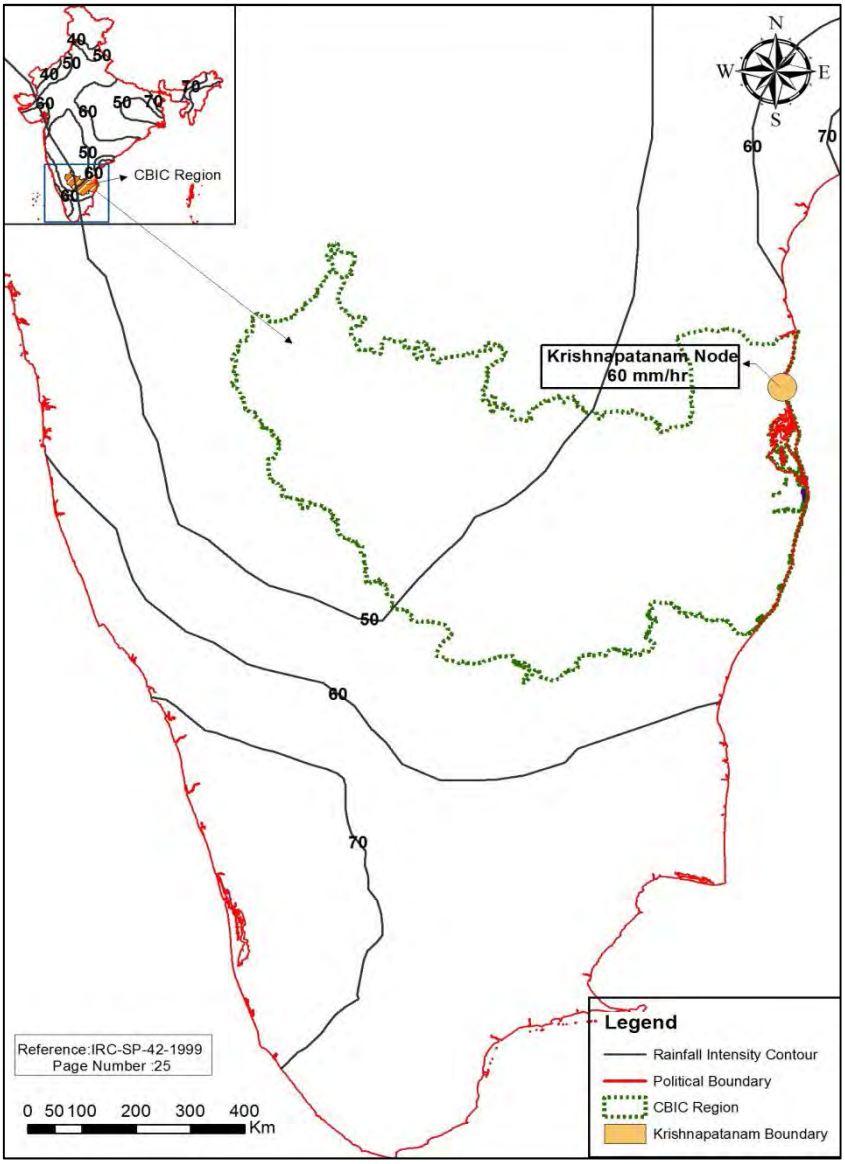
Source: *World Health Organization Publications on "Surface Water Drainage for low Income Communities" & Tamil Nadu Urban Infrastructure Financial Services Limited (TNUIFSL) guidelines for "Standards / Requirements for SWD"*

(4) Intensity of Storm

The Intensity of Rainfall to be used in computing the design run-off in equation in the above (1) is related to the concentration time and the frequency of occurrence of the storm.

A point to point design of the Storm Water Drainage System requires repeated selection of the Intensity of Rainfall for increasing Concentration Time intervals. This is possible if the relationship of the Intensity of Rainfall with the concentration Time for a given Frequency of Occurrence is known for the particular catchment. This relationship is known as Intensity – Duration – Frequency (IDF) relationship and can be expressed in the form of a formula or in the form of a graphic curve. Such a relationship can be developed by conducting an analysis of past rainfall records for this area under study.

The CPHEEO Manual on Sewerage and Sewage Treatment states that the intensity of precipitation for the Indian conditions, to be adopted in the design, is usually in the range of 12mm/hr to 20mm/hr. (Manual on Sewerage and Sewage Treatment, Page No. 41, Chapter No. 3.3.1 and Sub chapter no. 3.3.1.). This limit for intensity of rainfall is on lower side. Therefore, for CBIC study, the intensity of rainfall is considered based on the standards of Indian Roads Congress (IRC) vide its publication, IRC: SP-42, 1994, “Guidelines on Road Drainage” Fig-6, one hour rainfall for different recurring intervals. For a five year return period, one hour maximum rainfall will be adopted as per (A) of Fig-6, IRC-42. The Figure: 7.50 showing the value of rainfall in one hour, intensity of rainfall (i) in mm/hr based on the Fig-6 of IRC-42.



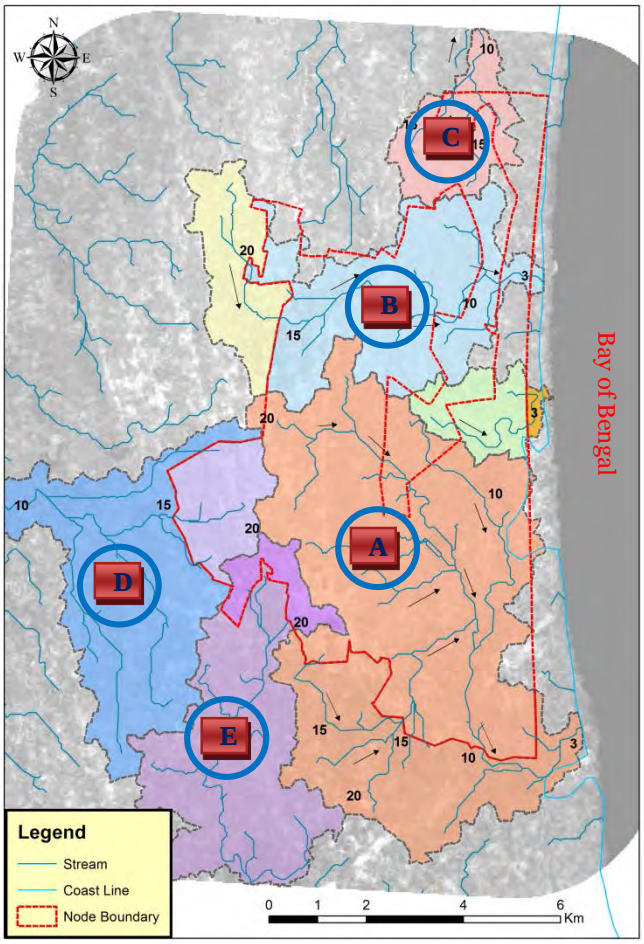
Source: JICA Study Team

Figure 7.49: Rainfall in One Hour as per IRC-42

From the Figure 7.51, the rainfall for one hour contours plotted, the intensity of rainfall for Krishnapatnam node is considered as 60mm/hr and the same value adopted for computing storm water discharge through rational formula.

(5) Drainage Basin Plan

The drainage basin plan for the catchment area for Krishnapatnam Node contributing to the storm run-off into the node presented in the Figure 7.51.



Source: JICA Study Team

Figure 7.50: Krishnapatnam Node Drainage Basin Plan

Figure 7.52 shows that the Krishnapatnam node area is divided into 5 drainage basins and the natural slope of the terrain slopes downward from South to North & West to East. Out of these five drainage basins A, B, C, D & E, drainage basins A & B will contribute to the storm water flow into the node and they ultimately disposed to Bay of Bengal. The run-off from the drainage basins C, D & E will flow away from the node and these basins will not contribute to the run-off to the node area.

(6) Total Stormwater Discharge

Storm Water Discharge is computed using rational formula. Krishnapatnam node development area is divided into 6 sub-zones, B-I, B-II, B-III, B-IV, B-V & B-VI based on the topography and the disposal of storm discharge. Summary of the storm water discharge in the collection network is presented in the Table 7.65.

Table 7.66: Summary of the Storm Water Discharge in each zone

Sl.No	Zone	catchment area (ha)	storm discharge (cum/s)
1.	B-I	701.43	70.14
2.	B-II	955.68	95.57
3.	B-III	660.26	66.03
4.	B-IV	308.41	30.84
5.	B-V	2225.25	222.53
6.	B-VI	676.16	67.62

Source: JICA Study Team

7.5.5 *Development Plan*

The water resource balance, the capacity of each infrastructure, the water treatment technology and process of each water treatment facility and the layout plan of each infrastructure are discussed in this section.

Water Resource Balance

As mentioned in the framework for infrastructure development in Section 7.2, based on the result of collection of relevant information, the candidate water sources for both potable water and non-potable water in Krishnapatnam Node are listed below.

Table 7.67: Potential Water Sources for Krishnapatnam Node

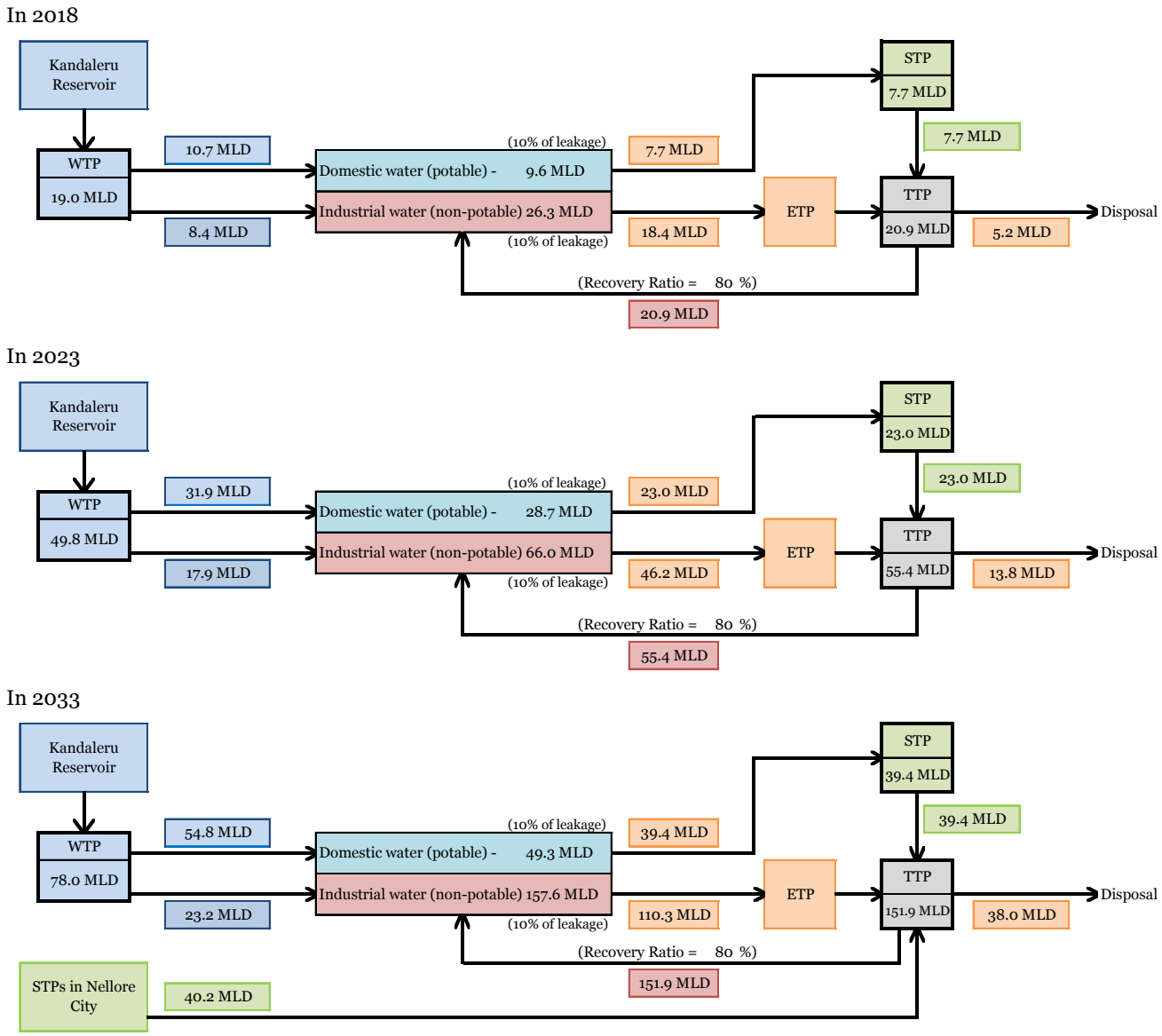
Water source	Possible water use		Capacity
	Potable	Non-potable (Industrial)	
Kandaleru Reservoir	✓	✓	78 MLD
New desalination plant (to be developed in the node, if necessary)	✓	✓	-
Secondary treated sewage from STPs in Nellore City		✓	109 MLD by 2045

Source: JICA Study Team

According earlier information from Krishnapatnam Port Company Ltd. (KPCL), Andhra Pradesh State Government has allocated 1 TMC (78 MLD) of water from Kandaleru Reservoir for immediate industrial needs. It has been reconfirmed with the Government of Andhra Pradesh and APIIC has requested for the allocation water of 1.5 TMC from Kandaleru reservoir through letter vide CE-I/APIIC/CBIC/08/2015-16 dated 23-05-2015.

Secondary treated sewage from STPs in Nellore City is also one of the potential water sources to be used in the node. For recycle of the treated sewage from the STPs, the node will have a tertiary treatment plant (TTP) by reverse osmosis (RO) process. The TTP will also recycle treated sewage from STP in the node which collect and treat sewage to be generated in the node. Recovery ratio of the RO process is assumed at 80% in the study. Recently, 70 to 80% of the recovery ratio is common in RO recycle system for industrial purpose. The applied recovery ratio (80%) assumes that the innovation in the water recycle technology will enable improvement in the recovery ratio.

Combining the possible water sources above, water balance of Krishnapatnam Node is proposed in Figure 7.52. As shown in the figure, Kandaleru Reservoir will satisfy the water demand in the node until 2023 but the demand in 2033 will exceed the reservoir's capacity. To supplement the gap between the water demand and the reservoir's capacity after 2023, Krishnapatnam Node will need to recycle the treated sewage from the STPs in Nellore City.



Source: JICA Study Team

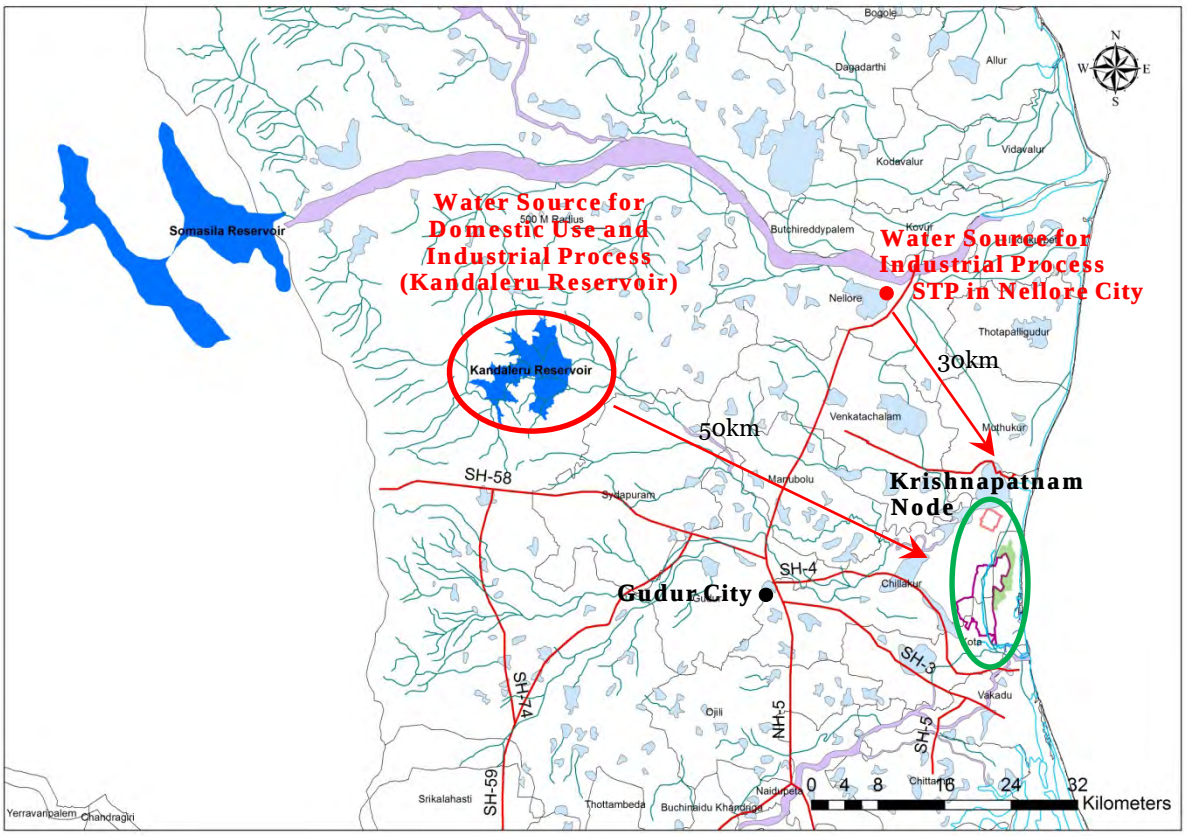
Figure 7.51: Water Balance of Krishnapatnam Node

Water balance of Krishnapatnam Node is proposed in Figure 7.53. Expected water supply amount of the water sources by water use is summarized in Table 7.68. Locations of the water sources are presented in Figure 7.54.

Table 7.68: Supply Amount of Water Sources for Krishnapatnam Node by Phase

Use	Water Source	Supply (MLD)		
		Year 2018	Year 2023	Year 2033
Domestic use	Kandaleru Reservoir	10.7	31.9	54.8
Industrial process	Kandaleru Reservoir	8.4	17.9	23.2
	Tertiary treated sewage of STPs in Nellore City	-	-	40.2

Source: JICA Study Team



Source: JICA Study Team

Figure 7.52: Location of Water Sources of Krishnapatnam Node

Water Treatment Technologies & Processes

(1) Selection of Water Treatment Processes

In Krishnapatnam Node, the following treatment plants are required to be developed newly.

1) Water Treatment Plant (WTP) to treat the raw water and supply the potable water to both the residential area and the industrial zone

2) Sewage Treatment Plant (STP) to receive the domestic sewage from the residential area and the industrial zone and treat them primarily and secondarily

3) Tertiary Treatment Plant (TTP) to receive the secondary treated sewage from the STP and treat it tertiarily in order to recycle the sewage for industrial processes

In order to meet the required water quality explained in subsection 6.5.3.2, the Study proposes the water treatment processes to the different types of the teratment plants above as presented in Table 6-69.

Table 7.69: Selected Treatment Processes for Krishnapatnam Node

Water source	Treatment Process	Remarks
Water Treatment Plant (WTP)	Rapid sand filtration process	Flocculation, coagulation, sedimentation and filtration
Sewage Treatment Plant (STP)	Conventional activated sludge process	Sedimentation and biological treatment
Tertiary Treatment Plant (TTP)	Reverse osmosis (RO) process	Flocculation, coagulation, sedimentation, UF, and RO

Source: JICA Study Team

Rapid sand filtration process, which will be applied to WTP in the node, is a very common treatment process for drinking water suppy purpose in the world. WTP of the rapid sand filtration process consists of grit chamber, chemical mixing tank, flocculation tank, sedimentation tank, rapid sand filtration tank and chlorine implantation tank.

Conventional activated sludge process, which will be applied to STP in the node, is also a very common process for sewage treatment. STP of the conventional activated sludge process consists of grit chamber, primary sedimentation tank, aeration tank, final sedimentation tank and disinfection tank, and is also the most conventional sewage treatment process in Japan.

As for the tertiary treatment process for industrial purposes, there are various kinds of treatment process depending on required water quality of the recycled water. The commonly-used treatment processes of sewage recycle for industrial purposes are categorized into sand filtration process with coagulating and sedimentation, and membrane processes which includes Micro-Filtration (MF) Process, Ultra Filtration (UF) Process, Nano Filtration (NF) Process and Reverse Osmosis (RO) Process which vary in the sizes of membrane pores. As recent deterioration of market prices of membranes, in the membrane processes, RO process has become more common because the recycled water by RO process can be used for wide range of industrial uses. Advantages and disadvantages of the sand filtration process and RO process are given below;

1) Sand filtration process with coagulation and sedimentation

- The treated water quality can be used for watering and wash of some machines. However, it cannot be used for purposes that may cause touch of the water with human bodies.
- If an industry needs higher quality of the recycled water, it needs to install more advanced water treatment facilities of its own, such as membrane processes, to improve the water quality.
- The recovery ratio of the process is approximately 99%.
- The construction cost and running cost are lower than the membrane processes. Water production cost including operation cost and amortization cost will be about 3 INR/m^3.

2) RO process

- The treated water quality is so good that the water can be used for very wide range of industrial uses. Although it is not drinkable, there is no sanitary problem even if a person touches the water and no scale will be accumulated in pipes or tanks in the industries.
- In principle, all industries can directly use the supplied water through RO process, with no additional treatment.
- The recovery ratio of the process is usually 70 – 80%.
- The construction cost and running cost are high. Water production cost including operation cost and amortization cost will be about 11.5 INR/m^3.

In the Study, considering the advantages and disadvantages above, process is proposed to the TTP in Krishnapatnam Node for the following reasons:

- In order to ensure the maximum utilization of water resources in the node, water recycle system in the node should be controlled by the node operator comprehensively. For that reasons and achieve lower unit prices by enhancing the scale merit, the water recycle system should attract the industries in the node.

- If the tertiary treatment process is sand-filtration, the industries will need to do further treatment for most industrial purposes by their own equipment. The industries will not be attracted to the recycling system because of this additional cost.

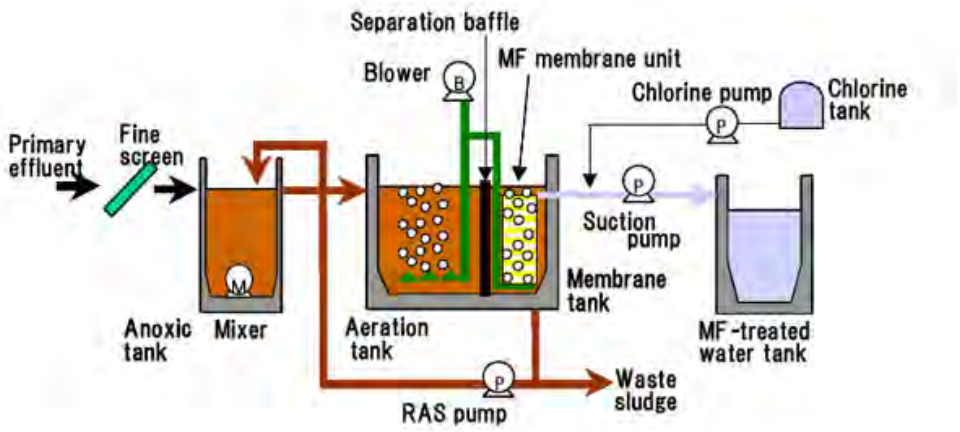
- As explained above, water production cost by RO will be more expensive than that by sand filtration by about 8.5 INR/m3. Apart from the water treatment cost, however, effluent collection to enable the water recycle and non-potable water transmission and distribution system will cost about 2.3 billion INR even for phase 1. This will bring about 20 INR/m3 of O&M cost. Therefore, Difference in the treatment cost will not be a critical difference in the economic comparison of the processes. Key driver of the unit price of the recycled water is water transmission and distribution cost.

(2) Alternative Technologies for the Sewage Recycle

1) Membrane Bioreactor (MBR)

MBR is a water treatment technology which is one kind of the activated sludge method processes. MBR is a similar process to the conventional activated sludge (CAS) process but replaces final sedimentation tank in CAS with MF membrane process as presented in Figure 7.55. Treated sewage from MBR is available for wider industrial purposes than the tertiary treated sewage by CAS and the sand filtration. Application of this process to STP enables cost saving in the total cost for secondary and tertiary treatment processes for water recycle. In Japan, Kubota Corporation, Swing Corporation, Hitachi Zosen Corporation, Hitachi Ltd., and several other plant makers own this technology.

In development of the node, water sources for the water recycle are domestic sewage and industrial effluent. Because of the industrial effluent is the already-treated water by each industry, primary and secondary treatment is not necessary for the industrial effluent. Therefore, the Study does not apply MBR in the node. However, this technology still has a possibility to be adopted in the STP to treat the domestic sewage.



Source: http://www.thembriste.com

Figure 7.53: System configuration of MBR

2) High Efficiency RO (HERO)

This technology is one of the RO processes of tertiary treatment for water recycle. This technology achieves 95% of the recovery ratio, which is generally 70 to 80% in usual RO process by operating the RO process at high pH condition. By this high recovery ratio, HERO will reduce the brine to be discharged from the RO process.

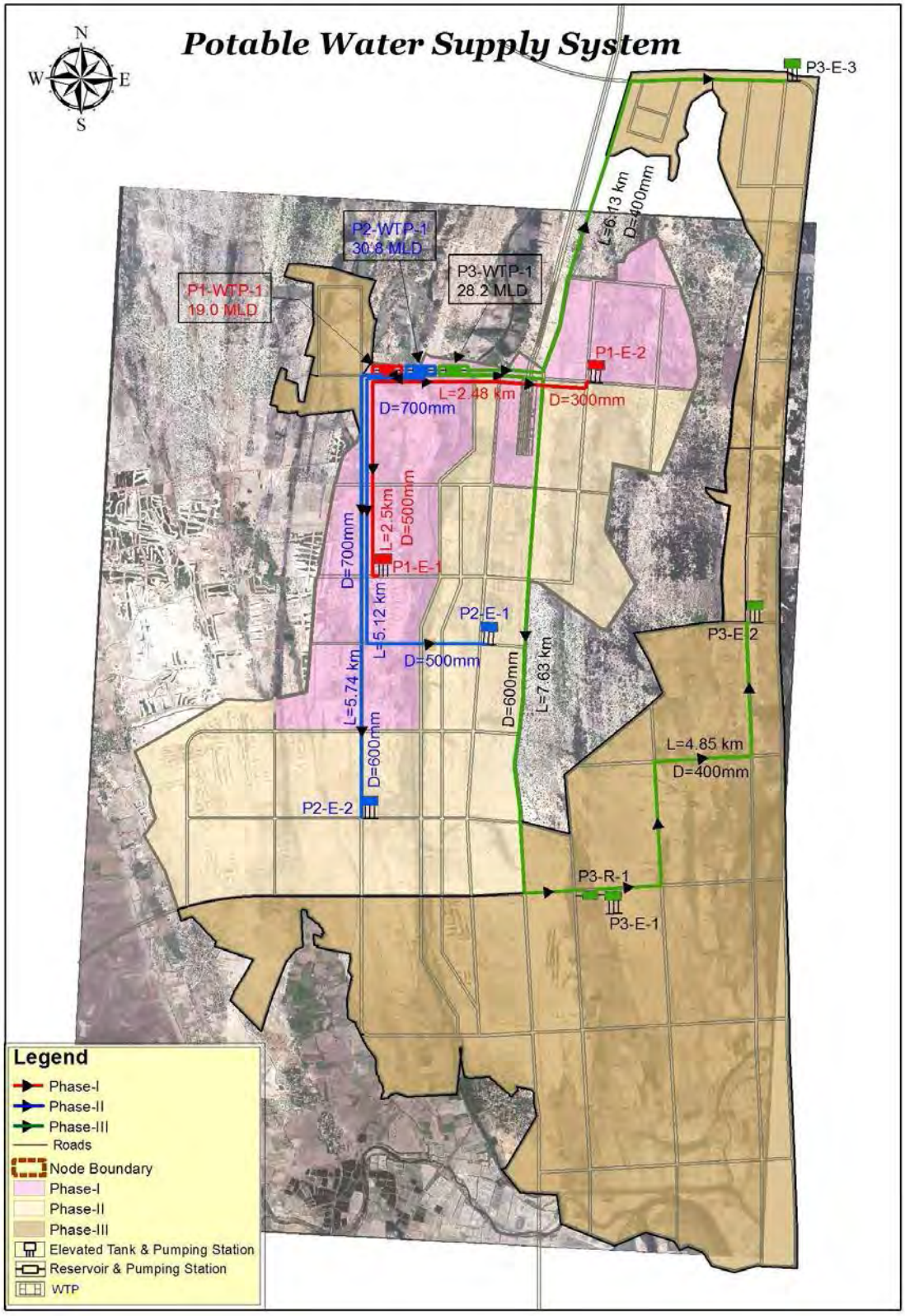
In this Study, HERO is only an alternative technology for the tertiary treatment process because only a limited number of companies such as UEM, a Toshiba affiliated company in India, own this technology. However, this technology may contribute to significant cost saving for the brine treatment and disposal, especially in India where zero-liquid discharge is required.

Plan of Potable Water Supply System

(1) Layout Plan and System Outlines

Layout plan of potable water supply system for Krishnapatnam node is illustrated in Figure 7.56 and outlines of the major facilities in the system are presented in Table 6-70.

Water treatment plant (WTP) will be located at the north-western end of the node area which is the most strategic point to receive the raw water from Kaduleru Reservoir. Water transmission and distribution system to the node will have independent system for each development phase. In all the systems, potable water produiced in the WTP will be distributed via ground reservoir and elevated tank(s). Reservoirs for phase 1 and 2 will be located in the same premises as the WTP except that for pahse 3. Considering the far isolated location of the phase 3 area from the WTP premises, the reservoir for phase 3 will be located in the phase 3 area to reduce the risk of system failure that may be caused by any accident in the water transmission system between the WTP and the pahse 3 area.



Source: JICA Study Team

Figure 7.54: Layout Plan of Potable Water Supply System

Table 7.70: Outlines of the Potable Water Supply Facilities

Facility		Outlines/Capacity			Remarks
		Phase 1	Phase 2	Phase 3	
Raw water conveyance system		DIP*1, D=1,000 mm L=50 km			From Kandaleru Reservoir
Water Treatment Plant (WTP)		19.0 MLD	30.8 MLD	28.2 MLD	Rapid sand filter Ultimate capacity: 78.8 MLD
Reservoir		9.5 ML	15.4 ML	14.1 ML	
Pumping station		1 location	1 location	1 location	
Elevated Tank		1.6 ML 0.4 ML	1.2 ML	2.0 ML 0.65 ML	Height: 20 to 25 m
Water transmission pipeline	DIP	2.5 km	7.5 km	22.0 km	D>300mm
	HDPE	2.0 km	0.0 km	0.0 km	D≤300mm
Water distribution pipeline	HDPE	86.6 km	113.3 km	178.8 km	D≤300mm

*1: DIP: Ductile iron pipe

*2: HDPE: High density polyethylene pipe

Source: JICA Study Team

(2) Plan of Raw Water Conveyance Pipeline

In order to supply freshwater from Kandaleru Reservoir to the residential area and the industrial zone, approximately 50km of water conveyance pipeline will be constructed. Kandaleru Reservoir is located at the highland area with the elevation of approximately 60m, and the proposed nodal area will be located near the coastal area with the elevation of approximately 5m. Therefore, water from the reservoir will be transfered by gravity to the node by the new pipeline. The diameter of the water conveyance pipeline is calculated by the Manning Formula as below.

$Q=1/n * (D/4)^{2/3} * i^{1/2} * \pi D^2/4$

Where,

Q: Water flow = Amount of water conveyance in 2033 = 78.0 MLD = 0.90 m^3/s

n: Roughness coefficient of the applied pipe material = 0.01 (Assuming ductile cast-iron pipe)

i: Hydalulic gradient = (Difference of elevation) / (Distance) between Kandaleru Reservoir and the node = 55 m / 50km = 0.11 %

D: Diameter of the water conveyance pipeline

Based on the above Manning formula, the diameter of the water conveyance pipeline is estimated 1.0m.

(3) Plan of Water Treatment Plant

The ultimate capacity of the water treatment plant in the node will be 78.0 MLD, which will be develped by three phases. The first phase will be 19.0 MLD by 2018 and the additionaly capacities in the second and third phases will be 30.8 MLD by 2023 and 38.2 MLD by 2033 as presented by the water balance in Figure 7.53.

(4) Plan of Water Reservoir

Water reservoir will be constructed to store the treated water for to avoid water supply disruption to be possibly caused by unexpected suspension of operation of the WTP or raw water conveyance system. Volume of the reservoir is planned as half-a-day amount of the water production capacity of the WTP.

(5) Plan of Elevated Tank

In water distribution network, elevated tanks will be constructed to buffer the fluctuation of the water consumption and to stabilize water supply pressure at the water taps. Volume of an elevation tank will be one-hour amount of the hourly maximum water consumption in the distribution area of the tank.

Hourly maximum water consumption is calculated by multiplying the average water consumption and peak factor. According to Manual on Water Supply and Treatment by CPHEEO, peak factor to be applied is 2 to 3 which depends on population in the distribution area (e.g. Peak factor to be applied is 3.0, 2.5 or 2.0 for the case that the population is less than 50,000, in the range of 50,000 to 200,000, or above 200,000 respectively.). In Krishnapatnam node, the peak factor is set at 2.5 at all elevation tanks. In the node, residential population in elevated tank's distribution is mostly less than 50,000 where peak factor should be 3.0 according to the CPHEEC's manual. On the other hand, the water consumption in industries tends to be much more moderate or constant and this trend will draw down the peak factor. The adopted peak factor of 2.5 is determined as the intermediate value of the applicable value in the CPHEEO's manual.

(6) Plan of Water Transmission and Distribution Pipelines

Diameter of water transmission and distribution pipes are determined to achieve sufficient water pressure at the water taps in the residentail areas or industrial areas. In the Study, to achieve the sufficient water pressure and to avoid significant powert consumption at pumping stations, diameter of the pipes between the reservoirs and elevation tanks were preliminarh calculated so that the water head loss in the sections would be less than 10 m, using the following Hazen-Williams formula:

$$H=10.666\ C^{-1.85}\ D^{-4.87}\ Q^{1.85}\ L$$

$$D = (H\ C^{1.85} / 10.666\ Q^{1.85}\ L)^{4.87}$$

Where,

H: Loss of water head (m)

C: Coefficient of flow rate = 110 (Standard value)

Q: Design water flow (m^3/s)

L: Pipe length (m)

D: Diameter of pipe (m) (minimum size is 150 mm according to CPHEEO's manual.)

For the distribution pipes after the elevation tanks, pipe diameters were estimated from the coverage of the elevation tanks. Distribution lines will be installed at the both sides of the roads whose right of way is wider than 25 m, while a single distribution line will be installed in the roads whose right of way is less than 25 m.

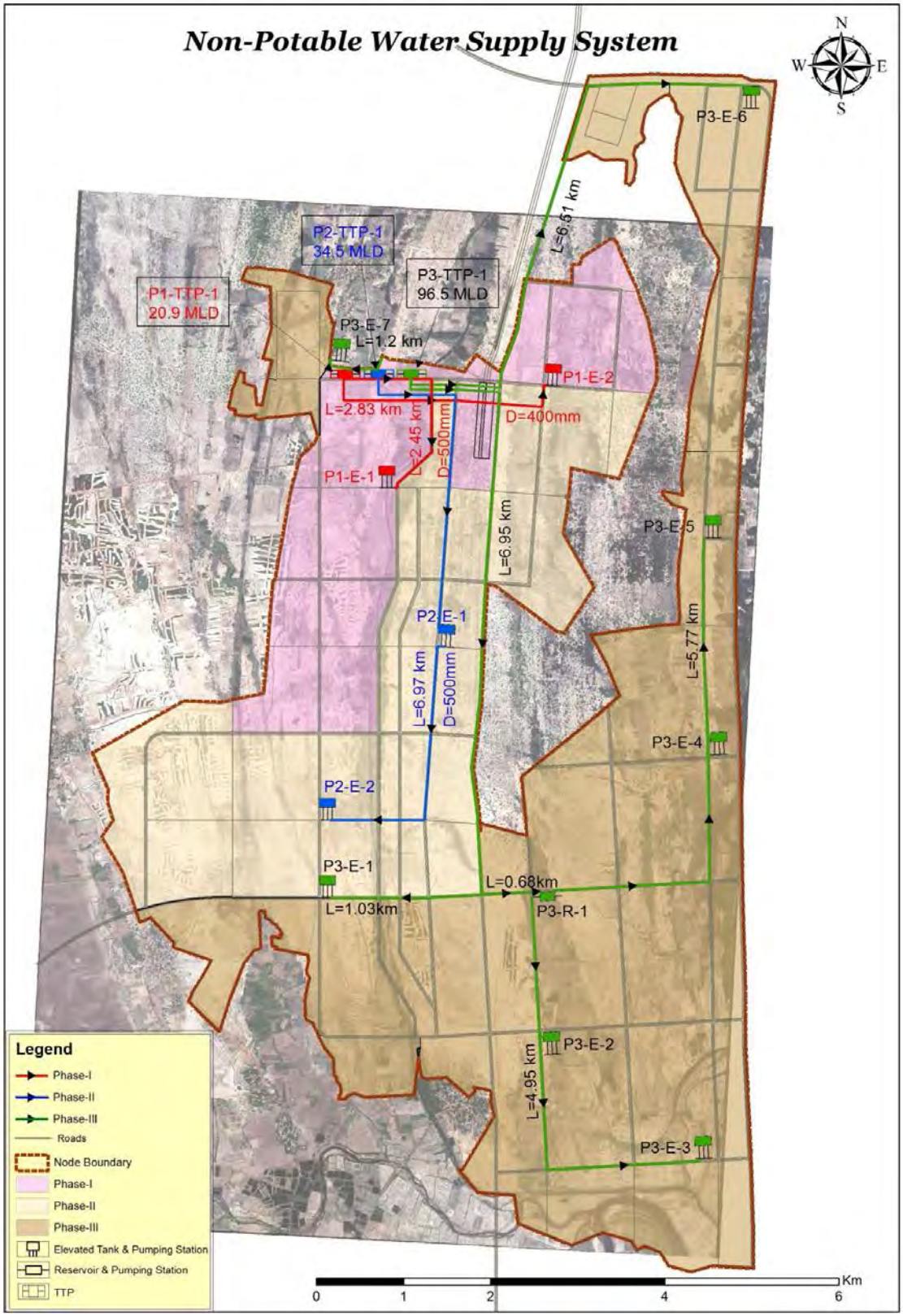
Plan of Non-Potable Water Supply System

(1) Layout Plan and System Outlines

Non-potable water supply system will supply recycled water for industrial purposes. Layout plan of the non-potable water supply system for Krishnapatnam node is illustrated in Figure 7.57 and outlines of the major facilities in the system are presented in Table 7.71.

The water supply system will have tertiary treatment plant (TTP) which will carry out the tertiary treatment of the treated sewage from the STP nearby. TTP will be located at the north-western end of the node area, which is the same location as the WTP and STP. This location of the TTP will enable integrated operation and maintenance of the water treatment facilities for the node.

Similar to the potable water supply system, water transmission and distribution system of the non-potable water will have independent system for each development phase, and the non-potable water produiced in the TTP will be distributed via ground reservoir and elevated tank(s). Locations of the reservoirs are the same as the potable potable water supply. However, more elevated tanks will be constructed that potable water supply system because the of the much higher water demand of non-potanble water than potable water.



Source: JICA Study Team

Figure 7.55: Layout Plan of Non-Potable Water Supply System

Table 7.71: Outlines of the Non-Potable Water Supply Facilities

Facility		Outlines/Capacity			Remarks
		Phase 1	Phase 2	Phase 3	
Tertiary Treatment Plant (TTP)		20.9 MLD	34.5 MLD	96.5 MLD	UF + RO Ultimate capacity: 150.9 MLD
Reservoir		10.5 ML	17.5 ML	48.0 ML	
Pumping station		1 location	1 location	1 location	
Elevated Tank		1.5 ML 1.25 ML	1.4 ML 2.2 ML	1.3 ML 1.5 ML x 3 2.0 ML x2	Height: 20 to 25 m
Water transmission pipeline	DIP	4.5 km	6.5 km	20.0 km	D>300mm
	HDPE	0.0 km	0.0 km	13.0 km	D≤300mm
Water distribution pipeline	HDPE	86.6 km	113.3 km	178.8 km	D≤300mm

*1: DIP: Ductile iron pipe

*2: HDPE: High density polyethylene pipe

Source: JICA Study Team

(2) Plan of Tertiary Treatment Plant (Sewage Recycle Plant)

The capacity of the tertiary treatment plant to be developed inside of the node is estimated 171.9 MLD which is the total amount of treated sewage and wastewater discharged from STPs and ETPs in 2033.

The ultimate capacity of the water treatment plant in the node will be 151.9 MLD, which will be develped by three phases. The first phase will be 20.9 MLD by 2018 and the additional capacities in the second and third phases will be 34.5 MLD by 2023 and 96.5 MLD by 2033 as presented by the water balance in Figure 7.53.

(3) Plan of Water Treatment and Distribution Facilities

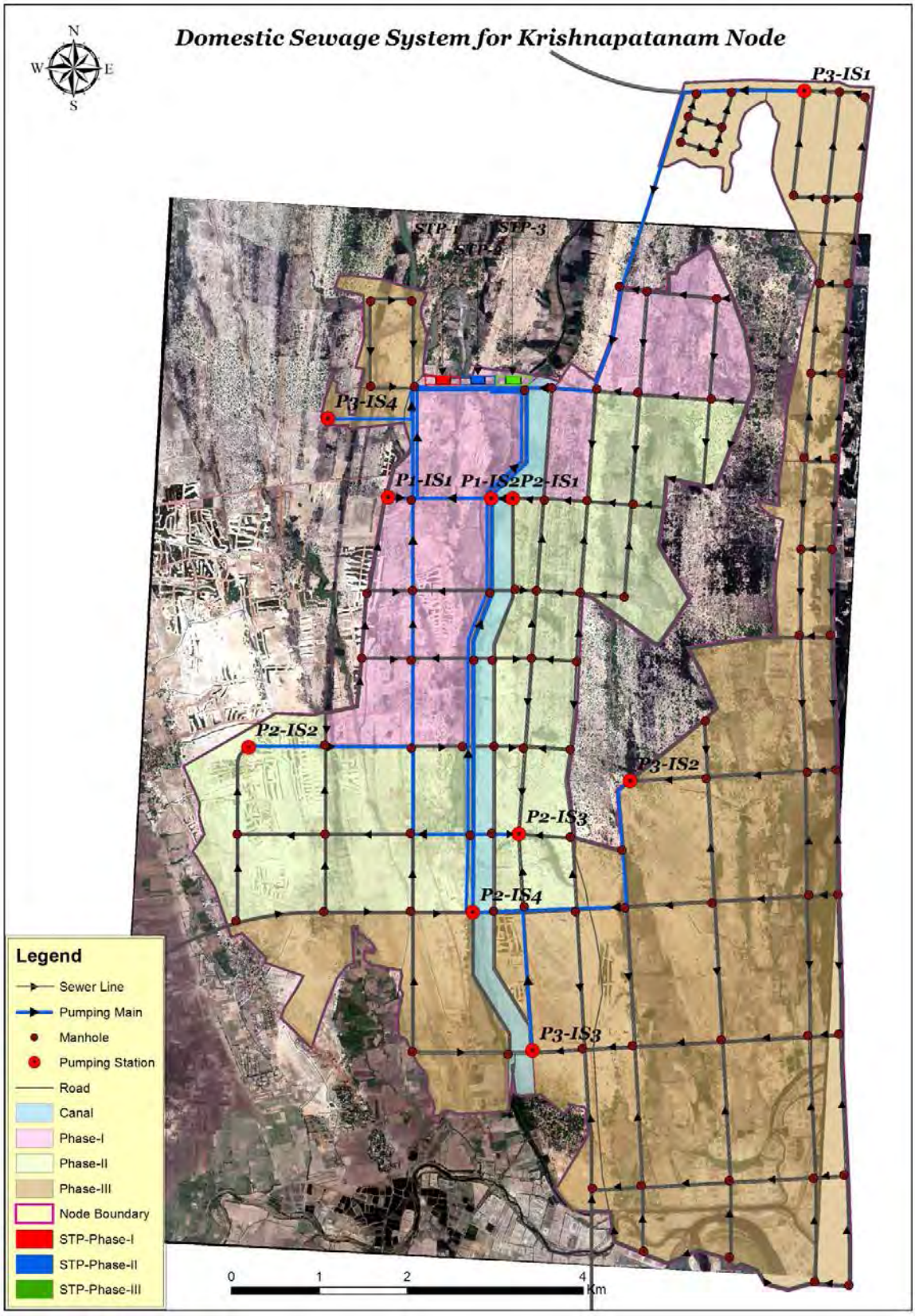
Water transmission and distribution facilities which include reservoris, elevated tanks, water transmission pipes and water distribution pipes are planned by the same conditions and methodologies as the potable water supply system.

Plan of Sewerage System

(1) Layout Plan and System Outlines

Layout plan of sewerage system for Krishnapatnam node is illustrated in Figure 7.58 and outlines of the major facilities in the system are presented in Table 7.72.

STP will be located at the north-western end of the node area, which is the same location as the WTP and TTP. This location will enable easy transfer of the treated sewage to the TTP for water recycle. Sewer network will be installed in the node to cover all residential and industrial areas. Sewage will be collected by the sewer network and transfered to the STP. Lift pump stations will be constructed to avoid extremely deep pipe for better constructivity.



Source: JICA Study Team

Figure 7.56: Layout Plan of Sewerage System

Table 7.72: Outlines of the Sewerage Facilities

Facility		Outlines/Capacity			Remarks
		Phase 1	Phase 2	Phase 3	
Sewage Treatment Plant (STP)		7.7 MLD	15.3 MLD	16.4 MLD	Conventional activated sludge process
Lift pump station		2 locations	3 locations	5 Locations	
Sewer pipe	RC Pipe*	D=250–500mm L=91.4 km	D=250–700mm L=116.21 km	D=250–700mm L=178.8 km	

*: RC: Reinforced concrete pipe
Source: JICA Study Team

(2) Plan of Sewage Treatment Plant

The ultimate capacity of the STP in the node will be 39.4 MLD, which will be develped by three phases. The first phase will be 7.7 MLD by 2018 and the additional capacities in the second and third phases will be 15.3 MLD by 2023 and 16.4 MLD by 2033 as presented by the water balance in Figure 7.53.

(3) Sewer Pipe

Sewer pipe will collect the sewage and transfer it to the STP. In the study, diameter and gradient of the sewer pipes are preliminarily determined determined by the following formula.

$$a = Q / v = \sum q * A / v$$

$$D = (4\,a / \pi)^{1/2}$$

Where,

Q: Design sewage flow (m^3/s)

v: Velocity of sewage flow (m/s) (Assuming 1.0m/s)

q: Sewage generation per unit area ($m^3/s/ha$)

A: Area of each residential area or industrial zone (ha)

a: Cross-section area of pipe (m^2)

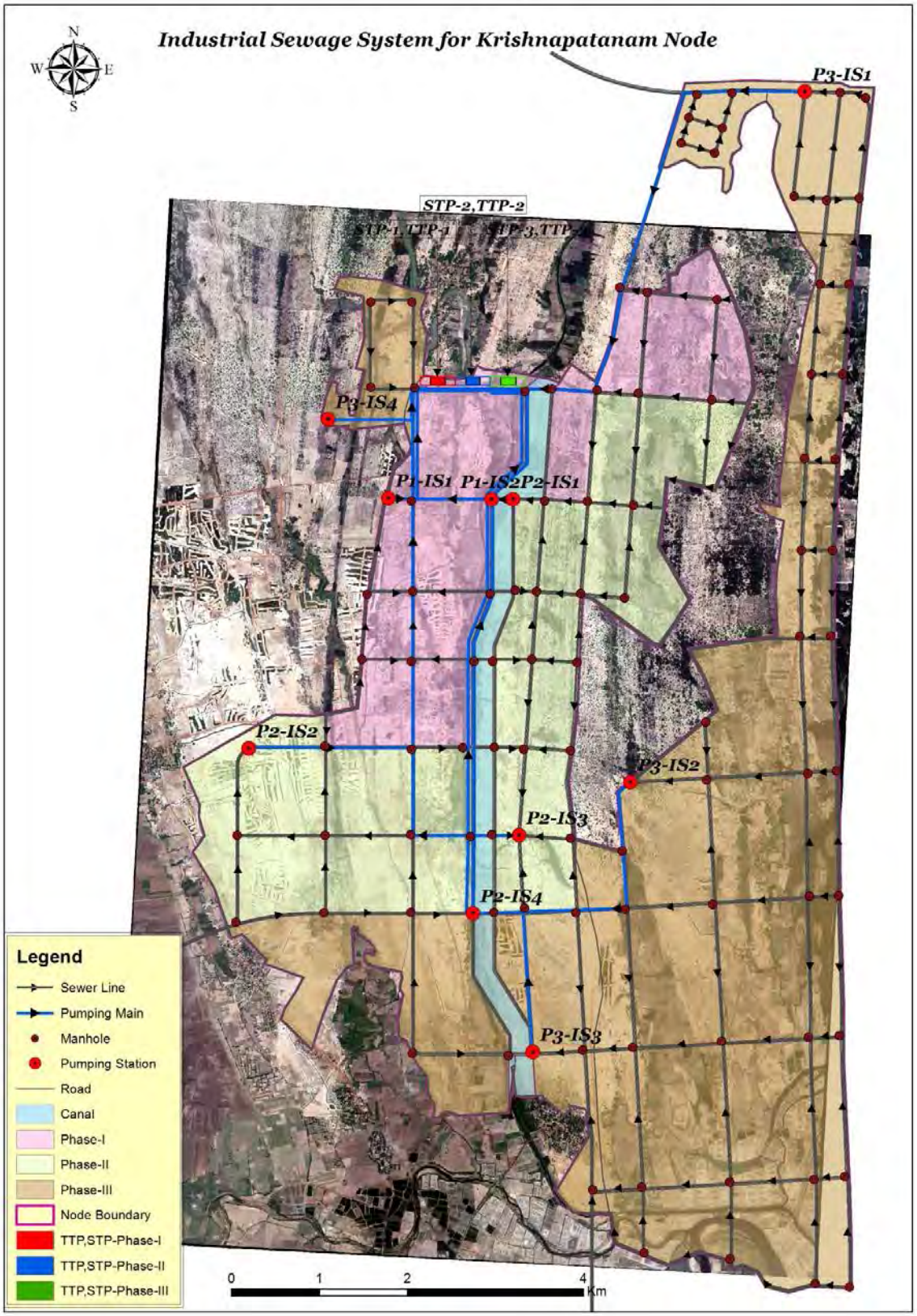
D: Diameter of pipe (m)

Design flows of the sewer pipes are determined by daily sewage amount and the peak factor. Applied peak factor is 2.5 refering to that for water supply. Sewer pipes will be installed in the both sides of the roads in the node.

Plan of Industrial Effluent Collection System

(1) Layout Plan and System Outlines

Industrial effluent collection system will collect the treated effluent from the industries and transfer them to the TTP for water recycling. Layout plan of the effluent collection and transfer system for Krishnapatnam node is illustrated in Figure 7.58 and outlines of the major facilities in the system are presented in Table 7.72. Similar to the case of the sewerage system, the effluent will be collected by the effluent collection pipe via lift pump stations.



Source: JICA Study Team

Figure 7.57: Layout Plan of Industrial Effluent Collection System

Table 7.73: Outlines of Industrial Effluent Collection Facilities

Facility	Outlines/Capacity			Remarks
	Phase 1	Phase 2	Phase 3	
Lift pump station	2 locations	3 locations	5 Locations	-
Sewer pipe	RC Pipe*1 D=300–800mm L=91.4 km	RC Pipe*1 D=300–1,000 mm L=116.21 km	RC Pipe*1 D=250–1,400mm L=178.8 km	-

*1: RC: Reinforced concrete pipe
*2: DIP: Ductile iron pipr
Source: JICA Study Team

(2) Plan of Industrial Effluent Collection Facilities

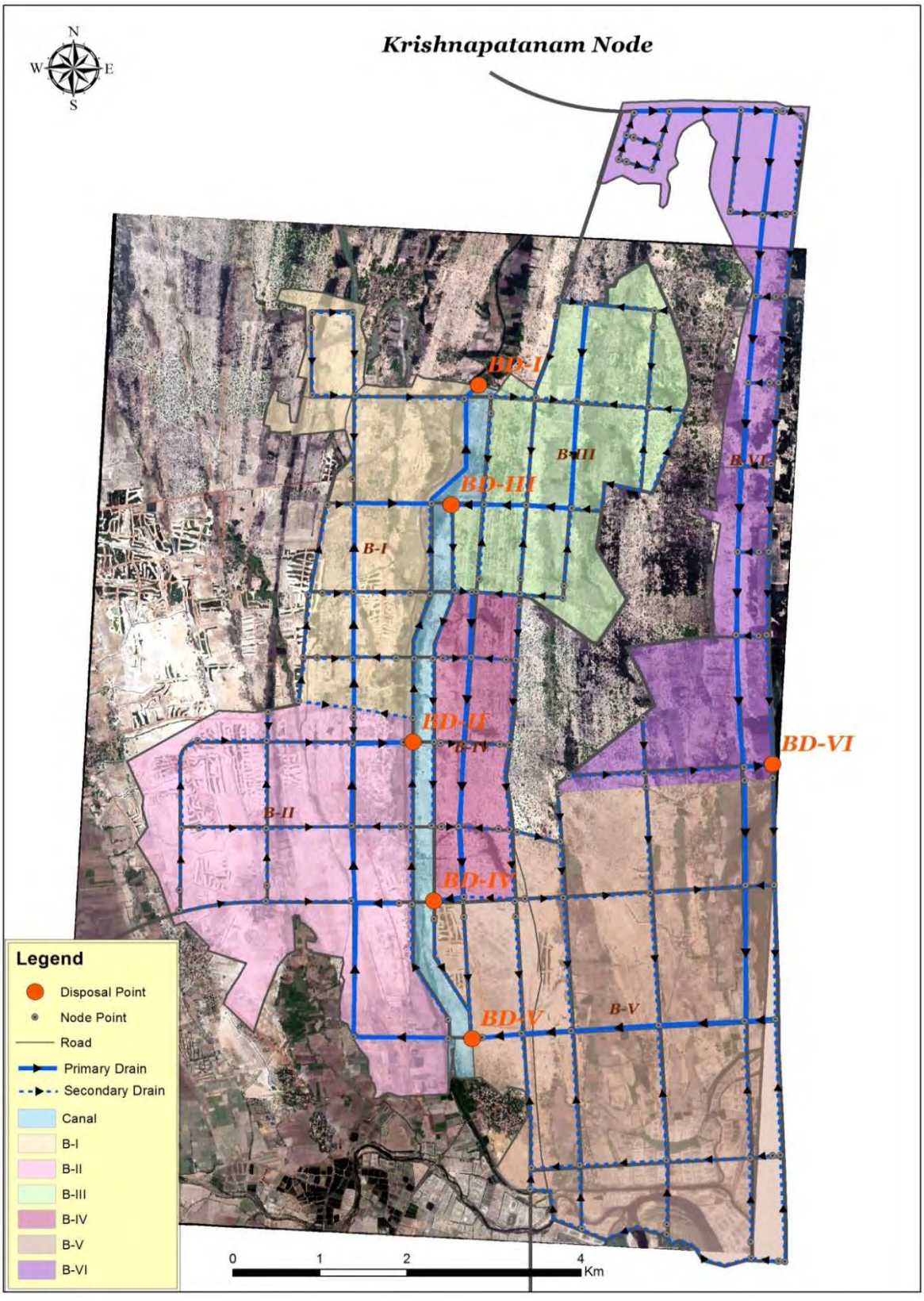
Industrial effluent collection system will cover the all industrial areas in the node. Diameters of the pipes are planned by the same conditions and methodologies so that all industrial effluent will be transfered to the TTP.

Plan of Stormwater Drainage System

(1) Layout Plan and System Outlines

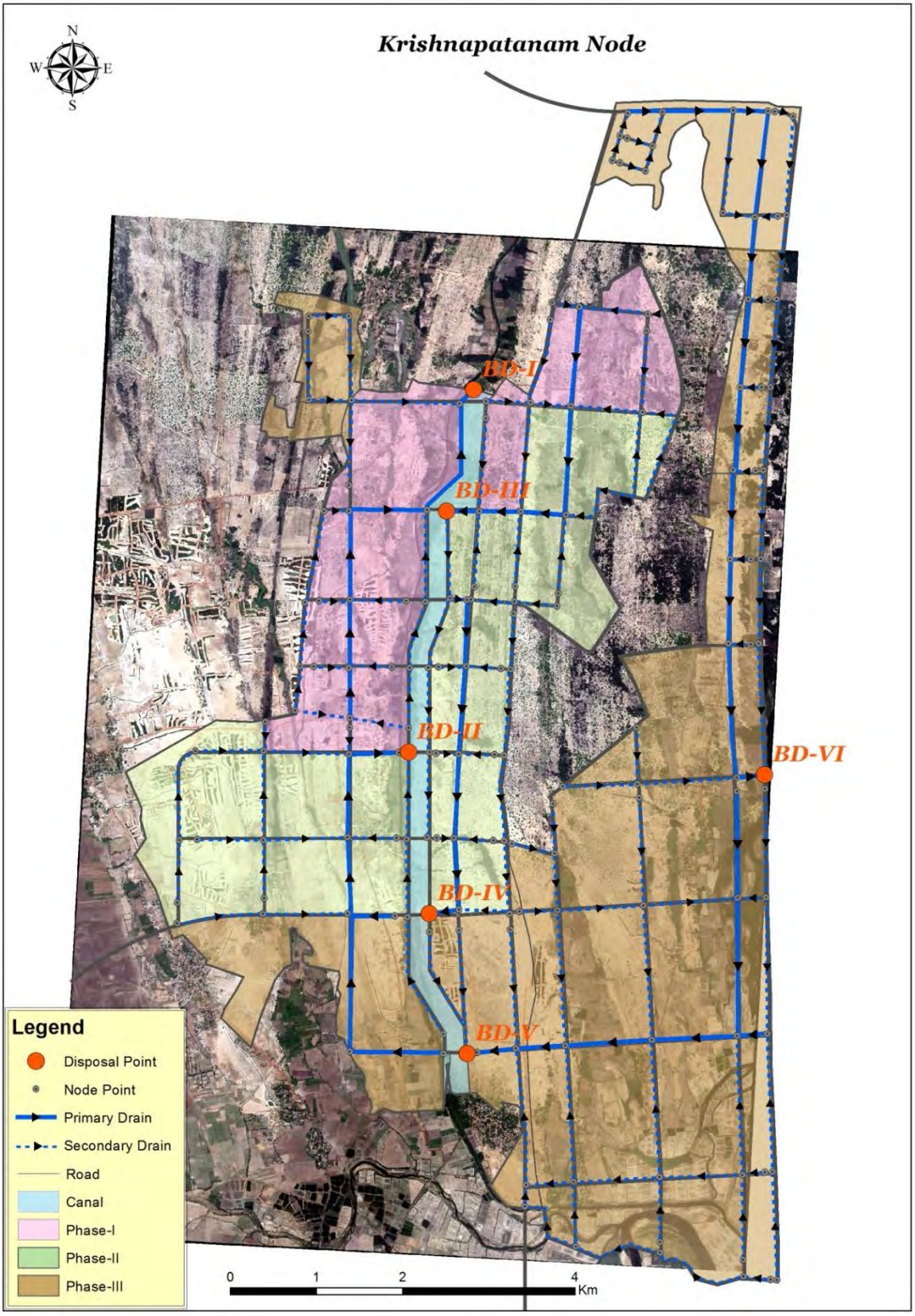
Stormwater diranage system is to drain the storm run-off from Krishnapatnam node during rainfall and manage the storm water entering into the node area and from other areas in the catchment. Layout plan of the stormwater drainage system for Krishnapatnam node is illustrated in Figure 7.60 and its phase-wise development plan is presented in Figure 7.61. System outlines are given in Table 6-74 and dimensions and length of drainage facilities are summarized in Table 7.75.

The proposed storm water in the node the node is divided into 6 drainage zones which are B-I, B-II, B-III, B-IV, B-V & B-VI. These zones will ultimately dispose stormwater to Buckingham Canal, with their respective disposal points denoted from BD-I to BD-VI respectively and suitable outfall structures are to be constructed at disposal points. As per the Phase wise development plan, Phase-1 development area comprises zone B-I, Phase-2 development area comprises the zones B-II, B-III & B-IV, Phase-3 development area comprises B-V & B-VI.



Source: JICA Study Team

Figure 7.58: Layout Plan of Stormwater Drainage System



Source: JICA Study Team

Figure 7.59: Phase Development Plan for Stormwater Drainage System

Table 7.74: Outlines of the Stormwater Drainage System

Sl.No	Zone	catchment area (ha)	storm discharge (cum/s)	Length of network (m)	Name of Disposal	Disposal
1.	B-I	701.43	70.14	37.50	BD-I	Buckingham Canal
2.	B-II	955.68	95.57	40.04	BD-II	
3.	B-III	660.26	66.03	34.01	BD-III	
4.	B-IV	308.41	30.84	27.47	BD-IV	
5.	B-V	2225.25	222.53	85.83	BD-V	
6.	B-VI	676.16	67.62	52.42	BD-VI	Canal
	Total	**5527.19**	**552.72**	**277.27**		

Source: JICA Study Team

Table 7.75: Sizes of Stormwater Drains

Size of the Drain (m x m)	Length (km)
1.00 x 1.00	88.20
1.50 x 1.00	16.14
2.00 x 1.00	4.07
1.00 x 1.25	16.57
1.50 x 1.25	23.75
2.00 x 1.25	21.00
2.50 x 1.25	3.03
1.50 x 1.50	5.03
2.00 x 1.50	4.99
2.50 x 1.50	12.70
3.00 x 1.50	5.59
2.50 x 1.75	6.74
3.00 x 1.75	7.11
3.50 x 1.75	4.99
4.50 x 1.75	2.00
3.50 x 2.00	6.68
4.00 x 2.00	5.21
5.00 x 2.00	2.00
5.50 x 2.00	2.00
6.00 x 2.00	4.96
7.00 x 2.00	3.20
7.50 x 2.00	3.20
4.00 x 2.25	2.11
4.50 x 2.25	0.66
5.00 x 2.25	1.99
7.00 x 2.25	3.05
9.00 x 2.25	0.71
4.50 x 2.50	1.78
5.50 x 2.50	2.51
6.00 x 2.50	2.85
6.50 x 2.50	1.00
7.50 x 2.50	2.03
9.50 x 2.50	2.00
16.50 x 2.50	2.00
7.00 x 2.75	1.00
8.00 x 2.75	0.70
10.00 x 3.00	1.36
18.50 x 3.00	1.14
21.00 x 3.00	1.22
Total	**277.27**

Source: JICA Study Team

(2) Plan of Stormwater Drainage Facilities

Drainage channels will be installed in the boths sides of the roads in the node. The size of the stormwater drain is computed with the following formula.

$a = Q / v = \sum q * A / v$

$A = B \times D$ (Rectangular in size)

Where,

Q:Design stormwater flow (m^3/s)

v: Velocity of stormwater flow (m/s) ($Assuming\ 1.5m/s$)

A: Area of each residential area or industrial zone (m)

B: Width of drain (m)

D: Depth of flow (m)

7.5.6 *Implementation Plan*

To correspond to the water demand of the industries in the node, all infrastructures should be constructed to be in time for the operation of each phase.

7.5.7 *Cost Estimate*

Summary of cost estimate of the construction and operation and maintenance (O&M) are presented in Tables 7.76 and 7.77, respectively. Also, the details of cost estimate of the construction and O&M are presented in Appendix "Detailed Information for Water Infrastructure Development" of this report. Unit costs for the construction items were refered to the past practices of the similar projects in South India for treatment plants, pumping stations, reservoirs and elevated tanks and standard unit costs of state government for pipe installation works.

Table 7.76: Summary of Construction Cost of Water Infrastructures

Item	Phase 1(2016-2018)	Phase 2 (2019-2023)	Phase 3 (2024-2033)	Total
	Cost	Cost	Cost	
	(Million INR)	(Million INR)	(Million INR)	(Million INR)
1. Potable Water Supply Works	5,710	2,147	2,379	10,236
2. Non-Potable Water Supply Works	1,842	2,727	7,477	12,046
3. Domestic Sewerage Works	347	594	804	1,745
4. Treated Sewage and Industrial Effluent Collection Works	695	1,214	5,283	7,193
5. Drainage Works	853	2,033	2,767	5,654
TOTAL	9,447	8,716	18,710	36,873

Source: JICA Study Team

Table 7.77: Summary of O&M Cost of Water Infrastructures

Item	Phase 1(2016-2018)		Phase 2 (2019-2023)		Phase 3 (2024-2033)		Total
	Annual	Phase Total	Annual	Phase Total	Annual	Phase Total	
	(million INR)	(million INR)	(million INR)	(million INR)	(million INR)	(million INR)	(Million INR)
1. Potable Water Supply Works	278	1,388	429	2,146	608	6,078	9,612
2. Non-Potable Water Supply Works	105	523	346	1,729	909	9,086	11,339
3. Domestic Sewerage Works	14	72	41	204	80	804	1,080
4. Treated Sewage and Industrial Effluent Collection Works	27	133	78	389	175	1,748	2,269
5. Drainage Works	43	213	144	1,451	283	2,827	4,492
TOTAL	466	2,329	1,038	5,920	2,054	20,543	28,791

Source: JICA Study Team

7.6 *Solid Waste Management*

7.6.1 *Sector Overview*

There is no hazardous waste management facility in the near vicinity of the Krishnapatnam Node. The closest common TSDF (final disposal landfill site) is located in Pharma City, Vishakhapatnam, about 500km away.

Municipal solid waste management services are provided in Nellore city and Gudur city. No services are available in the rural areas in the Krishnapatnam Node. However, recent economic development has led to increases in levels of waste generation. This in turn has caused a deteriorating environmental situation, which has created concern. The population of Nellore city is expected to double in the future. Therefore, the current practice of open dumping of solid waste needs to be replaced by more appropriate waste management practices including recycling.

Local residents raising NIMBY issues with the establishment of hazardous or solid waste facilities have constrained construction of waste management facilities. Therefore, promoting waste reduction through the 3R policy will be crucial in minimising the environmental burden of the facilities and coming to an agreement with the local residents.

In this section, the following items are studied in order to develop the infrastructures required to manage the solid waste generated from industrial activities and residents in the Node.

Forecasts of the future volume of municipal solid waste and industrial waste
Preparation of development plan of the solid waste management system in the Node
Preparation of the implementation plan to develop the infrastructures
Preliminary estimation of infrastructure costs.

7.6.2 *Framework for Infrastructure Development*

Appropriate solid waste management is an integral part of providing a secure quality of life and sanitation in the Node area, which leads to sustainable node development. The framework of infrastructure development for building solid waste management facilities in and around Krishnapatnam Node is shown below.

1. Hazardous waste management facility

The Part A study identified that common TSDFs in Hyderabad and Vishakhapatnam were located about 500km away from the node and it was therefore necessary to establish a regional TSDF within the CBIC area. However, following discussions between the Andhra Pradesh Pollution Control Board and the JICA study team, the following changes have been considered.

- At the time of the Part A study the state of Andhra Pradesh had not been divided. Before the division, Andhra Pradesh hosted two common TSDFs, one in Hyderabad and another in Vishakapatnam. At that time, it was only necessary to plan for anew common TSDF to serve the CBIC area (Nellore、Chittoor and Anathapur districts). However, the subsequent division of the state into Andhra Pradesh and Telengana means that the common TSDF in Hyderabadis now in Telengana. Therefore, waste generated from the central districts of AP (Kurnool, YSR, Prakasam and Guntur districts) cannot be taken to the Hyderabad TSDF despite its proximity. A new common facility is needed for these districts.

- The economically and geographically efficient solution for waste generated from these districts is for it to be transported to a site within the southern part of the state. Therefore a new common TSDF should be established, not only for the CBIC area but also the surrounding districts.

- The districts of Kurnool, YSR, Guntur and Prakasam are outside the CBIC area. Future indicators for these districts, such as forecasts of industrial demand and waste demand, are not covered by this study.

Therefore, this development plan deals with the construction of a new common hazardous waste treatment facility in the southern region of AP State (including Kurnool, YSR, Guntur and Prakasam districts).

Future volumes of hazardous waste generated outside the CBIC area are estimated by using the average growth rate of output and the proportion of each type of hazardous waste within CBIC area.

However, it should be noted that any common TSDF should be developed in accordance with guidelines for common TSDFs which cover the entire state given the economy of scale and efficiency of treatment and the presence of NIMBY issues. Therefore, as per the initiative of the state government, the plan for a new TSDF covering southern AP should take into consideration the distances to the TSDF from each district and forecast volumes of waste.

2. Municipal solid waste management Facility

- Municipal solid waste management services are provided in Nellore and Gudur municipalities. Recent economic development has led to increases in the volumes of waste generated and contributed to the deteriorating environmental situation. This deterioration has caused concern in both municipalities. Additionally, Nellore is expected to see its population double in the future. Therefore, the current practice of open dumping needs to be replaced by more suitable waste management practices including recycling. However, neither Nellore nor Gudur municipalities are planning to receive waste from outside of their own administrative areas.

- The Gram Panchayats that are located around the node area were originally agricultural areas. Therefore solid waste management services are not provided. The Zilla office, which administers the rural area, has recognised the need to introduce waste management services including collection and recycling in the highly populated areas.

Therefore it is identified that a municipal solid waste management facility for Krishnapatnam Node shall be established within the node area.

7.6.3 *Design Conditions*

The design conditions forinfrastracurerelated to the solid waste management sector are presented below.

Development Phases of Proposed Node

Krishnapatnam Node will be developed inthree phases; the target year for thefirst phase is 2018 andthe target years for the second and third phasesare2023and 2033 respectively. Accordingly, generated volumes of solid wastewill be projected forthe years 2018, 2023 and 2033.Figures for years between the target yearsare calculated by dividing the target figures proportionally by the number of years.

Population Forecast

As described above, the targeted residential and working populations of Krishnapatnam Node in each target year are forecasted inTable 7.78.

Table 7.78: Population Forecast of Krishnapatnam Node

Year	2018	2023	2033
Resident Population	33,408	83,695	200,000
Employed Population	97,336	243,849	582,706

Source: JICA Study Team

Forecast of Industrial land demand

The land demand of each industrial sector in Krishnapatnam Node is shown below.The output of each industry was calculated based on these land demand figures. Then the future amount of waste was estimated based on these industrial outputs.

Table 7.79: Proposed land demand of Each Industrial Sector in Krishnapatnam Node

Industrial Sector	Land demand (Acre)		
	Year 2018	Year 2023	Year 2033
Metallurgy	234	587	1,402
Food Processing	424	1,063	2,540
Textiles & Apparels	76	190	453
Electrical Machinery	212	532	1,270
Chemicals & Petrochemicals	83	207	494
Pharmaceuticals	12	29	69
Medical equipment	65	163	389
Machinery	65	163	389
Auto	65	163	389
Computer, electronic and optical products	65	163	389
Total	1,300	3,258	7,785

Source: JICA Study Team

Relevant Technical Standards

The development plan of each facility is based on the following technical standards.

Table 7.80: Applicable Technical Standards for Development Plan

Type of soild waste	Technical Standard
Hazardous waste	- Hazardous wastes(management, handling and Transboundary Movement) rules 2008 - Guidelines for storage of Incinerable Hazardous wastes by operator of CHWTSDF and captive Hazardous waste incinerators - Guideline for Common Hazardous waste Incineration - Criteria for Hazardous waste landfills - Guideline for Proper Functioning and Upkeep of Disposal site - Guidelines for Transportaiton of Hazardous waste
Municipal solid wasste	- Municipal Solid Wastes (Management and Handling) Rules, 2000. - Manual on Solid Waste Management (CPHEEO: Central Public Health &Environmental Engineering Organization,Ministry of Urban Development, GoI) - Technical EIA Guidance Manual for Common Municipal Solid Waste Management Facilities (The Ministry of environment and forests GoI,2010) - Guidelines on Co - processing in Cement/Power/Steel Industry Central Pollution Control Board Ministry of Environment & Forests, GoI, 2010

Source: JICA Study Team

7.6.4 *Demand Forecast*

The volume of solid waste generated in Krishnapatnam Node has been estimated in order to identify the required capacity of each facility. The types of solid waste which planning needs to be undertaken, industrial waste and municipal solid waste, are described below. In the Phase A study, the focus was on hazardous waste with high potential impact. In this phase of the study, non-hazardous waste generated from each industry has also been included in the forecast to evaluate the node development in more detail.

Table 7.81: Type of the target waste for planning

Type	Type of waste
Industrial solid waste	Hazardous waste： landfillable waste, incinerable waste, Recyclable waste, and waste treated by AFR
	Non-hazardous waste
Municipal solid waste	Residential waste, commercial waste, Institutional waste, Street sweeping waste

Source: JICA study team

Industrial waste Demand forecast

Industrial hazardous waste demand forecast

As indicated before, the amount of hazardous waste that is discharged by industrial activities was estimated for the southern region of AP State, including Kurnool, YSR, Guntur and Prakasam districts. For the estimation of hazardous waste generation in CBIC area, the figures presented in the phase A study were used. In addition, the estimation of industrial hazardous waste to be generated in Kurnool, TSR, Guntur and Prakasam districts was calculated based on the average growth rate of industrial output and the proportion of each type of hazardous waste to be generated in CBIC area (Annex E), as there was no forecasted industrial output for those districts.

Table 7.82: Industrial hazardous waste generated in CIBC area

	Year	2018	2023	2033
Incinerable hazardous waste	TPY	126	219	701
Landfillable hazardous waste	TPY	14,818	23,717	74,436
AFR hazardous waste	TPY	19,916	33,341	106,772

Source: JICA Study Team

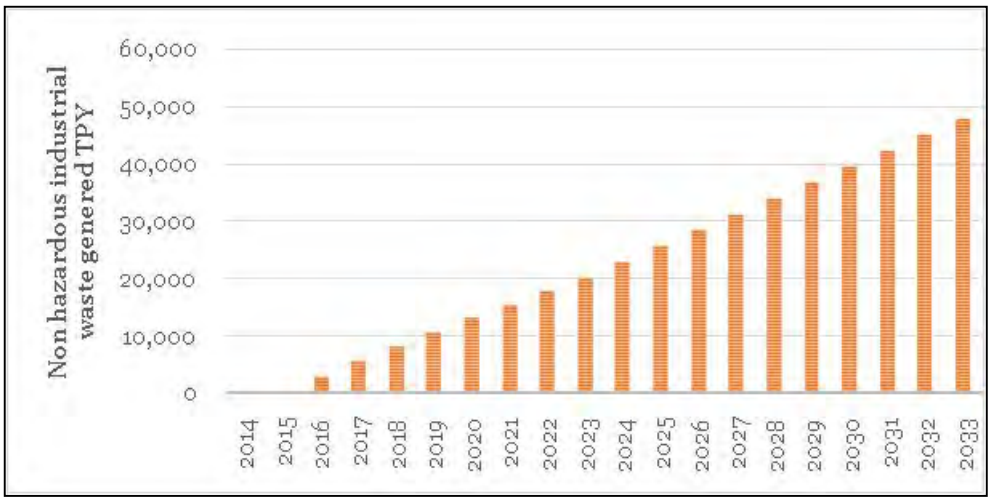
Non-hazardous Industrial waste Demand forecast

There is no publicly available data on non-hazardous waste generated from each industry. According to the interviews conducted by the JICA study team, a number of items are being recycled. Estimations were made for the items for which high levels of recycling are desirable (such as plants and animal residues, animal waste in solid form, glasses, concrete slabs, ceramics, and debris). It was calculated by using the amount of waste generated per output by industry type in Japan, presented in Annex E. In addition, food residue from canteens of industry will also be discharged. It was calculated as 0.05kg/employee/day according to the interviews carried out by the JICA study team. Estimated volumes of non-hazardous waste from the industries in the node are shown in the table below.

Table 7.83: Non-hazardous waste generated in the Krishnapatnam Node

	Year	2018	2023	2033
Number of employee		97,336	243,849	582,706
Canteen waste	TPD	4.9	12.2	29.1
Plants and animal residues, animal waste in solid form	TPD	14.4	36.2	86.4
Glasses, concrete slabs, ceramics, and debris	TPD	2.5	6.3	15.1
Total	TPD	21.8	54.7	130.7

※The figure of 0.05kg/employee/day was used for the food residues from canteens, based on the interviews made by JICA study team.



Source: JICA study team

Figure 7.60: Estimates of Non-hazardous Industrial Waste

Municipal Solid Waste Demand

Municipal solid waste demand was calculated based on the total estimates for residential waste, which is the product of the projected residential population and the amount of waste generated per capita per day. The estimate for the total residential waste is then used to identify the total volume and also the volumes of other categories using the ratio of waste by type (for commercial, institution, and street cleaning).

1. Waste type, characteristics, and waste kg/capita/day for residential, commercial, institution and street cleaning waste

The estimate, presented in the following table, was made with reference to the Clean CITIE program report 2014prepared by the neighbouring City of Nellore Municipal Corporation in 2014.

Table 7.84: Date of waste generation based on generators in Nellore Municipal Corporation

	Waste generator	Total waste t/day	Generation ratio %	population	kg/capita/day
1	Residential waste	112.40	52.6%	604,938	0.186
2	Commercial waste, institutional waste	73.19	34.3%	-	-
3	Street cleaning waste	28.10	13.1%	-	-
	Total	213.69	100.0%	-	-

Source : Calculated by JICA study team based on the Clean CITIE Program Report 2014 by Nellore Municipal Corporation.

There is no data on waste characteristics. The data compiled by NEERI in 2006, outlined below, was used as reference.

Table 7.85: Details of qualitative analysis of MSW

	Quality of waste	%
1	Plastics	7.48%
2	Paper	8.38%
3	Rags	3.11%
4	Organic Matter	51.35%
5	Rubber & leather	0.19%
6	Glass	0.29%
7	Wood	0.50%
8	Metals	0.19%
9	Coconut	2.48%

	Quality of waste	%
10	Inert	26.02%
11	Bones	0.01%
	Total	100.00%

Source: NEERI, 2006

2. The amount of waste generated per capita per day of residential waste for future

The amount of waste generated per capita per day for the target year 2033 was set as 0.7kg/capita/day which was determined by referring to the figures shown in the table below. The figures for other years were evaluated using the figure of 0.186kg/capita/day for the year 2014 in Nellore Municipal Corporation as the base.

Table 7.86: Waste generated per capita per day of other municipalities of Asia

Municipality	waste generated kg/capita/day	Note
Bengaluru	0.651	BBMP Master plan for MSWM 2007 (2033 Estimated figure)
Bangkok	0.88	APO(2007)
Jakarta	0.6	UNEP(2005)
Japan (Tokyo Tama area)	0.796	Tokyo municipal Government Committee (2011)

Source: JICA study team

The amount of residential waste, based on the waste generated per capita set above, was calculated by the following equation. The amount of commercial waste, institutional waste and street cleaning waste was calculated by using of amount of residential waste and the ratio of each waste type generated in Nellore Municipal Corporation.

The amount of Residential waste generated = Residential waste generated per capita per day ×population of each year

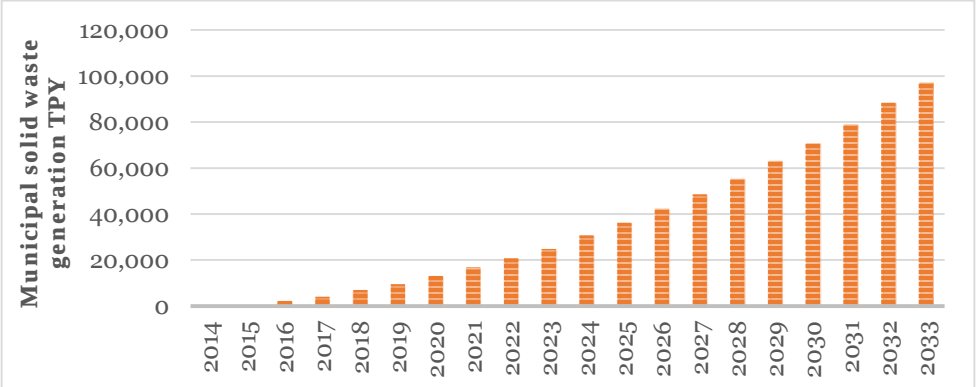
3. Demand of future of municipal solid waste

Estimated future projections of the volumes of municipal solid waste generated for each residential, commercial, institutional and street cleaning are presented in Table 7.87.

Table 7.87: Future prediction of Municipal solid waste generation in the Node

	year	2018	2023	2033
Resident Population		33,408	83,695	200,000
waste generated per capita per day	kg/capita/day	0.2942	0.4295	0.7
Residential waste	TPD	10	36	140
Commercial, institutional waste	TPD	7	23	91
Street cleaning waste	TPD	2	9	35
Total	TPD	19	68	266

Source : JICA study team



Source : JICA study team

Figure 7.61: Estimates of Municipal Solid Waste

7.6.5 *Development Plan*

Appropriate solid waste management is essential for providing safe and hygienic living environment. It also promotes sustainable development of the node and reduced environmental impacts. To maximise the effectiveness and efficiency of solid waste management, it is important to consider the entire process of waste management, from generation to final disposal, and to develop an integral system including both infrastructure and institutional development.

Scope of the development plan

The scope covered by this development plan is set as follows.

- In this development plan, it is assumed that the developer of the node is responsible for the solid waste management within the node area.

Development concept and policy

Various concepts and measures necessary for the solid waste management in the node, including the smart city concept (which is the vision for the node's urban development), have been considered.As a result, the following concept and policies for the solid waste management have been identified.

Table 7.88: Concept and Policy for solid waste management in the Node

	Items	Outline
Development concept	Building a sustainable Sound Material-Cycle Society	To achieve the development of a smart city, the vision of the urban development of the Node, building of sustainable sound material-cycle society is aimed at through the solid waste management.
Development Policy	Establishment of an appropriate waste management	To secure safe and clean living environment in the node area, appropriate waste management from generation to final disposal should be conducted to minimise the environmental impact.
	Reduction in the volume of waste that goes into final disposal through 3R promotion	To establish a Sound Material-Cycle Society, reduction in the volume of waste that goes into final disposal site shall be achieved through 3Rpromotion at each stage of waste management, namely generation, discarding, collection, treatment and final disposal. Reduction of waste shall also be sought in the private business activities through promotion of a sound material-cycle based production.

	Items	Outline
	Selection of environmentally and economically sustainable treatment system	Any technology adopted for each stage of waste management, i.e. collection, transport, recycling, treatment, and landfilling shall be environmentally and economically sustainable. Also collection system shall be designed for easy recycling and processing. Participation of private industries which could contribute to economically efficient and effective waste management shall be considered.
	Coordination with the stakeholders	Without understanding and cooperation of stakeholders such as citizens and private businesses who are generating waste, it is not possible to achieve a sustainable sound material-cycle society. Therefore, the coordination with the stakeholders shall be promoted. Protest movements by inhabitants over NIMBY issues tend to easily happen during construction of any waste management facilities. However, waste management facilities are absolutely necessary to maintain public sanitation especially in light of future increases i n solid waste volumes with economic development. To build consensus with the inhabitants, a waste management system that would minimise the environmental impact should be developed, and smooth consensus building with the inhabitants shall be achieved through conducting public consultation.
	Capacity development of institutions relevant to waste management	To execute the above mentioned policies, capacity of institutions, controlling authorities as well as individuals relevant to waste management shall be strengthened.
	Integration of solid waste management facilities	Any waste management facilities, either for hazardous or municipal solid waste, shall be integrated as much as possible at one location to reduce the environmental burden and to increase efficiency of the process by sharing land use and necessary environmental measures. Recycling industries shall be actively invited to promote efficient solid waste management systems as a whole.

Source: JICA Study team

Development program

To achieve the policy mentioned above, the following programs have been identified, with the activities to be conducted by responsible parties.

Table 7.89: Policy and program for solid waste management in the Node

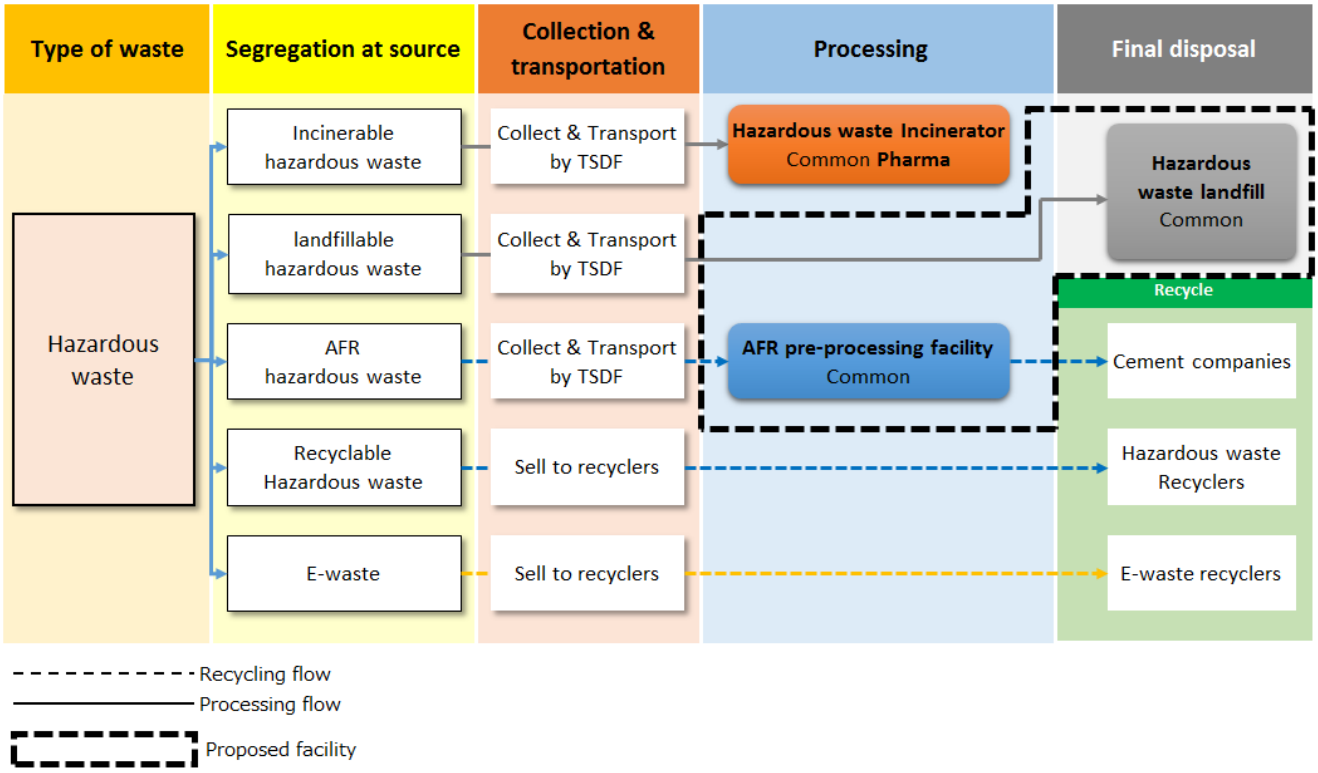
Concept	Building a sustainable sound material-cycle society		
Development Policy	1) Establishment of appropriate waste management 2) Reduction in the volume of waste that goes into final disposal through 3R promotion 3) Selection of an environmentally and economically sustainable treatment system 4) Coordination among the stakeholders 5) Capacity development for institutions relevant to waste management 6) Integration of solid waste management facilities		
Development program	Within the Node area		include the areas outside of the Node
	Hazardous waste management (Private or PPP)	Municipal solid waste management (including non-hazardous industrial waste) (Developer)	Waste management (state government)
	■Hazardous waste management facility development program - Devising of a development plan for hazardous waste management facilities - Development of a collection and transportation system - Development of a hazardous waste management treatment facilities	**■Municipal solid waste management facility development program** - Development of a municipal solid waste management plan - Development of a collection and transportation system - Development of municipal solid waste treatment facility **■Capacity development program for appropriate waste management** - Strengthening capacity in operation of solid waste management **■Program on 3R Promotion** - Awareness rising on 3R activities - Development and promotion of markets for reused and recycled products - Promotion of cooperation with NGOs and recyclers - Development of a focal point for awareness rising	**■Program for development of common hazardous waste treatment facilities on the state level** -Devising a common hazardous waste treatment facilities development plan for the state **■Institutional capacity development program for the authorising organization (state government, etc.)** - Strengthening the management capacity in controlling illegal dumping, temporary storage, and inappropriate treatment - Establishment of a monitoring and auditing institution and its capacity development **■Support program for the private industries** - Support for zero-waste technology for private companies, as well as for cooperation among the private businesses

Source: JICA Study team

Hazardous waste management

1. Hazardous waste management facility development program

A common hazardous waste TSDF for the southern region of Andhra Pradesh State shall be developed, as shown in the process flow diagram below. Hazardous waste management shall be done as indicated in the process flow shown below, in which wastes are sorted according to their segregation classification and are treated under the responsibility of the waste generator. Upon developing the common hazardous waste TSDF, development of a common hazardous waste TSDF plan is required for each phase by private operators or via PPP.



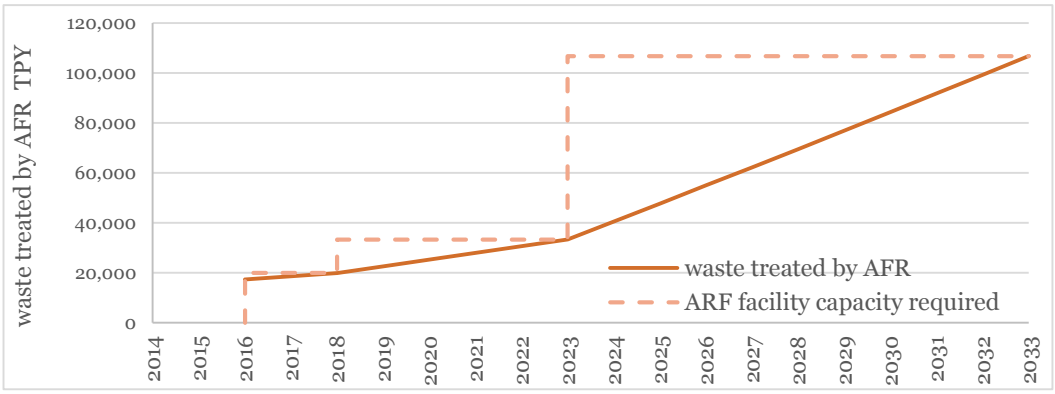
Source: JICA Study team

Figure 7.62: Hazardous waste treatment system

Capacity of each Infrastructure facility

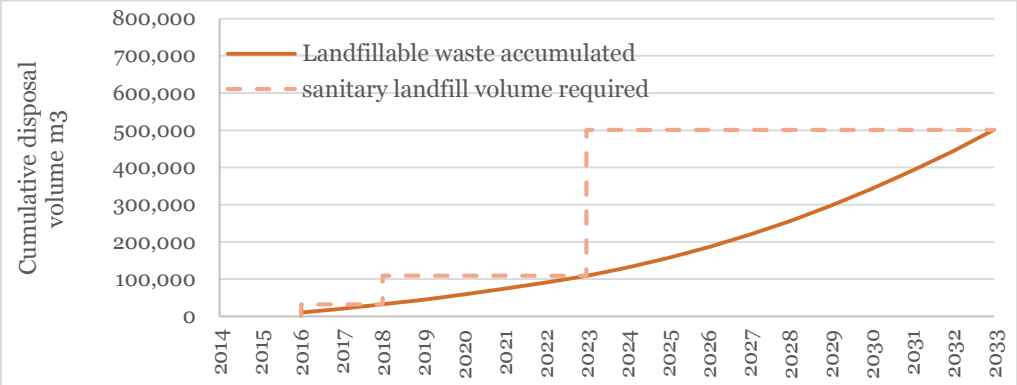
For the hazardous waste treatment system, the scale of the facility for each phase is calculated from the volume of waste generated. The results are indicated below.

The volume of incinerable hazardous waste is estimated to be a maximum of 1.9t / day in 2033. The scale of the incinerator is too small to consider the 24-hour operations required for measuring dioxins emissions. Therefore, no hazardous waste incinerator will be installed. Incinerable hazardous waste will be processed by the existing common TSDF in PharmaCity.



Source: JICA study team

Figure 7.63: capacity of AFR pre-processing facility



Source: JICA study team

Figure 7.64: Capacity of hazardous waste sanitary landfill

Table 7.90: Facilities capacity of each phase

Capacity of infrastructure		2016-2018	2019-2023	2024-2033	Total	Note
AFR pre-processing facility	TPD	57	38	210	305	Operation rate is set as 96%
hazardous waste sanitary landfill	m^3	50,600	120,900	617,700	789,000 (by 2033)	The ratio of landfill capacity used for cover soil is set as 20% Service life is calculated as 20 years.

Source: JICA study team

Municipal solid waste management

Municipal solid waste facility development program

To reduce the environmental impact, an appropriate waste management system shall be implemented. This system would minimise the environmental impact through each process from its generation, collection and transportation, treatment and to final disposal.

The facility plays a very important role in waste management. Details of waste management at each stage of process are summarised below. For the selection of the identified systems, consideration was given to the development policy of 1) establishment of an appropriate waste management system; 2) reduction in the volume of waste that goes into final disposal through 3R promotion; and 3) selection of environmentally and economically sustainable treatment system.

Development of collection and transportation system

Collection and transportation is a starting point for efficient waste management. An efficient collection system can take away waste from the living environment of the people safely and without delay, as well as preventing illegal dumping. In order to implement the collection services efficiently and economically, the collection system should be planed systematically. In the medium to long term, maintenance for the collection vehicles and management machineries shall be conducted periodically and their equipment should be repaired and/or renewed as necessary.

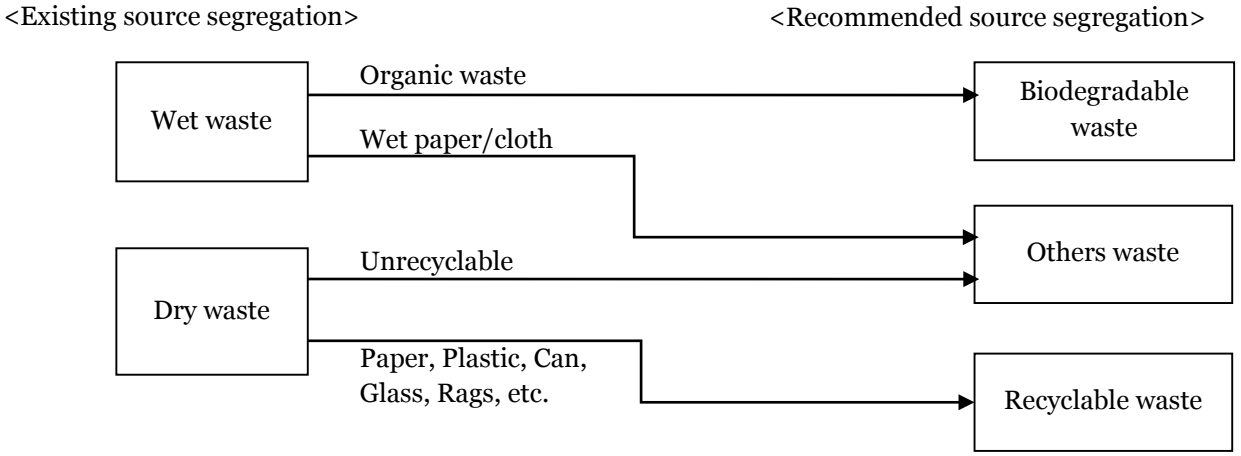
In India, collection of waste by segregation at source into wet and dry waste are conducted or planned in many areas. This method of collection has a great benefit for waste management for the following reasons.

- Promotion of recycling of recyclable materials,

- Prevention of contamination to ensure more appropriate composting, biomethanation, incineration and landfilling,
- To reduce space required for a landfill by reducing the waste amount, and
- Raising awareness on waste among the waste generators.

Therefore it should be applied as standard as it will lead to a reduction of waste that goes into final disposal in the node area.

However, “wet waste” currently includes items such as wet paper or cloth. These items are likely to be incorrectly classified, which should be noted if considering the introducing of composting or biomethanation. Therefore, "Wet waste" is recommended to be revised and categorised as "Biodegradable waste" based on the aim for thorough separation. Also, “dry waste" currently includes recyclable paper and plastic etc. The classification should be revised and divided into "Recyclable waste" and "Others waste".



Source: JICA study team

Figure 7.65: Segregation at source

In addition, transport of non-hazardous waste generated from private business activities to intermediate treatment facilities will be the responsibility of the private entities themselves. The reasons are; 1)the characteristics and amount of those wastes are different from household wastes2) the businesses are mandated to carry out their own waste management. For those who do not have a system of transportation for their waste, waste management companies shall provide collection and transportation services at reasonable prices.

Collection vehicles and machineries required are calculated based on the conditions mentioned below.

- Door to door collection by 5ton (10 ㎥) compactor trucks for residential houses within the node, as these houses are newly built and accessible by collection vehicles.
- Bulk specific gravity of 0.5t/㎥ and loading ratio of 96% are set
- Frequency of collection services is set at 3 times/week for organic waste and2times/week for “other waste” and “recyclable waste”.
- Collection trips are set as 3 trips per day.
- 2collection areas
- Collection of non-hazardous waste from industries/businesses is outsourced to waste management companies

Table 7.91: Collection vehicle required

Type of collection vehicle	2018	2023	2033
Compacter	7	16	33
Number purchase vehicle of each phase	7	9	17

Source: JICA study team

Development of intermediate facilities

The following technologies for process of municipal solid waste in the Node area could be considered. The intermediate technologies have some individual characteristics. The technology shall be selected according to future economic and social conditions.

With regards to RDF (Refuse Derived Fuel), residues after sorting mixed waste collection are used as fuel in the cement kilns in India. Sorted plastic waste with high calorific values is targeted for RDF. However, those plastics have been assumed to be sorted at the source of waste generation and recycled as AFR in this plan. And it would also be necessary to consider the demand for RDF products outside of the Node. Therefore RDF is excluded from this plan.

Table 7.92: Option of municipal solid waste intermediate technology

	Merit	Demerit	remark
Compost	Reducing waste amount by using organic waste Relatively small initial cost running cost Relatively simple technology Experience already accumulated in India	Difficult to maintain the quality of the product Competing with the low cost of chemical fertilisers Availability of the demand for the compost Not suitable for mixed waste of organics and non-organics	Stable demand is necessary for compost An alternate use as cover soil for the landfill site shall be considered.
Biomethanation	Reducing waste amount by using organic waste Recapturing of biogas as renewable energy Increasing experiences in India	Large initial investment and running cost High skills required for operation Demand for the sludge may be low	Not many examples available of large-scale facilities
Waste to Energy (Incinerator)	Effective for public health Reducing waste amounts Power generation available for large facilities over certain scales.	Large initial cost and running cost High skills required for operation Not suitable for low calorific waste Potential for NIMBY problem	Various experiences in Japan and high technical convince

Case of each technology in Japan is shown in Annex E.
Source: JICA study team

For the reasons outlined below, composting and biomethanation is selected as intermediate treatment for municipal solid waste and food waste from industries and canteen waste of industries, respectively.

- Reduction in the volume of final disposal through 3R promotion(basic policy)
- Obtaining separated organic waste by implementing segregation at source
- Lowest cost of development and maintenance for the biodegradable waste of MSW. Selection of environmentally and economically sustainable treatment system(basic policy)
- Food residues from factory canteens as well as plants and animal residues from food processing industry can be used in the biomethanation plant.
- There is a vast green belt within the node, and products from composting as well as sludge from biomethanation plant can be applied to those areas. In addition, the vast agricultural areas surrounding the node can also be potential sources of demand.
- According to the demand forecast of waste, the capacity of the facility is less than 300t/day and is considered unsuitable for Waste to Energy system. When the amount of waste to be treated exceeds 300t/day after 2033, however, the waste to Energy plant can be considered as an option.

Moreover, a sorting plant shall be established to reduce the volume of waste that goes into final disposal. The final residues will be taken to final disposal site for landfilling. As for plastics, recycling shall be conducted at AFT facilities and/or at the plastic recyclers. In addition, recyclables among the non-hazardous waste generated from industrial activities shall be sold to recyclers by each business entity, and the remained waste will be treated as municipal solid waste.

Development of a Sanitary landfill

A landfill site functions to separate residues from the natural environment through recycling and intermediate treatment processes to dispose it in a sanitary manner and therefore to reduce environmental impacts. A sanitary landfill site in accordance with the facility development guidelines in India shall be established.

Other

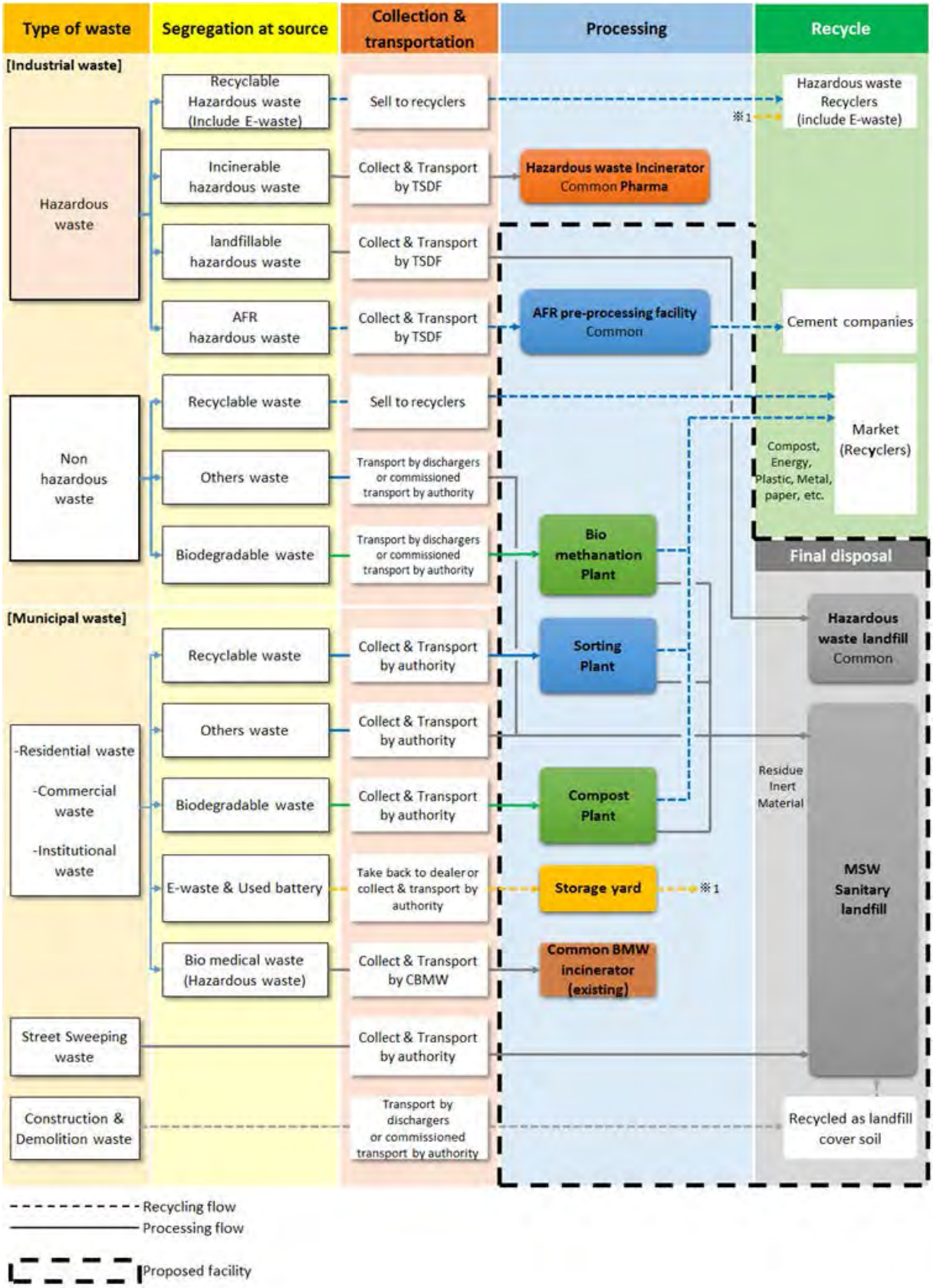
- construction and demolition waste

  Construction and demolition waste typically includes concrete, plaster, metals, and woods. These are usually heavy and bulky. This waste is not treated by municipalities. They are discarded and scattered around low-lying land, streets and near waste collection containers. The volume of this waste is expected to go up due to increased economic growth in the future.

  As a counter measure to this problem, discarding of construction waste at the waste collection point for municipal solid waste shall be prohibited, and the waste generator shall take these wastes to the landfill themselves or by contracting with waste management companies. A storage area for these construction wastes shall be allocated within the landfill site, and this waste can be used as cover soil for the landfill site or as construction materials. (Establishment of a recycling plant for construction waste might be possible in case the price of virgin materials become higher than the recycled materials. The case in Japan is shown in Annex E) In addition, imposing of a landfilling charge shall be considered.

- Compostable waste from street cleaning shall be composted, and the remainder shall be landfilled.
- E-waste shall be stored at a temporary storage yard, and then taken to e-waste recyclers.
- In principle, used batteries shall be taken to the sales agent for a take-back system. Used batteries identified in collected mixed waste shall be stored at a temporary storage yard and then taken to the battery recyclers.
- Medical waste shall be directly taken to the common medical waste treatment facility located within the area by the waste generators.

The following diagram shows the entire process flow for hazardous and municipal solid waste respectively, based on the points highlighted above.

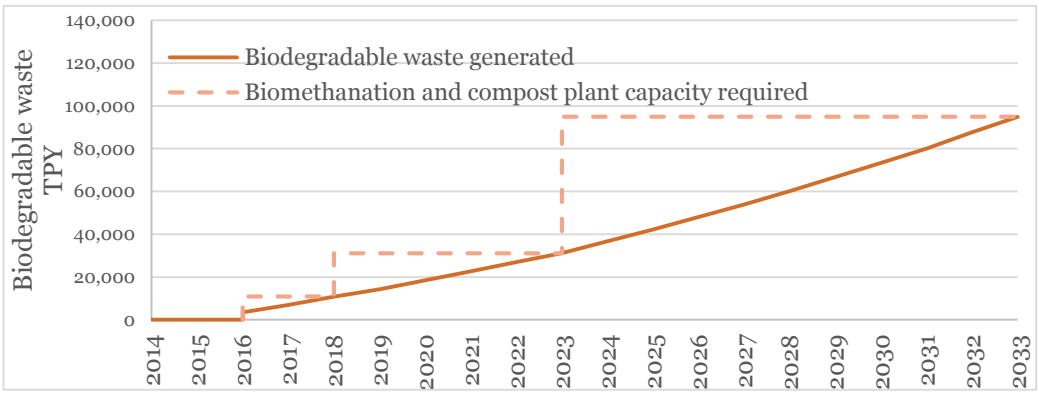


Source: JICA study team

Figure 7.66: Solid waste management in the Node

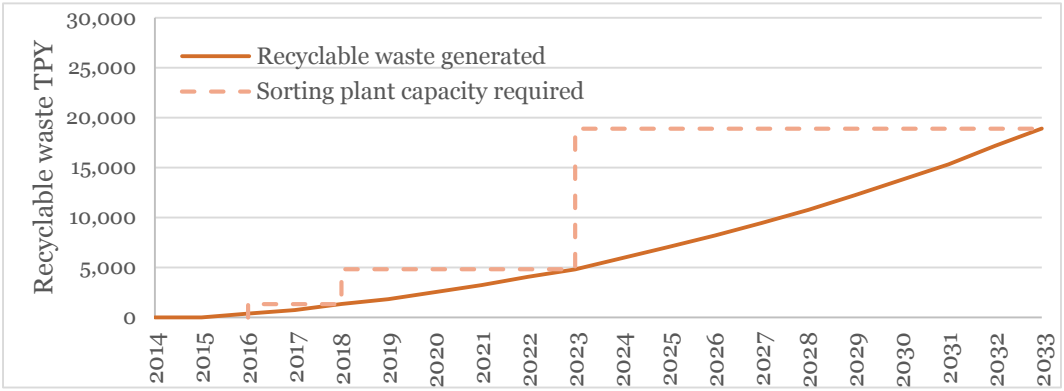
Capacity of each facility

The capacity of each facility for each phase is calculated from the volume of waste generation. The results are shown below.



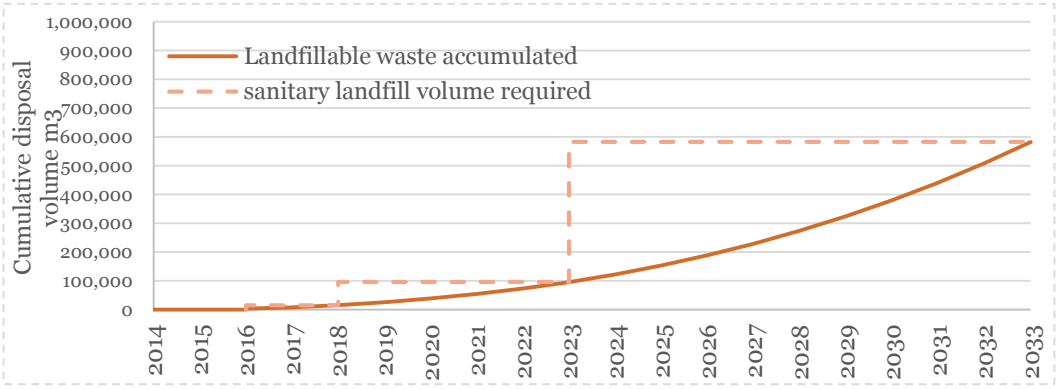
Source: JICA study team

Figure 7.67: Capacity of Compost plant and biomethanation plant



Source: JICA study team

Figure 7.68: Capacity of sorting plant



Source: JICA study team

Figure 7.69: Capacity of Sanitary landfill

Table 7.93: Capacity of each facility

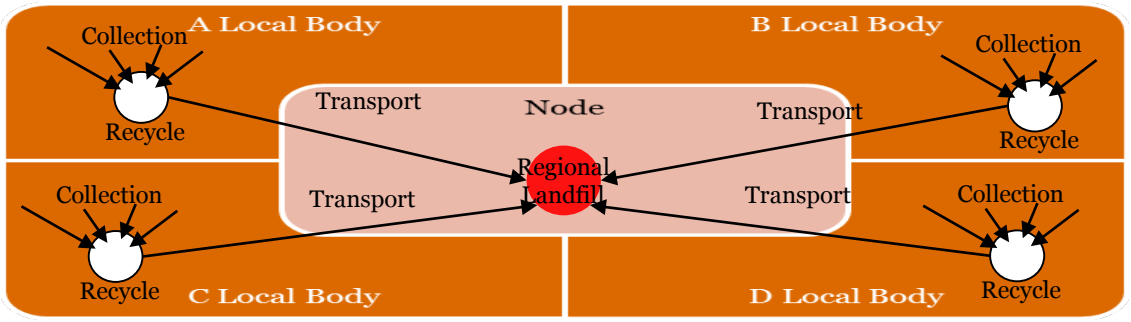
Facility		2016-2018	2019-2023	2024-2033	Total	Note
Compost plant	TPD	13	31	126	170	Operation rate is set as 86%
Biomethanation plant	TPD	24	35	81	140	Operation rate is set as 84%
Sorting plant	TPD	5	12	46	63	Operation rate is set as 86%
Sanitary landfill	m3	14,489	70,503	421,173	506,165	The ratio of landfill capacity used for cover soil is set as 20%

Source: JICA study team

Development of master plan for municipal solid waste management

To develop municipal waste treatment facilities, a municipal solid waste management master plan shall be identified for each phase by developer. It should focus on the following: 1) operation method; 2) setting of an appropriate solid waste management fee and its collection method; and 3) waste management in LB area, located outside of the Node area, shall require careful evaluation. In addition, the master plan shall be reviewed every 5 years depending on the industrial development in the Node and the increase in the population.

- Waste treatment for the areas administered by local body within the Node
  As an alternative plan, any waste generated outside the node area in nearby villages shall be treated at the waste management facilities within the node area. It is therefore necessary that the surrounding areas' administrative authorities be included in the planning of municipal solid waste management. In this case, it is recommended that each village shall prepare action plans for waste management including collection and recycling. Residues (non-recyclables) from the villages shall be transported and treated at the facilities in the node area (Figure7.72).



Source: JICA study team

Figure 7.70: Image of municipal solid waste management

Capacity development program for appropriate waste management

To achieve the development policy of establishment of appropriate waste management, capacity development of the parties involved in waste management is indispensable, and therefore measures on capacity development of the individuals and institutions are important.

Strengthening capacity in operation of solid waste management

Capacity development of individuals and institutions in various aspects, such as those outlined below, are necessary to achieve appropriate waste management.

- Capacity to create action plans for municipal solid waste management
- Capacity in public communication on collection by sorting and its improvement
- Capacity in planning and coordination for awareness raising program

- Capacity in devising a staff training program
- Technical capacity for facility operation and maintenance
- Capacity to analyse various monitoring data on quantity / quality of waste, etc.
- Capacity to dissemination of information towards establishment of sustainable sound material-cycle society.

Program on 3R Promotion

The reduction of waste that goes into final disposal by controlling the generation of waste and promotion of recycling is considered the most important component of a good solid waste management system. This will minimise the environmental impact from waste management and establish sustainable sound material-cycle society. This also leads to reduction in the cost required for development and maintenance of waste management facilities as well as prolonging the life of the final landfill site. Therefore, the priority should be on the following, in order 1) reduction of waste at the source of generation; and 2) reduction of waste through reuse and recycling of the waste generated. Moreover, 3R promotion including waste reduction in the private sector is important, and the private companies should aim to reduce their volumes of waste by leading the resource based production activities.

Awareness rising activities on 3R

To achieve establishment of sustainable sound material-cycle society, the role of awareness rising through education is important. For promoting3R to reduce waste at source, obtaining the understanding and cooperation of the local residents and private companies (i.e. the sources of waste generation)is considered of primary importance. Residents and companies can act on their own with 3R on their mind; "knowing" and "thinking" is required from them. Therefore, there should be more active planning and execution of programmes to increase awareness, including enhancement of the programmes undertaken by groups such as ITC and NGOs in local communities. Environmental education should be promoted via a focal point within the communities as this will lead to residents' awareness levels being raised high enough to "know the reality."

Development, promotion and networking of markets for reused and recycled products

There are already a number of recyclers and markets for second-hand and recycled products. To advance 3R activities further, the development, promotion and networking of these markets shall be promoted. Recycling industries can be invited to the same location as the waste treatment facility to be built by the project.

Promotion of cooperation with NGOs and recyclers

With the improvement in the quality of life due to economic development, the volume and the quality of waste will vary. Without understanding and cooperation from stakeholders such as citizens and private companies, the generators of waste, the establishment of sustainable sound material-cycle society cannot be realised. Therefore, active participation by each stakeholder is important, and cooperation with stakeholders such as NGOs and recyclers shall be promoted.

Development of a focal point for awareness rising on 3R and information disclosure/exchange on other environmental issues

To promote environmental activities as mentioned earlier, a focal point of public relations which can be used for information disclosure and exchange as well as raising awareness on3R and other environmental issues should be established. This should target citizens and corporations and should be part of the functions of waste management facilities. The space can be used by NGOs and community organizations mentioned earlier to conduct their awareness rising activities and also can be used for second-hand markets and flea markets.

Waste management including outside of the Node area

For achieving the establishment of appropriate waste management and reduction of waste through 3R activities as stated in the basic policy, it is important to implement a program not just in the node area but also in the area outside of the node. It is the responsibility of the state government to select the land for development of hazardous waste management facilities as well as implementation of appropriate municipal solid waste management and monitoring of the related facilities. The programmes for the state government in executing its responsibilities are outlined below.

1. Programme for development of common hazardous waste treatment facilities at the state level

This development plan considers the common hazardous waste TSDF not only for the CBIC area (Nellore、Chittoor, Anathapur districts) but also for the central part of Andhra Pradesh state (Kurnool, YSR, Prakasam and Guntur districts). However, as discussed above, it is necessary to re-plan for a new common hazardous waste TSDF with considerations given to the distances from each district as well as to the forecasted volume of hazardous waste generated in the future. A common hazardous waste TSDF development plan covering the entire state should be developed by the initiative of state government.

2. Institutional capacity development program for the authorising organization (state government, etc.)

Appropriate solid waste management is indispensable to provide a safe and clean living environment and to establish a sustainable sound material-cycle society. Any inappropriate practices currently followed must be removed. For this to be realised, capacity development of the state government staff in monitoring and authorising management practices of citizens and private companies has primal importance.

Strengthening the management capacity in controlling illegal dumping, inappropriate temporary storage, and treatment

At present, there are some cases of inappropriate practices regarding both hazardous waste and municipal solid waste. By the development of appropriate waste treatment and disposal facilities, illegal dumping and/or inappropriate temporary storage of waste should be removed. For this to be realised, management capacity of private companies handling waste and the administrative staff (state PCB) controlling illegal dumping, inappropriate temporary storage and treatment should be strengthened.

Establishment of a monitoring and auditing institution and its capacity development

For appropriate waste management, setting up of a third party organization such as IWMA (associations of waste generating companies conducting monitoring of management practice by contractors) is also promoted along with the capacity development of administrative staff (state PCB).

3. Support environmental technology program for the private industries

To promote zero emissions of waste through the use of waste as resources among industries, support and information should be provided on the latest recycling technologies and dialogue exchanges among companies should be facilitated. Technical support for development of cleaner production methods with low environmental impacts shall also be provided for the establishment of a sustainable and sound material-cycle society.

7.6.6 *Implementation plan to develop the infrastructure*

The capacitiesof eachinfractructure facilities foreach target year is shown below.

Table 7.94: Capacity of each infrastructure facility for each target year

Infrastructure			by 2016	by 2018	by 2023	Total
Hazardous waste facilities	AFR pre-processing facility	TPD ha	57 1.3	38 0.9	210 4.8	305 7.0
	Hazardous Waste landfill	m3 ha	50,619 0.5	120,921 1.1	617,666 5.9	789,206 7.5
MSW facilities	Composting Plant	TPD ha	13 0.3	31 0.7	126 2.6	170 3.6
	Biomethanation Plant	TPD ha	24 0.6	35 0.9	81 2.0	140 3.5
	Sorting Plant	TPD ha	5 0.1	12 0.2	46 0.7	63 1.0
	Sanitary Landfill	m3 ha	14 0.3	71 1.5	421 9.2	506 11.0
	Collection vehicle Garage & workshop	Unit ha	7 0.1	9 0.1	17 0.2	33 0.3
	Stockyards for e-waste, etc.	ha	0.1	0.1	0.1	0.3
	Space for future recycling industrial facilities	ha	0.7	1.1	5.1	6.8
Total		ha	4.0	6.7	30.5	41.1

*A space for future recycling industrial facilities is calculated as 20% of the total space of solid waste management facilities.

Source: JICA Study team

7.6.7 *Preliminary cost estimation of infrastructures*

The cost estimation for the infrastructure is indicated below.

Table 7.95: Preliminary cost estimation of infrastructures

1. Capital Cost

Item	Description		Unit	Unit Rate	Phase 1(2014-2018)		Phase 2 (2019-2023)		Phase 3 (2024-2033)		Total
					Quantity	Cost	Quantity	Cost	Quantity	Cost	
				(INR mil.)		(INR mil.)		(INR mil.)		(INR mil.)	(INR mil.)
Hazardous waste infrastructure	1) Hazardous waste landfill	includes infrastructure (roads, water drainage, electricity) & Equipment(JCB, bulldozer, weighbridge, etc.)	$1000m^3$	0.48	50.6	24.4	120.9	58.2	617.7	297.4	380.0
	2) AFR pre-processing facility	includes infrastructure & Equipment	TPD	2.64	56.9	150.1	38.4	101.2	209.8	553.5	804.9
MSW infrastructure	1) Composting plant	includes infrastructure & Equipment	TPD	0.66	13.0	8.6	31.0	20.5	126.0	83.3	112.3
	2) Biomethanation plant	includes infrastructure & Equipment	TPD	1.76	24.0	42.2	35.0	61.6	81.0	142.6	246.4
	3) Sorting plant	includes infrastructure & Equipment	TPD	0.66	5.0	3.3	12.0	7.9	46.0	30.4	41.6
	4) Sanitary landfill	includes infrastructure (roads, water drainage, electricity) & Equipment(JCB, bulldozer, weighbridge, etc.)	$1000m^3$	0.40	14.5	5.8	70.5	28.4	421.2	169.4	203.5
	5) Stockyards for e-waste, etc.		ha	77.00	0.11	8.3	0.11	8.3	0.11	8.3	24.9
	6) Collection vehicle		vehicle	2.94	7.0	20.6	9.0	26.5	17.0	50.0	97.0
	7) Collection vehicle garage & workshop		ha	77.00	0.09	6.9	0.09	6.9	0.15	11.6	25.4

2. Operation and Maintenance Cost

Item	Description		Unit	Charges	Phase 1(2014-2018)		Phase 2 (2019-2023)		Phase 3 (2024-2033)		Total
					Annual	Phase Total	Annual	Phase Total	(INR Cr.)	Phase Total	
				(%)	(INR mil.)	(INR mil.)	(INR mil.)	(INR mil.)	(INR)	(INR mil.)	(INR mil.)
Hazardous waste infrastructure	1) Hazardous waste landfill	Routine maintenance (repair every year), periodic maintenance (each 5 years)	I.s.	10%	2.44	7.31	8.26	45.43	38.00	418.03	470.77
	2) AFR pre-processing facility		I.s.	15%	22.52	67.56	37.70	201.07	120.73	1,287.81	1,556.45
MSW infrastructure	1) Composting plant		I.s.	10%	0.86	2.58	2.91	15.99	11.23	123.57	142.13
	2) Biomethanation plant		I.s.	15%	10.56	31.68	19.80	104.19	41.18	436.48	572.35
	3) Sorting plant		I.s.	25%	0.83	2.48	2.81	14.60	10.41	108.24	125.32
	4) Sanitary landfill		I.s.	7%	0.44	1.31	2.55	14.47	15.20	172.38	188.16
	5) Collection vehicle		I.s.	25%	5.05	15.14	11.54	60.05	23.80	247.69	322.88

3. Cost of soft component

Item	Phase 1(2014-2018)		Phase 2 (2019-2023)		Phase 3 (2024-2033)		Total
	Period	Phase Total (INR mil.)	Period	Phase Total (INR mil.)	Period	Phase Total (INR mil.)	(INR mil.)
■Capacity development program for appropriate waste management & ■Program on 3R Promotion	2years	86	1years	43	3years	128	257
■Program for development of common hazardous waste treatment facilities on the state level	1years	53		0		0	53
■Institutional capacity development program for the authorizing organization (state government, etc.) &■Support program for the private industries	2years	107	1years	53	2years	107	267

Source: JICA study team

8 Economic cost benefit assessment

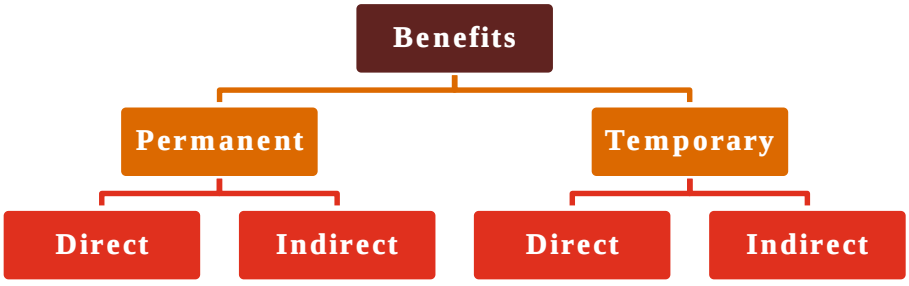
8.1 *Methodology for economic cost benefit assessment*

Creation of industrial nodes under the umbrella of CBIC is envisaged as a massive development that would catalyse economic growth within the region. It will have obvious impact on economy of each participating state as well. The project is expected to create various investment opportunities for industrial sectors identified as focus sectors in the CBIC region.

While analysing possible benefits to be created with development of each industrial node, both permanent and temporary aspects of the benefits to be realized were considered.

Temporary benefits mostly evolved around creation of direct and indirect employment during the construction period of each industrial node. In monetary terms these benefits include construction gross value added (GVA) to be created in the course of construction activities at the site.

Permanent benefits arise out of creation of direct and indirect employment opportunities across manufacturing and services sectors with respect to each node. In monetary terms these benefits will include gross value added in manufacturing and some relevant services that are expected to be created once the tenant industries commence manufacturing/support services activities.



Both types of benefits have been translated into monetary equivalent using GVA per capital.

8.2 *Assumptions*

The methodology of economic cost benefit assessment was based on the following assumptions:

GVA per capita has been projected taking into consideration real GDP growth projections.[42][43]

Table 8.1: GDP growth ratio

India's GDP projection	1980-99	2000-12	2013-20	2021-30
Real GDP growth, % p.a.	5.6%	6.9%	6.3%	6.9%
Ratio		1.23	0.91	1.10

GVA per capita

It has been calculated using GVA by kind of relevant economic activity for industrial nodes and employment in India.

[42] Standard Chartered - The Super Cycle lives: EM growth is the key (November 2013)
[43] Ratio beyond 2031 has been assumed to be 1.0 (PwC)

Table 8.2: GVA per capita

Sectors	GVA by kind of economic activity at constant (2005) prices - US dollars, 2009[44]	Employment, India, 2009[45]	GVA per capita
Construction	83,643,310,443	52,160,000	1,604
Manufacturing	173,141,000,000	48,540,000	3,567
Transport, storage and communication	102,167,000,000	19,360,000	5,277
Wholesale, retail, hotels	179,354,000,000	47,990,000	3,737
Total	**1,067,340,000,000**	**460,180,000**	**2,319**

Multiplier assumptions

Multiplier effect usually considered as every direct employment creates number of indirect employment opportunities and hence additional indirect income sources. Higher multiplier has been assumed for construction sector (under temporary benefits estimates) based on the proposed multiplier by the Planning Commission. Permanent multiplier in overall manufacturing sector has been taken based on international benchmarking and estimates of historical manufacturing multiplier of the Indian economy.

Table 8.3: Construction and manufacturing multipliers

Multiplier assumptions	
Temporary multiplier (construction)	1.8x[46]
Permanent multiplier (manufacturing)	1.5x[47]

Deadweight and displacement assumptions

Deadweight is defined as the gross direct effect of the reference case as a percentage of the gross direct effect of the intervention option. In case of each node the consultant has considered output/GVA growth rate projected for CBIC region to arrive at the deadweight. CAGR of BAU scenario is 6.3% and CAGR of BIS scenario is 14.6%. The figure below presents the following:

E0 - baseline

E2 - E0 - BIS scenario

E1 - E0 - BAU scenario

E2 - E1 - impact/addition (14.6%-6.3%) = 8.3%

Deadweight is a difference between BIS scenario growth rate (14.6%) and impact (8.3%) = 6.3% which is 43% of 14.6% growth rate CBIC output is expected to grow over the projected period.

[44] http://unstats.un.org/unsd/snaama/selCountry.asp
[45] Planning commission data tables, Table 62, http://planningcommission.nic.in/data/datatable/index.php?data=datatab
[46] Planning commission, REPORT OF THE WORKING GROUP ON CONSTRUCTION FOR THE 11TH FIVE YEAR PLAN (2007-2012), planningcommission.nic.in/aboutus/committee/.../wg11_constrn.pdf
[47] Interim Report 3 projections

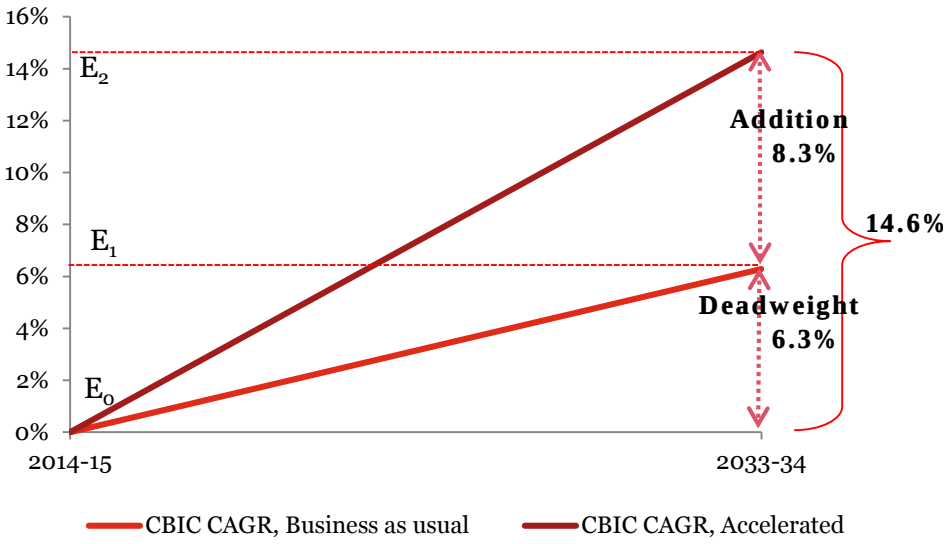


Figure 8.1: Deadweight assessment[48]

Displacement is the proportion of intervention benefits accounted for by reduced benefits elsewhere in the target area. Displacement arises where the intervention takes market share (also referred as product market displacement) or labour, land or capital (referred to as factor market displacement) from other existing firms within the geographical area under influence of the intervention.[49]

The following ready reckoner[50] has been adopted as a guideline to assume displacement percentage:

Table 8.4: Displacement ready reckoner

Level	Description	Displacement
None	No other firms / demand affected	0%
Low	**There are expected to be some displacement effects, although only to a limited extent**	**25%**
Medium	About half of the activity would be displaced	50%
High	A high level of displacement is expected to arise	75%
Total displacement	All of the activity generated will be displaced	100%

Given the greenfield development nature of Krishnapatnam low displacement effects are anticipated.

[48] Adapted from Additionality and Economic Impact Assessment Guidance Note, A Summary Guide to Assessing the Additional Benefit, or Additionality, of an Economic Development Project of Programme, November 2008, by Dr. Alastair H. McPherson, Scottish Enterprise, p. 7
[49] Same as above, p. 10.
[50] Same as above, p. 11

8.3 *Key Economic Benefits*

Some of the key benefits that would be expected include:

Direct benefits:	Indirect benefits:
• Gross economic value added • Employment generation • Land development and monetization in industrial node • Industrial investments in industrial node • Taxes collection by the state/central government	• Indirect potential employment generation by sector • Exports promotion prospects • Availability of quality industry/infrastructure o Enhanced mobility and alternate transportation o Efficient and responsible infrastructure use o Availability of work-life balance benefits o Intangibles such as social welfare change

8.3.1 *Direct benefits*

Direct potential employment generation by sector

Employment generated in proposed industrial nodes will comprise of direct and indirect employment opportunities. Direct employment refers to employment directly related to the production of products or services across sectors identified as focus sectors in each industrial node. By the end of phase 3, the total number of employment opportunities will be 233,082.

Table 8.5: Direct potential employment of Krishnapatnam Industrial Node

	Total direct employment
Traditionally strong sectors	***148,331***
Metallurgy	14,304
Food Processing	49,712
Textiles & Apparels	33,234
Electrical Machinery	37,888
Chemicals & Petrochemicals	11,830
Pharma	1,363
Potential sectors	***84,751***
Total	**233,082**

Source: JICA Study Team for CBIC

Developed land in industrial node

Total developable land in industrial node is 13,971 acres. The major saleable elements of this land will be industrial land – 7,785 acres and residential and commercial land – 1,699 acres. Population projected to reside in industrial node is 200,000 people by the end of Phase 3.

Table 8.6: Land demand, acres

	Developable land, acres
Traditionally strong sectors	**6,228**
Metallurgy	1,402
Food Processing	2,540
Textiles & Apparels	453
Electrical Machinery	1,270
Chemicals & Petrochemicals	494
Pharma	69
Potential sectors	***1,557***
Total industrial area	**7,785**
Residential area	**1,699**
Total revenue generating land	**9,484**

Source: JICA Study Team for CBIC

Industrial investment

Industrial land is expected to attract tenants from various sectors identified for Krishnapatnam Industrial Node as focus sectors. Total land for traditionally strong sectors with higher probability to get occupancy is **6,228** acres. Potential sectors are projected to occupy 1,557 acres of industrial land in Krishnapatnam IN. Together these tenants are expected to infuse Rs. 50,596 crore (USD 8,433 million) of investment in the by the end of projected period.

Table 8.7: Industrial Investment in Krishnapatnam Industrial Node

	Industrial Investment, Rs. Crore
Traditionally strong sectors	***34,935***
Metallurgy	9,673
Food Processing	9,477
Textiles & Apparels	3,261
Electrical Machinery	7,746
Chemicals & Petrochemicals	4,447
Pharma	332
Potential sectors	15,661
Total	**50,596**

Source: PwC projections

8.3.2 *Indirect benefits*

Indirect potential employment generation by sector

Direct employment results in generation of employment in the businesses that supply goods and services to the manufacturing/service sectors of the node, i.e. indirect employment. Finally, when these directly and indirectly generated incomes are spent and re-spent on a variety of items in the broader economy (e.g., food, clothing, entertainment), it gives rise to induced employment effects. For the purpose of this analysis both indirect and induced potential employment is called indirect potential employment.

Indirect employment in industrial node is expected to amount to 349,623.

Exports promotion prospects

Availability of quality industrial infrastructure

Prime aim of planned development lays in creation of state-of-the-art industrial infrastructure facilities within the node. It also envisages development/enhancement of transportation system in the vicinity of the node and its proper connection to the major logistics and trade hubs.

Enhanced mobility and alternate transportation

A detailed and comprehensive master planning of the industrial area aims at introduction of efficient transportation network to connect the node to the trade, residential, retail and other commercial centers in the vicinity of the node. Residential area is envisaged to have interconnected streets and provision for future expansion of roads and transportation facilities in case of further incremental development.

Efficient and responsible infrastructure use

Development of industrial nodes proposed as a part of CBIC region is a planned approach brings opportunities to locate, design and phase infrastructure incrementally combined with residential and other proposed uses. This approach offers improvement of systems' operating efficiency and financial feasibility. Also it is able to make affordable and accessible sustainable technologies in various areas, including manufacturing process, support services and habitant development.

Availability of work-life balance benefits

This planned development will facilitate employment creation in the node where residential facilities are also proposed. This approach gives more people the option of living near work and also provides them with opportunities to avail better facilities for their families, including healthcare, residential, shopping, education and recreation facilities.

8.4 *Detailed cost-benefit analysis Krishnapatnam IN*

8.4.1 *Temporary benefits*

Temporary benefits include potential gross value added from construction activity as a result of development of proposed Krishnapatnam industrial node. Total temporary employment is anticipated to be 53,271 and total temporary GVA is expected to amount to USD 1,814 million.

Total direct temporary employment is expected to be 19,025 and corresponding indirect employment is projected to amount to 34,246.

Table 8.8: Temporary employment to be generated in Krishnapatnam Industrial Node

Total temporary employment	Phase 1	Phase 2	Phase 3
Direct temporary employment	6,443	5,201	8,428
Indirect temporary employment	11,597	9,361	15,171
Total temporary employment	**18,040**	**14,562**	**23,599**

Table 8.9: Total temporary impact in monetary terms, Krishnapatnam Industrial Node

	Phase 1	Phase 2	Phase 3
Direct temporary impacts – Infrastructure development cost, USD mn	335	347	963
Indirect GVA impacts USD mn	47	49	137
Total temporary impacts, USD mn	**381**	**396**	**1,101**

8.4.2 *Permanent benefits*

Permanent benefits include potential gross value added from various manufacturing activities across sectors identified as highly potential for Krishnapatnam IN as well as some relevant services. Total permanent employment adjusted to deadweight and displacement assumptions (net employment) till 2052 is anticipated to be 249,107 and total direct GVA contribution is expected to amount to USD 46,331 million.

Table 8.10: Permanent net employment to be generated in Krishnapatnam Industrial Node

Total permanent net employment	Nos
Direct permanent net employment	99,643
Indirect permanent net employment	149,464
Total permanent net employment	**249,107**

Table 8.11: Projected GVA benefits, Krishnapatnam Industrial Node

Total GVA	USD mn
Net additional direct GVA	1,981
Net additional indirect GVA	2,971
Total additional net GVA	**4,951**

8.5 *Benefit-cost ratio*

Total net present value of benefits is expected to be USD 1,206 million. The summary of costs and benefits is given in the table below.

Table 8.12: Summary of Net Present Costs and Benefits, Krishnapatnam Industrial Node

Summary of costs and benefits	
Total projected costs, USD mn	1,645
Total projected benefits GVA, USD mn	4,951
Total net benefits, USD mn	**3,307**

Having calculated the net present value of projected costs and benefits till 2033-34, the project is estimated to have a benefit-cost ratio of 1.6 ignoring any optimism bias in the estimated costs and benefits.

Table 8.13: Benefits-Cost Ratio for Krishnapatnam Industrial Node Development

Full-term NPV	
NPV of projected costs USD mn	759
NPV of projected benefits USD mn	1,206
Benefit - Cost Ratio (BCR)	**1. 6x**

Thus, development of Krishnapatnam Industrial Node can be considered economically beneficial given the costs anticipated for development of this industrial node. Implementation of this project taking into consideration the unbundling of utilities and their development by individual SPVs will further improve benefit-cost ratio.

9 Financial Assessment and Planning

9.1 Basic assumptions for the Financial Model

The financial model has been built for the master SPV which will be responsible for undertaking the development of the Krishnapatnam Industrial node. The development of the node will entail land acquisition and development for let out to industry and support infrastructure, creation and operation of support infrastructure, collection of revenues from the occupants of the land towards upfront land lease, infrastructure usage fee. Alternately, the SPV also has the option of managing just land acquisition, development and sale of land with only none or some or all of the support infrastructure facilities. This means that the SPV has the option of offloading specific infrastructure components to separate SPV's which will be independent entities. The two options provided in the financial model are as under.

Table 9.1: Financial model options

Financial Model Option	Description
Option -1 – Master SPV only	Only one SPV (Master SPV) that controls land acquisition and development together with creation, operation and maintenance and revenue appropriation from all support infrastructure like road, rail, water, power solid waste management etc.
Option – 2 – Master SPV and multiple SPVs	Master SPV controls land acquisition, development and operations and also chooses to retain some or none of the support infrastructure facilities. The one's not under the control of the master SPV will function as separate SPVs.

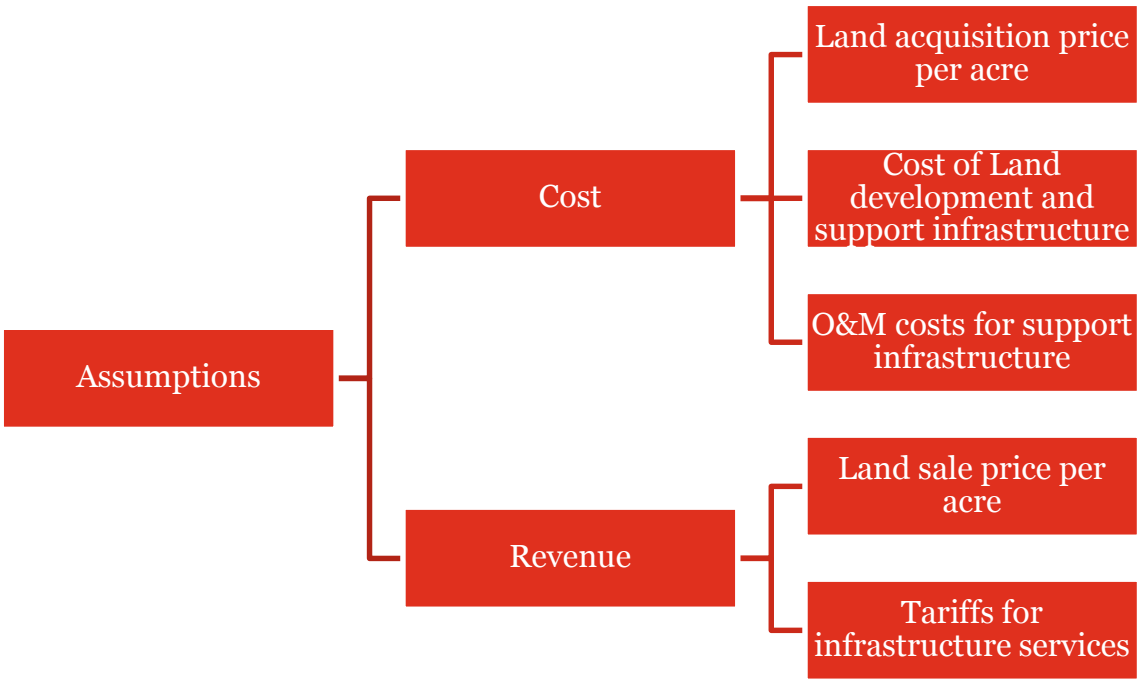
9.1.1 Timelines

The Financial Model has been prepared by assuming that the commencement of construction activity for the support infrastructure and the land offtake will happen in the financial year 2016-17. The perspective plan for the CBIC region and so the node is till 2033-34. As a result, the capacity expansion and the ultimate land offtake is not slated to be later than this date. However, the financial model period is kept at 35 years (form the year 2016-17) by assuming that no capacity creation would be effected at the node later than 2033-34. The costs for capacity creation have been estimated at constant prices with the base year as the current year i.e. 2014-15. The same has been escalated using an index which grows exponentially at 5%. To sum up, the assumptions mentioned herein are reproduced in the table below:

Particulars	Timeline
Base Year for Costs and Tariffs	2014-15
Construction Start Date	2016-17
First year of Operation	2017-18
Last year of Financial Model	2052-53
Financial Model Period (Operational years)	35 years

Source: Financial Model prepared by JICA Study Team for Krishnapatnam Industrial Node

As mentioned above, the base year for cost estimates has been assumed as the current year (2014-15) as the estimates are being made from the current year onwards. The cost and revenue estimates are in the following areas as shown in the diagram below.



The costs for land development and creation of support infrastructure have been estimated for each year based on the capacity that is injected into the node. The costs and tariffs have been escalated using the same index growing at 5% year on year. The price of land acquisition and sale per acre is as shown in the table below.

Particulars	Rs. Crore	Assumption basis
Land acquisition price per acre	0.55	APIIC official website, as on Jan 2015
Land development cost per acre (total cost over 35 years including inflation)	0.07	JICA Study team estimates
Selling price of land per acre (in FY 16, escalated by 10% y-o-y)	1.00	JICA Study team estimates

9.2 *Project cost*

The Project cost has been estimated through detailed analysis of Infrastructure requirement based on the nature of industry and the extent of offtake of land for industry. The Project cost has been considered including the cost of land acquisition and land development, development of support infrastructure within the node, contingency and the derived value of Interest during construction. The estimation of quantity has been made based on detailed technical assessment and master planning for the node, the costs have been benchmarked with national and international values for unit costs. The Capital cost estimate has been provided in the table below.

Table 9.2: Capital cost

Item	Rs. crore	% share of TPC
Land acquisition cost	7,648	41%
Land development	795	4%
Roads	2845	15%
Railway	112	1%
Water and Effluent Treatment Facilities	4,760	26%
Solid Waste Management	288	2%
Power infrastructure cost	1,316	7%
Contingency (7% of cost excl. land)	506	3%

Item	Rs. crore	% share of TPC
Interest During Construction	279	2%
Total	**18548**	**100%**

Source: JICA Study Team for CBIC

From the table above, it may be observed that out of the total project cost of Rs. 18,548 crore, 41% of which goes towards land acquisition and development. The second most significant element of cost is in the development of water and effluent treatment facilities. The total developable area identified by the SPV has been estimated at 11,992 acres.

It is to be noted that two master scenarios were envisaged for the purpose of the financial model. These are as follows:

- One Master SPV for the entire node responsible for ownership of all land to be given under long term lease and the infrastructure ownership along with the obligation of infrastructure service delivery.
- One Master SPV and multiple SPV's one each for those infrastructure components which can be developed and operated as separate companies through individual Concession Agreements.

The above table pertains to the first scenario which envisages all development and delivery by one master SPV.

9.2.1 *Key cost assumptions*

Considering the scenario of master developer undertaking the responsibility for land and all infrastructure, the following are the key financing assumptions for the purpose of the financial model.

Financing structure

Aligned to the DMIC model, it has been assumed that the Master Developer SPV will be constituted with centre and state government participation (and private sector, in cases where the state wishes) and land is brought into the SPV as equity contribution. Base case financing structure for development of Krishnapatnam node:

Financing component	Rs. crore	% contribution of TPC
Equity (Infusion into proposed SPV through land and other expenses)) Includes GoI Equity of Rs. 3000 crore	7648	41%
Debt (Land development & infrastructure cost) Includes JICA loan – 50% (Rs. 3963 crore)	7976	43%
Internal Accruals	2925	16%
Total	**18548**	**100%**

The Commercial loan is assumed to be borrowed for a door to door tenor of 14 years with a moratorium of 3 years.

Phase- wise project costing (capital cost)

Based on the prerogative of corridor development, the development is continuous over the years ending in FY 2033-34. However, the following table shows the quantum of investment required in the short term, medium term and long term which have been respectively identified as the years 2016-19, 2020-24 and 2025-34. The capital costs to be incurred have been presented in the table below.

Item	Phase I Upto FY 19	Phase II FY 20-24	Phase III FY 25 onwards
Land acquisition cost	7,648	0	0
Land development cost	90	165	540
Roads	886	669	1,290
Railway	80	5	27
Water and Effluent Treatment Facilities	837	843	3,080
Solid Waste Management	28	39	220
Power infrastructure cost	137	412	767
Contingency	103	107	296
Interest During Construction	78	81	120
Total	**9,887**	**2,321**	**6,340**

It is to be noted that the phasing of development of other infrastructure has been planned with dependence on the land offtake. The land offtake is assumed to be completed in the financial year 2034.

Operating costs

The Operations and Maintenance expenses have been arrived at based on benchmarks at both national and international level. The key determinants are the capacity of the infrastructure component, corresponding manpower required and the extent of maintenance that is required based on the industry characteristics. A 5% y-o-y escalation has been assumed. The following chart shows the break up of O&M costs for the Krishnapatnam Industrial Node under the current scenario of Master SPV managing all infrastructure components of the node.

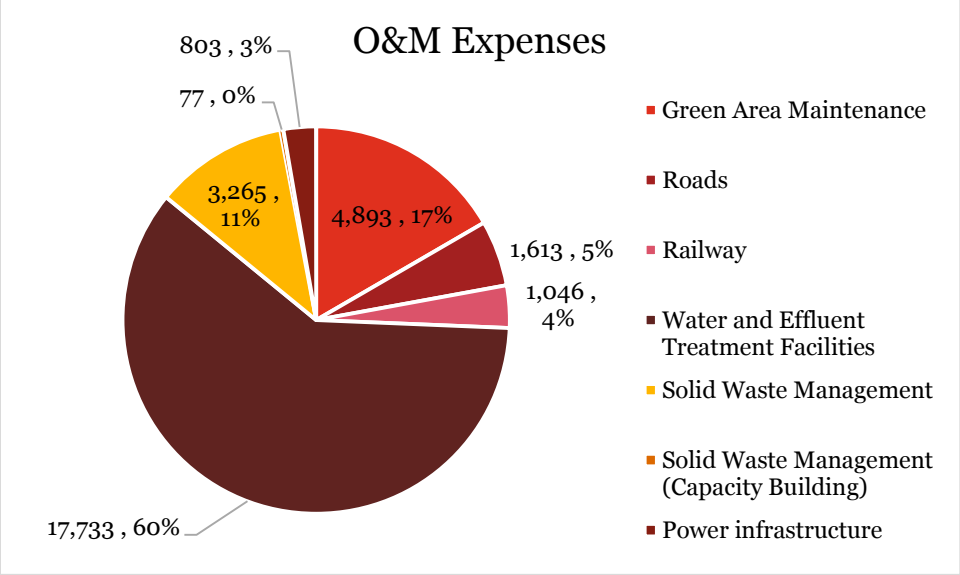


Figure 9.1: O&M costs – Krishnapatnam Industrial Node

Source: JICA study Team Analysis

From the above chart, it may be observed that the water and effluent treatment system accounts for maximum O&M at 60%. Other significant components of O&M include green area maintenance, solid waste management, roads. Maintenance of green area has been assumed at Rs. 5 per sq. ft. per year of other area escalated.

9.3 *Revenues*

Revenue streams envisaged for the project include land lease upfront lease rentals (99 year lease based on prevailing practice in Industrial Estates of APIIC), user charges from provision of utilities such as power, water, logistics and railways, sale of recyclable wastes and service fee mark-up of 10% of total O&M costs, for provision of utilities. A y-o-y escalation of 5% has been assumed. Revenue estimations are based on ongoing market rates for land lease rates in Krishnapatnam, and user charges for utilities in the area.

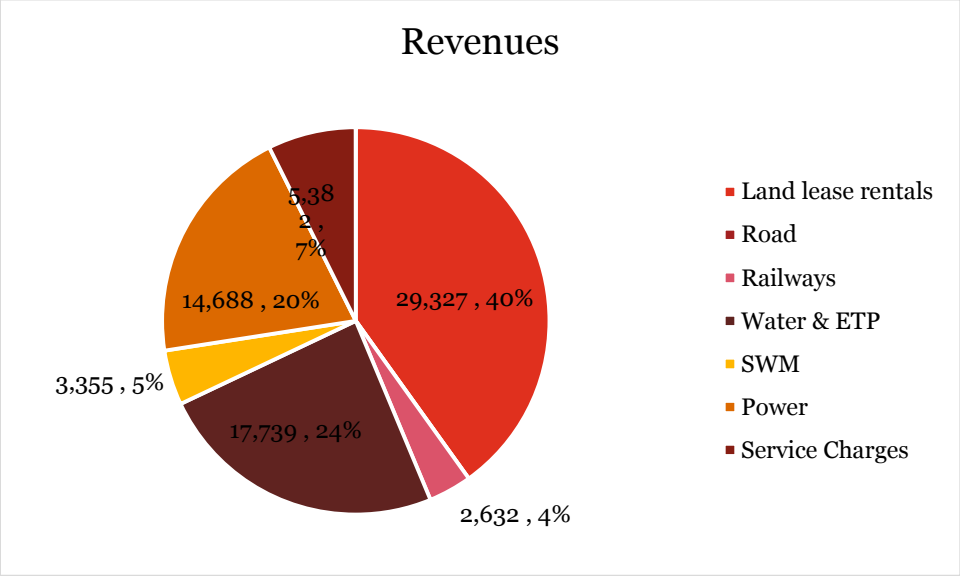


Figure 9.2: Revenue streams in Krishnapatnam Industrial Node

Key revenue assumptions

The land lease rentals have been assumed at Rs. 1.0 crore per acre to begin with and consume a 10% escalation year on year. For the elements, Water and Effluent Treatment and Solid Waste Management, the tariffs have been assumed by attempting to bring about parity in NPV of revenues with the NPV of estimated O&M costs.

Table 9.3: Key revenue assumptions

Item	Rate
Land lease rental	Rs. 1.0 crore/ acre
Water tariff • **Potable** • **Non potable**	 • Rs. 10/ KL • Rs. 30/ KL
Power	Net margin of Rs. 0.69 per unit
SWM	Mark- up of 12% over break even tariffs for each category - Rs per tonne • MSW: Rs. 1,578 • Non-hazardous waste: Rs. 1,474 • Land fillable hazardous waste: Rs. 1,078 • Hazardous waste treated by AFR: 2,540
Railways	Various sources such as handling at container yard, Warehousing, Cold Storage, Office rentals etc.

Revenues have been based on the above assumptions, and, as seen in the chart below, are Cash Flow Available for debt Service (after O&M) to meet loan debt service obligations.

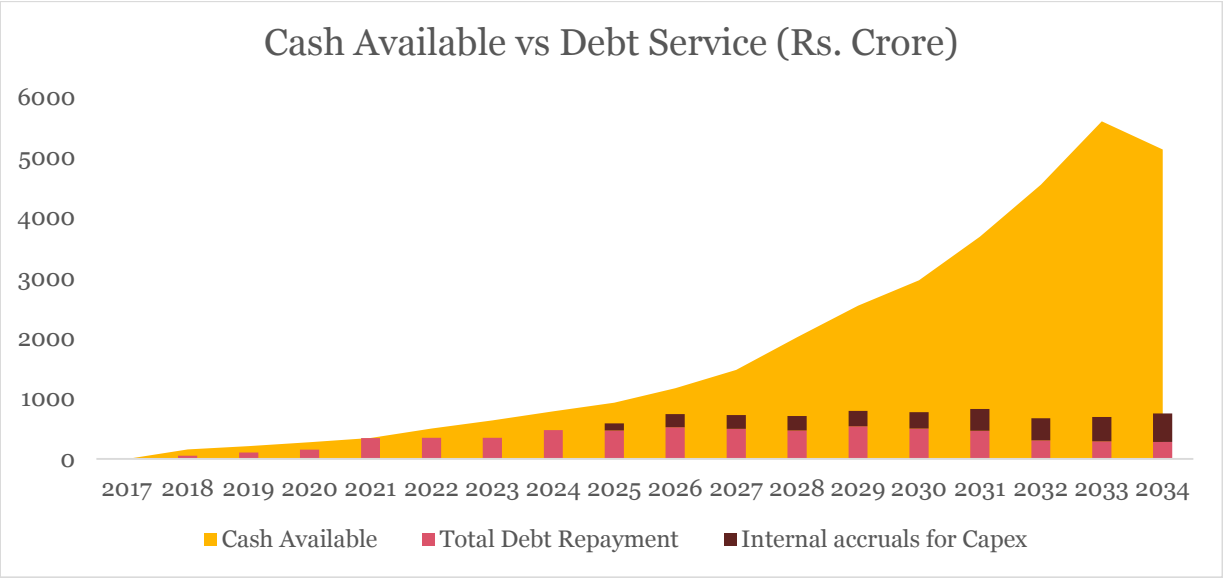


Figure 9.3: Cash available vs debt service obligations, Rs. crore

9.4 *Scenario and Sensitivity Analysis for Project Viability*

Under the current financing structure, and cost and revenue assumptions, the project IRR stands at 8.31% and Equity IRR at 8.76%. Other scenarios of unbundling entities for independent operation have been assumed

1. **Land lease rentals:** Currently the ongoing lease rentals at Krishnapatnam have been assumed with a 10% y-o-y escalation. It is to be noted that the Master Developer can sell land only to the extent of total area under industrial and residential land- use. Other areas such as road, green space, water body etc are essentially non- saleable areas and form around 14% of total land area under proposed project. A scenario was assumed to reduce the initial lease rentals to Rs. 0.8 crore per acre. The Project IRR as a result reduced to 6.57% and Equity IRR to 6.63%.

2. Land acquisition price falls by 10% and 20%: The impact on Equity IRR was assessed for this scenario and presented in the chart below.

3. Fall in land sale price by 10% and 20%

4. Fall in water tariffs for both industrial and potable water by 10% and 20%. This scenario has been assumed as water tariffs are a sensitive issue.

5. Land absorption in KPT Industrial Node is extended to 5 more years (Till March 2038).

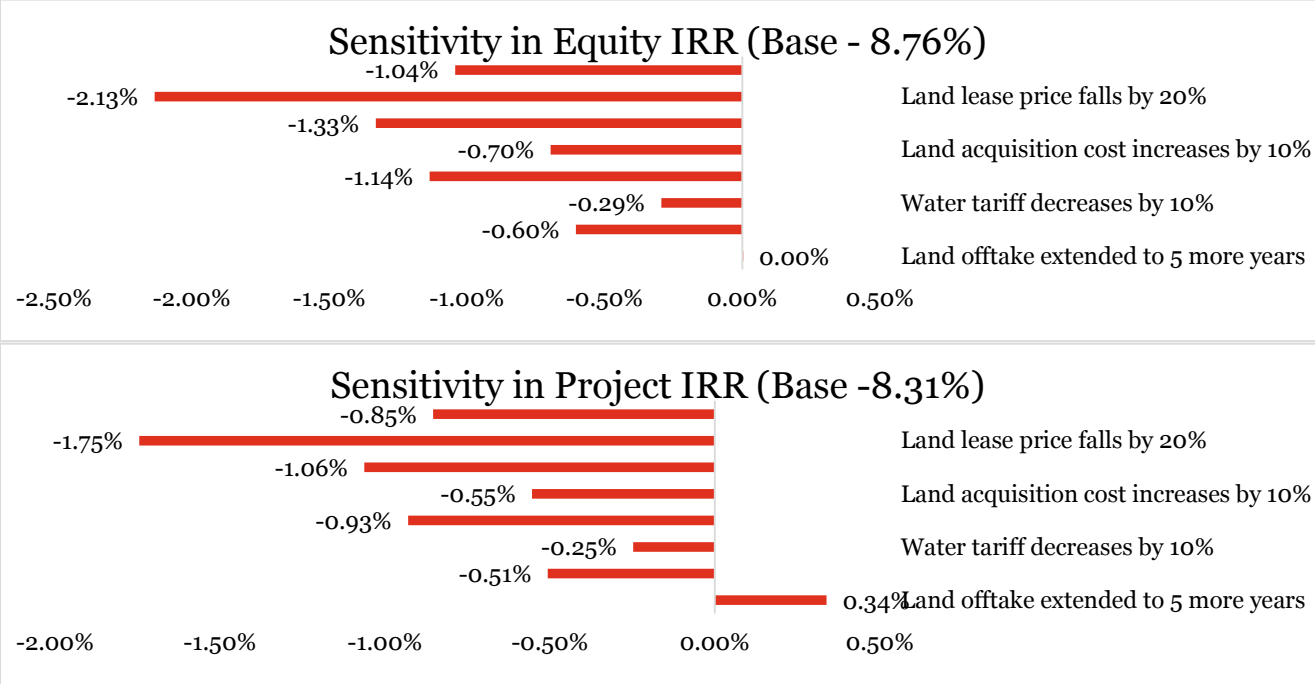


Figure 9.4: Sensitivity Analysis – Master SPV

The above sensitivity analysis has been performed for the scenario of the Master SPV managing the entire infrastructure without unbundling of SPV. From the above, it may be observed that the financial model is most sensitive to the EPC cost fluctuations, land acquisition price and the land sale price.

All infrastructure components are expected to generate revenue except road SPV. No revenue model is anticipated for the road utility, no toll collection is envisaged as well.

Infrastructure component	Revenue generated
Rail	Yes
Road	No
Water	Yes
SWM	Yes
Power	Yes

The scenario pertaining to unbundling of roads is not envisaged as there is no revenue model for the road utility. Hence, under all circumstances, it should be assumed that the road utility is to be vested with the master SPV.

The other sensitivity analysis has been performed by assuming unbundling of individual infrastructure services through separate SPV's from the Master SPV (assumed that each time sensitivity analysis is performed only one utility is unbundled and the others remain with the Master SPV).

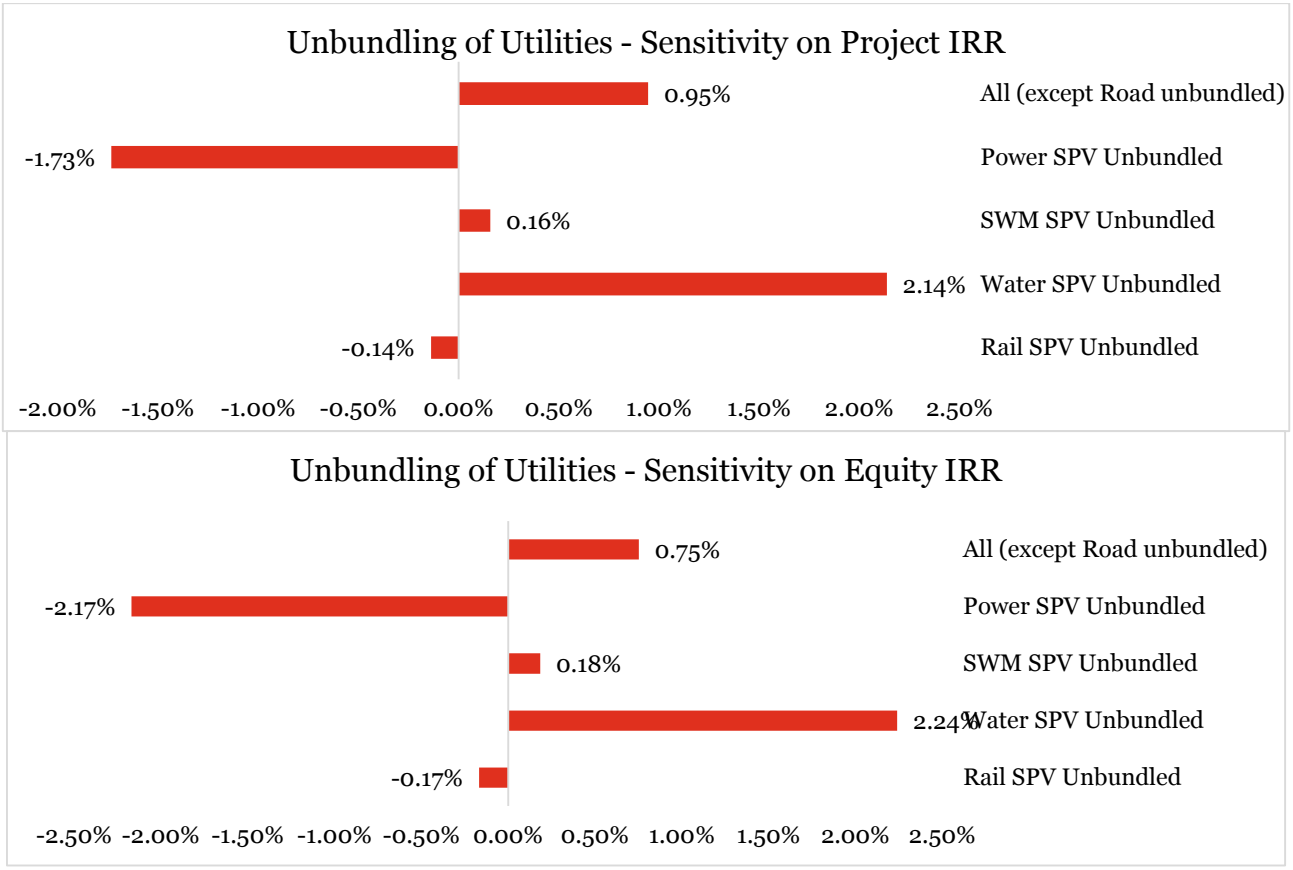


Figure 9.5: Sensitivity Analysis – unbundling of utilities

From the above, it may be observed that the unbundling of all utilities (except road) results in a slight increase in Project IRR from 8.31% to 9.26%. The highest impact is in case of unbundling of water SPV, followed by power SPV.

Unbundling infrastructure components may be possible given the fact that the demand build-up for individual utilities is sufficient in later years. Based on current projections, only SWM and power SPVs are analyzed to be viable as standalone SPVs. Other infra such as rail, road and water are not viable as standalone SPVs and fall short of Equity IRR below market expectations (18%). Thus unbundling such components will require infusion of any additional government grant/ sub-ordinate loan etc (if applicable).

10 Environmental and Social Considerations for Node Development Plan

10.1 Introduction

The following three(3) Nodes were selected as prioiptized Nodes by Indian Government and JICA referring the fact findings and assessment results of the JICA CBIC Study Team.

- Ponneri Node
- Tumakuru Node
- Krishnapatnam Node

The development plans for the prioritized nodes have been preparing by the JICA Study Team in the Part B of the CBIC Study.

10.2 Necessary Environmental Studies for the Prioritized Nodes

The JICA Study Team (JST) interviewed to Delhi Mumbai Industrial Corridor Development Cooperation Limited (DMICDC) to ask the necessity for conducting any environmental and social considerations on the development plan on 25th November 2013. As a result, the Environmental Clearance (EC) for the development plans will have to be obtained from Ministry of Environment and Forests (MoEF), Govt. of India.

As per the EIA notification 2006, the project proponent shall submit the prescribed application form"Form1" with proposed terms of reference (TOR) to the Expert Appraisal Committee for determination of the TOR for EIA study. The TOR will be conveyed to the project proponent by the Expert Appraisal Committee within sixty days of the receipt of Form 1.

10.3 Framework for EIA Studies for the Prioritized Node Developments

Figure 10.1: Review Meeting on 25th July,

Source: JICA Study Team

The framework for EIA studies for the prioritized node developments were confirmed in the "Review Meeting" chaired by Mr. Shatughna Singh, the additional director of DIPP, held on 25th July, 2014. The summary of the discussion is as following.

- The EIA studies for the development plans are under responsibility of the DIPP. The DIPP will entrust the implementation of the EIA studies to the DMICDC, including procurement of environmental consultants. The JST will support the DMICDC in terms of preparation of TORs for the EIAs.
- The JST will prepare the first draft of the development plans for the three prioritized Nodes by the end of October after finalization of the Node boundaries. The first draft of the development plans will be finalized for Final Report by the end of December 2014.

The implementing schedule for EIA studies for the prioritized node developments were discussed between JST and DMICDC on 23rd September, 2014.

The summary of the discussion is as following.

- The procurement for the EIA consultant will be conducted only after getting official approval on the Node development plans including Node boundaries from the related local govt. The selection of EIA consultant will be carried out based on the international tender system. Approximately three months will be necessary for the process.
- The application form for the EIA ("Form 1"with Draft TOR for EIAs) will be prepared by the DMICDC using in-house consultant.
- The initial environmental examination (IEE) level study on the development plans for the Nodes will be conducted in the course of the technical assistance for CBIC study by the JST. The study will be conducted based on the JICA Guidelines. It is expected that the results of the IEE level study will be useful information for the preparation of "Form 1" and Draft TOR.

10.4 *Initial Environmental Examination (IEE) Study*

10.4.1 *Objectives and Methodologies*

(1) Objectives

In the Part A of the Study, the development policies for realizing the proposed regional structure plan were clarified, first. Then, the environmental impact items which should be considered in the realization of the plan were selected using environmental checklist. The evaluation was conducted based on the selected environmental impact items in terms of positive and negative impacts.

In this chapter, the environmental study on Initial Environmental Examination (IEE) Study level for the individual development plan for prioritized Node was conducted in the course of technical assistance for environmental and social considerations. It is expected that the results of the study will be reflected to the terms of the references for environmental impact assessment (EIA) study.

(2) Methodologies

- To grasp present condition of the Node area
- To discuss the contents of the development plan
- To conduct environmental scoping through consideration on the present environmental condition and the contents of the development plan
- To clarify the matters for consideration in the EIA study based on the results of the environmental scoping

10.4.2 *Outline of the Node*

(1) Topography

The land area runs parallel to the coast of the Bay of Bengal. The site is located approximately 30 km from Nellore city and about 10 km south of Krishnapatnam port. This land area is flat and the elevation various from 10 to 20 meters above sea level.

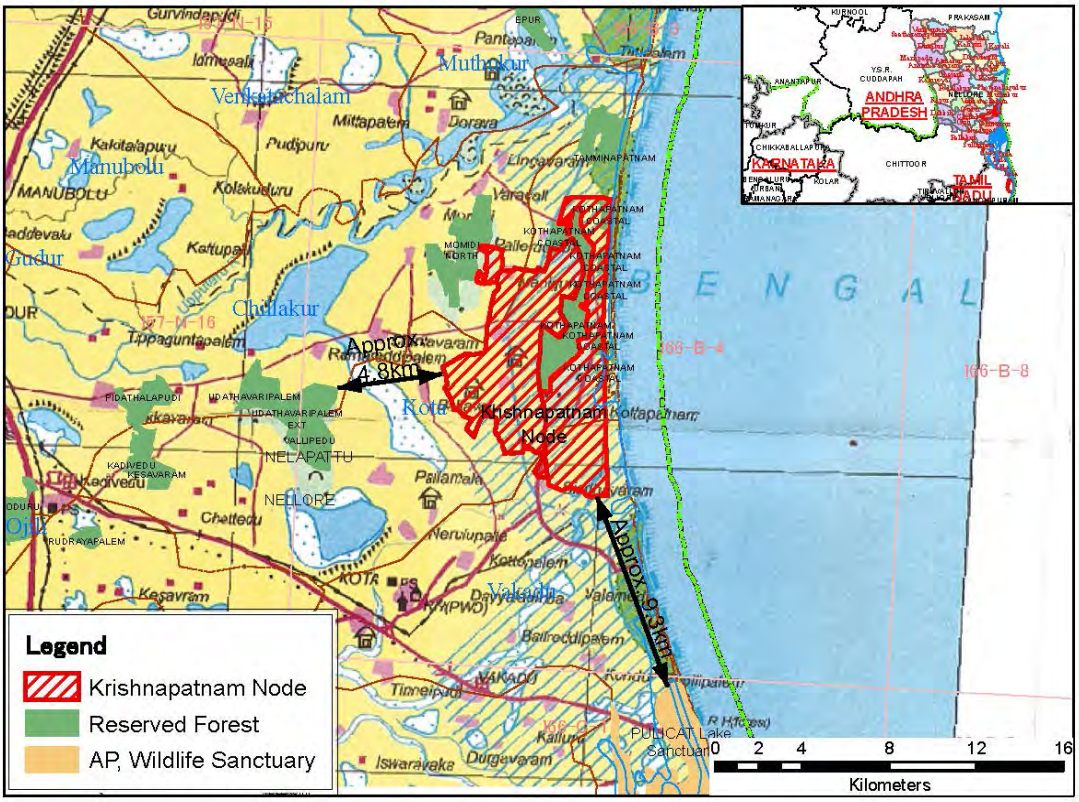
(2) Climate

The climate of Nellore is a typical tropical maritime climate, with warm, humid summers and mild winters. April and May are the hottest months and the hot conditions generally last till the end of June. December, January and February are the coolest months. As Krishnapatnam is near the Bay of Bengal, the sea breeze renders the climate moderate both in winter and summer. Nellore does not receive much rainfall during the Southwest Monsoon. Rainfall in Nellore occurs between the months of October and December due to the Northeast Monsoon. This period sees about 60 percent of the annual rainfall. Cyclones are common in Nellore during this period, causing floods and havoc from place to place.

The maximum temperature is 36-46°C during summer and the minimum temperature is 23-25°C during winter. The rainfall ranges from 700–1,000 mm from the Southwest and Northeast Monsoons. Nellore is subject both to droughts and to floods depending on the seasons.

(3) Sensitive Area

The development area doesn't contain any environmental sensitive area such as forest reserve as shown in the below Figure 10.2.



Source: JICA Study Team

Figure 10.2: Location of Sensitive Area

(4) Land use

The current land use pattern and distribution of settlements are as follows:

- Most of the land within the Krishnapatnam node area is vacant. However, a few settlements are scattered inside of the area.
- A small stream cuts across the site in a north-south direction. In view of the need for environmental conservation, this alignment should be unchanged.
- Since this area is located along the coastline, the topsoil is sand
- There is no health center in the node area. However there is a community school located within the node which is being constructed by Krishnapatnam Port Company limited.

(5) Land Acquisition Status(as of November 2014)

The land acquisition status for Krishnapatnam Node is as shown in the Table 10.1 . The land acquisition for 8% of Phase I and whole of Phase II has not been completed.

Table 10.1: Land Acquisition Status of Krishnapatnam

Phase	Area		Land Acquisition Status
	acre	ha	
1	5,865	2,374	About 92% of land held under KPIL,
2	6,000	2,429	Yet to be Acquired
Total	11,865	4,803	

Source: JICA Study Team

The general view of the site is shown in the Figure 10.3.

Source: JICA Study Team

Figure 10.3: General View of Krishnapatnam Node

10.4.3 *Development Plan*

The contents of the development plan for Krishnapatnam Node are as shown in the Table 10.2

Table 10.2: Project Component (Krishnapatnam)

	Contents of Construction
Road	● Internal Roads (Primary Roads (Industrial), Primary Roads (Urban), Secondary Roads, Tertiary Roads) ● Bridges ● Intersections (Level Intersection (signalized), Grade-separated intersection) ● Bus facilities (Bus terminal, Bus bay) ● LRT ● BRT ● External Roads (Widening, New)
Railway	● Single track electrified access line from the Venkatachalam-Krishnapatnam Port mainline (distance approx. 13.5 km) ● Three track electrified arrival/departure yard outside the Logistics Hub, to permit re-positioning of locomotive and push-back into hub.
Logistics	The logistics Hub, containing: ● Separated paved loading/unloading yards for containers and steel ● Non electrified Railway loading/unloading tracks (2) embedded in pavement ● Container Freight Station (CFS) for stuffing/unstuffing of containers with partitioned area for customs inspection of cargo ● Warehouse for long term storage of cargo ● Two storied Administration Building with space for rental by cargo agents, etc. ● Container trailer park ● Workshop for container repair and maintenance of handling equipment ● Separate security controlled entrances for containers and steel
Power & Renewable Energy	● Substation ● Solar and wind power plants
Water supply	（Drinking water and industrial water） ● Water purification plant for water from Dam ● Sewage disposal plant ● Tertiary water treatment plant for sewage recycling ● Partially water supply from desalinization plant
Drainage	（Rainwater） ● Storm Water Drainage System with proper disposal arrangement.
Solid Waste Management	(Municipality waste) ● Compost treatment plant ● Biomethanation Plant ● Sorting plant ● Sanitary landfill
	(Hazardous solid waste) ● No construction any facility(treatment will be carried out based on the existing treatment system)

Source: JICA Study Team

10.4.4 *Environmental Scoping*

The environmental scoping through consideration on the present environmental condition and the contents of the development plan was conducted using matrix table consisting of 30 environmental impact items referring the environmental check list of the JICA Guidelines. The rating of the environmental impacts was carried out for pre-construction/construction stage and operation stage, respectively. The rating criteria are as follows.

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown (serious impacts are not expected, but survey and analysis shall be done)

- : No impact is expected.

Table 10.3: Environmental Scoping and the Reasons

	No	Likely Impacts	Rating		Description
			Pre-construction/ Construction	Operation	
Social Environment	1	Resettlement	A	-	● There is a possibility to occur involuntarily resettlement due to land acquisition (approx. 2,600 ha). ● Also, there is a possibility to occur involuntarily resettlement due to land acquisition necessary for construction of external roads and railways. ● The establishment of income restoration program for affected families is necessary.
	2	Local economy such as employment and livelihood, etc.	-	-	
	3	Land use and utilization of local resources	-	-	
	4	Social institutions and local decision-making institutions	-	-	
	5	Existing social infrastructures and services	-	-	
	6	The poor, indigenous and ethnic people (inclusive gender and right of children)	-	-	
	7	Misdistribution of benefit and damage	-	-	
	8	Cultural heritage	-	-	
	9	Local conflict of interests	-	-	
	10	Water Usage or Water Rights and Rights of Common	-	-	
	11	Sanitation	-	B	● The stable and safe supply of drinking water for people living in the node, 200,000 in the future and labors working at factories is necessary.
	12	Hazards (Risk) Infectious diseases such as HIV / AIDS	B	-	● Influx of labors for construction activities into the area might cause prevailing of infectious diseases such as HIV/AIDS
Natural Environment	13	Topography and Geographical features	-	-	
	14	Soil Erosion	-	-	
	15	Groundwater	-	-	
	16	Hydrological Situation	-	-	
	17	Coastal Zone	-	-	
	18	Flora, Fauna and Biodiversity	C	C	● The Reserved Forest adjacent the site might be affected during construction and operation stages.
	19	Meteorology	-	-	
	20	Landscape	-	B	● The provision of comfortable ling condition to people living in the site is necessary. The number of the people is supposed to be approx. 200,000 in the future.
	21	Global Warming	-	-	
Pollution	22	Air Pollution	A	A	● The increasing of number of vehicle at surrounding of the site during construction and future might cause air pollution.
	23	Water Pollution	-	A	● The water pollution at coastal area might cause due to establishment of factories and housing areas

No	Likely Impacts	Rating		Description
		Pre-construction/ Construction	Operation	
24	Soil Contamination	-	-	
25	Waste	—	A	● The solid waste will be generated due to establishment of factories and housing areas.
26	Noise and Vibration	A	A	● The noise and vibration caused by vehicles during construction, In addition, the increasing of the number of vehicles at surrounding areas in the future might cause noise and vibration.
27	Ground Subsidence	-	-	
28	Offensive Odor	-	-	
29	Bottom sediment	-	-	
30	Accidents (inclusive traffic accident)	A	A	● Traffic jam and car accident might be caused by vehicle for construction activities. ● In operation stage, the entering of the tracks for freight to CFS and buses for commuting of labors (approx.600,000 people) into existing local road network might cause traffic jams and car accidents.

Source: JICA Study Team

Conclusions

(1) Summary of the Results of the Environmental Scoping

The summary of the results of the environmental scoping is shown in the Table 10.4. These items should be taken consideration in the TOR of EIA study.

Table 10.4: Summary of Matters for Consideration

Item	Matters for Consideration
Social Environment	● Appropriate land acquisition ● Appropriate income restoration programme such as provision of job opportunity for farmers living in the project site ● Traffic jam caused by incorporation of large size vehicle into local transportation network ● Provision of amenity for living environment
Natural Environment	● Appropriate conservation of Reserved Forest found adjacent to the project site ● Appropriate sewage treatment for water quality control at coastal area
Pollution Control	● Counter measures for air pollution, noise and traffic accidents caused by increasing of traffic volume adjacent to the project site ● Appropriate treatment for solid waste generated in the project site

Source: JICA Study Team

(2) Draft TOR for EIA Study

The draft TOR for EIA study considering the matters for consideration resulting from the IEE study was prepared as following. It is expected that the DMICDC will prepare the TOR referring the draft TOR for EIA study.

The TOR will be approved by the Expert Appraisal Committee after submission to MoEF.

1) Policy, legal, and administrative framework for EIA study

2) Project Description

- Site location, co-ordinates and land requirements
- Proposed Development / Activities
- Justification for site and the project
- Proposed concept plan
- Power and water supply requirement and source

- Water balance, waste generation and proposed control measures
- Project development phasing

3) Present Environment

i) Natural Environment

a) Physical Environment
Secondary information on topography, geology and hydrology of the area will be collected within 15 km radius of the site.

b) Climate
Temperature, rainfall, wind direction, wind speed, relative humidity

c) Ecology
Information on flora and fauna will be gathered through primary surveys for the study area. Related information will also be collected from District forest Offices/Botanical and zoological survey of India (BSI and ZSI) offices. The result of the surveys will be interpreted to identify threatened and endangered species as per Red data book and wildlife Act 1972.

ii) Socio -Economic Environment

Demographic information, economic activities, literacy profile, landuse, infrastructure resource, economic facilities, cultural heritage

iii) Environmental Quality

a) Air Quality
Information on air quality will be collected through monitoring of ambient air quality. The monitoring parameters will be suspended particulate matter (PM2.5 and PM 10), Oxides of nitrogen (NOx), Sulfur Dioxide (SO2), Hydrocarbons (Methane, Non Methane), and carbon monoxide (CO).

b) Water quality
The surface and ground water samples will be collected for analysis of following parameters (as par IS10500/Indian Standard Specification for drinking water).

- Physical parameters: pH, Temperature, conductivity, Turbidity and color;
- Chemical Parameters: Alkalinity, TDS, TSS, Salinity, oil & Grease, DO, Chlorides, Total hardness, Calcium, Magnesium, Sulphate, Fluorides, Nitrate, Iron, Phenolic compound, COD,BOD, Phosphate, Anionic Detergents, PCB, Total Petroleum Hydrocarbon and heavy metals like copper, Mercury, Barium, Cadmium, Arsenic, Lead, Zinc, Chromium, Manganese: and
- Bacteriological Parameters: Total Coliform, Faecal Coliform

c) Noise
Ambient noise quality will be monitored to determine hourly equivalent noise levels. The results of the findings will be analyzed to work out Leq hourly, leq day and leq night.

iv) Traffic Volume

Information on traffic volume will be collected for roads connecting the project site by traffic volume monitoring. The traffic volume counts will be recorded continuously for 24 hours at one time during the study period to assess the existing total daily traffic, peak hour traffic and traffic Composition.

4) Environmental impacts Assessment

Assessment of impacts for environmental components will include the impact for construction and operation:

- Estimation of water balance and assessment of impact on regional water demand and availability of fresh water for developmental activities:
- Assessment of wastewater characteristics, treatment and disposal provisions;
- Assessment of solid waste disposal, storage facility and potential for soil contamination;
- Assessment of impact on Landuse, ecology, socio-economic of the study area;
- Assessment of impact on traffic and Noise; and
- Assessment of impact on community in the immediate surrounding

5) Analysis of alternatives

Reasons for selecting the present site with details of alternative sites examined earlier and rejected/selected on merits with comparative statement.

6) Environmental Management Plan (EMP)

Description on mitigation, monitoring, and institutional measures to be taken during construction and operation in order to eliminate adverse impacts, offset them, or reduce them to acceptable levels. Social impacts and concerns will also be identified and an outline rehabilitation and resettlement(R&R) Framework will be prepared.
An EMP suggesting economically feasible control technologies and procedures to minimize any impact on environment will be developed. The EMP will include;

- Pollution control measures (Air, water, noise, soil etc.)
- Water conservation, treatment and disposal
- Solid/Hazardous waste management
- Training and monitoring requirement for the project
- Occupational health and safety Measures
- Requirements for green belt and landscaping
- Traffic Management plan

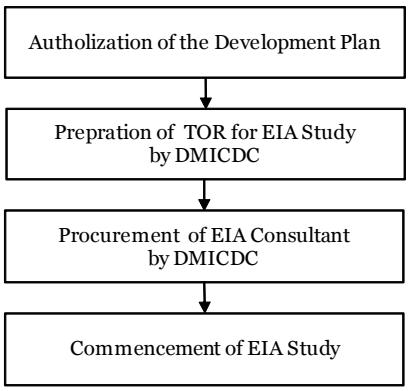
7) Public Consultation

Public consultation will be carried out for the project as per the procedure defined in the EIA notification, 2006. After completion of the public consultation, the environmental concerns expressed during the consultation shall be incorporated to finalize EIA/EMP.

10.5 *Recommendations (Necessary Action and Schedule)*

10.5.1 *EIA*

The EIA studies for the development plans are under responsibility of the DIPP. The DIPP will entrust the implementation of the EIA studies to the DMICDC, including procurement of environmental consultants. The necessary action and schedule for EIA after establishment of development plan is as shown in the Figure 10.4 and Table 10.5.



Source: JICA Study Team

Figure 10.4: Necessary Action for EIA study

Table 10.5: Expected EIA Schedule

	Month	1	2	3	4	5	6	7	8	9	10
Submission of Draft Final Report	▲										
Authorization of The Development Plan		—	—	—							
Preparation of Draft TOR for EIA Study by **DMICDC**					—	—	—				
Procurement of EIA Consultant**(3 months)**								—	—	—	
Implementation of EIA Study											— →

Source: JICA Study Team

10.5.2 *Land Acquisition*

As shown in the Table 8.4.1, the land acquisition for 8% of Phase I and whole of Phase II has not been completed(approximately 2,600 ha in total).

According to the interview to Andhra Pradesh Industrial Infrastructure Corporation LTD, (APIIC, the land acquisition for Krishnapatnam Node will be conducted by the State Government of Andhra Pradesh based on the "Land Acquisition, Rehabilitation and Resettlement Act (Sept 2013)". The acquired land will be disposed to APIIC.

Although the procedure of land acquisition is complex and time-consuming, the land acquisition for project site is indispensable for the realization of the development plan. It is highly recommended to monitor the progress of land acquisition progress carefully.

The pprocedures for land acquisition with responsible agency are shown in the Table 10.6.

Table 10.6: Procedures for Land Acquisition

Activity	Agency in Charge
(1) Preparation of Social Impact Assessment (SIA) Study	District Collector/ Commissioner of Rehabilitation and Resettlement committee (RRS)
(2) Appraisal of SIA by Expert Group	Land Administration Department/State Government
(3) Decision of Land Acquisition by Government	District Collector
(4) Publication of Preliminary Notification	District Collector
(5) Preliminary Survey	Land Survey Department /State Government
(6) Hearing of Objection	District Collector
(7) Preparation of Rehabilitation and Resettlement Scheme (RRS)	District Collector/ RRS
(8) Review and approval of the RRS	District Collector/Commissioner of RRS

(9) Publication of Declaration and Summary of RRS	District Collector
(10) Public Notice	District Collector
(11) Inquiry and Land Acquisition Award	District Collector
(12) Determination of Amount of Compensation	District Collector
(13) Award of Solatium	District Collector
(14) Taking Possession of Land to be Acquired	District Collector

Source: JICA Study Team

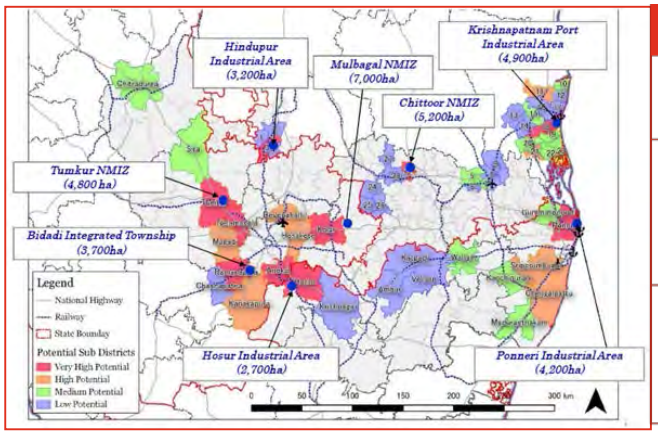
11 Institutional and Financing Framework for Krishnapatnam Industrial Node

Realisation of primary objectives of the National Manufacturing Policy[51] (NMP) are envisioned through measures such as business process simplification, industrial training, skill up- gradation, and most importantly by promotion of **large- scale clusters and aggregation of industrial units**. Aligned to this Govt. of India has planned/ approved around 5 industrial corridors[52] and 16 NIMZs[53] since the inception of the NMP.

For the development of such mega scale projects there is a need for induced co- operation among various stakeholders at the central, state and local government levels to steer corridor development in a collective & coordinated manner.

Induced co- operation an underlying criticality for development of CBIC

- Spanning over a length of 560 km, the CBIC covers an area of about ***91,000 sq. km*** (about3% of area of all of India) ***covering around 17 districts*** across three states of Tamil Nadu, Karnataka and Andhra Pradesh under its influence area.
- Identified nodes for industrial development along CBIC, range between 25- 70 sq. km, and are comparable to the size and functioning of small satellite cities such Cyberabad (A.P) and Kengeri (Karnataka), complete with all municipal functions



State	Planned Area	Area sq. km
Tamil Nadu	Ponneri Industrial Area	42
	Hosur Industrial Area	27
Karnataka	Bidadi Integrated Township	37
	Tumkur NIMZ	48
	Mulbagal NIMZ	70
Andhra Pradesh	Hindupur Industrial Area	32
	Chittoor NIMZ	52
	Krishnapatnam Industrial Area	49

Figure 11.1: 8 industrial nodes selected along CBIC

- Co- ordination for project implementation would be required across multiple jurisdictions (states), between different levels of urban local bodies within states, state entities, central entities, private sector developers, multilateral agencies, funding institutions, project affected people, citizens

- Range of project activities involved towards node development, such as planning, financing, implementation and operation & maintenance across the project life-cycle can be mapped to multiple stakeholders. Some of the key project related activities that need to be undertaken on ground for development of such nodes will include:

[51] Increasing manufacturing sector growth to 12-14% over the medium term, enhancing share of manufacturing in GDP from 16-25% and increasing the rate of job creation in manufacturing to 100 million additional jobs by 2022
[52] DMIC, CBIC, BMEC, VCIC, AKIC
[53] Of these, eight are along the Delhi Mumbai Industrial Corridor (DMIC). Besides, eight other NIMZs have been given in-principle approval: (i) Nagpur in Maharashtra, (ii) Chittoor in Andhra Pradesh, (iii) Medak in Andhra Pradesh (now Telengana), (iv) Prakasam in Andhra Pradesh (v) Tumkur in Karnataka, (vi) Kolar in Karnataka, (vii) Bidar in Karnataka, and (viii) Gulbarga in Karnataka.

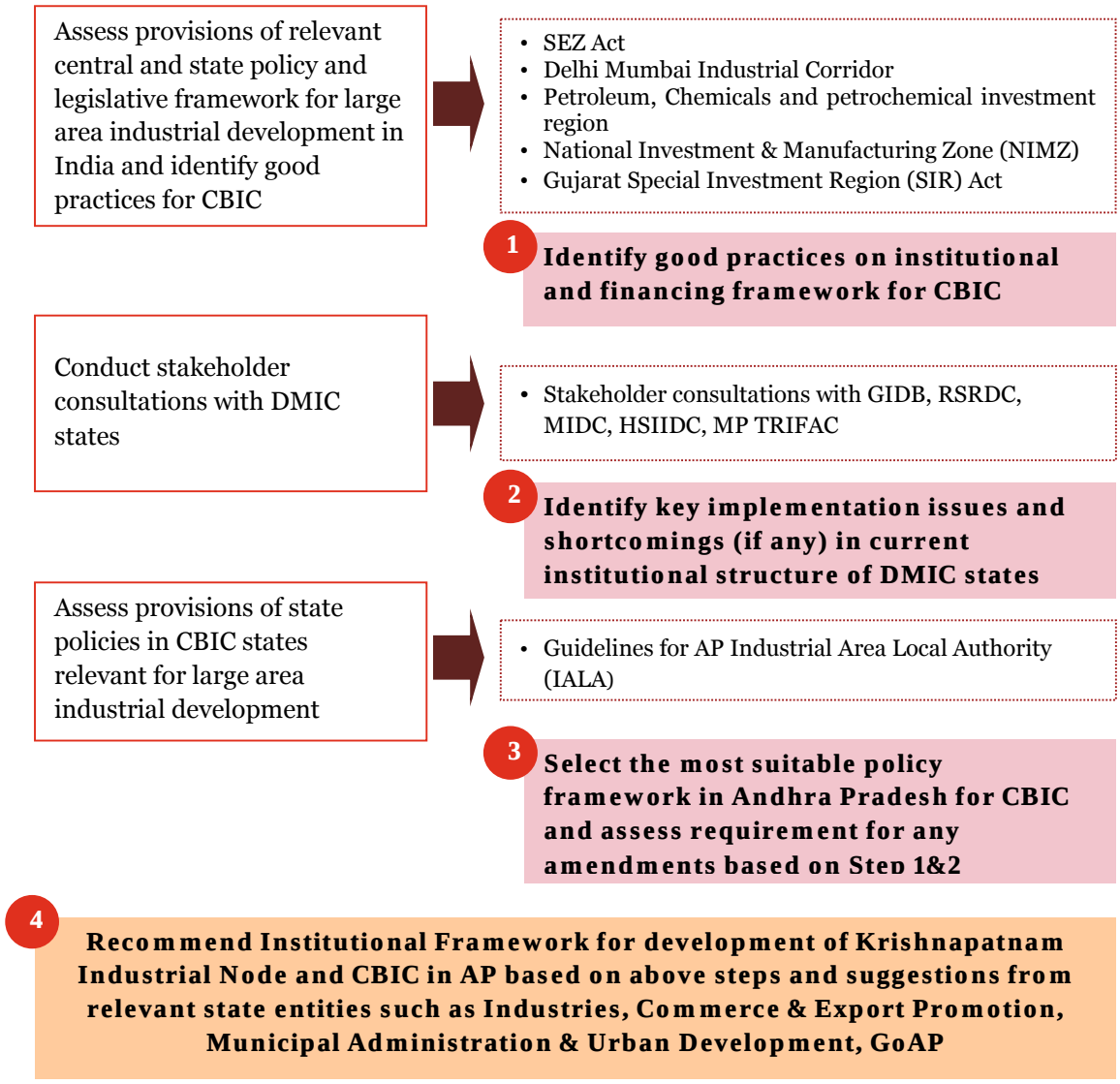
Table 11.1: Indicative roles and responsibility framework for list of project related activities for CBIC

	Planning				*Development of internal and external infrastructure (incl. financing)*							*Ease of doing business*		
	Land delineation	Master Planning (Node / external)	Land acquisition	Clearances	Urban Transport	Energy	Roads	Rail	Water supply & Sewerage	Ports	Airports	Single window clearance	Routine issues	Policy and Regulations
Central Govt		✔		✔	✔	✔	✔	✔	✔	✔	✔	✔		✔
State Govt	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
SPV		✔		✔	✔	✔	✔	✔	✔	✔	✔			✔
Multilateral funding					✔	✔	✔	✔	✔	✔	✔			✔
Industry Associations				✔								✔	✔	✔
Private Sector					✔	✔	✔	✔	✔	✔	✔			

Co-operation and co-ordination between multiple stakeholders will be crucial for timely and successful delivery of projects thus mandating the need for a clear project implementation framework and institutional structure for Krishnapatnam node and CBIC development.

11.1 *Approach towards formulation of Institutional Framework for CBIC*

Basic approach of institutional and financial framework analysis is depicted in the diagram below. Existing structure and precedents such as DMIC cases are examined and necessary improvements are incorporated in a proposed suitable structure for CBIC.



11.2 *Assessment of key provisions of administrative and implementation framework for large area industrial developments in India*

With a view to overcome the shortcomings experienced on account of the multiplicity of controls and clearances; absence of world-class infrastructure, and an unstable fiscal regime and with a view to attract larger foreign investments and provide a boost to manufacturing in India, the Special Economic Zones (SEZs) Policy was announced in April 2000. Prior to the SEZ Policy, large scale industrial development projects were implemented as industrial areas/ estates under the purview of central/ state level Industrial development corporations (or boards), where the respective government entity would acquire and develop land, and provide basic infrastructure and lease/ sell industrial plots to investors. The private sectors role was restricted to implementation and operation of industrial units within the estate.

With the advent of the SEZ policy, private sector role increased significantly from O&M of industrial units, to conceptualization, implementation and operation of large scale SEZ areas in the range of 500ha and more (for multi- product SEZs) combining processing area and areas for residential, civic amenities, including provision of all necessary utilities and other infrastructure. In order that the private developer perform the role akin to an urban local body enabling it to provide and operate multiple municipal functions efficiently (all civic amenities

and infrastructure including roads, sewerage systems, open spaces, green spaces, education facilities, power, water supply and housing etc.) within the delineated area, the SEZ Act provided necessary enablers such as:

- Constitution of SEZ authority, a body corporate chaired by a Development Commissioner (of IAS rank), and comprising representation from Central/ State government, the developer and other nominated members empowered to acquire land, prepare master- plan, guidelines for land- use, FAR etc for the SEZ, levy user- charges for services, dispose land/ property ass sale/ lease etc;

- Simplified procedures for development, operation, and maintenance of the SEZ and for setting up units and conducting business in SEZs;

- Single window clearance for setting up of an SEZ; and for setting up a unit in a Special Economic Zone;

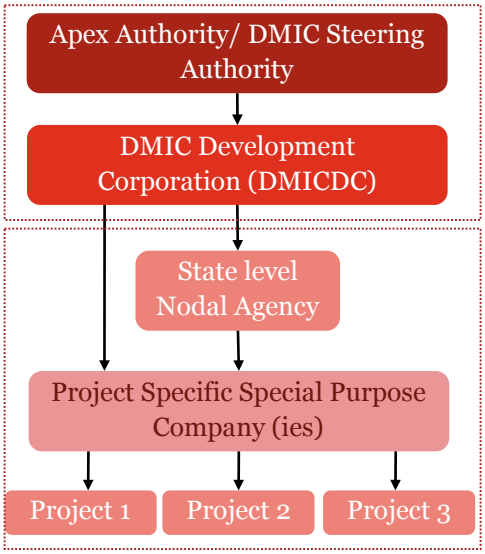
- Single Window clearance on matters relating to Central as well as State Governments;

- Simplified compliance procedures and documentation

Subsequently, mega industrial areas were planned under the Delhi- Mumbai Industrial Corridor project (DMIC) in the influence areas of proposed western Dedicated Freight Corridor (DFC) sanctioned under the Eleventh Five Year Plan (2007-12), covering an overall length of 1483km and passing thru the States of U.P, NCR of Delhi, Haryana, Rajasthan, Gujarat and Maharashtra. In order to achieve the ambitious vision of DMIC[54], 24 special investment nodes, 11 investment regions (min. area of 200 sq. km) and 13 industrial areas (min. area of 100 sq. km) have been identified for joint development by central and state governments. Private sector participation (through PPP) is largely envisaged in the development of the investment areas through formation of Special Purpose Companies (for both critical external infrastructure and trunk infrastructure within the investment areas) for project implementation, operation, and maintenance in the DMIC region.

Implementation Framework under DMIC

To undertake the mammoth project of DMIC covering 7 mega industrial nodes (as part of the first phase) and running through six states, a 4 tier institutional framework has been created.



Headed by the Finance Minister; Minister for Commerce & Industry, other cabinet ministers, and chief ministers of 6 states as members- Responsible for overall project supervision, monitoring and commissioning of projects, policy framework, fast- tracking clearances & approvals

Incorporated as an SPV, Project Development Partner or Knowledge Partner to all SPVs and State Government agencies; Current shareholding pattern - DIPP (49%), IL & FS (41%), IDFC (10%); Responsible for project advisory services, Master Development Plan for DMIC, project prioritization and allocation to Central/ State Governments, raise financing instruments etc.

Responsible for co-ordination between the DMICDC, various state government entities and the project implementing agencies/ SPV; Node formed as an Industrial Township under Article 243 Q(1)(c) of the Constitution with composition of the Node SPV comprising of 49%- DMIC Trust and 51%- state nodal agency;

Project SPVs for both central and state govt. sponsored projects (ports, railways, air, road, industrial, utilities)

Both node and project SPVs are responsible for obtaining approvals & clearances, commissioning and monitoring of project implementation, arranging finance etc

Figure 11.2: DMIC Project Implementation Framework

[54] Double employment potential in 7 years; Triple industrial output in 9 years; Quadruple exports from the region in 8-9 years; Target growth 13-14% per annum for manufacturing sector on sustained basis over next three years

Node Level Structure

For implementation of individual nodes, a node/ city level SPV (Node Authority) is proposed to be set up. Composition of the SPV is to comprise of 49%- DMIC Trust and 51%- State nodal agency. The node/ city level SPV may have suitable representation from private sector wherever the State Government decides to involve the private sector (private equity participation in a node/ city level SPV to be limited to 49%, currently none of the SPVs have envisaged private sector as an equity partner in the node level SPV). The SPV is to be notified as an Industrial Township under any relevant State Act or **Article 243Q of the constitution** by the respective State Governments, empowering the SPV to discharge the dual role of a municipal body and planning and authority.

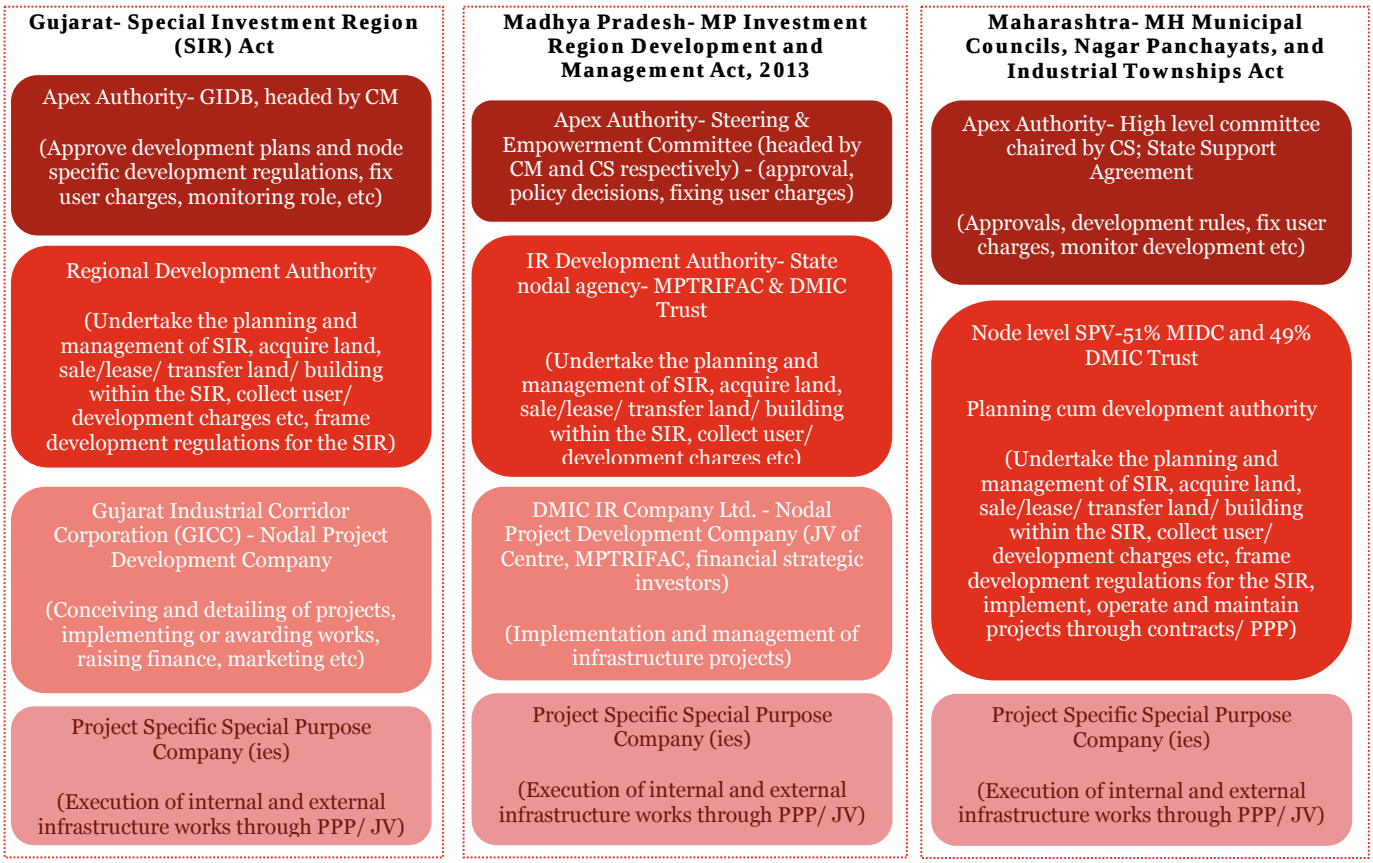
> Article 243 Q (1) of the Constitution is of particular relevance to large area industrial development in India which allows for constitution of an area as "Industrial Township". It empowers for constitution of an Industrial Township Authority to act in the capacity of a municipal body, secure planned development and maintenance of the industrial area; and provide, operate and maintain utilities and civic amenities within the industrial township.

This will empower and ring- fence the SPV to function on its own with little dependency on the state government, thereby facilitating faster and smoother project implementation and monitoring.

Each SPV is managed by:

- A board of 6 directors
    - 3 nominated by DMIC Trust
    - 3 nominated by relevant State Industrial Development Corporation (SIDC)
- Chairman of the Board- Principal Secretary, Industries
- CEO & MD of the SPV
    - Appointed by Board Chairman in consultation with CEO of relevant SIDC
    - Minimum 3 year term; Responsible for day to day operations of the SPV
- Business team of professionals to support CEO & MD – appointed by the Board

The node level institutional structure follows existing legislative framework applicable existing in the DMIC states. **While some states have combined the planning and development function into a single node level SPV, other states have segregated these functions, where the node level SPV acts as the Planning Authority for the node and a separate Project Development Company is formed for implementation of projects within the node.**



Financing framework for DMIC

A "DMIC Project Implementation Fund" has been established as a Trust with an inter-ministerial Board of Trustees headed by Secretary, DEA. Central Government will provide a grant-in-aid of Rs 17,500 crore to the Fund/Trust over the next 5 years beginning 2011-12, for the development of the 6 industrial cities @ Rs 2500 crore per city on an average, subject to a ceiling of Rs 3000 crore per city. The Fund/ Trust would leverage the resources provided by GoI to raise long term funding from financial institutions and raise Tax Free Bonds, Capital Gains Bonds, Credit Enhancement, etc for financing the development of these cities. Alternately, the nodal/ city level Special Purpose Vehicles (SPVs) will be further able to raise long term debt finance through credit enhancement by appropriate credit enhancement features from the Fund/Trust.
Equity in node/ city level SPVs and in project specific SPVs and holding companies will be held by the Fund/ Trust subject to limits specified (upto 50% in node SPVs and 100% in project SPVs). All investment into the SPVs by GoI will be routed through the Fund/ Trust so that all debt service payments by SPVs and proceeds from equity disinvestment from SPVs, can be ploughed back into the Fund corpus, enabling the Fund/ Trust to undertake the development of more such industrial cities in the DMIC region in future.

The Corpus of the Trust would be used for:

- Providing equity and/ or debt to the nodal/ city level SPVs for development of non-PPP infrastructure and for investment in project specific SPVs that may be set up by a node/ city level SPV;
- Providing equity and/or debt to other project specific SPVs and sectoral holding companies consisting of project specific SPVs; and
- Providing grant to DMICDC for project development.

The Board of Trustees are empowered to appraise all proposals placed before it with the recommendations of DMICDC and approve and sanction equity and/ or debt to SPVs and grant to DMICDC for project development upto a ceiling of Rs 300 crore. All proposals exceeding Rs 300 crore are to be submitted to the Cabinet

Committee on Infrastructure (CCI), after appraisal by the PPPAC[55] of the Ministry of Finance or the Trust as the case may be.

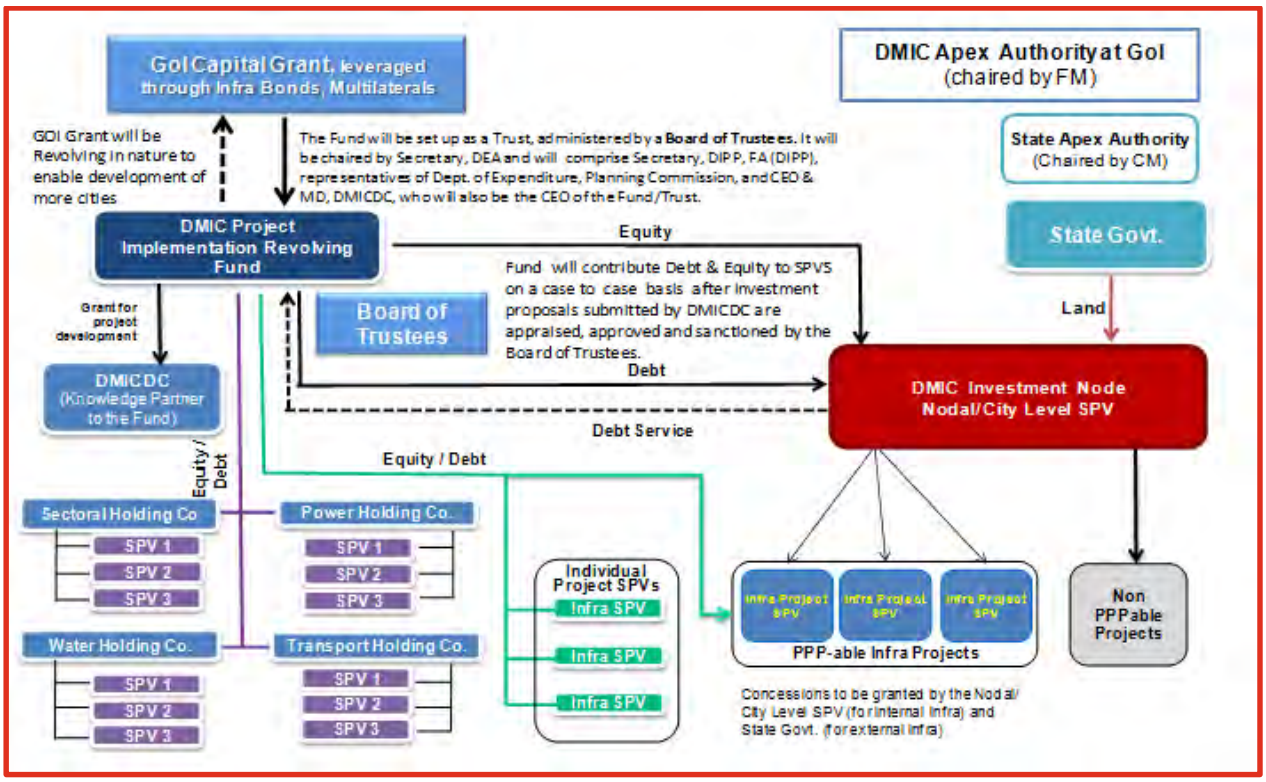


Figure 11.3: Financing framework for DMIC

Given that fund flow is highly centralised through the DMIC Project Implementation Revolving Fund, there is strict monitoring in terms of disbursement and collections. The revolving nature of the fund ensures self-sustainability where revenues from node/ project SPVs are ploughed back into the fund for further use. Fund access is routed through Node SPV's, and also directly to holding companies and individual project SPVs enabling faster fund routing.

Funds from Government of Japan: Funds to be committed by Government of Japan will be routed through existing framework, i.e. JICA funding will be provided to procurement agencies, Ministries and state governments, through MOF, and JBIC funding will be provided for private sectors. However, the initial planning on funding has been done at DMICDC level, possible disconnection between funding planning and project planning is raised from some stakeholders. In addition, considering the benefit for the States to utilize grant fund, actual disbursement from Government of Japan has not been realized at this point.

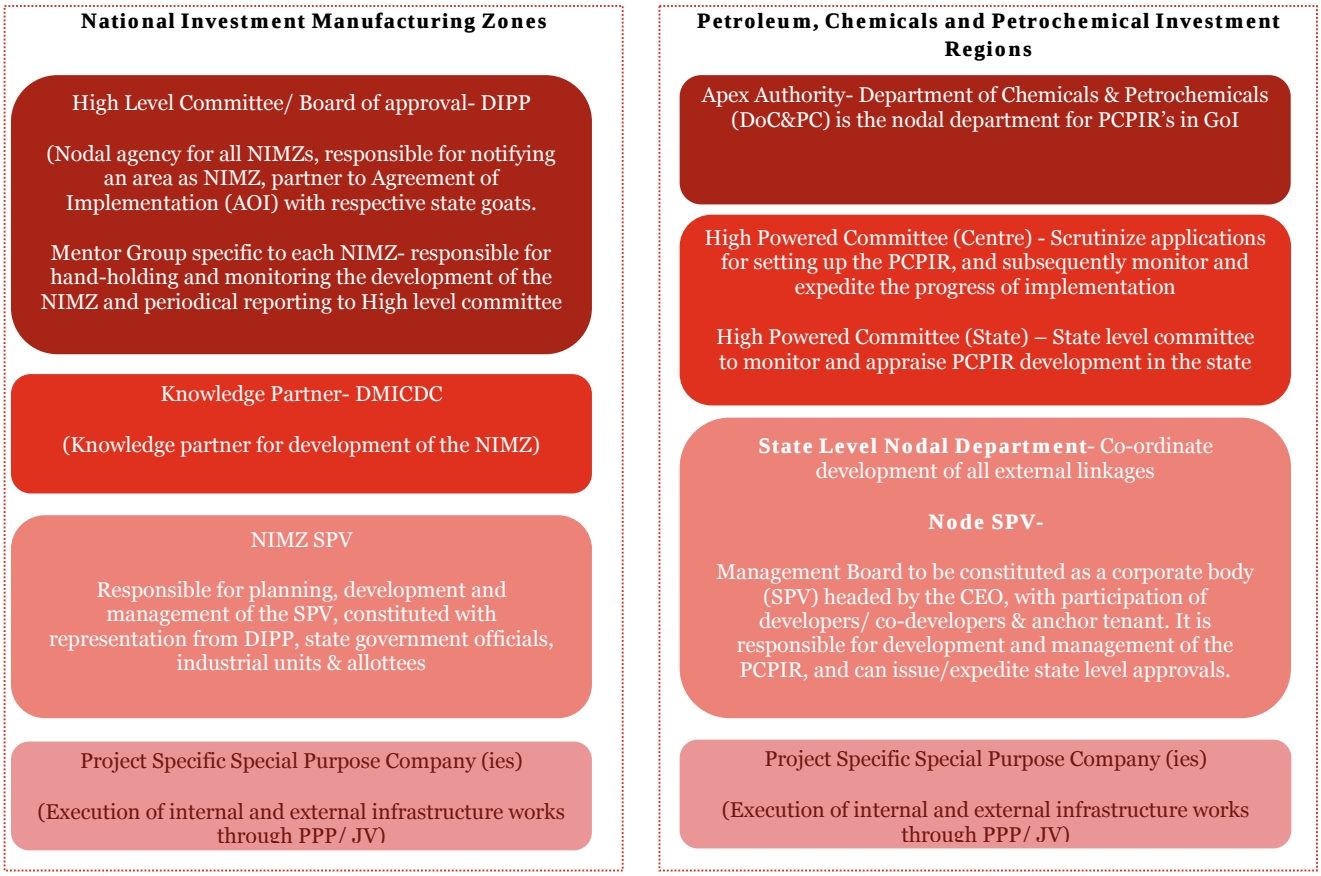
Implementation Framework under PCPIR & NIMZ

At the Central Level, other large area industrial developments proposed are NIMZs and PCPIRs. NIMZ's are an important instrumentality of achieving the objectives laid down under the National Manufacturing Policy. Proposed to be set up in a minimum area of 50 sq. km, an NIMZ is envisaged as an integrated industrial township with state of the art infrastructure. The ideology behind PCPIR is to develop an investment region with an area of around 250 square kilometres (5 times the size of an NIMZ) specifically for the establishment of manufacturing facilities for domestic and export led production in petroleum, chemicals & petrochemicals industry, along with associated services and infrastructure.

Both mandate similar project implementation frameworks with robust centre/ state representation. It is envisaged that while the Central/State Government (based on project jurisdiction) will be responsible for all external infrastructure, and wherever necessary will provide support in the form of viability gap funding,

[55] SIPP and CEO, DMICDC will be members of PPPAC to appraise and fast- track PPP projects in the DMIC region

budgetary provisions, credit enhancements for other forms of financing etc for creation of these linkages. All internal infrastructure is to be provided by Developer/ co- developers.



Proposed National Industrial Corridor (NICDA)

In order to put in place an overall enabling institutional, funding and operational framework for the development of Industrial Corridors in India, the proposal has been mooted to form an umbrella organisation in the form of NICDA. **It is proposed by GOI that NICDA will form the Apex Authority for all industrial corridors including DMIC, and will subsume the roles of current Central Trust and DMICDC, thereby acting as a project advisory body (akin to DMICDC) and a funding body (akin to Central Trust).** It is understood that principles for functioning of NICDA has been approved and the same is pending for Cabinet Approval by GoI.

It is envisaged that each industrial city in the industrial corridor shall be implemented by a SPV set up under the Companies Act, as a Joint Venture between GoI, represented through NICDA and the respective State Government on the lines of institutional structure approved for DMIC. The node/city level SPV may have representation from private sector wherever the State Government decides to involve them.

11.3 *Key pointers for CBIC from stakeholder consultations on current DMIC structure*

To understand the pros and cons of the current implementation framework under DMIC, stakeholder consultations were held with the state nodal agencies of DMIC states and private sector. Based on this a consultation matrix is presented below:

Issue	Remarks	Good Practice
Land acquisition	No transparency in valuation of land, resistance towards land acquisition due to poor	• Gujarat mechanism of land pooling through Town Planning scheme

Issue	Remarks	Good Practice
	compensation, no means of land monetisation by the land owner as a result of proposed development	• Customised land acquisition and R&R packages to enable land owners to reap the benefit of such development
Challenge in creation of Node Development Authority	Conflict regarding cessation of existing local bodies within the delineated area in some DMIC states	• Gujarat SIR acts allows for retaining existing village settlements + plus 200 m buffer zone, administration of which remains with the gram panchayats, even after formation of RDA and hence there is hardly any resistance • Other state acts such as Karnataka and AP provision for revenue share of property tax collected with existing local authority within the delineated area
Financing arrangement for development of node and external infrastructure	• In some cases, state's contribution as equity in the SPV exceeds 51% due to higher land valuations. • Cost of acquisition is a huge burden for the state. • Lack of transparency in apportionment of Trust Funds esp. for external infrastructure projects • Funds from GoJ is planned to be utilized project by project basis and sometimes less incentives are provided to States, Ministries considering availability of grant funding from GoI	• The excess amount may be shared between the state and Central Trust to retain original equity share • The excess amount may be treated as state loan to the SPV, conditions for which are clearly indicated in the Shareholder agreement • Scientific methodology (based on economic benefit etc) to be adopted for prioritisation of external infra projects and fund planning to be done accordingly • Integrated project planning considering alternative source of funds will be required
Project advisory and procurement	Lack of clarity in whether project advisory services are undertaken by DMICDC/ respective state and central line departments	• Centralised monitoring and funding of project advisory and procurement services through DMICDC to various central/ state departments • Clear Result Framework Document with agency responsible and timelines for projects to be taken up by DMICDC and other state/ central departments
External infrastructure projects	Lack of ownership for planning and monitoring of critical external infrastructure projects for the node	• Industrial corridor cell maybe proposed in key central agencies such as NHAI, Shipping, Railway Board etc to plan, implement and operate projects under their jurisdiction • State level nodal agency may be identified to implement external infrastructure projects (under state jurisdiction) through respective state departments • For developing unviable external infrastructure by NHAI etc, funding options may be identified based on prioritised project list through options such as Central grant, International Finance Assistance etc
Delivery capability of state nodal agency and other departments	• State nodal agency lacks capacity to deliver enhanced role of implementing nodes in the range of 25- 50 sq. km • Ownership of state agencies	• Industrial corridor cell maybe created in state nodal agency and sufficiently capacity by hiring of external experts/ project management units etc • State high level empowered committee maybe suitably chaired at CM/ CS levels and represented with key department officials for proper

Issue	Remarks	Good Practice
	for projects is lacking	monitoring of project status • Representation of GOJ/JICA at state high level committee and node level SPV management board may be included, to enhance collaboration & knowledge transfer
State representation in Apex Level Committee	• Lack of state representation in DMIC Steering/ Apex committee	• High level representation from state Finance Department may be made part of DMIC Apex committee apart from Chief Minister of the State
Lack of co-ordinated industrial development in the state	• Lack of centralised state agency undertaking planning and monitoring of all large area industrial developments in the state- NIMZs, PCPIRs, Industrial Corridors etc	• Based on the existing legislative provisions of the state or through suitable amendment, a single nodal agency may be identified to oversee all large area industrial developments in the state akin to Gujarat Industrial Corridor Corporation formed under the SIR Act
Private sector participation (PSP) in Node level SPV	• Current structure restricts PSP to project level SPVs	• By segregating planning and development functions to Node Authority (Govt. body) & Project Development Company (Govt. + private sector), private sector efficiency in land monetisation and project implementation and monitoring can be leveraged, while retaining all planning and statutory functions with the Node Authority. • Contractual and/ or revenue share mechanisms from collected taxes maybe worked upon between the node authority and the PDC, in case the PDC provides any statutory services • Private sector may either participate through equity infusion in PDC (Master Developer SPV) or through sub- SPV's for provision of viable services within the node through the PPP route

11.3.1 *Successful operational examples of private sector participation in large area industrial developments s*

GIFT city

Gujarat International Finance Tec-City is planned as a financial central business district for the global financial services sector with the state of the art connectivity, infrastructure and transport access. GIFTCL is a Public Limited Company with IL&FS and GUDC both holding 50% each of the share capital of the Company. GIFT is being developed on 886 acres of land. GIFT facilitates Multi Services SEZ of 261 Acre and Domestic Finance Centre and associated social infrastructure on 625 acres. The SEZ is divided into two parts; 131 acres for Processing Area and 130 acres for Non-Processing Area

The development of infrastructure within GIFT is the responsibility of GIFTCL, which acts as the master developer. Gujarat government has declared the entire GIFT area as notified under section 264A of the Gujarat Municipalities Act, 1963. Following this the GIFT Urban Development Authority has been constituted as the area development authority for GIFT area as per the Gujarat Town Planning and Urban Area Development Act, 1976. The GIFT Authority will be chaired by State Urban Development Secretary and its members include R&B Secretary, GIFT Chairman, GIFT MD, CEO GUDA, MD GUDC, Gujarat's Chief Town Planner and Gandhinagar District Collector, along with an Additional Collector as Secretary of this committee.

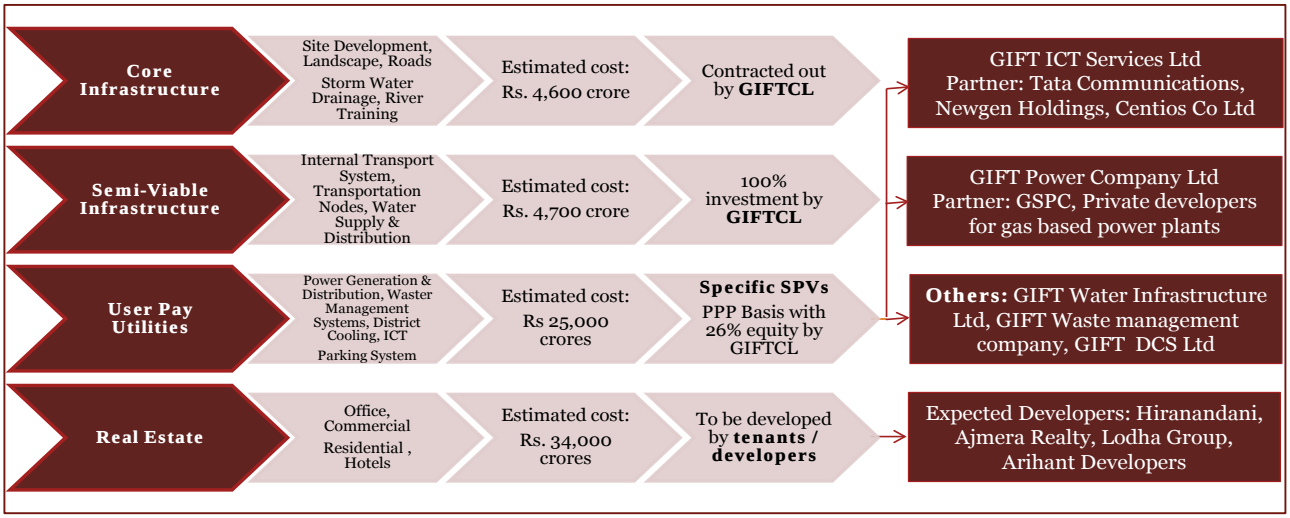
The Project is geared for encouraging significant private sector participation into specific viable components. It is envisaged that while site development and basic infrastructure would be contracted out by GIFTCL, Special

Purpose Vehicles (SPV's) have been set up to implement the critical utility components through major private sector participation. **GIFT has 6 subsidiary companies for providing the utilities namely power, water, solid waste management, ICT, District cooling system and transport.**

- GIFT District Cooling Systems Limited
- GIFT Water Infrastructure Limited
- GIFT Waste Management Services Limited
- GIFT SEZ Limited
- GIFT Power Company Limited
- GIFT ICT Services Limited

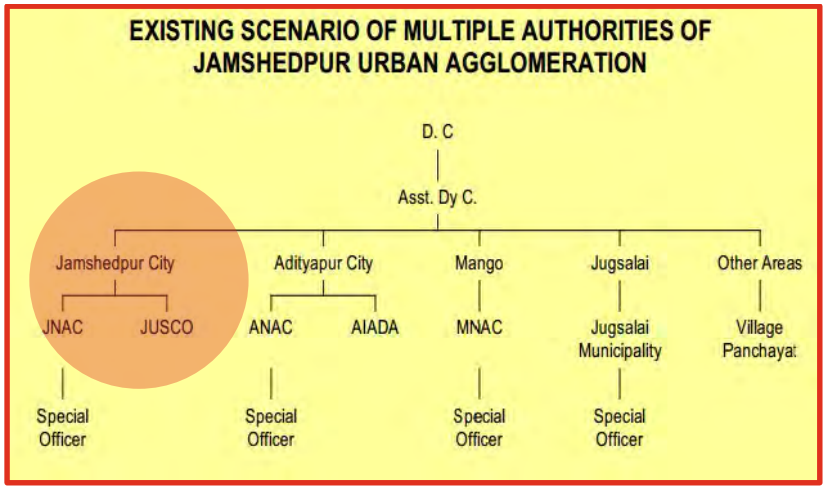
Each SPV presents a separate business case.

Real estate would be developed by individual developers, with GUDC acting as the Single-Window Area Development Authority.



JUSCO

Jamshedpur was formed as a steel township city in early 20th century. Jamshedpur is currently administered by the Jamshedpur Notified Area Committee (JNAC). Civic administration in JNAC is divided into two bodies- JNAC for non- Tata leased lands and Jamshedpur Utilities and Services Company (JUSCO). JUSCO is a 100% subsidiary of Tata Steel was formed in 2004 and is India's first and only private sector comprehensive urban infrastructure services provider. Its core competency is "creation and subsequent O&M of urban infrastructure and services". The governance structure of Jamshedpur Urban Agglomeration is as shown below:



For municipal services provided by JUSCO covering an area of around 64 sq. km and to over 7 lakh people, JUSCO is empowered to levy user charges determined in consultation with the district administration. At present, JUSCO provides the following services to the residents of Jamshedpur:

- Power Services
- Water and Wastewater Management
- Construction Services
- Municipal Solid Waste (MSW) Management
- Horticulture Services
- Geographic Information System (GIS)
- Integrated Facility Management
- Customer Services: single window complaint lodging and follow-up system for citizens
- Other Services

While JUSCO can provide municipal services within the JNAC area, it has no coercive powers to maintain law and order, for eg: removing encroachments, police services etc.

11.4 *Summary of key learnings for CBIC*

Based on assessment of relevant acts for development of large industrial areas in India as elaborated above, a summary of learnings has been presented for CBIC to help formulate a robust institutional and financing structure for development of industrial nodes and the industrial corridor in its entirety. Incorporating these learnings and through extensive stakeholder consultations with DIPP, JICA, and relevant AP state government departments such as Dept. of Industries, Commerce & Export Promotion, Municipal Administration & Urban Development, the institutional framework for Krishnapatnam Node has been formulated.

- ***Strong commitment at Central Level:*** *Constitute an Apex Authority at the Central Level in the form of NICDA to oversee and ensure coordinated planning of all industrial corridors. Apex Authority to be sufficiently empowered with high level representation from Finance Minister, other relevant cabinet ministers, important departments such as NHAI/ Railways/Shipping/ AAI/ MoEF,* ***high level representation of participating states*** *from finance depts. and chief minister's offices*

- ***Co- ordinated planning of industrial corridors:*** *NICDA may have different verticals such as DMIC corridor unit, CBIC corridor unit etc with shared horizontal departments such as Procurement Dept., Planning & Project Development Dept., Finance Dept. (Central Trust), etc*

- ***Fast- tracking external linkage projects:*** *Departments crucial for external linkages such as NHAI/ Railways/Shipping/ AAI can have a dedicated vertical- Industrial corridor unit, which can facilitate expediting of planning and implementation of such projects*

- ***Strong commitment at State Level:*** *Apex committee at the state level may be constituted as an umbrella organisation for all industrial corridors/ large area industrial developments in the state to periodically monitor status projects, approvals and clearances, take decisions on policy reform, facilitate ease of doing business etc. Strong commitment in the form of chairing of the committee by CM/ CS, and high level representation from relevant state departments such as Finance, Land and revenue, Industries, Environment, Urban Dev. Dept./ Town Planning Dept., State nodal agency, Board members of mega industrial projects in state will facilitate fast- tracking and smooth implementation of the project. Also,* ***involvement of GOJ (and multilateral agencies involved) at State Apex committee level will ensure adequate knowledge transfer*** *and collaboration for policy, financing and other decisions.*

- ***Co-ordination entity for external infrastructure:*** *State may appoint a nodal agency responsible for implementation of all external linkage and utility projects. The agency will act as a co- ordination between different state and central departments responsible for implementation of such projects and periodically report to the Apex committee regarding status and any issues.*

- ***Capacity building:*** *State nodal agency for development of the industrial node/ corridor may be sufficiently capacitated by formation of an Industrial Corridor Unit which will enable fast- tracking of land acquisition, application procedures, clearances etc. The cell may be suitably capacitated with technical experts, project management consultants to enable to nodal agency to sufficiently monitor the progress of projects.*

- ***Node Autonomy & private sector participation:*** *State may declare the industrial node as an Industrial Township, and grant adequate autonomy to the Industrial Area Authority to act as a planning and development body under any relevant state law, or under Article 243Q of the Constitution, thereby reducing its dependency upon the state government for provision of services and certain clearances. The authority may be empowered to form development regulations for the node, and decide on tariffs/ user charges for services within the node in consultation with the State Govt.*

  The planning and development functions may be segregated, such that an Authority is formed which acts essentially as the Planning body with all statutory functions such as approval of master plan, collection of taxes, provisions of statutory functions such as police, etc;

  And for the development function a separate SPV in the form of ***Project Development Company*** *(Master Developer) may be formed with representation from centre/ state and the private sector. The Authority may empower this PDC with development rights and enable them to collect any relevant user charges/ development charges fixed in consultation with the Node Authority. Based on the financial viability of node development, private sector participation may be as equity share in the PDC, or as separate SPVs under the Master Developer SPV for provision of specific services.*

11.5 *Proposed Institutional and Financing Framework for development of Krishnapatnam Node and CBIC in Andhra Pradesh*

11.5.1 *Institutional Framework*

Suitable Legislative Framework

In order to formulate the institutional structure for Krishnapatnam industrial node under CBIC, it is important to understand the relevant legislative framework in Andhra Pradesh which allows for such development. In this context, the suitability of 2 relevant state acts was assessed, namely:

- AP Urban Development Act
- Guidelines to Industrial Area Local Authority (IALA)

An assessment of provisions of the above acts reveals that **the IALA Act is most suitable for development of Krishnapatnam Node**. A suitability matrix for selection of legislative framework for CBIC development in AP has been presented below.

Table 11.2: Suitability matrix for selection of legislative framework for CBIC in Andhra Pradesh

Provisions of the acts	AP IALA Act	AP Urban Development Act
Declaration as industrial area or township/ investment region/Special Area	Yes	Yes
Special planning authority	Yes	Yes
Node	Industrial Township Area/ (similar to Article 243 Q)	Special planning area
Minimum area of delineated area	As per census planning area classifications	As per census planning area classifications
Area Authority	Andhra Pradesh Industrial Infrastructure Corporation (APIIC)	Special Area Development Authority (SADA)
Functions	Planning Authority, and all municipal functions	Planning Authority, and all municipal functions
Funds	• Grants, loans, advances from Govt. • Taxes, levies, tolls, rents etc • Money received from the disposal of land, buildings property	• Grants, loans, advances from Govt. • Taxes, levies, tolls, rents etc • Money received from the disposal of land, buildings property
Suitability for CBIC	● (Provision for formation of node as Ind. Township area with special local authority, enables private sector representation- industrial units in the implementation of the industrial area)	◑ (Although separate planning and municipal body maybe constituted, the body will be a state govt. entity with functioning and representation akin to any Municipal Corporation/ Municipality)

Key considerations

- Land delineated under Krishnapatnam industrial node is to the extent of 11,864 acres. Of this around 43% of land is under the possession of Krishnapatnam Infratech Private Ltd. (KPIL). Around 4% of land is

currently with APIIC, and the remaining is under acquisition by APIIC. Constitution of the Node SPV will be proposed taking into consideration existing land- holding of private sector (KPIL).

- The delineated area currently has existing village settlements under the jurisdiction of 7 Gram Panchayats[56]. It is proposed that the settlements be relocated to an appropriate location within the industrial node and subsumed as part of the economic activity of the node, so that planning for the node will be comprehensive and contiguous.

- Discussions with Dept. of Industries, Commerce & Export Promotion, Municipal Administration & Urban Development, have revealed that although the existing IALA Act provisions for transfer of certain powers and functions of municipal bodies to APIIC to exercise the same in Industrial areas/ SEZs in AP, to promote the concept of self- governance in the Industrial Area, IALA may not be capacitated enough to undertake planning, development and operation of envisaged world- class industrial township in Krishnapatnam.

- Thus, it has been suggested that the central legislative framework be adopted for Krishnapatnam node development. The node is to be declared as an Industrial Township by the state government under Article 243 Q, and a separate Krishnapatnam Industrial Area Authority is to be formed which will assume the role of the municipal body for the node. In accordance with the provisions of Article 243 Q, the existing Gram Panchayats within the node will cease to exist upon formation of such Authority.

[56] Gram Pachayats within the Node:
- Kota Mandal: Kothapatnam, Siddavaram, Karlapudi, Putchalapalle
- Vakadu Mandal: Valamedu
- Chillakur Mandal: East Kanupur, Vellapalem

Table 11.3: Model comparison

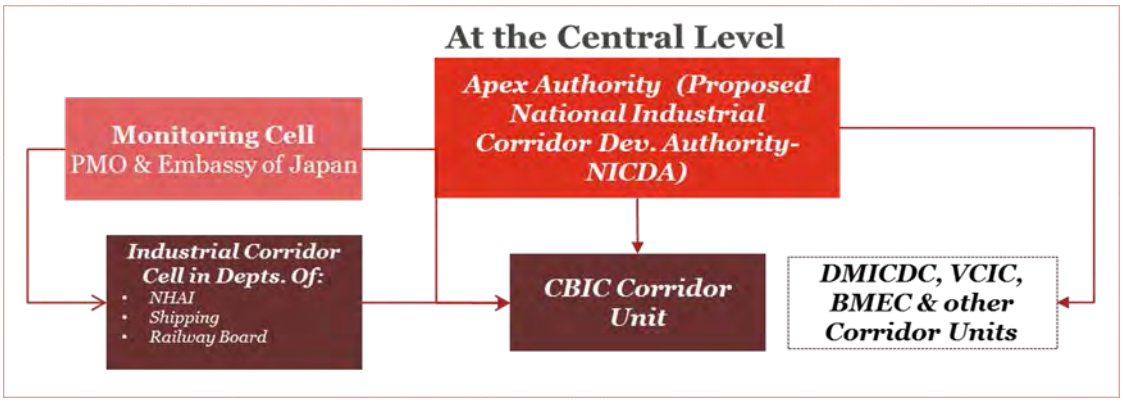
	GIFT City	JUSCO	Sri city	Dahej SEZ	Mahindra World City SEZ (Jaipur)
Land area (acres)	886	15,814.70	7000+	4279.86	3000
Private sector equity	No JV: Gujarat International Finance Tec-City Company Limited' (GIFTCL), between Gujarat Urban Development Company Limited (GUDC) and Infrastructure Leasing & Financial Services established a Joint Venture Company	Yes 100% subsidiary of Tata steel	Yes Sri City Private limited (formerly Satyavedu Reserve Infracity Private Limited) , attracting Private Equity Fund	No JV between ONGC(Oil and Natural Gas Corporation) and GIDC (Gujarat Industrial Development Corporation)	Yes JV between the Mahindra Group and TIDCO
Unbundling of utilities	GIFTCL (master developer-site development and basic infrastructure) 6 subsidiary companies (SPV's) with private sector participation were formed for providing the utilities namely power, water, solid waste management, ICT, District cooling system and transport. Each SPV presents a separate business case.	Nil	Nil Power: APSPDCL - Andhra Pradesh Southern Electricity Distribution Company Telecommunicaton: a number of service provders Gas: various commercial providers	Nil Water: GIDC Drainage/Effluent Disposal: GIDC Power: Torrent Energy Ltd Gujarat State Petronet Ltd. Telecommunication and Data Transmission: Bharat Sanchar Nigam Limited	Nil

	GIFT City	JUSCO	Sri city	Dahej SEZ	Mahindra World City SEZ (Jaipur)
Revenue resources	Development rights Commercial Development Rights: Rs.1250 per sq(GIFTCL) / Rs.1000 per sq(GIFT SEZ) Residential Development Rights: Rs. 950 per sq(GIFTCL)/Rs.750 per sq(GIFT SEZ) Social Facilities Development Rights: Rs.350 per sq (GIFTCL)/Rs.250 per sq (GIFT SEZ)	Municipal service charges (Power Services Water and Wastewater Management, Construction Services, Municipal Solid Waste (MSW) Management, Horticulture Services, Geographic Information System (GIS), Integrated Facility Management, Customer Services: single window complaint lodging and follow-up system for citizens and others.)	Water charge Services charges	Long-term lease (30 years) Short-term lease (5 years) Allotment price – Rs. 1,200 /sq. m. / annum One time application fee One time deposit Service charge – Rs. 12/sq. m. /annum	a 99 year lease

- *Source: Official websites*

Proposed Institutional structure for Krishnapatnam Node and CBIC in Andhra Pradesh

Taking into key considerations the key learnings for CBIC and suggestions from GoAP, the following institutional structure has been proposed for Krishnapatnam Node:



- Proposed National Industrial Corridor Development Authority (NICDA) to oversee all industrial corridor development in India including DMIC
- NICDA will act as a project development partner to all SPVs and State Government agencies for implementation of industrial cities/projects in the various industrial corridors
- CBIC corridor unit to be formed below NICDA
- Key central agencies such as NHAI, Ministry of Shipping & Railway Board will be represented on the NICDA Board. They may form special cells within each department to facilitate planning, implementing and monitoring of critical external infrastructure projects
- Monitoring cell comprising of PMO and Japan embassy to form the apex level monitoring body

Figure 11.4: Central level institutional structure for CBIC in Andhra Pradesh

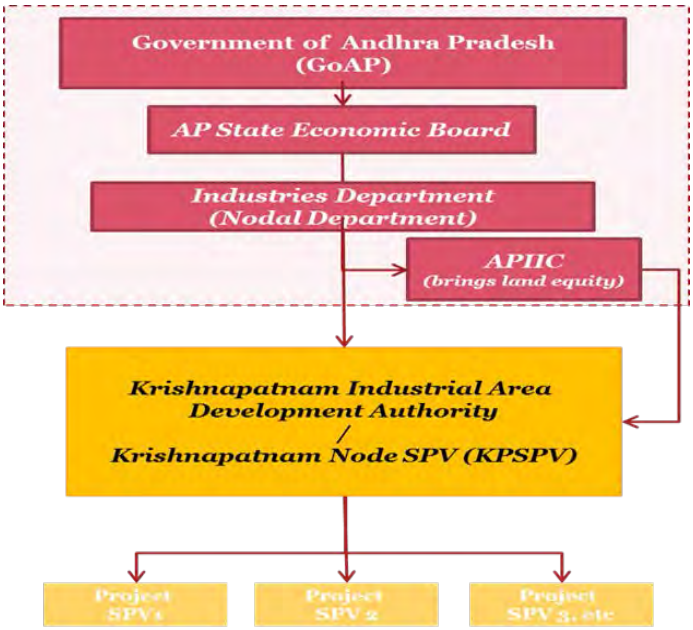


Figure 11.5: State level institutional structure for CBIC in Andhra Pradesh

Key features of the proposed institutional structure

Co- ordinated planning of industrial corridors & Strong commitment at Central Level:

At the Central Level, an apex body in the form of NICDA is proposed to oversee co- ordinated planning, funding and monitoring of industrial corridors in India. It is proposed that a CBIC corridor unit be formed under NICDA to periodically update NICDA upon the progress of CBIC.

Proposed representation of NICDA:

- *Chaired by Union Finance Minister*
- *Minister for Commerce & Industry*
- *PMO*
- *GOJ/multi- lateral agencies*
- *Proposed Nitti Aayog*
- *MoEF*
- *Other relevant cabinet ministers*
- *Chairman- NHAI/ Railways/Shipping/ AAI*
- *High level representation of participating states- State*

Strong commitment at State Level:

The AP State Govt. has proposed for creation of an apex body at state level namely the **"State Economic Board"** which will be formed as a high powered apex body to provide direction to economic and industrial promotion activities and projects across the state. The Board being sufficiently empowered will facilitate policy decisions and prioritization of corridor development related projects. The Economic Board will co- ordinate with the CBIC Corridor Unit at Central Level to periodically update progress of CBIC development in the state

Proposed representation of State Economic Board:

- *Chief Secretary AP(Convenor)*
- *Cabinet Ministers*
- *PS Industries Dept.*
- *PS Revenue Dept.*
- *PS Finance Dept.*
- *PS I&I*

Co-ordination entity for external infrastructure

Based on discussions with GoAP, INCAP has been identified as the nodal agency for coordinating implementation of all external infrastructures for CBIC in AP. INCAP will act as a facilitator by coordinating with relevant state govt. entities, organizing for project clearances, conducting project advisory studies, project marketing etc.

- Under the existing organisation set-up of the department, a new cell for Industrial Corridors may be set up headed by a Joint Director.

Capacity building

The state nodal agency Industries Department may be suitably capacitated by creation of a special Industrial Corridor Cell by passing of requisite GO and staffing the cell suitably, to enable it to undertake land acquisition and any other activities for such large scale projects.

Proposed experts for Industrial Corridor cell in APIIC:

- Subject matters experts in the field of industrial and urban planning
- Project management office (PMO- external consultants)
- Financial advisor
- Liaison officer

Node Autonomy & private sector participation

In order to facilitate private sector participation, it was felt necessary to segregate the planning and development functions of the node, such that Government retains all statutory functions such as framing of development regulations, approvals, NOCs, collection of taxes, etc.

Proposed composition of Krishnapatnam Industrial Area Development Authority/Krishnapatnam Node SPV (KPSPV)

- NICDA*
- State: APIIC
- Private sector-Krishnapatnam Infratech Pvt. Ltd.

For the development function a separate SPV may be created, Krishnapatnam Node Project Development Company (PDC) which shall contain KPIL and any other private sector participation and be responsible for implementation and operation of the node. The suggested composition for Krishnapatnam node PDC is based on indicative guidelines proposed by NICDA.

Proposed composition of Krishnapatnam Node Project Development Company:

- NICDA-GoI's equity contribution (to be decided)
- APIIC- as per valuation of land under APIIC
- KPIL- as per valuation of land under KPIL's possession– capped at 49% share
- Private sector participation may also be through creation of sub- SPV's for provision of viable infrastructure and utility services within the node through the PPP route

Collaboration with Japan to attract investors with Knowledge Transfer:

Participation of GOJ has been proposed both at the Central Level (Monitoring Cell) and the State Level (State Economic Board) to attract international investors to the node and related infrastructure development. It will

be effective to incorporate necessary development of external (and/or internal) infrastructure, investment environment improvement, and investment promotion from the planning and preparation stage in order to accommodate international investors' view. International investors could facilitate knowledge transfer and technology collaboration in newer areas such as Smart City concepts, Green Buildings, Zero Waste Discharge etc. This will also ensure adequate appraisal, due- diligence and monitoring in planning and implementation of projects at State & Central levels. Also such representation will enable project marketing in parent countries of these agencies.

JICA Study Team (JST) had made a detailed presentation to GoAP on 3rd December 2014 about the proposed Institutional Structure and some observations were made. Based on that, JST again made a presentation on January to GoAP. The Structure mentioned here in this report is based on the above.

Detailed Roles & Responsibility Framework for key stakeholders

Key Task	Responsibility
Land Delineation for the Node & Project Development Studies	APIIC is responsible for conducting pre- feasibility assessment for the node, and delineating appropriate land parcel for development
Land Acquisition	APIIC is responsible for all land acquisition and R&R activities
Preparation and approval of node master plan	The detailed master plan for the node is to be prepared by the Project Development Company and approved by proposed Node Authority KTIADA and State Government through the State Economic Board
Preparation of development guidelines for master planning of node	The Node Authority is responsible for preparing any node specific development regulations for Krishnapatnam Node if provisioned for under state legislative framework. Such guidelines may be approved by the State Economic Board
Approvals, Clearances, NOCs	Based on the jurisdiction for approvals, the Centre/ State/ Apex Committee & the Node Authority will be responsible for all approvals and clearances. For eg: The Node authority will be responsible for approving all building registrations, node development related NOC's etc; Approvals for external connectivity projects within state jurisdiction will have to be through State Economic Board; Any environmental clearance for mega projects shall take the existing route of approval from the Centre through MoEF
Implementation of external infrastructure	All external infrastructure shall be implemented by relevant state and/ or central govt. entities based on the jurisdiction of the project
Co- ordination and monitoring of external infrastructure	INCAP has been proposed as nodal agency for co- ordination & monitoring of external infrastructure. Monitoring such project status shall be conducted by the State Economic Board and the Central level Monitoring Cell
Land lease/ sale within the node	The Node PDC (Master Dev SPV) is responsible for all land transactions within the node
Provision of statutory function and services within the node	The Node Authority will be responsible for provision of statutory functions within the node. The Node Authority may delegate provision of certain functions such as garbage collection etc to the PDC, for which it may suitably share taxes/ provide fixed fee for provision of such services
Collection of user charges/ development charges	The node PDC is responsible for collection of development and user charges at rates/ tariffs determined based on consultations with the Node Authority & as approved by the State Economic Board

11.5.2 *Financing Framework*

Two options for financing framework have been considered for CBIC development in Andhra Pradesh. First option is similar to current practice in DMIC and incorporates recommendations of NICDA. The second option incorporates alternate suggestions provided during stakeholder consultations with DMIC states and JICA.

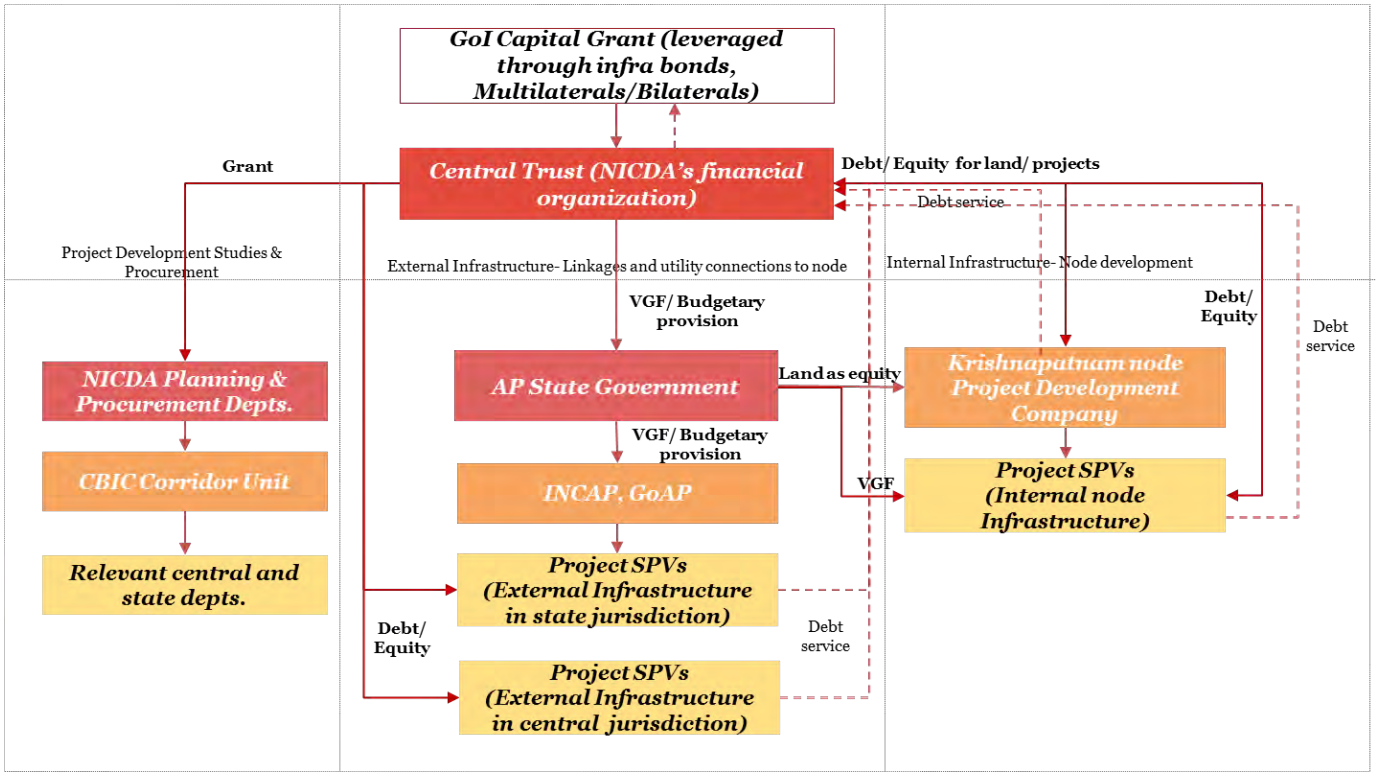


Figure 11.6: Option 1- Financing framework for CBIC in Andhra Pradesh

Key features of proposed financing framework:

- **The first option is similar to existing fund flow mechanism under DMIC. All fund routing is through the Central Trust (Financing arm of NICDA).**

  - NICDA undertakes centralised project development and advisory studies through self or through relevant central/ state government entities for critical external infrastructure projects for CBIC. For conducting the same the Central Trust provides grant to NICDA project planning and advisory department which is then routed to different central/ state entities as applicable.

  - NICDA can route funds for external infrastructure within central jurisdiction to relevant central govt. entities (as VGF/ Budgetary provisions) or as Debt/ Equity directly to Project SPVs

  - For external infrastructure within state jurisdiction, funds can be routed to the designated state nodal agency, namely INCAP, GoAP, from where it may be routed to relevant state departments (VGF/ Budgetary provisions). Again, NICDA may also choose to directly invest into project SPVs (both internal & external infrastructure) in the form of Debt/ Equity.
  - For the development of the node, GoAP's equity contribution in the Krishnapatnam node PDC, is in the form of land, NICDA's contribution may be in the form of Debt/ Equity, equity share capped at 49%, KPIL/ private sector equity contribution also to be capped at 49%.

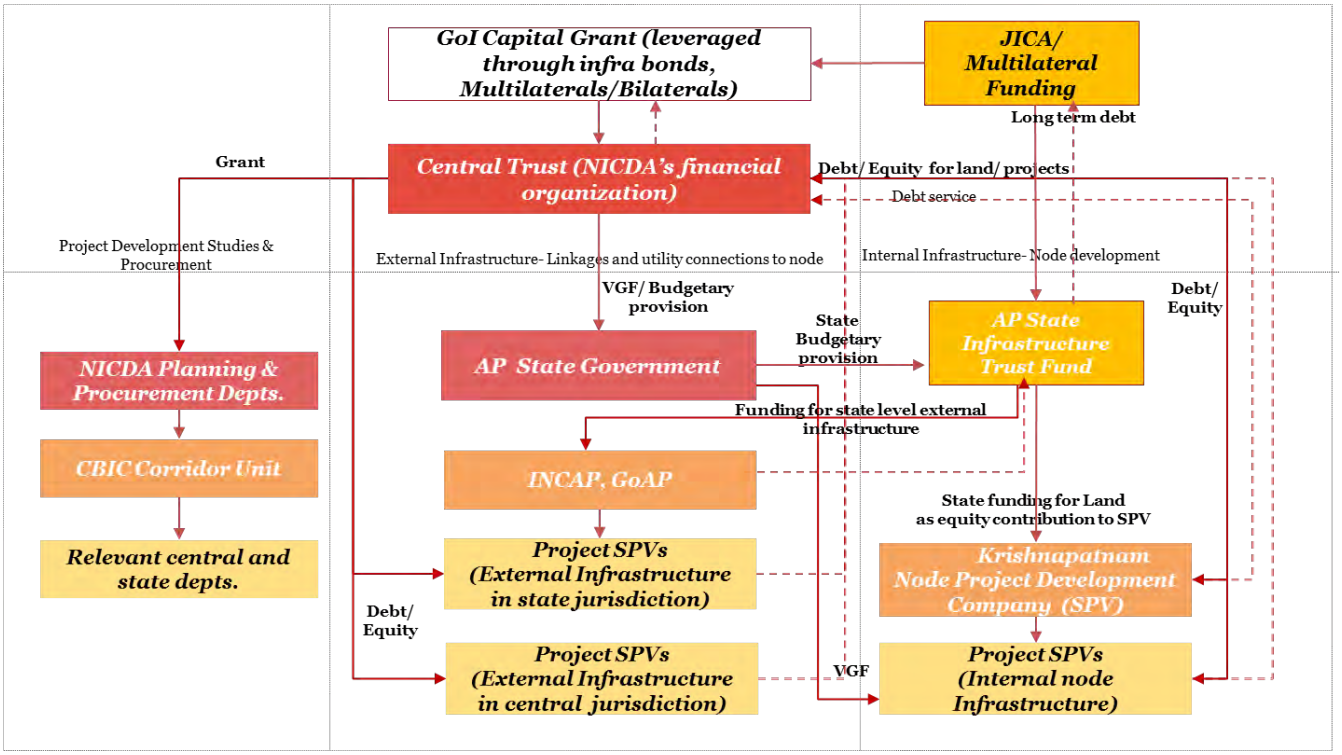


Figure 11.7: Option 2- Financing framework for CBIC in Andhra Pradesh

- In the second option, it is proposed that **JICA funding may be made available both at central level and state level**. JICA can directly fund the state through **creation of Andhra Pradesh state infrastructure trust fund or budget support allocation, such as a program loan**. This will enable direct fund routing from JICA to the state government for state implemented projects, while funding will be routed to the central government for projects implemented by central agencies.
- Close arrangement of project funding and project planning will enable an integrated development under implementing agencies, such as Ministries and State Government, under the coordination of corridor development authorities.

An initial round of discussions has been held with AP State Government (APIIC, Industries Dept., MA & UD) regarding the institutional and financing framework for Krishnapatnam Node and CBIC development in AP. Based on further consultations with DIPP and GoAP such framework will be finalised and presented in the Final Feasibility Report.

12 Investment Environment Improvement

12.1 Background

The strength and weakness of CBIC states was reviewed to assess their potential as a global investment destination in comparison with the rival countries/regions as well as investors' view on the ground. Recommendations were thus identified for the CBIC state to enhance the investment environment.

The quantitative analysis of Indian states and cities as well as the global competitors reveals that the positions of the CBIC states in the investment dynamism. This is followed by the qualitative analysis of the comparative advantages/disadvantages of CBIC to clarify the bottlenecks through the result of interview surveys to Japanese companies those already operating in CBIC on the ground.

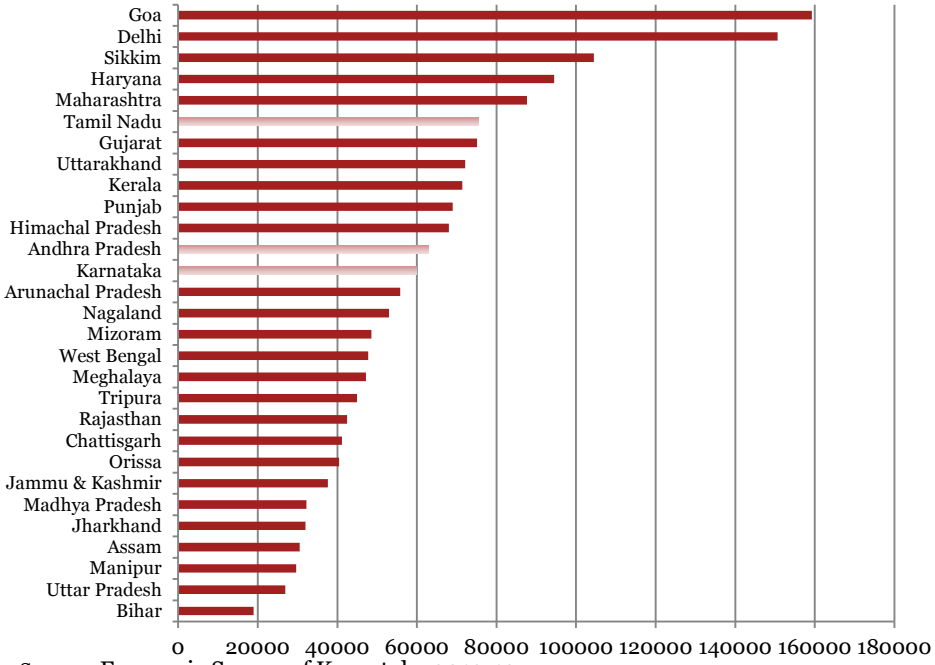
Based on the analysis, we adopted five key perspectives, infrastructure, land acquisition/building approvals, skill development, business process, and industrial park/cluster, to conduct benchmarking study across CBIC states and best practice state to highlight the area for improvements. We have also used the regional examples from South East Asia for benchmarking to indicate additional approaches for improvement. The private sector feedbacks analysis, from the in-depth interview with the companies who find hurdle in entering India, is also analysed to indicate further area of improvement for the CBIC state to become the key destination of the investment.

Focus of our recommendation hereafter is primarily on the five perspectives where the states have a strong role to play. Although we conducted benchmarking with regional competitors and took indication, the key focus area as a first step remains best practice from the India states and also the feedback from the private sector to make sure our recommendation are practical and ground in the realities in India.

12.2 CBIC state investment environment status

12.2.1 Quantitative analysis

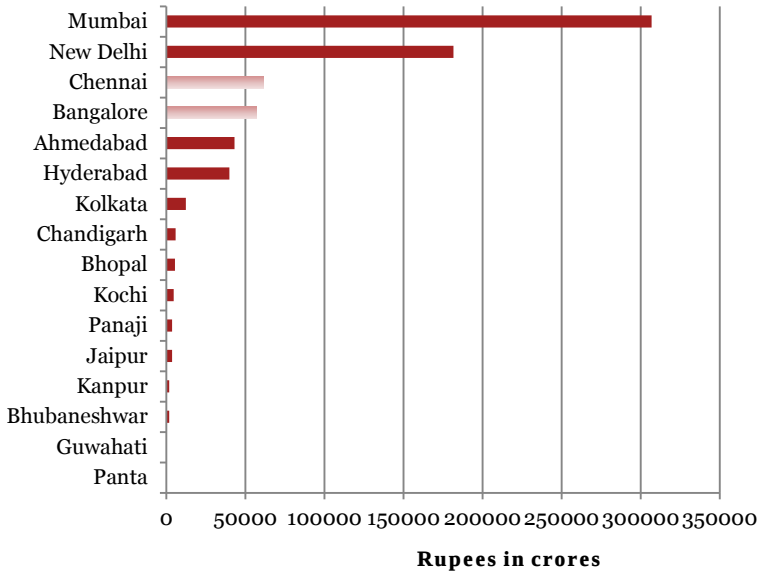
This section deals with "state" and "city" level comparative analysis for CBIC's investment climate. It defines CBIC as the accumulation of Tamil Nadu, Karnataka and Andhra Pradesh States at the state level, and Chennai and Bangalore at the city level. First of all, it goes through the data of per capita GDP in order to sense a degree of purchasing power of people in the market. In all states in India, Goa and Delhi States show good performance. It tends to be high in the states with major cities, and low in the states with large rural area. The three states in CBIC are included in the high score group. CBIC can be said as one of the promising markets in India, which consists of people who holds certain purchasing power.



Source: Economic Survey of Karnataka 2012-13

Figure 12.1: Per Capita Income at Current Prices (2010-11)

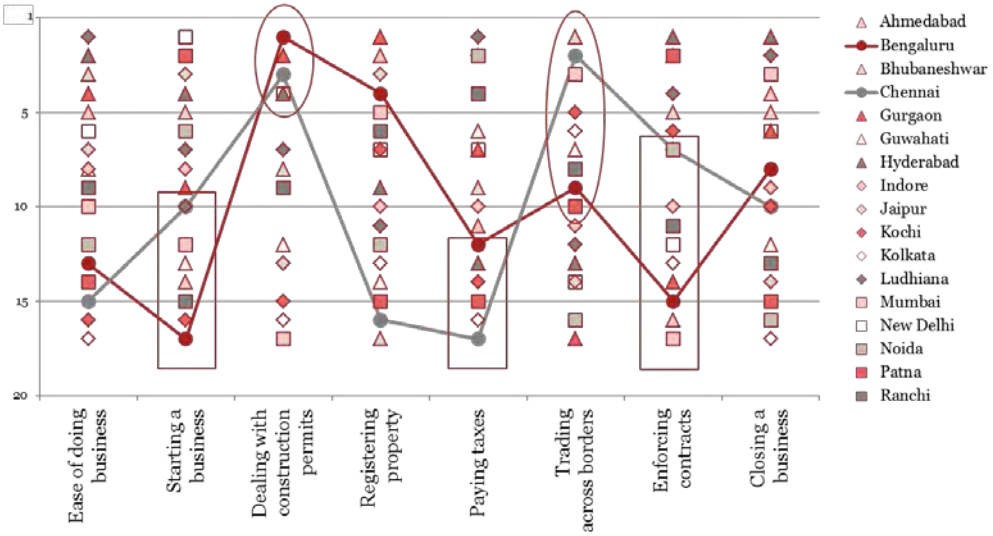
As to FDI inflow, Mumbai and Delhi show outstanding performance on the city level comparison. Chennai and Bangalore are following the top two cities, but Mumbai is collecting four times as much FDI as the two cities in CBIC. The total of two states in DMIC is three times as much as that of two states in CBIC. As a result, it can be said that CBIC can be evaluated as one of the promising global investment destinations, but currently lagging far behind the domestic rival, DMIC.



Source : GOI - FACT SHEET ON FDI
From APRIL, 2000 to NOVMBER,

Figure 12.2: Received FDI Equity (April 2000 - November 2013)

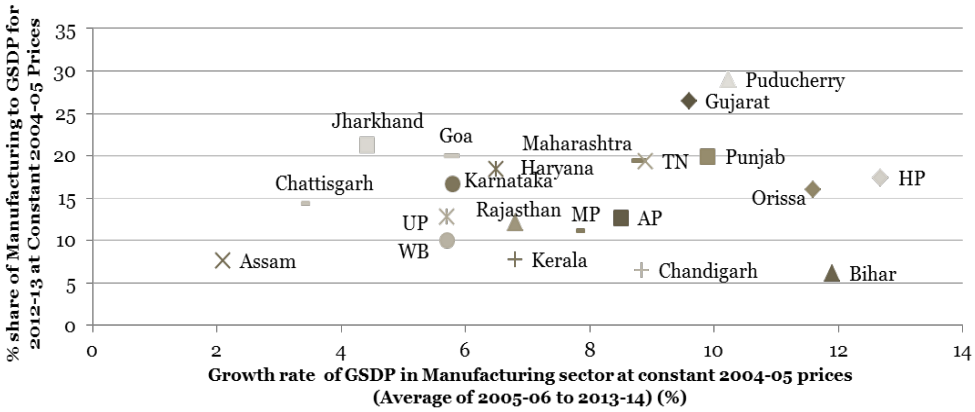
According to the investment climate survey of World Bank for 17 major cities in India, the two cities in CBIC are ranked at the lowest level in terms of ease of doing business, which means aggregate evaluation of investment climate. Chennai is placed in the 15th position. It is inferior to the other cities in the criteria of registering property and paying taxes. Bangalore is ranked at the 13th position. It has weakness in starting business, paying taxes, and enforcing contracts. While both cities receive high evaluation in terms of dealing with construction permits and trading across borders mainly thanks to the volume of construction works and import/export due to the rapid growth in infrastructure development and industrial clusters. (Please refer to Appendix for the details.)



Source: World Bank

Figure 12.3: Doing Business Ranking in India (Latest-2009)

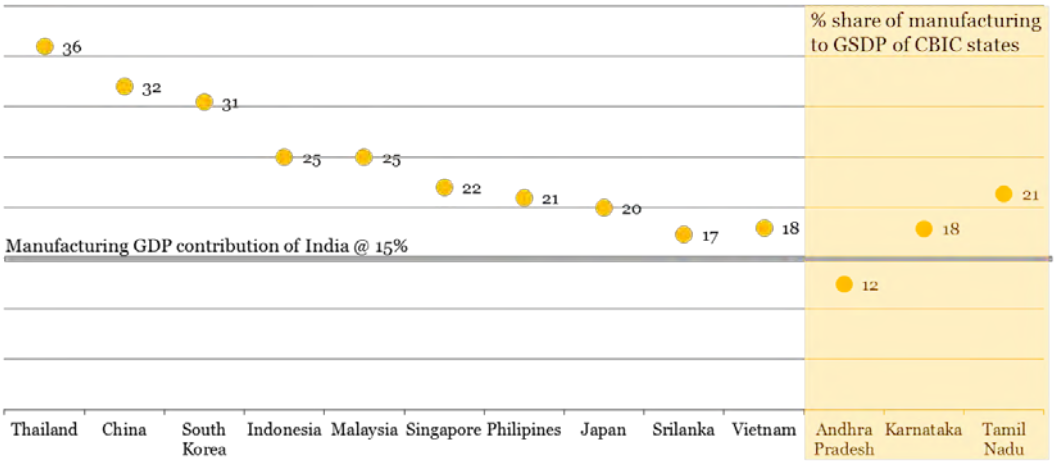
In addition, the manufacturing industry maturity of DMIC states, such as Gujarat, Maharashtra, Punjab and Himachal Pradesh, and Orissa and Puducherry, emerge as top performers at above India average levels. Among the CBIC region, Tamil Nadu is ranked in the top level, while Andhra Pradesh and Karnataka still have much to improve.



Source: http://planningcommission.nic.in/data/datatable/0814/table_64.pdf
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3600125/table/Tab1/

Figure 12.4 : Manufacturing industry maturity (2005)

Comparison among CBIC states and other Asian countries also vividly shows that CBIC states lag behind in the manufacturing industry development. The contribution of the manufacturing industry to GSDP is lower than South East Asia countries in all the state, highlighting the strong necessity of investment enhancement.



Source: Council on Competitiveness

Figure 12.5: International comparison of manufacturing GDP contribution (2010)

12.2.2 *Qualitative analysis*

Interview surveys to the foreign companies which have already penetrated in the CBIC region were conducted. This section describes the key advantages and disadvantages of the investment environment of CBIC from the investor's point of view.

CBIC's Comparative Advantages Attracting Foreign Companies and Investors

According to the survey result, major factors currently attracting foreign companies/investors to the CBIC region are as follows.

1. Formulation of Large Scale Industrial Clusters and High Technical Potential

The best advantage of the CBIC development for foreign companies/investors is future possibility of enhancing the global competitiveness through effective industrial clusters. Due to the presence of Indian national manufacturing as well as inflow of foreign investments, industrial clusters in the CBIC region are rapidly growing in these years. In addition, suppliers of parts and materials as well as skilled labours necessary for the industries' production activities have already been available to some extent, thanks to a unique history of India's manufacturing industry, especially, the automobile sector. In addition, in the future, the diverse industrial clusters will show synergy effects each other. For example, skilled suppliers and workers in automobile sector could potentially supply parts and materials for heavy industry or a part of electronics industry. Furthermore, core cities, Bengaluru and Chennai, locate close to key industrial parks and provide relatively finer living condition to foreign workers than the other regions in India.

2. Access to Entire Indian Domestic Market

The size of the CBIC's population, over 50 million, surpasses that of major Asian countries, such as Korea and Malaysia. The total population of three States in CBIC, i.e., Tamil Nadu, Karnataka and Andhra Pradesh State, is comparative to that of Indonesia, the most populated country in South East Asia. This tremendous market size and volume of workers are attracting foreign investors. In addition, CBIC locates along with the Golden Quadrilateral Highways which enable manufacturers to deliver their products not only within CBIC, but also to all over India. The accessibility to entire Indian market makes CBIC a promising production base for foreign manufacturing companies.

3. Promising Future Economic Growth

Despite the recent economic downturn, India has shown high economic growth trend over the decades as a leading player of world's emerging economies. Besides, three states of CBIC are showing higher growth trend than the average of India. The growth rate is often proportionate to production or sales of industries. According to an empirical analysis of automobile industry, the growth of per capita GDP tends to proportionate to the growth of automobile sales. Given the experience in China where the sales of vehicles surpassed 20 million recently, it is said that the auto sales of India may surpass 10 million within next 10 years. It is crucial for foreign investors whether they have a production base in such a region when the market has grown the size.

4. Location Merit as a Potential Global/Regional Hub - Access to Asian and African Regional Markets

The East end of CBIC faces a coastline stretching over Andhra Pradesh and Tamil Nadu States, where four ports are in operation. CBIC's comparative advantages for foreign investors considerably owes to the location merit which offers easy access to both Asian and African growing economies. Furthermore, CBIC holds one domestic and two international airport in the region. The large evacuation capacity enables foreign companies to consider CBIC as a hub of their global and/or regional value chains in their long term strategy. Indeed foreign manufacturers in the CBIC region have already started exporting their products to all over the world, including Asia, Africa, US and European countries.

5. Low Labour Cost

Middle income countries which used to attract global investments are currently facing severe increase of average wages. For example, the minimum wage in the Jakarta city in Indonesia has increased in 44% from last year. The average wages are rapidly increasing also in Viet Nam, Malaysia and Thailand in these years. The increase of wages leads to increase of whole production costs and suffers foreign manufacturers operating in the region. Relatively small wage increase rate in India is strengthening CBIC's global competitiveness.

6. Proactive Investment Promotion by the Government

In 2002, the Indian Government allowed foreign companies/investors to operate their business in India with a ratio of 100% Foreign Direct Investment (FDI). The difference between India and China, where the ratio is 50%, is considerably enhancing global competitiveness of CBIC. Moreover, the Indian and the CBIC's three State Governments are positive to further invite foreign investors and continue dialogues with many foreign partners.

CBIC's Major Difficulties Alienating Potential Foreign Companies & Investors

When foreign companies/investors make a decision on an investment destination, they need to pick up one or some of regions from numbers of other options. Although they carefully check the risks and chances through various methodical ways, the result of decision is made with consideration of (i) higher competitiveness than other states and (ii) cost competitiveness with industrial accumulation areas. In order to meet the above conditions, establishment of external or internal infrastructure and development of institute, lands and human resources for industrial accumulation areas like industrial park/cluster should be considered.

The CBIC region, currently known as a part of Southern India including Chennai and Bengaluru, is regarded as the promising investment destination. However, there is another negative reputation as the "risky" and/or "unprofitable" region, due to gaps between the global fame and reality on the ground. Based on the interview with foreign companies currently operating or intend to enter India, we describe the key difficulties for their business.

1) Challenges of Infrastructure Bottlenecks

There are challenges of infrastructure bottlenecks inside and outside the industrial areas. As to the transportation sector, essential improvements needs to be addressed, e.g., mid-long term road planning, construction of access roads to main roads and major port, establishment of management system for freight

railway and loading points, and enhancement of overall operation of major ports. Similarly in the power sector, chronic shortage of electricity should be solved through development of comprehensive electricity supply and demand plan.

Key feedback from the foreign companies

1) Power

- "The chronic shortage of electricity is causing difficulty in production, e.g., restrictions on the use of electricity, planned as well as frequent unexpected outages."
- "The shortage of electricity supply forces companies to make downward adjustments to their production plan. The frequent unexpected outages will abruptly stop production lines and produce a large number of defective products. "
- "The companies will have no choice but to introduce privately-owned electrical power facilities for avoiding this situation, but the burden would be large considering that this would require large investments and the electricity cost would be around twice the ordinary charge."

2) Port

- "The cost for usage of some ports is more than twice that for other ports in India, and over 5 times the international level. Further revision of port charge is necessary."
- "The gate through which the trucks can enter the port for receipt and delivery is very limited. A security check is conducted at the gate on the trucks one by one, and the line of trucks waiting to enter reaches several tens of kilometres. A vicious circle where trucks cannot enter the Port, cannot receive the load, and ships are waiting in line to discharge their load."
- "Logistics problems frequently occur at ports, especially at Chennai Port. Due to lack of organized and integrated regulation or guidelines, rules of mandatory submitting documents and licences for clearance are often changed suddenly by orders of clearance officers at the port. Also, there are numbers of local rules and regulations in each port/airport which are not officially enforced by the Government. Some foreign companies are feeling the human cost and time for port clearance in CBIC region takes 10 times as much as that of Singapore."

3) Road

- "In some area in CBIC, the constructions of roads connecting industrial parks are yet to be built and the smooth distribution of parts and materials from the assembler to the supplier is an issue. Logistics activities between affiliated companies are facing serious inefficiency"
- "The delay in the construction of an access road in the area surrounding main ports, the gateway to CBIC, is impeding business operations in the entire CBIC region. Large traffic jams caused by the delay makes cargos arriving late. An accurate lead time cannot be estimated. "

4) Water and sewage treatment

- "Although water connection exists, there isn't sufficient water. In some cases, companies have to have their own bore wells for commercial and residential purpose."

2) Insufficient land acquisition and building approval process

Land availability and building approval are always major bottlenecks in starting business in India. The process requires time and effort, and delay in land allotment affects the schedule of projects in terms of time taken from conceptualization to production. The problems mainly relevant to the land acquisition are the scarcity of the land itself and the lack of transparency of the land allotment process

Key feedback from the foreign companies

1) Land acquisition

- "When serious problems occur on land acquisition in industrial park, private company has to solve by taking all responsibilities."
- "Within one or two years, additional land acquisition might be necessary, but all issues in the investment approval process would be the hindrance to make a decision on new investment, even though they are confident in the increase of demand along with the market growth."

2) Land allotment

- "Unfair allotment is caused by lack of the personal relationships with the authority of land allotment. In such case, it would be only fair to ask government to interfere and deal with land allotments for a more fair allotment process."

3) Land information

- "Information on industrial park is closed and difficult to know for potential investors unless they have connection with the Government officials."
- "Expansion of plant was very tedious process due to lack of land availability and information on land availability. Government should take initiatives to improve the land related information to investors."

3) Low availability of the skill development system

India is characterized by the high quality labour pool in comparison with the other emerging markets and each state has implemented various approaches to enhance it; nevertheless, the pace of the demand growth overcome the supply speed, and many of the business entities suffers from the shortage of quality labour. Also, as the India has positioned itself as the leading nation in the global community, the needs to incorporate gender equality into the labour development rises takes momentum, requiring more comprehensive approaches to the skill development.

Key feedback from the foreign companies

1) Skilled Labour

- "Quality of skilled labour is very poor. They need training but companies except big companies like Toyota, do not have the capability to train them. Hence the quality at institute or college level for Industrial Training Institute (ITI) students should be improved. This can be supported by Government by providing some grants to bring in machines for training such as a turner or a CNC machine at the institutes /colleges. "
- "Although the government is taking some actions like establishing training institutes, skilled labour availability is low. People do not show interest in getting trained in different skills."
- "White collar professionals prefer Bangalore to Tumakuru. It is difficult to retain them."

2) Labour law

- "Labour laws are extremely favourable to workmen, which makes it hard for employers to take suitable actions at a certain situation. Employers do not have any liberty to lay off any labour even though his/her performance is not satisfactory with the work."

3) Labour union

- "There are union issues. These are more majorly because of interface of villages from surrounding areas. Shut down is caused by union issues."

4) Business Process

Concerns were raised with respect to the time and investment that goes into negotiating with line ministries to get permits while starting the business. Although many of the states set up Single window agency to facilitate the business process, many foreign companies have shown low satisfaction for their service; after all, the companies need to conduct multiple visits to various ministries and go through various process to obtain the approval.

Key feedback from the foreign companies

1) Permitting Process

- "A company must submit various applications to the State Government when penetrating the market, but the process is enormously time consuming. For example, when constructing a plant or an office, a declaration will be made on the environmental impact of the business and construction works which will require assessment by specialist as needed. In many cases, this process takes 3-4 months on average."

- "Application process and instruction on submission of required documents were clear. However, Single window clearance system was not effective and not practical at all. Clearance certificate is not considered seriously and one has to go behind each line of departments to obtain utilities and approvals."

2) MSMEs

- "Although the states give MSMEs the preferential treatment with incentives and subsidy, MSMEs takes much more time to obtain approvals than major companies. The requirement and difficulties MSEMs hold should be considered."

5) Lack of Readiness of Industrial Parks

The quality of the industrial park in the CBIC region is far from an average industrial park in the international standard. Due to the low quality, the foreign manufacturers newly invested in CBIC are facing serious problems, e.g., shortage of water, lack of stable power supply, delay of planned road construction, and deferral of the Government permission. In some cases, they even encounter the situation that land allocation and acquisition is not completed even after starting construction of the facilities on the allotted land. Moreover, in order to solve the problem, they have to negotiate with each line ministry though highly ambiguous and time consuming process. This happens partly because many of the industrial parks in CBIC are still under public operation. While successful industrial parks in the world were operated by private developers.

Key feedback from the foreign companies

1) Operation of Industrial Parks

- "At many of industrial parks in CBIC, the tenant must build and maintain by themselves basic infrastructures such as water, electricity, draining facilities and surrounding roads. An agreement on the construction of infrastructure between the tenant and the Governmental corporations managing the industrial park was not realized in many cases in the past."
- "Application process and instruction on submission of required documents were clear. However, Single window clearance system was not effective and not practical at all. Clearance certificate is not considered seriously and one has to go behind each line of departments to obtain utilities and approvals."

2) Access Roads from Industrial Parks to Main Roads

- "Main roads and industrial parks are not effectively connected in the CBIC region. Since many of the access roads are unpaved and damaged, the worsened traffic jam does not allow vehicles to travel in an ordinary manner. Even if a national highway (NH) is constructed or expanded, the lead time between industrial parks and ports will result longer without the effective access roads which connect the NH and industrial park. "

3) Roads inside Industrial park

- "Construction of roads within industrial parks is insufficient. In particular, difficulty is found in carrying heavy loads. The construction of roads within industrial parks is initially responsibility of the state's public development corporation. However, in many cases, the progress is slow. "

4) Regulations

- "According to the current Indian environmental standard, metal plating and coating industry are categorized as "Red" industries. The category creates a hurdle for them to construct a factory near Chennai and Bengaluru. It makes automobile industry difficult to form complete cluster in the CBIC region. "

12.3 *Analytical framework*

Through the consultation and interviews with private sectors and past published research, it became clear that a range of issues as well as measures taken by the states have been identified. Out of the result, we adopted five perspectives as the key factors for the investment environment improvement, which are strongly advocated by the private sectors; "A. Infrastructure", "B. Land Acquisition/Building Approval", "C. Skill Development", "D. Business Process" and "E. Industrial Park/Cluster" .

Perspectives	Voice from the foreign companies
A. Infrastructure	• "We suffer from the blackout during the operation time; to avert the risk we purchased self-generation, which has caused the significant cost up" • "Unless the company has the prioritized channel to the power supply from the state or other authority, it needs to have its own power facilities, resulting in way higher cost than the local competitors"
B. Land acquisition/ building approval	• "Land acquisition is always the blocker for the business development". Without the clear system and procedure in the acquisition, we cannot take risk of investment. • "For the city development, the authority need to take top down approach to acquire land. Gujarat seems to make success with the strong leader"
C. Skilled Labor	• "We are short of the good quality labor at the local factories. Even though the state governments provide the vocational school, the quality does not meet the standard from the foreign companies" • "The labor law is too complicated that the labor management is difficult"
D. Business process	• "We plan to build a power plant , but the registration process takes much time as well as requires a significant amount of man power" • "Each state has different business process; even in one state, we had tough time to understand and reach to the key stakeholders. Unless the business process becomes simplified and transparent , we do not intend to go to other states"
E. Industrial Park/ Cluster	• "Industrial park as well as clusters need to be established as the hub of the growth ; especially Chennai has been successful in establishing automotive hub. Other state can learn from it" • "Internal and external infrastructure need to be built up for the good quality of industry cluster"

Figure 12.6: Feedback from private investors

With these five perspectives, we conducted three dimensional approaches to identify the issue relevant to the investment environment improvement, and identify the indication for the CBIC states;

1. **Benchmarking among CBIC States and best practice in India**
2. **Analysis of the South East Asia**
3. **Feedback from foreign private sectors**

As for the benchmarking among the India, we compare the CBIC states with best practice state in India to understand the status of the each state as well as the key initiative taken by the best practice state. For the second, we also apply the five perspective analysis to the regional competitors, such as Singapore, Thai, Indonesia, and Vietnam mainly to identify indication for the policy. The private sector feedback is also analyzed to build recommendation; the request from the foreign companies sometimes lack feasibility or practicability from the India perspectives, but it surely provide insight for CBIC to overreach the top level of investment destination.

12.4 *Analysis*

12.4.1 *Benchmarking among CBIC states and best practice in India*

In this section, the CBIC states and best practice are compared in quantitative and qualitative view based on various information sources. For each perspective, the analyses use multiple parameters relevant to the perspectives to compare the performance of the states and lead to the key indication. The best practices of each perspective are selected based on the quantitative analysis and consultation with various stakeholders.

Infrastructure

This section covers power and port as infrastructure, which are often raised by the private sectors as major bottlenecks regarding the infrastructure.

1. Power

Efficient power supply is essential for the growth of industry and can be done by the provision from not only power authority but also private sectors. Although each state of CBIC region has made effort to improve the power supply, only Andhra Pradesh has achieved substantial improvement over the past 6 months.

The JST has benchmarked power related aspects of CBIC states with Gujarat against two dimensions - availability and tariff

Availability and Tariff

Gujarat has achieved almost zero energy and peak deficit and no power cuts observed by industries and has the lowest industrial power tariff. On the other hand, Karnataka and Tamil Nadu have persistent energy/peak demand deficit last year and mandatory power outages. Power supply positon in Andhra Pradesh has improved substantially over the past year. For the past 6 months it is able to meet peak demand and registered the lowest deficit among other CBIC states.

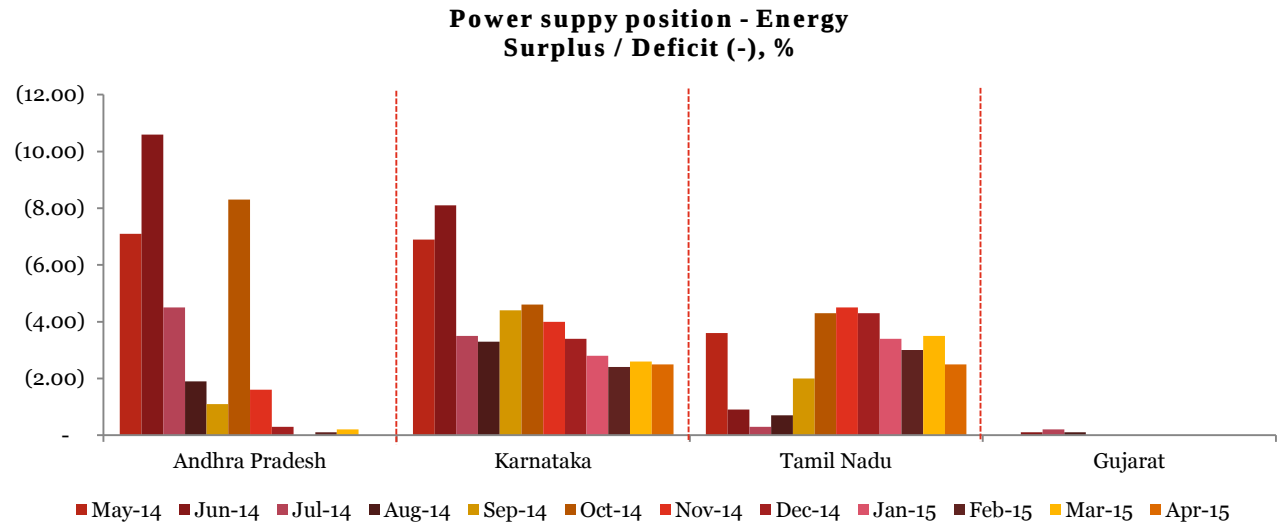


Figure 12.7: Power supply position (Energy), CBIC states vs Gujarat

Source: CEA

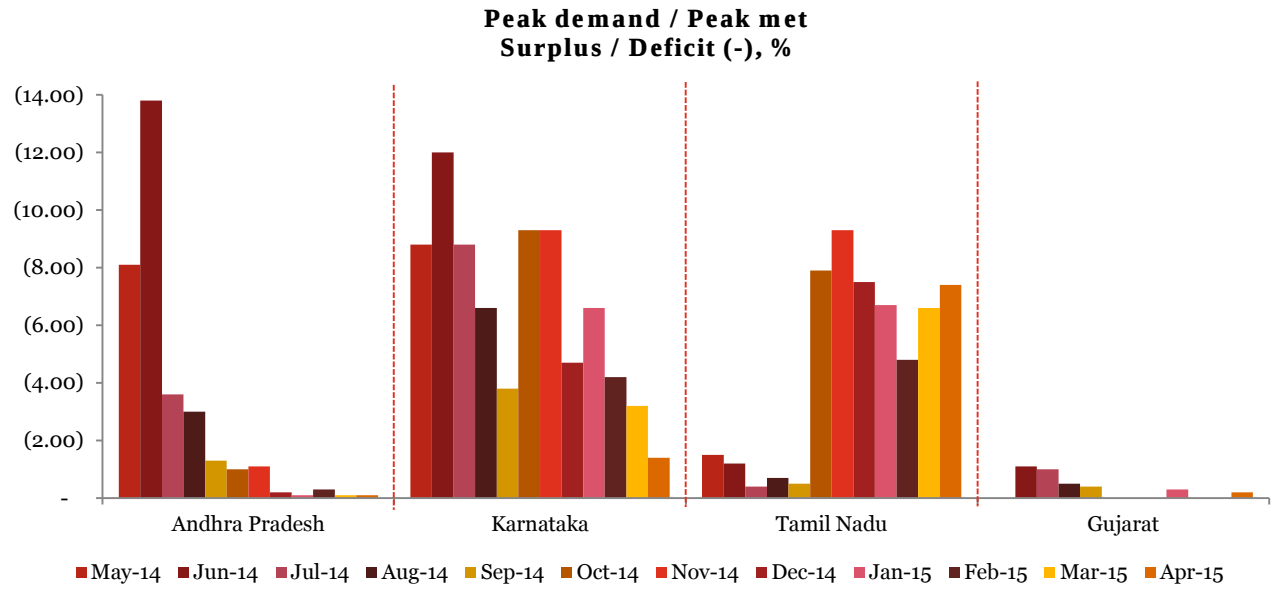


Figure 12.8: Power supply position (peak demand met), CBIC states vs Gujarat

Source: CEA

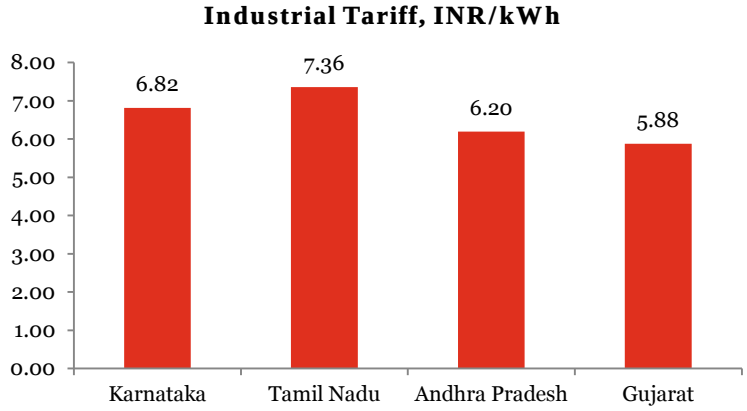


Figure 12.9: Industrial electricity tariff, 2014-15

All CBIC states have open access regulation as well as renewable promotion regulation. CBIC states have taken a leap in renewable energy promotion. Installed capacities are above the benchmarked state of Gujarat with Tamil Nadu in the leading position.

However, Gujarat has taken step further; in Gujarat, the independent demand side management is made and independent feeders for consumers come to the forefront due to the ease of doing business. Gujarat is also implementing the largest solar project in India and targets the energy generation through renewable sources to be 10% of the total energy generation by 2019, and 100% of HT consumers are on smart metering, leading to loss reduction for utilities.

Having utilized private sector participation in electricity generation, Gujarat leads among benchmarked states; all CBIC states have almost equal share of IPP installed capacity in total electrical installed capacity.

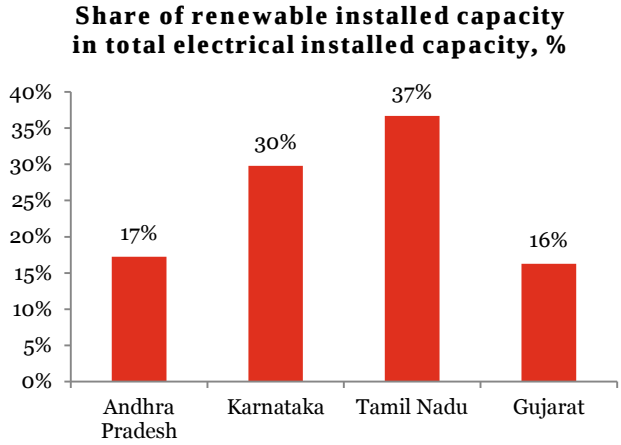


Figure 12.10: IPPs installed capacities

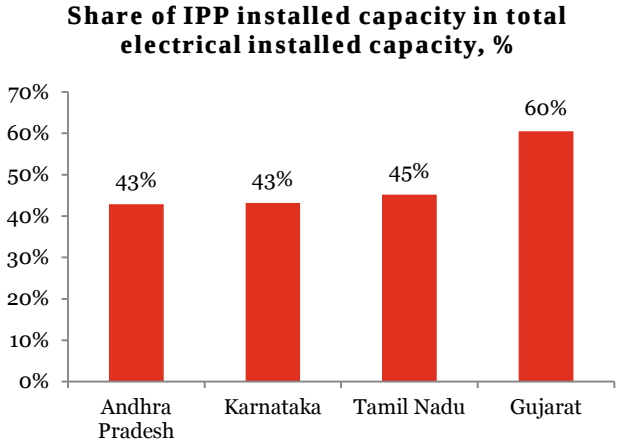


Figure 12.11: Renewable energy installed capacities

Port

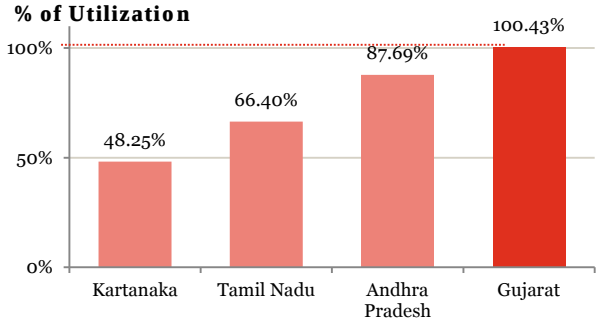
Smooth port operation serves the increase of trading volume and then development of industry in the area. We utilize two key perspectives, utilization and non-major port policy to delve into the CBIC state performance.

1) Utilization

All states have own Port Policy to achieve various purposes such as to increase its share and cargo volume, then expanding the utilization, which is calculated by the cargo volume per its capacity. Gujarat has Kandla as a key Major Port with fairly high utilization, resulting in the overall highest utilization ratio. Andhra Pradesh has

Visakhapatnam as a Major Port with high utilization. Tamil Nadu has three Major Ports, Chennai, Ennore and Tuticorin with fairly high utilization. Karnataka, despite that it has two Major Ports, New Mangalore & Karwar, is characterized by low utilization.

According to ease of doing business study by World Bank, cross-border trading in all CBIC states takes longer time if compared with best practices in India and South East Asian countries.



Source: Basic Port Statistic of India (2012-2013)

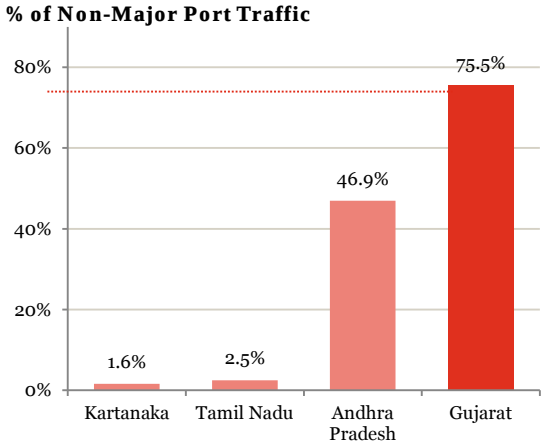
Figure 12.12: Port Utilization of a Major Port in each state

It has been identified by private investors that logistics issues frequently occur due to lack of organized and integrated regulations or guidelines, especially at Chennai port. Several stakeholders from foreign countries have identified that the human cost and time for port clearance in CBIC region takes 10 times as much as that of Singapore, indicating that there are areas for the improvement in operation.

2) Non-Major Port

The traffic of the Non major port differs much among the state. Gujarat established Non-Major Port Policy and Schemes implemented through Gujarat Maritime Board. This has driven the development of Non-Major Ports. Also since the existing major ports are under tremendous pressure to handle the increasing cargo traffic, causing demurrages and huge loss in foreign exchange, Gujarat set the policy to decongest the overburden on existing major ports on Western India by providing efficient facilities and services and to support the country's domestic and international trade.

Other state lagged behind and still set the government agency the key operator in all the ports. In Karnataka, traffic of Non-Major port is the lowest and also Tamil Nadu's traffic is low well. If CBIC states aim to deal with the increasing cargo volume, they may have to change the entire Non-Major Port scenario.



Source: Basic Port Statistic of India (2012-2013)

Figure 12.13: Non-Major Port per Total in Traffic

Table 12.1: Port Summary

	Karnataka	Tamil Nadu	Andhra Pradesh	Gujarat
Major Port (mn tons)	237.04	399.55	159.04	193.62
Non-Major Port (mn tons)	110.61	150.93	1251.81	41287.82
Traffic (mn tons)	37.75	100.48	110.85	381.44

Source: Basic Port Statistic of India (2012-2013)

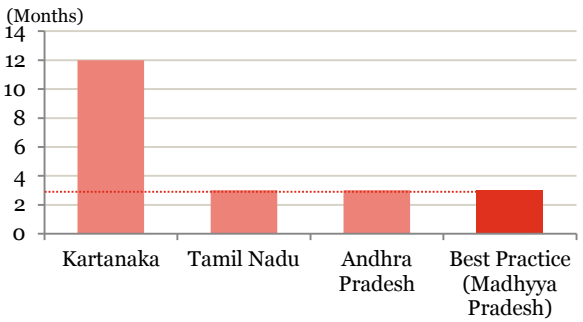
Land acquisition/building approval

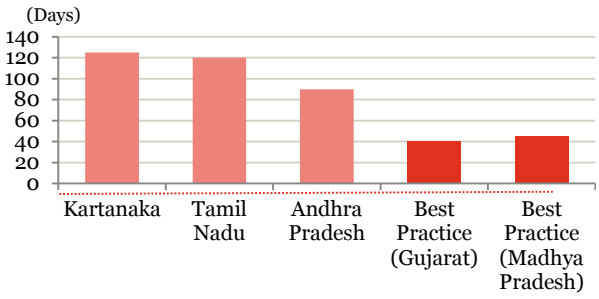
Land acquisition/building approval procedure is compared through two key questions; how much time is taken for the procedure and whether the land acquisition policy is explicitly established. As for the former question, we set three quantitative parameters to compare the maturity of the procedure in CBIC and best practice states; duration of land allocation, land conversion and approval for building plan. For the latter, we examine the policy of each state and highlight the difference

1) Duration for Land allocation, Land Conversion, and Approval for the building plan

Time required for the allocation of the land for the industry vary depending on the state. In Madhya Pradesh, it only takes 90 days. Andhra Pradesh has promoted computerization & integration of all land records is and shortened the time required for the process to 90 days. The initiative has taken further momentum as part of the Bhu Bharti initiative.

It also takes time to go through the process and obtain approval to convert the land for agriculture to land for industry. Gujarat and Madhya Pradesh, as the best practice states, have made process simpler and reduced the duration to around 40-45 days. Andhra Pradesh also has succeeded in simplifying the process to 90 days under the APIIC's guidance. However, in Karnataka, though land acquisition process is established, the service to ameliorate the land acquisition is still not sufficient, that it takes longer time than other states.

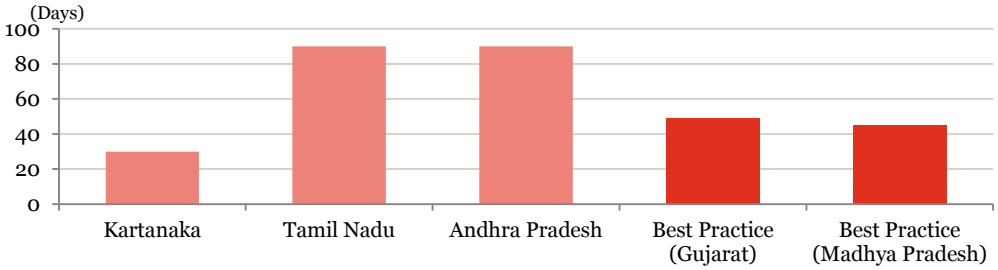




Source: Survey on business regulatory environment for manufacturing, FICCI report, DIPP website

Figure 12.14: Duration for Land allocation **Figure 12.15: Duration for Land conversion**

Online approval and tracking system has made the process simpler and reduced the time taken to 34 days in Madhya Pradesh. Karnataka has built CAD based online system which help the builder go through the entire process and shorten the time required to around 30-40 days. However, in Tamil Nadu and Andhra Pradesh, building approval takes longer time than the other states. Although the online system is already functioning, the usability is reported to be sill not sufficient.



Source: DIPP

Figure 12.16: Duration for Approval for the building plan

2) Land acquisition Policy

All the CBIC state has established the land acquisition policy along with the designated authority, such as KIADB, SIPCOT and APIIC, and provided support to the land acquisition.

However, Gujarat differentiates it from other states by providing more comprehensive support to the land related process; scientific determination of market price through tie –up with academic institution, extensive information on land characteristics from online portal including availability of land, gas, power, distance from port/airport etc, SEZ, Real time land data availability; grievance redressal system of land related issues; and land bank system. Madhya Pradesh also has made continuous approach to simplify the process to reduce the land related legal cases.

In Andhra Pradesh, land bank is available but only information on vacant plots is in public domain and no clear picture on land acquisition status. In addition, it is difficult to acquire land due to new land acquisition act.

Also, in Karnataka, information on the land is not enough for the investor, and the investors need to approach KAIDB to get the information and select the locations out of options KIADB has given. And Existing Land Portal, Kaigarika Bhoomi is not updated regularly, not providing up-to date information. There is not land pool system operating. In Tamil Nadu, land related information is still not easily accessed.

Table 12.2: Land Acquisition Policy

Category	Karnataka	Tamil Nadu	Andhra Pradesh	Best Practice (Gujarat)	Best Practice (Madhya Pradesh)
Authority	· Karnataka Industrial Areas Development board (KIADB)	· SIPCOT	· Andhra Pradesh Industrial Infrastructure Corporation (APIIC)	· Gujarat Industrial Development of Corporation (GIDC)	· MP government takes initiatives
Land acquisition related support	· Land can be obtained by three methods; from KIADB, partial KIADB, and Direct acquisition	· Apply for SIPCOT; Sign an MOU with the TN government	· It assist owner in 4 ways: allotment from existing land banks, industrial parks, government land, and private land	· GIDC provides land banks so that entrepreneurs can acquire land speedy; other support includes, Scientific determination of market price through tie –up with academic institution, extensive information on land characteristics from online portal including availability of land, gas, power, distance from port/airport etc, SEZ, Real time land data availability; Grievance redressal system of land related issues land bank system	· The new policy endorsed in 2014 makes the process clearer to reduce legal case.

Source: Survey on business regulatory environment for manufacturing, FICCI report, DIPP web sit

Skill Development

According to the feedbacks from private sectors, a lot of enterprises have not been satisfied with the infrastructure of skill development, and requested the re-building of the policies. Skill development can be measured based on three levels; individuals/skilled labours, gender and R&D. With regard to individuals/skilled labours, educational /vocational initiatives and the number of higher education institutions and vocational training infrastructure are counted, and as for gender and enterprises, the policy for gender support and research and development are compared respectively.

1) Individuals/skilled labours

Each state established the initiatives to proceed with the skill development and institutes with the various curriculums have been developed. In terms of the number of such institutes, it is difficult to compare the status among the states considering the differences in population, land area and the number of students per institute.

In Gujarat, as a best practice, Gujarat skill development mission has driven the skill development through various channels such as establishment of anchor institution, extension of training institution from SEZ and development of short term bridge course through PPP.

Andhra Pradesh initiated Rejiv Yuva Kiranalu to provide skill based training and employment to the youth and private sectors are involved for further trainings. However, skilled labour is still not enough because sector specific training institutions still do not meet some criteria and the curriculum followed by educational institutions does not much the skill level of labour. Additionally, it is prevalent in Karnataka that the skilled labour is not sufficient due to the not-enough quality curriculum. Private sectors in Tamil Nadu stated that the number of vocational facilities is quite high but still need to be developed to meet the demand for skilled labour.

Table 12.3: Initiatives for Skill Development

Karnataka	Tamil Nadu	Andhra Pradesh	Best Practice (Gujarat)
· Karnataka Vocational Training & Skill Development Corporation (KVTSDC) was established.	· GoTN has established the Tamil Nadu Skill Development Mission (TNSDM) as a joint effort between the public sector and the private sector	· Rejiv Yuva Kiranalu is initiated by AP Govt to provide skill based training and employment to the youth · NSDC training partners are established: Britti Prosikshann, Centum WSI etc; the partners have 63 centers in 22 districts with almost 60K students trained	· Gujarat skill development mission has driven the skill development initiatives through various channels.

Source: Survey on business regulatory environment for manufacturing, FICCI report, DIPP web site etc

Table 12.4: The number of Higher Educational Instituted and Vocational Training Infrastructure

		Karnataka	Tamil Nadu	Andhra Pradesh	Gujarat
Higher Educational Institution	Polytechnics Engineering	289 187	351 491	263 707	-
	Others	-	Art & Science college: 633	MCA: 644 MBA: 926 Pharmacy: 290	University/College: 489 Private: 605
Vocational Training Infrastructure	ITIs + ITC	1,488	1,747 (Government IT: 62)	775	816
	Others	-	Industrial school: 933	Women: 25 Polytechnic: 251	VTPs: 575 Private: 69

Source: National Skill Development Corporation (NSDC)

1. Gender Support

All CBIC states have each Industrial Policy for women entrepreneurs. Andhra Pradesh, Tamil Nadu and Gujarat will provide subsidy and skill development programs for women entrepreneurs. Especially, in Tamil Nadu, subject to the related labour laws and the parameters of the Industrial Employment (Standing Orders) Act, 1946 (Central Act 20 of 1946) , flexibility in employment conditions including flexible working hours for women and shorter and longer duration of working hours, 24x7 operations (3 shifts), employment of women in the night shifts and flexibility in hiring contract labour will be permitted

2. Research & Development

Technology is a key element for the increase of competitiveness and acceleration of innovation. All CBIC states encourage enterprises to proceed with Research & Development in Technology with subsidy and fund. However, Gujarat, as a best practice, not only provides financial support but also facilitate to set up R & D institution and promote co-work with universities.

Table 12.5: Policy for Research & Development

Karnataka	Tamil Nadu	Andhra Pradesh	Gujarat
Karnataka is one of the top five states in India in the area of R&D spending Minimum Two R&D centres per annum will be promoted and Technology Development Fund of '100.00 crore will be provided to assist for MSMEs.	The government encourages development of "Centres of Excellence and Innovation", which network with Angel Investors and Venture Capitalists to provide mentoring and financial support to start-ups. For capital goods to be used in setting up hi-technology R&D centres, VAT would be zero rated.	Andhra Pradesh has more than 50 prestigious and central and state R&D laboratories · Cellular and Molecular Biology · Centre for DNA Fingerprinting and Diagnostics · -Indian Institute of Chemical Technology -National institute for Nutrition · International Crops Research institute for the Semi-Arid-Tropics (ICRISAT) · National Geophysical Research Institute (NGRI). - The necessary budget for Technology Development Fund has been provided.	Incubation Centres associated with Universities and Management Institutions will be promoted to encourage research/inventions in to industrial project.

Source: Industrial Policy in each state

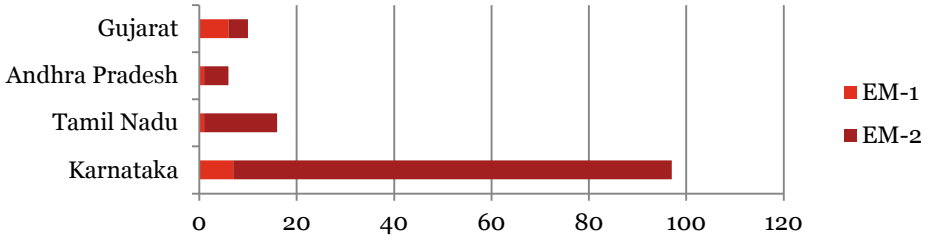
Business Process

In India, business process has been reputed as complicated and taking a considerable time in some states. With the state government effort, there has been significant improvement in the business process of CBIC states. However, some of the foreign companies still require the improvement to ameliorate the process and ease the investment. In a best practice, application of Single Window mechanism serves for attracting the investors. Registration process and single window mechanism are compared with best practice.

1. Registration Process

This point deals with the time and effectiveness of process for Entrepreneur's Memorandum (EM). Andhra Pradesh and Gujarat takes a short time for the approval. It is noted that Gujarat has an online monitoring system for entrepreneurs to catch up status, and help them take actions if any delay takes place.

On contrary, Karnataka, although it has an online registration and tracking system, still require multiple visits to the concerned departments. It is considered that the system itself is not well developed, that not many of the departments depend on the system to deal with the process. It also still takes time in investment application process of Tamil Nadu because investors have difficulties to know the status due to lack of system integration.



Source: Survey on Business Regulatory Environment for Manufacturing –State Level Assessment

Notes: EM means the initial registration required at central level, when an investor sets up an entity in India.

Figure 12.17: Business Regulatory Compliances for EM Registration

2. Single Window Mechanism

All CBIC states are utilizing Single Window Mechanism in order to simplify and shorten the process. Gujarat, as a best practice, has succeeded in deploying online system called Investor's facilitation portal (IFP) along with

hand-on support to business owners. IFP also provides the various services, information dissemination, facilitating and monitoring investment proposals, and supports business owner to obtain environmental clearance from GPCB.

In CBIC, Andhra Pradesh established the State Investment Promotion Committee (SIPC) as a single window under Single Window Clearance ACT 2002 and SIPC provides information on doing business easily available online. However, some key procedures are not included in the Single Window mechanism like multiple and lengthy approvals, duplication of functions in the departments and licenses duplications. Karnataka may need to improve the application process, that it is reported that even with a window organization, such as KUM, the applicants need to take additional documentation work as well as multiple visits to various departments. In Tamil Nadu, since Single Window for MSMEs does not work well, it prevents from expanding industrial clusters.

Table 12.6: Single Window Mechanism

Category	Karnataka	Tamil Nadu	Andhra Pradesh	Gujarat
Single Windows	Yes, but still require multiple visit to relevant departments for follow up (Udyog Mitra)	Yes with multiple common applications	Yes (run by SIPC) established under state level approval committee (SLAC) to obtain fast track support to the large investment projects	Yes with investor's facilitation portal Also the fast track support to the large investment projects is provided
Time for approval	-	30 days	45 days	-

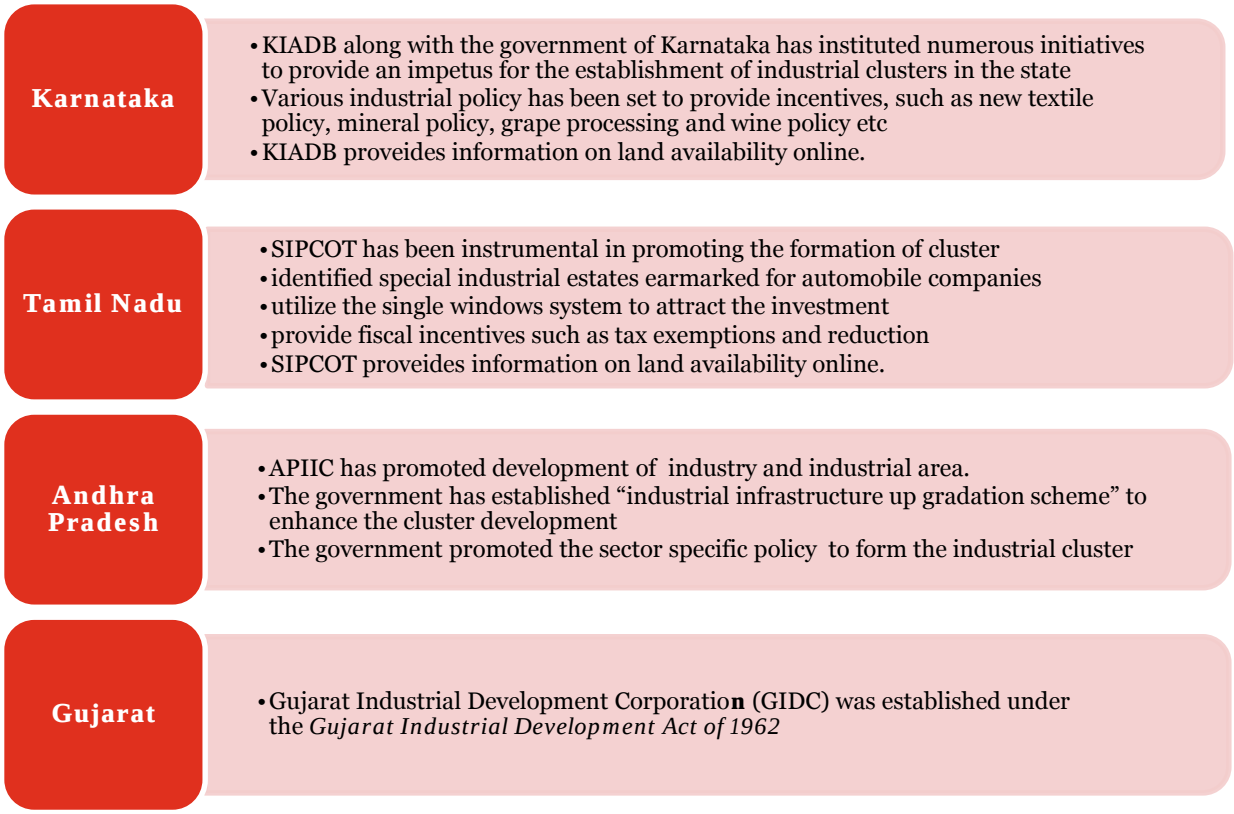
Source: Survey on business regulatory environment for manufacturing, FICCI report, DIPP web site etc

Industrial park/cluster

Industrial parks as well as clusters have been developed and operated by states' own scheme as a hub of industry. Some states make good practices through the collaboration of public and private sector, but others still have areas to be remedied in terms of operation and policy. Authority, operational scheme, and adoption of Green Practices were analysed.

1. Authority

Development of Industrial park/cluster is assisted and implemented by each state government. Gujarat Industrial Development Corporation (GIDC) has promoted entrepreneurs to invest by securing industrial parks/clusters in operation. All CBIC states have an institution like KIADB, SIPCOT and APIIC and provide infrastructure such as roads and street lighting, electricity supply.



Source: Survey on business regulatory environment for manufacturing, FICCI report, DIPP web site etc

Figure 12.18: Authority for Industrial Park Development by State

2. Operational Scheme

In addition to forming industrial clusters and developing infrastructures, operation and maintenance are key factors for investors to achieve sustainable development in the area. In Gujarat, GIDC set 32 A (Act) to determine the process for the maintenance and the Corporation is authorized to levy service charge / development as per respective Act. Gujarat Policy also mentions incentive of 50% of total expenditure limited to Rs.200 million dedicated to development of Core infra Core Infrastructure within the industrial park, also provides for assistance on Common ETP at 40-75% of total project cost

The government of Andhra Pradesh amended its Act and also provides APICC with Local Authority Status on maintenance of industrial parks. Some power under the Andhra Pradesh Panchayat Raj (APPR) Act were transferred to APIIC subject to condition that APIIC shall remit 35%/50% of the Property Tax/Revenues collected to the concerned Local bodies.

On the other hand, Tamil Nadu has an Industrial Policy to encourage maintenance of industrial parks with finance. There are some claims from residents due to the lack of maintenance and insufficient infrastructure. Karnataka has also set the policy but there is no mechanism and no fund for the maintenance and has problems like lack of internal road of industrial area, connectivity to the highways and port connectivity, In Andhra Pradesh, the availability and the condition of utilities and infrastructure in the Industrial Parks/Clusters/Estates or SEZs developed by APIIC is not as good as the infrastructure maintained in the private parks.

3. Adoption of Green Practices

All CBIC states aim for the sustainable industrial development and have intention to adopt green practices with a policy. Particularly, Gujarat and Karnataka set Zero Discharge policy and intend to install more environmental friendly equipment, system and standards with a wide range of incentives in water consumption, power saving and solid waste management.

Table 12.7: Policy for Green Practices

	Karnataka	Tamil Nadu	Andhra Pradesh	Gujarat
Green Policy & relevant subsidy	**Yes**	**Yes**	**Yes**	**Yes**
Authority & key activities	Dept. of Commerce and Industries (DCI) will create awareness, educate and engage the industry in reducing environment pollution.	TN will promote integrated solar generation and manufacturing parks which will house the entire ecosystem for solar manufacturing including wafer, cell and module making, and Balance of System(BoS) component manufacturing. Dedicated Effluent Treatment Plants (ETP) and / or Hazardous Waste Treatment Storage and Disposal Facility (HWTSDF) set up by individual manufacturing units would be eligible for an Environment Protection Infrastructure subsidy	AP promotes gas based industry for environment friendly industrial development with greater efficiency and cost effectiveness.	GoG provides a wide range of incentives to encourage all sectors to comply environmental standards. GoG aims at zero discharge from specific industrial sectors over a period of 10 years by getting carbon credit and reducing carbon foot print.

Source: Industrial Policy of each state

12.4.2 *Analysis of the South East Asia*

Benchmarking with the ASEAN countries is conducted to identify the area of improvement on the above five perspectives. Many foreign companies have made a lot of investments to ASEAN countries due to the attractive business environment in terms of ease of doing business, well developed infrastructure and adequate living standard. Singapore is awarded as the best country in the world from the view point of "Ease of doing business", published by World Bank in 2014. Thailand, Vietnam and Indonesia are ranked as 26th, 78th and 114th、respectively. Given that India is ranked as 142nd in doing business, the comparisons with those regional competitors are expected to provide insights for the India states to make enhancement of the investment environment.

Infrastructure

Benchmarking is conducted on “Power”, “Port” and “Road”.

1. Power

In ASEAN countries, stable power supply is realized by privatization, advanced technologies utilization and high awareness of energy saving with a strong initiative.

Parameter

- Power Generation & Distribution
- Power Capacity and Demand
- Renewable Energy
- Electricity Tariff

1) Power Generation & Distribution

Power supply and distribution system has/had been developed by the public authority delegated by the government to secure power supply and then privatization of power countries has been directed for stable supply. In Singapore, power supply system was developed by Public Utility Board (PUB) at first, then power generation and distribution were managed by Themasek Holding, a government institution and now most of the power generation is operated by private sectors. In Thailand, Electric Generation Authority of Thailand (EGAT) has promoted privatization, and IPP has been introduced to cover power supply. In addition, EGAT has promoted installing energy efficient appliance and spreading energy saving awareness with finance support.

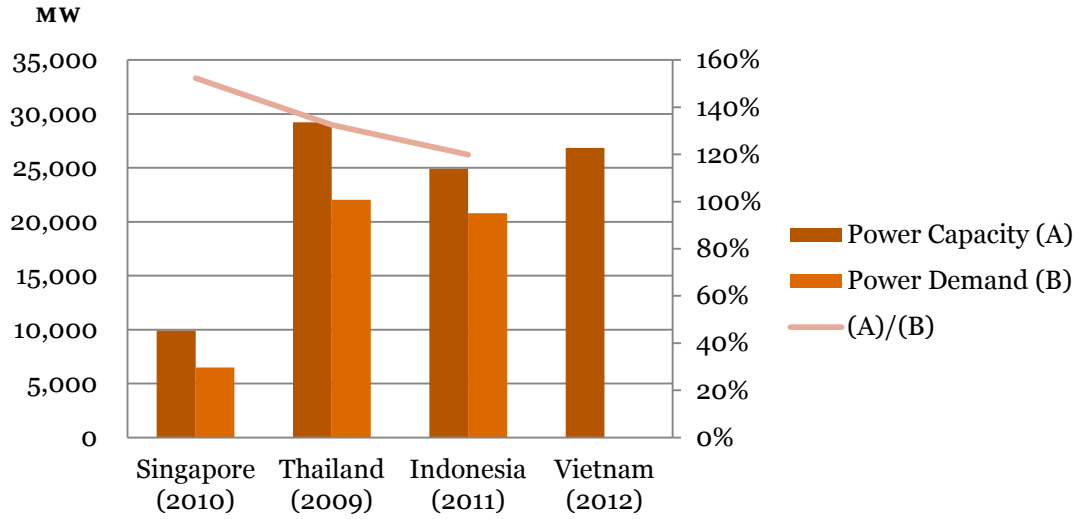
Table 12.8: Power Generation and Distribution

Category	Singapore	Thailand	Indonesia	Vietnam
Public authority	Power Supply System had been developed by Public Utility Board.	Public authority, EGAT has led the liberalization of the electricity biz in tandem with the involvement of the private sector since 1990.	Public authority, Perusahaan Listrik Negara (PLN) has led the liberalization, and gradually opened the biz to the private sectors	VietNam Electricity (EVN) is a public corporation, having an installed electricity generation and a distribution network
Activities for privatization	Tuas Power, Senoko Power and Power Seraya were established under a government institution, Temaseck Holdings in 1995 and privatized from 2008. Power Grid as a distribution company and Power Supply as a sales company were established under Temaseck Holdings in 1995. While Power distribution is solely done by Power Grid, Power sales have been privatized.	Private power supply companies like EGCO and RATCH were established separately from EGAT in 1992 The private IPP business is progressing by establishing their business in Thai Industrial parks and is building their own power supply system.	Electrical transmission business is limited to PLN but power generation business is allowed by IPP Since the power development plans in 2006 was launched, the power supply situation has improved.	Generation and distribution have been partially privatized and IPP and BOT have been introduced. The government have plans to expand the Fire Power Plants and introduce nuclear power generations

Source: JDC, EGAT, JPEC

2) Power Capacity & Demand

Singapore has an enough capacity to supply power stably against the power demand at the peak. Thailand and Indonesia also provides relatively stable power supply. Especially the gap between demand and supply of Indonesia appears to be small.

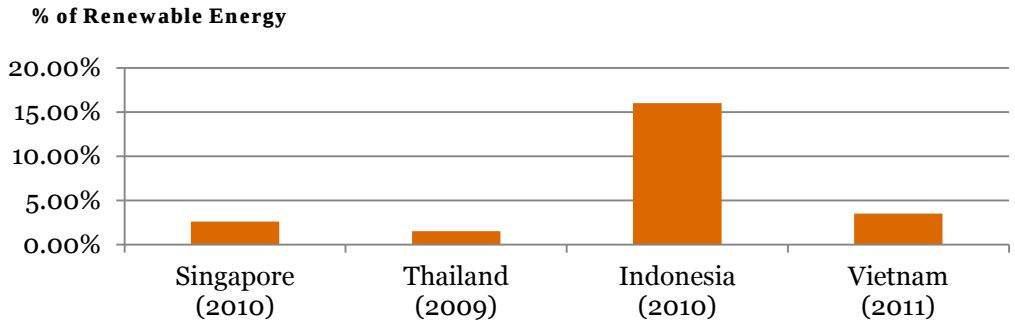


Source: JETRO, EGAT, PLN

Figure 12.19: Power Capacity and Demand (MW)

3) Renewable Energy

Each country promotes to introduce renewable energy as an alternative, environment friendly energy source. Especially, Indonesia is one of the counties which have the most geothermal resources in the world. Utilizing geothermal and water resources, Indonesia has a plan to expand the capacity of such power plants. Singapore promotes a sustainable development; positions business of clean energy like solar as a strategic and growing field and expect 7,000 job-creations and SGD 1.7 billion GDP by 2015.

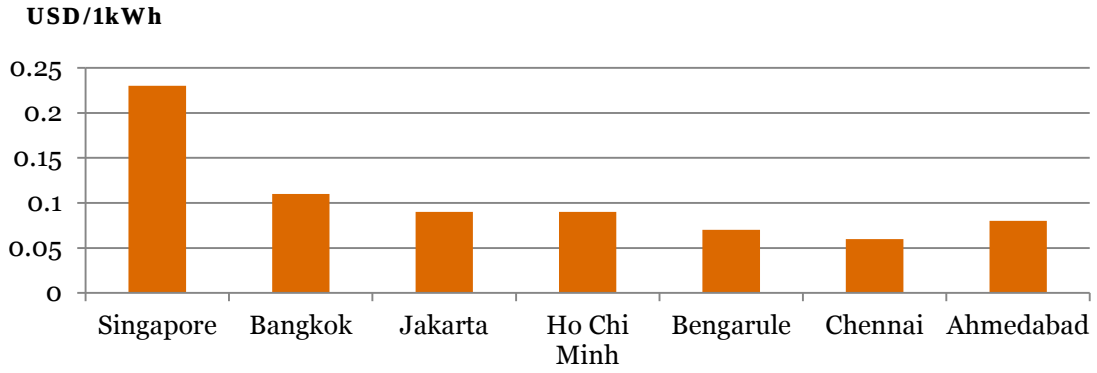


Source: JETRO, JBIC

Figure 12.20: Ratio of renewable energy

4) Electricity Tariff

Electricity tariff in Singapore is substantially higher than other ASEAN countries and all the CBIC states. The high cost may be an obstacle for foreign investors to start business with intensive energy use in Singapore. On the contrary, India keeps the lower level than other competitors.



Source: JETRO (2013)

Figure 12.21: Electricity Tariff

2. Port

It is crucial that ports have been developed and operated by the authority with a strong initiative. Each country has the authority and has been operated the ports smoothly.

Parameter

- Port Authority
- Traffic of Cargo Container

1) Port Authority

Singapore is located in the heart of Southeast Asia and connected six hundred ports in one hundred twenty countries with daily sailing to every major port of call in the world. Ports in Singapore have been expanded through the training of petroleum with Middle-East Countries and chemical, commodities and electronics among Asian countries. Port of Singapore Authority (PSA) has enormously contributed the establishment of the hub port dealing with the trade all over the world for its competitiveness and implemented various activities such as operation and maintenance, water & raw materials supply, collection of garbage and delivery. In Thailand and Vietnam, subject to the act, port development and operation has been directed.

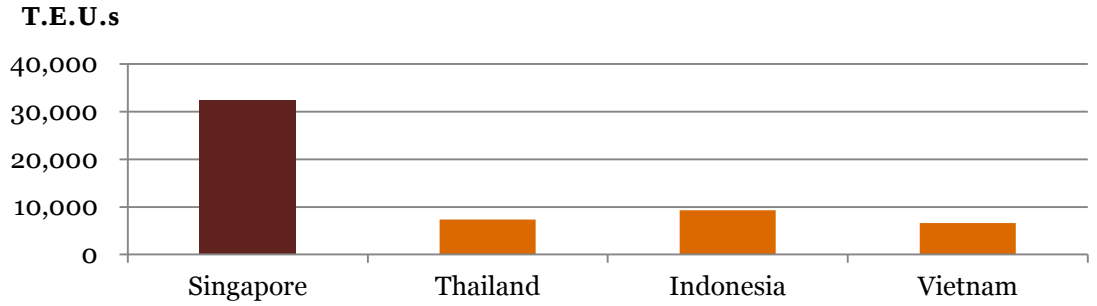
Table 12.9: Port Authority

	Singapore	Thailand	Indonesia	Vietnam
Authority/Association	Port of Singapore Authority (PSA) was established under the Ministry of Communication in 1964 and has developed port and related facilities	The Port Authority of Thailand (PAT) was established under the Port Authority Act B.E. 2494 (1951) as an autonomous body under the general supervision of the Ministry of Transport and Communications.	PT. Pelabuhan Indonesia (PELINDO) I-IV, which are national port companies, manages and operated ports and related facilities.	Vietnam Seaport Association (VPA) has 40 members ports with annual cargo throughput accounting for more than 80%
Key activities	PSA International has been voted "Best Global Container Terminal Operating Company" for eight years since 2005 at the Asian Freight & Supply Chain Awards.	On 29 November 2000, the amendment of Port Authority of Thailand Act 1951 was made and announced in the Government Gazette to enable to PAT to be registered as the Limited Company or Public Company to engage in other businesses within the scope of PAT's objectives and to join with other persons or shareholders in the limited.	Port development and operation were partially privatized in accordance with an agreement with IMF.	Master Plan for Vietnam Seaport system till 2020 was approved in 1999 by the Prime Minister. According to regions, Vietnam seaport system is divided into 6 groups.

Source: PSA, PAT, JBIC, Vietnam Maritime Administration, VPA

2) Traffic of Cargo Container

Singapore was the 2nd largest in cargo container trans-shipments all over the world in 2013 and has been awarded for the best effective operation since 2005 at the Asian Freight & Supply Chain Awards. The utilization of container trans-shipments reaches 80% in Singapore.



Source: World Bank (2012)

Figure 12.22: Traffic of Cargo Container (T.E.U.s)

3. Road

Authorized and focused institutions develop roads and related facilities and achieved high ratio of surfaced road.

Parameter

- Authority of Road Development
- Surfaced Road

1) Authority of Road Development

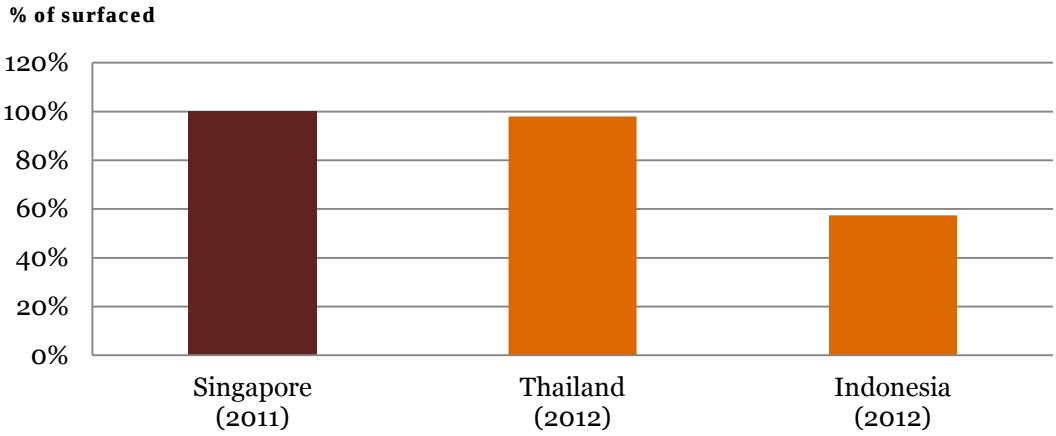
In Singapore, Land Transport Authority (LTA) has not only developed the structured roads but also committed to ensure the safety of motorists and commuters. In Thailand also, under the Ministry of Transport (MOT), the government administrations such as Department of Highway, Department of Rural Roads and state enterprises have developed road and carried out maintenance.

Table 12.10: Authority to develop roads

Singapore	Thailand	Indonesia	Vietnam
Land Transport Authority (LTA) manages and operates all of the land transportation like metro, road and vehicles. LTA is committed to ensuring the safety and security of motorists and commuters, for example, installation of some device and technology/system.	Under the Ministry of Transport (MOT), the government administrations like Department of Highway and Department of rural roads and the state enterprises have developed road and carried out maintenance. . "Asia Highway", which is connected to neighbor countries, is over 5,000km and has 2 traffic lines (Limited highway: 67,000km)	PT/Marge (PEERSERO), which is a national company, develops and operates highways Private sectors are allowed to enter other roads business. - Total Length : 470,000km	Ministry of Transport has developed the roads and expressways through the recent reorganization of the sectors with the creation of the Directorate for Roads of Vietnam (DRVN) and other administrations.

Source: LTA, MOT, JBIC, ADB

Singapore has achieved 100% of surfaced road and Thailand also has developed the roads over 98%. However, Indonesia has a room to improve this situation.



Source: World Bank, JBIC

Figure 12.23: Ratio of surfaced road

Land Acquisition/building approval

In Southeast Asia, acquisition of lands for industrial use is smoother than that in India with authority based on the coherent and transparent policy with sufficient supports.

Parameter

- Policy
- Support System

1) Policy

For industrial use, Industrial Estate Authority of Thailand (IEAT) leads the land acquisition with the strong power delegation and transfers the lands to foreign investors. According to Constitution, fair compensation shall be paid to all rights holders affected by the land acquisition. Since land space is limited in Singapore, the government agencies control land system in order to optimize the land use and increase land productivity for its competitiveness.

Table 12.11: Land Acquisition Policy

	Singapore	Thailand	Indonesia	Vietnam
Authority	URD (reorganized into Urban Redevelopment Agency (URA) under the Ministry of National Development)	Industrial Estate Authority of Thailand (IEAT)	- (The government can acquire)	- (The government can expropriate land with important national projects)

Features in Policy	URD was 41,000 ha (58% of Singapore land) is a government owned land, which are managed by SLA, HDB, JTC and URA.	IEAT can transfer the expropriated land to operators specified by IEAT as for business purposes related to industrial park development. Foreign companies can own the land with the approval from IEAT's approvals A JV with more than 50% funded by Thai investors can purchase lands except for ones in industrial parks.	The price of compensation is decided by an independent investigation team approved by the Department of National Land. Tenant companies purchase through industrial park business lots with Rights to Build according to Basic Agrarian Law (1960). .	The government can expropriate land with important national projects under new Constitution and the Land Law 2004. Foreign companies and foreign parties with partnership agreements shall not hold the ownership of land in accordance with the Land Law (2003).

Source: JDI, JETRO, JBIC, JTC, IEAT,

2) Support System

In order to proceed with the land acquisition smoothly, support systems have been established. In Thailand, according to the provisions of the Constitution, the government sets up a process of public hearings with land owners affected by projects and discloses information before the process of land acquisition. Also, IEAT specifies clearly the application procedure online and provides the following information as "One-stop service center" regarding industrial parks/clusters.

- The latest situation in the industrial park
- The locations
- The number of factories
- Project progress reports

In Indonesia, a process of land acquisition is defined in 2012 No. 71 Presidential Decree as an administrative instruction of 2012 No. 2 Land Acquisition ACT (enforced in January 2012). The Investment Coordinating Board (BKPM), which executes all by applying "On-door integrated service", can go through the procedures for acquisition of land rights, although the actual implementation is still a challenge.

Skill Development

As one of the best practices in ASEAN countries, special curriculum is built in partnership with high academic institution as well as the private sectors who potentially hire those labors.

Parameter

- Policy
- Skill Development Infrastructure

1) Policy

Each country has a policy/plan to direct skill development in order to raise the competitiveness of industry. In Singapore, the Ministry of Trade and Industry launched Strategic Economic Plan in order to enhance skill development and the Ministry of Manpower and its below institute, Workforce Development Agency (WDA) established Skill Development Fund (SDF) for skill training and education. Additionally, Singapore, through Human Capital Leadership Institute, develops human resources for not only domestic purpose but also regional one.

Table 12.12: Skill Development Policy

Singapore	Thailand	Indonesia
Skill Development has been enhanced under the Ministry of Trade and Industry. Work force Development Agency (WDA) established under Ministry of Manpower (MOM) is responsible for implementation of training from basic to technical skills and established Skills Development Fund (SDF). Human Capital Leadership Institute established under Ministry of Manpower (MOM) in 2010 has collaborated with universities and make a strong effort to develop human resources	IEAT establishes the human resource development centers in IEAT industrial parks to enhance the workers' skills.	(No specific authority identified for the skill development) The Gross Enrolment Rate of university education increases from 18% in 2009 to 25% in 2014, according to the national Medium-Term Development Plan (RPJMN) 2010-2014, However, no industrial park provides a human resource development program.

Source: JDI, EDB, OVTA

2) Skill Development Infrastructure

Skill Development Infrastructure such as Institute of Technological Education (ITE) and training centers plays an important role for skill development. Singapore Government has made a lot of investments for training and education by ITE. ITE is a principal provider as a skill training institute and has three colleges. In Thailand and Vietnam, training centers and educational schools were established in Industrial Parks and collaboration with higher educational institutes and private sectors are directed.

Table 12.13: Skill Development Infrastructure

Singapore	Thailand	Vietnam
The Institute of Technical Education (ITE), Singapore, was established as a post-secondary education institution in 1992 under the Ministry of Education (MOE). - ITE is a principal provider of career and technical education and key developer of national occupational skills certification and standards to enhance Singapore's workforce competitiveness. **Under its "One ITE System, Three Colleges" Model of Education and Governance, ITE has three Colleges, comprising ITE College Central, ITE College East and ITE College West. WDA established fund for kill development.**	**The following human resource development centers were established.** - Training centers of the Automobile Association and the Institute of Electrical and Electronics in Bangpoo industrial estate - Ayutthaya High-tech industrial park (Banker industrial Estate) - Training center (Thai-German Institute) in Amata Nakorn Industrial Estate - Swinburne School of Engineering in Laem Chabang industrial estate (This school has provided a special curriculum for workers in the industrial park.) - IEAT cooperate with NIDA (National Institute of Development Administration) and is planning human resource development in environmental control at each industrial park and is set to establish a master's course in environmental engineering.	**A private industrial park called VSIP established Vietnam/Singapore technical training school in the adjoining land to VSIP. It provides 4 courses, Electrical Equipment, Mechanical Maintenance, Electronic Engineering and Mechanical Engineering since 1998.** - In 2011, a Japan/Vietnam technical training school was established as a JV of a Japanese Consultation Company in Ho Chi Ming and a Vietnamese local building materials manufacturing company.

Business Process

One of key factors of Business Process is that the authorities delegated some module of workds in a transparent manner to cover multiple modules such as permission/approval of applications, of which authorities belong to Ministries, consulting the investment of the owners, e-service infrastructure building, provision of information etc.

The detailed comparison of ASEAN countries and CBIC states on the business process in terms of cost and time are described in the Appendix; but the time boundary is regulated by the institutes and laws in ASEAN countries.

Parameter

- Single Window Mechanism

1) Single Window Mechanism

Single Window Mechanism is a key factor for foreign investors to proceed with administration procedures smoothly. In Singapore, Enterprise One Portal offers a single point of access to a wide range of comprehensive information on government assistance with a call center and was awarded as Enterprise Challenge (TEC) Public Service Innovation (2006). Economic Development Board (EDB) also supports to invite manufacturing companies to Singapore.

In Thailand, Industrial Estate Authority of Thailand (IEAT) has been delegated the authority not only for receipt of applications but also for permissions, of which belongs to some Ministries. Moreover, IEAT established Information Center and Consultation Center and provides E-service; application form and tracking system. While Investment Coordinating Board (BKPM) in Indonesia also provides the similar services to foreign investors with Thailand, the Investment review committee in Vietnam can accept the application paper work but only deliver it to the right point.

Table 12.14: Single Window Mechanism

Category	Singapore	Thailand	Indonesia	Vietnam
Single window mechanism	**Yes** Enterprise One Portal, which is managed by Singapore Spring under the Ministry of Trade and Industry Also, the Economic Development Board (EDB) was established under Ministry of Trade and Industry (MTI) for the purpose of technical support service to manufacturing companies.	**Yes** IEAT has been delegated the authority for permission in accordance with Industrial Estate Act, Article 42/1979	**Yes** The Investment Coordinating Board (BKPM) was established in 1973 directly under the President and executes all at once by applying "One-door integrated service"	**Yes** **The investment review committee for each industrial park is established by the prime minister of Vietnam in order to smooth administrative procedure for foreign companies.**
Key functions	**(Not specified)**	· Information Center one-stop service center · Benefit, Permission, Approval center one-stop service center · Permission /Approval center for industrial park developers · Consulting about the investment and simplifying and smoothing procedures · E-Service	• Easing the conditions for permissions/approvals • Simplifying the procedure • Shortening the duration • Indicating and reducing the fees	· Providing the proper guidance to the companies in the industrial parks · Accepting investment application paper work and delivering to the proper organization · Permitting and approving the investment up to US$ 40 million regarding export, import, building permission or granting VISAs.

Source: JDI, Enterprise One Portal, Trade Net, BOI, IEAT, BKPM

Industrial Park/cluster

In the best practice among ASEAN countries, guidance on the industrial park/cluster and Corporate Governance are well developed and detailed to operate industrial park/cluster efficiently and ease the actual implementation. With R&D investment, innovations for competitiveness are realized in terms of Environment and Technology.

Parameter

- Institutes for Development of Industrial Park
- Maintenance of Industrial Park

1) Institutes for Development of Industrial Park

JTC Corporation in Singapore has well developed corporate governance system in order to operate industrial parks smoothly and focuses on three aspects: deepening the cluster knowledge and capabilities; increasing land productivity; and expanding its innovation capacity.

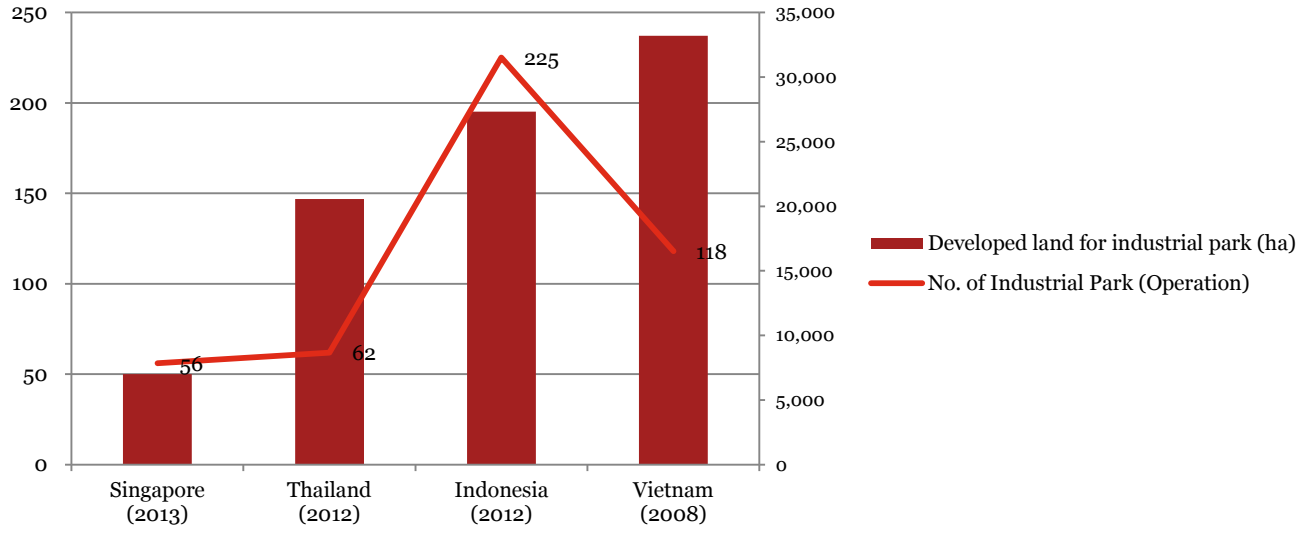
In Thailand, BOI and IEAT established the detail guideline on the procedures.

Table 12.15: Institutes for development of Industrial Park

Singapore	Thailand	Indonesia	Vietnam
JTC Corporation has managed and operated Industrial parks and provided information on Industrial Parks to investors.	IEAT regulate and guide the industrial park development	The President or BKPM makes an investment approval and then Ministry of Commerce and Industry issue a principle license.	(Not specified) Based on Law on Investment, Industrial Park Development has been carried out.

Source: JDI, JTC Corporation, BOI, IEAT, BKPM

The following chart indicates the number of Industrial Parks under operation and area of the developed land for industrial park in Singapore, Thailand, Indonesia and Vietnam.



Source: JDI, ASEAN-JAPAN Center

Figure 12.24: The No. and area of Industrial Park

2) Maintenance of Industrial Park

With respect to operation and maintenance of industrial parks, detailed guidelines and powerful leadership are essential for its competitiveness and sustainable development.

JTC Corporation is looking at developing innovative infrastructure solutions that not only optimize land use and address the challenges of environmental sustainability, but also provide a unique competitive advantage for industries in Singapore with sophisticated and green technologies. In Thailand, IEAT committee takes responsibilities to carried out maintenance and operation with detailed guidelines.

Table 12.16: Maintenance Policy for Industrial Park

Singapore	Thailand	Indonesia	Vietnam
JTC Corporation maintains infrastructure within Industrial Parks with clear guidelines.	**The IEAT committee makes decisions about important matters such as infrastructure development.**	**Ministry of Commerce and Industry conducts coordination, such as linked infrastructure with industrial park development including a technological standard of infrastructure like roads, water dispose works and power supply.**	**Ministry of Planning/Investment and Vietnam Board of Management of the IZ are given authority by the Prime Minister and deal with the problems related to Industrial Park Development including linked infrastructure.**

Source: JDI, JTC Corporation

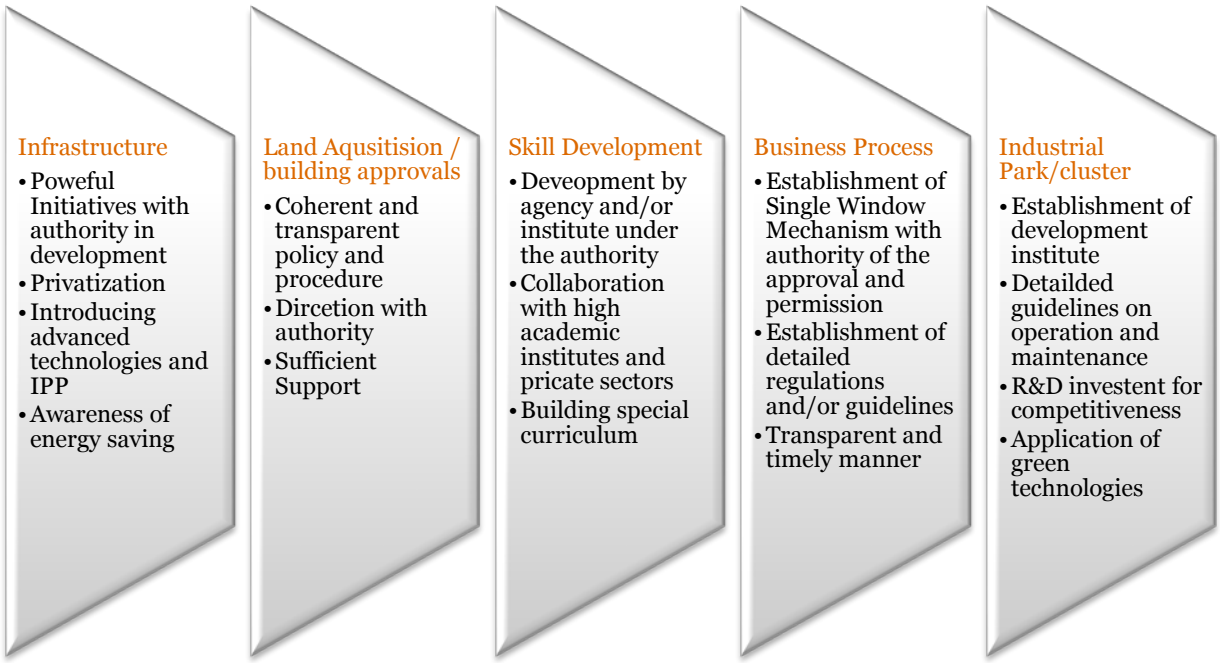


Figure 12.25: Summary of Key Implication

12.4.3 *Feedback from the foreign private sector*

Foreign companies provide feedbacks on the key hindrance for their further investment in India based on the 5 perspectives in this chapter. They, however, also provide additional feedbacks on the investment environment; some of the feedbacks are surely relevant to the enhancement of the investment environment, but require drastic changes for the state policy. Others are ones that relate to the cross states approaches, not limited to each CBIC state activity.

Feedback for all the states

1. Low profitability

Most of the Japanese foreign companies describe the character of the Indian market as "exhaustively cost competitive." Many of them feel the values of their products, such as the higher quality, life cycle cost and safety for users, are underestimated by the Indian consumers.

Especially in many of the India infrastructure projects, the project structures are divided into small pieces for bidding and fall into price competition; as the result, the project size tends to be less flexible and less profitable,, making the foreign companies hesitate to bring in investment

Also another concern related to the profitability is the price ceiling set by the authority; the price for the utility is set at not high enough to recover costs, coercing the business entity to run red, then making it hard to expand the business or even continue business. Many of the energy related companies request the flexible price program at least for the initial phase, but currently such options are not admitted in any state.

2. Business uncertainty

Indian economy is currently losing the growth momentum. The GDP growth rate of India decreased to 3.24% in 2012. Given the economic downturn, foreign companies tend to postpone their investment plan as well as downgrade the growth estimation to India. Observed the China's high growth period facing earlier slowdown, global investors currently start considering the future growth of emerging economy has been overestimated. Under the situation, small and medium scale foreign companies, mostly essential parts suppliers for manufacturing, are confronting a serious challenge in order to determine investments to CBIC.

Also, the unexpected change in the India's political landscape adds further uncertainty in the business environment. India is characterized by the drastic change in the industry policy depending on the political party. The change in the ruling party, thus, often causes the funding or subsidy committed by the previous party ineffective, and makes the private sector's project plan meaningless which heavily depends on the funding. With the risk, it appears too risk for the foreign companies to invest in significant size even with the support from the current political party.

3. Feeble infrastructure for Tier 2 players

Tier 1 enterprises are often treated with sufficient infrastructure support from the central or state government in terms of power, water, transportation etc. On the other hand, Tier 2,3 parts supplier who actually provide critical elements of the products, are not provided with minimum level of the supports. It is reported that the one of the Tier 2 suppliers suffer from 7 hours blackout per day; this may hinder them from operating in India, making critical impact on the Tier 1 player.

4. Weak foundation for Intellectual property

Intellectual property rights (IPR) are crucial for foreign companies to fully operate in India from R&D. Many foreign companies complained the lack of the IPR regulatory framework in India, including slow registration process, complicated application and approval steps, and the lack of transparency in the standard for screening.

India Government, mainly led by CGPDTM under DIPP, has made progress in many areas, such as digitization of the IPR related process and data, standardization of the application processes across the states, and increase

in the number of staff to ameliorate the process. The Modi government also plans to establish clear IPR policy based on the regulatory framework in 2015 to enhance the momentum of IPR, and also plan to expand the staff in the Patent office in order to speed up the pending application clearance. With those efforts, the number of the intellectual property applied by the foreign companies has increased sharply in many industries, especially in automobile and telecommunications.

However, in spite of those measures, many foreign companies still have addressed their concern over the IPR policy in India and showed their intention to conduct R&D investment outside the India. In order to attract further investment into India, especially the investment which contribute to enhancement of manufacturing industry, the current approaches need to be driven forward.

5. Unstandardized business process

Business processes are very complicated and require a significant amount of man hour to comprehend even in one state. However, the issue is that all the states have different styles in the business registration / application / approval / clearance process in India and require the companies to re-learn the entire process if they intend to expand their business. It causes big time loss and a significant investment, that it has now become major hindrance for the foreign companies.

6. Burdensome tax system

CBIC is characterized by the high tax rate, but the another burden on the private sector is CST which occur for the cross state business. Currently, when the products or parts for the final products go across the state boarder, it requires the CST on each transaction. This increases the amount of cost for the products, and decreases the price competitiveness. Given the tough competition faced by the foreign companies against the local companies in light of the price, it is critical to reduce the CST.

Also, another issue related to the tax is the frequent change in the tax policy. It is reported that the tax system has changed randomly due to the political party change or natural disasters. Although some states provide tax incentives for the investment support, those uncertainty offset them, or even make the situation worse. Many of the private sectors prioritize the stability in the tax system; the unexpected change in the tax system has often caused the anxiety in the private sector, then deterring them from further investment"

12.5 *Recommendations to improve investment environment*

12.5.1 *Recommendation for Andhra Pradesh*

The above analysis shows that the each CBIC state has both of strength and weakness in the investment environment and has conducted various approaches to enhance it. Although the analysis shows that there is some commonality in their approaches, such as single window approach to ameliorate the business process or State-led policy to improve the industrial parks, but the details in their approach differ depending on the each state status.

However, it is also obvious that in comparison with the best practice states, all the CBIC state still have big room to improve. In this section, we summarize the basic recommendation for Andhra Pradesh to improve the investment environment based on the five perspectives we employed in the analysis.

Recommendation for Andhra Pradesh

Andhra Pradesh has enhanced the investment environment through various policies and ranked high among the India states. However, the state needs to undertake various policy measures to improve business processes.

Table 12.17: Recommendation for Andhra Pradesh

Perspectives	Detail of the Recommendations
Infrastructure	· Promote systems like installation of smart metering systems and smart grid systems · Spread power saving awareness and set measures to achieve the purpose · Ensure rolling out road improvement/new road construction projects in order to connect proposed nodes to the main highways and ensure seamless connectivity. This will help taking forward the nodes development at higher speed
Land Acquisition/Building approval	· Expand the information provided through the online system, such as the price, detailed description of the land, development status etc. · Enhance the usability of the online land information system by developing key factors, such as interface, functions, support process, software and tools · Promote the system to increase awareness across the states and boost the usage ratio · Establish submission manual for building plans to mitigate construction approval process
Skill Development	· Collaborate with private sector and higher educational institute to enhance the curriculum, especially to develop sector specific curriculum, which can be fully utilized right after the course completion to increase number of qualified workforce · Vocational training institutes in collaboration with private educational group and industry should be also proposed, since the majority of employment is expected to be skilled (engineering, management graduates) and also semi-skilled. · Collaboration between a private institution, government and industrial units should be in line with newly introduced Industrial Development Policy of AP 2015-20)
Business Process	· Further empower the authority of the mechanism to be more comprehensive and govern the process over the various department as one agency · Increase the functions of the transparent system to help investors monitor and track the application status online and assure single window mechanism until the approval and during the operational stage (not only at the application stage but also during the following up stage) · Develop skills to deal with IT and computer for implementation of the single window system
Industrial park/Cluster	· Establish detailed industrial park guideline on the key factors such as base infrastructure, environment standard, minimum level operation standard, and maintenance operation based on the private sectors' needs and strengthen its enforcement with empowered authority institutionally and financially with self- governance system. · Create an annual plan on the budget and for cluster's sustainable development · Collaborate with the private sector to develop higher level of infrastructure service that can meet the demand of the foreign companies · Provide customized fiscal incentives for primary industrial sectors · Fiscal incentives can be proposed for MSMEs, which are primarily in the engineering sector. This will help building the necessary vendor base in the node where major output is expected to come from engineering sector. Such sectors as electrical machinery, machinery, automobiles require presence of large vendor base in the immediate proximity. Hence, such incentives can be proposed.

11.6 Policy Recommendation on Improvement of Soft Issues

As indicated in the previous chapters, despite the significant potential of the region, investors and industry players show concerns on current and future investment environment. There are various actions which are recommended by investors and industry players in order to make CBIC as a preferred destination of their investment. They can be categorized into two types due to the level of the issues and commonalities of the actions: actions need to be taken by state government, and actions need to be taken by the central government (or CBIC unit positioned at the central level). This section summarizes the latter. It is recommended to set up a necessary program to consider the detail action plans on soft issues in the next phase.

12.5.2 *Improvement of Investment Environment*

Policy support

To Provide mid- long term policy guidance for private sector

Many of the private sectors suffer from the unexpected change in the policy from the government. Especially when the leading party changes where the company invested, the incentive programme or subsidy committed by the previous authority can be altered or even cancelled, that it affects the business feasibility of the private sector. Such anxiety has become hurdle for the company to make investment on their own risk.

It is strongly recommended that the central government be involved in the discussion on the key policy that affects the private sector's business decision, and provide a certain level of necessary commitment from the central government to keep the promise to the private sector and to promote private investments and FDI even if the political party changes take place at the state level. Such commitment is expected to provide confidence to the private sector, and is to encourage them to conduct a large scale investment from their own budget.

Implementing Agency: DIPP, MOF, Ministries in charge of each sector

To Establish infrastructure to support IPR

The number of the patent application has increased rapidly over the 10 years, and the number of those received by the authority has reached over 40,000, four times more than that of 10 years back. The number has already reached the 8th largest in the world, following Germany and Russia, and is expected to increase more.

However, despite such sharp increase in the interest, many investors and industry players show their strong concern over the insufficient understanding of the patent system in India. Some of the reason is attributed to the lack of knowledge from investor sides, but some parts are argued that the government needs to take proactive actions if the Government of India requests manufacturing industry to shift from other countries in India, which are considered most patent related industry.

To that end, the central government is expected to take three activities to establish the solid foundation for intellectual property: i) to conduct seminars for private sectors to enhance awareness on Patent law and application process/requirement in India and to encourage IPR registration; ii) to conduct workshops for Government IPR officials to familiarize with the concepts; and iii) to play a role of PMU to appoint a point of contact person in charge of any IPR related matter including litigations, who can coordinate with relevant Government IPR officials when required. The IPR is a very complicated area from the foreign companies' point of view, those types of knowledge sharing approach are strongly in need.

Implementing Agency: DIPP

To Set up appropriate standards on technical and environmental aspects

Along with the increasing volume of the foreign investment and the expanding number of foreign residents, the sustainability has become one of the key issues. Especially foreign companies, who already have their footholds in the India, strongly request further approaches to be taken by central government on technical and environmental standards in order to enhance environmental friendly, sustainable development, and eventually improve the living and working conditions.

It is, however, noted that such standards will increase the cost for the installation and establishment of facilities, especially the cost of technologies utilized. Given the many of the state government suffer from the budget deficit and cost oriented decision making tends to be made, the overall direction needs to be made by the central government, and needs to start from pilot cases and to be evangelized across the country.

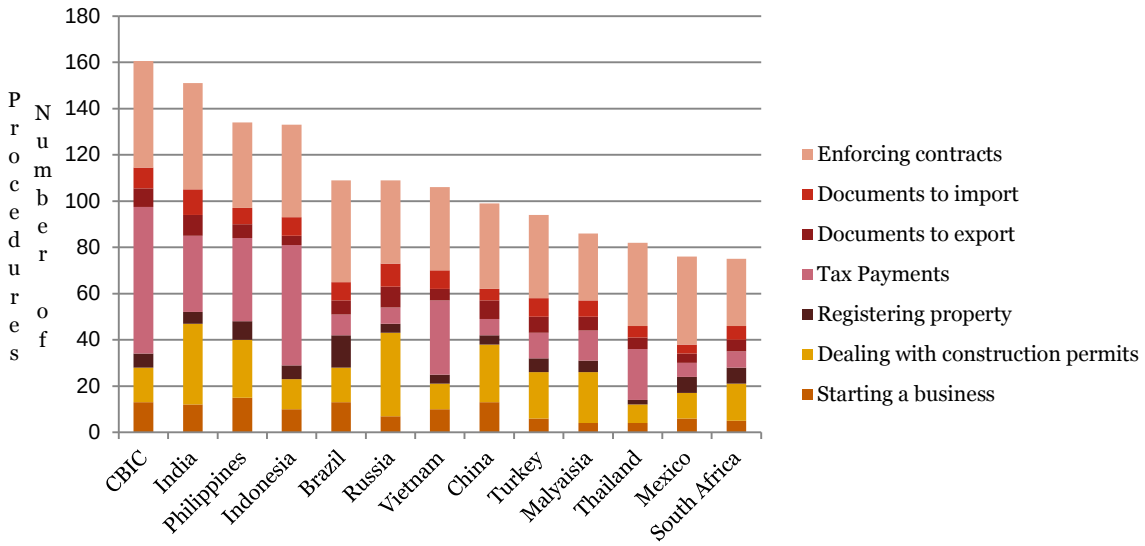
The recommendation for the central government, thus, is three steps: i) to develop the framework/guidelines for development of industrial parks with safety and environmental standards; ii) to test the above standards in specific industrial parks with governmental initiative and adjust the framework/guidelines based on the feedback; and iii) to hold a round table discussion with State's representatives on a regular basis to share successful models and the experiences

Implementing Agency: DIPP

To Reduce, Simplify and Clarify Procedures on Approval and Authorization

In order to develop CBIC to a world class investment destination, the Government of India and the related State Governments are recommended to reduce, simplify and clarify the procedures for approval and authorization.

The comparison analysis in the previous chapter shows that doing business in CBIC is highly time and cost consuming. The situation is summarised in the following figure and table.



Source: World Bank

Figure 12.26: Number of procedures

The comparison of necessary periods of major administrative procedures in CBIC and 12 countries are shown in the table below. The Best Practice and Average show the most competitive practice and the average, respectively, among 12 countries. It is recommended for CBIC Region to set the target period at least at the level of the average in order to enhance the global competitiveness.

Table 12.18: Period of Procedures in CBIC Region

Name of Procedures	Period of Procedures in CBIC Region	Comparison with Rival Countries/Regions		Authority in Charge	
		Best Practice	Average	Gov. of India	State Gov.
Starting a business	37 days	6 days (Mexico)	31 days	√	√
Dealing with construction permits	120 days	77 days (Philippines)	181 days	√	√
Registering property	38 days	2 days (Thailand)	33 days	√	√
Trading across borders Export	25 days	11 days (Mexico)	17 days	√	
Trading across borders Import	22 days	11 days (Mexico)	18 days	√	
Enforcing contracts	968 days	270 days (Russia)	533 days	√	
Paying taxes	292 hours	133 hours (Malaysia)	292 days	√	√

The interview survey for the investors in CBIC also highlighted the perception on above mentioned status. The land acquisition, import/export procedures, and environmental assessment are the most frequently identified areas where bottlenecks of soft-infrastructure exist. The challenges are summarized below.

Table 12.19: Key Bottlenecks in Administrative Issue in CBIC Region

	Key Issues	Bottlenecks
1.	Land Acquisition on Industrial Parks	■ When serious problems occur on land acquisition in industrial park, private company has to solve by taking all responsibilities. ■ Information on industrial park is closed and difficult to know for potential investors unless they have connection with the Government officials.
2.	Import/Export at Ports and Airports	■ Due to lack of integrated guidelines, rules of mandatory submitting documents and licenses for clearance are frequently changed by orders of officers at the port or airport. ■ Number of local rules and regulations which are not officially enforced by the Government exist in each port and airport. ■ One invoice needs to be provided to Taxation Bureau per part when receiving a refund on VAT. As the invoice is requested in hard copy, more than 10,000 invoices are required.
3.	Environmental Assessment and Approval of New Projects	■ Environmental assessment takes too much time, i.e., 3-4 months on average. ■Approvals for new projects, such as approvals of State's high level committee and issues of official approval letters are taking too much time.

The central government can improve the situation in four ways: i) the central government coordinate the technical consultant to establish IT base solution to enable single window process and simplified procedure, which include in the area of import/export operation at ports/airports, environment approvals etc., and enhance the usability of the system; ii) along with the digitization, it can also increase the information itself accessible to the public, which is expected to enlighten the citizen and the private sector, and encourage them to proactively take action in driving the business; iii) to assign PMU to monitor the business process status

regularly and evaluate based on the feedback from the field, so that the central government can provide incentives to each government to stimulate the competition, and promote the improvement of the entire states; and iv) to show strong commitment to lead the initiatives on debottlenecking, such as land acquisitions of strategic industrial parks etc.

Implementing Agency: DIPP, Ministries in charge of each sector

To Set Competitive Tax Rate

As has been identified by investors for a long time, the tax burden for foreign investors in CBIC region is more than the other rival countries and regions. The higher tax rates critically deteriorate the attractiveness of CBIC as an investment destination.

Comparison of major tax rates in CBIC and other rival countries are shown below. The Best Rate and Average Rate show the most competitive practice and the average, respectively, among 12 countries. It is considered to be necessary for CBIC Region to achieve at least the average tax rates in order to be a globally competitive investment destination which is chosen and preferred by major global investors.

Table 12.20: Current and Recommended Tax Rates for CBIC

Name of Tax	Current Rate	Comparison with Rival Countries/Regions		Authority in Charge	
		Best Rate	Average Rate	Gov. of India	State Gov.
Corporate Income Tax	40%	0%	17%	√	
Personal Income Tax	30%	17%	31%	√	
V.A.T.	13-15%	0%	8%		√
Interest Remittance Tax	10%	0%	8%	√	
Dividend Remittance Tax	15%	0%	9%	√	
Loyalty Remittance Tax	10%	0%	10%	√	
State Entry Tax	Varies	0%	0%		√
Import Tax	25%	10%	15%	√	

The central government can improve the situation by reviewing the optimal tax system considering the competitiveness of the CBIC region as a destination of investments.

Implementing Agency: DIPP, MOF

Business profitability

To Enable private participation in Node Development

Some of the foreign companies, especially the infrastructure related service provider, argue that it is difficult for them to establish the sustainable business model in India without the government subsidy or incentives to cover uncontrollable risks by the private sectors, such as tariff, demand etc. This means that given the government support tends to be time limited, many of the projects are not likely to be profitable for the private sectors in the long term, which make them hesitate to investment in the first place.

One of the key reasons why the above mentioned issue has often been observed is that many companies tend to be receptive to the government tender, and not be able to take part in from the planning phase. In other words, they argue that they cannot build their positions as business partner to the government, rather stay as simple vendors to individual projects. As long as such sentiment is shared and hard to be taken away in some of the key private sectors, the win-win relation between India and Japan cannot be sustainable.

One solution for the central government to take is to establish a foundation for collaboration between India and Japan from upstream phase; that is, the central government can build framework for private sectors to be

involved in the development planning phase in the node, and to actively build the new business model in tight collaboration with the government. The business model can be built with integration of the various sectors businesses such as real state, power, railway etc., or in collaboration with the international financial organization.

Implementing Agency: DIPP, Ministries in charge of each sector

To Enable the infrastructure service provider to sustain the user charge based business

As described in the previous section, to build the profitable business model is difficult for some of the private sector; especially for the infrastructure related service provider, establishment of the user charge based business is crucial, but at the same time, hard to establish in India. This makes it hard for them to collect the initial investment cost, and also re-invest to maintain the business in the long term.

To support the private sector, the central government may provide guarantee funding to sustain the business at least till the private sector to collect the initial investment cost. Also, it can support the private sector to establish PPP model through assisting the operation in the initial phase. To make the user charge based business more efficiently, the government can also invest into the smart meter as common asset and deploy across the CBIC area for all the relevant service providers.

Implementing Agency: DIPP, Ministries in charge of each sector

Cross state business enhancement

To Establish interstate infrastructure

Issues that block the smooth interstate business, such as CST, stamp duty, interstate transportation system etc., have been addressed by the central government and dealt with by some approaches. Nevertheless, many of the companies still show their frustration regarding those issues by highlighting the slow progress in the remedial approaches and the insufficient information provided from the government on the progress.

To address this, it is crucial for central government to share the status of each project through online channel, and set PMU at the central level to monitor and coordinate the stakeholder to make sure the progress to be made along with the planned timeline.

Implementing Agency: Ministries in charge of each sector

To launch reform initiatives in regulation

The difference of regulation, business process, and business related law etc. are inevitable, but they are often the key blocker for the private sector to expand the business across the state. Many of the companies contend that a certain standard or unification of the process would help the smooth business operation, and would provide incentive for them to expand the business. Especially if the CBIC is addressed as the cross state industrial corridor, such support would enhance the attractiveness of the region to the investors.

The central government can provide support to them by firstly organizing the discussion committee to identify and share the key issues in current regulation/laws (especially Labour laws, environment related regulation); and then it can encourage the state governments to hold round table discussion with representatives on regular basis to share successful models and experiences to resolve the issues.

In order to effectively improve the investment environment of CBIC by taking the above mentioned measures, the Government could consider incentivizing investors and designating CBIC as a national “special region”, which allows flexible arrangement of business/investment rules and regulations beyond the regular arrangements in the other regions of India. With the status, the issues which the central Government is in charge, such as most items on taxation, import/export procedures and environment assessment, are easier to be addressed.

Implementing Agency: DIPP, Ministries in charge of each sector

12.5.3 *Investment Promotion Program*

The above mentioned issues and recommendations would be considered to be dealt under the integrated programme focusing on urgent needs of debottlenecking in hard and soft infrastructure and improve investment environment.

JICA has set up a program loan for Tamil Nadu State which deals with existing infrastructure bottlenecks as well as policy issues. The similar initiatives would be necessary for further promotion of business environment in the region.

The program loan to Tamil Nadu Government is supposed to be the concessional loan of 13 billion yen (approximately Rs. 767 Crore) in 2015 under the JICA's program entitled "Sector Program Loan for Tamil Nadu Investment Promotion Program." The main purpose of the program is the improvement of investment environment in Tamil Nadu. The expected outcome consists of the following four components: 1) improvement of investment application process, 2) enhancement of land acquisition system, 3) promotion of capacity development for industrial workers, and 4) development of the Governmental mechanism on construction of link infrastructures, e.g., road, power and water, surrounding key industrial parks where foreign companies/investors are in operation. The fund will be disbursed in stages upon the result of annual joint monitoring by the Tamil Nadu Government and JICA for evaluating the degree of improvement in investment environment. Similar arrangement and funding support from JICA should be applicable for Karnataka and Andhra Pradesh.

Enhancement of the collaboration between Japan and India

Collaboration with Japan is crucial to shift the plan into implementation and bring about the tangible result to the CBIC states. However, despite the fact that the collaboration has been driven forward at the central level, it takes a while for the decision or order from the central to the field at the state level; sometimes the private sector cannot endure the time taken for the decision to be made and to take effect. It also applies to the bottom up case; the decision agreed at the state level often takes time to reach to the central level, resulting in the missing the opportunity for the private sectors.

As the recommendation to solve the issue, the multi-layer collaboration needs to be promoted; Japanese experts are to be assigned at the multi layers of the organization as the collaboration liaison for Japanese companies and India companies as well as governments.

At the central level, the key bottleneck for the Japanese companies is that they need to negotiate with various ministries in order to obtain approval and agree on conditions, which takes a large volume of men-hours. The expert can support and facilitate the process by handling the procedure likely to take place at the central level for the CBIC projects.

At the CBIC special unit level, coordination between CBIC as a region and state government is to be a key; as the state government may have the different priority in the projects which are not aligned with CBIC, the balance of those needs to be controlled as the situation changes. If such coordination is delegated to an each private company, it is likely to block their actual business operation and discourages them to conduct further investment. Some personnel assigned as a coordinator will help both of India and Japan to build the win-win relation.

And the expert at the state level also takes important role. It is often contended that the investors or industry experts find it hard to communicate with the state government since they do not have much relationship at each state level; however, it is also told that the network at the state level is indispensable for smooth business operation in all the states in India. The expert will support to build in tight collaborative relation between India and Japan, then maximize the benefit of the collaboration.

All those experts need to work closely, exchange information, monitor the situation, and collaborate with Government of India and Japan to conduct further approach, if required.

13 Way Forward for Development of Nodes

The following activities need to be undertaken by the Government of Andhra Pradesh (GoAP) for moving project towards implementation of Krishnapatnam Node.

Legal/Regulatory Framework

Basic legal/regulatory framework needs to be developed and enacted.

c) Declaration of Industrial Township of the proposed Krishnapatnam node as aligned to Article 243Q

d) Review of samples of State Support Agreement (SSA) and Share Holder Agreement (SHA) and starting a dialogue with DIPP to discuss and sign the agreements

- Need to identify the role and responsibilities of each stakeholder, i.e. NICDA, State, and private sector

Institutional Framework

Based on the legal/regulatory framework, details of roles and responsibilities among central and state governments, and private sectors, setting up necessary organizations and building organization structure, hiring appropriate human resource will be required.

g) Issue of Government Order for Establishment of Institutional Structure as agreed by GoAP

h) Setting up Development Authority which will assume the role of the municipal body for the node

i) KPIL representation in node development SPV needs to be decided

j) Setting up a node development SPV

k) Developing a framework on the involvement of additional private sector to the node and infrastructure development

- Set up a strategy to have effective involvement of private sector
- Conduct market soundings with potential private developers
- Develop action plan and road map

l) Establishment of Program Management Unit within [APIIC or an appropriate organization] as a transition unit to lead coordination with Central Govt and State Govt Agencies and facilitate the implementation of the role of State under SSA and SHA

Financial Framework

Since the node development includes the large area development and various infrastructure developments, an integrated financial strategy will be required.

e) Prioritizing node and infrastructure development projects

f) Development of a funding plan considering economic and financial implication of prioritized projects on competitiveness of the node

g) Identification of alternatives on funding source including own budget, funds from central government, donor support funding (a project specific loan, a budget support loan) etc.

h) Developing necessary monitoring mechanism of project progress

Operation

Following steps will be required for physical node development and improvement of soft infrastructure.

f) EIA (to be initiated by DIPP)

g) Land assessment of the node to identify the details of necessary land development work

h) Preparation for land acquisition plan for the part of land which is not owned by GoAP currently within Master Plan Area so as to avoid the higher acquisition price due to speculation

i) Identification and preparation of priority projects under State responsibility

j) Developing a framework to implement necessary steps in response to recommendation on investment environment improvement including assurance of infrastructure services, supply of skilled labour, streamlining of business process etc.

Appendix A. - Industrial Analysis

A.1. Central and State Scheme for Electronics Sector

Scheme	Policy	Incentive
Central Scheme	EMC(Electronics Manufacturing Clusters)	75% of the project cost (subject to the a ceiling of Rs.50 Crore) given to SPV formed for this purpose
	MIP-S (Modified Special Incentive Package Scheme)	CPEX subsidy of 25% to Non-SEZ Units Reimbursement of CVD for capital equipment for Non-SEZ Units Reimbursement of central taxes and duties (custom duties, service tax, excise duty) for high technology and high capital investment units (such as semi-conductor units)
State Scheme	ESDM Policy 2014	Reimbursement of 50% of the actual costs for filling a patent. Reimbursement of 50% of actual cost incurred in export promotion activities (international marketing, sales promotion, trade show participation etc.) Reimbursement of 20% of the actual R&D expenses 10% capital subsidy or Rs. 5 crore for the first two Anchor Units in greenfield cluster Reimbursement of 95% of Central Sales Tax for domestic sales outside Karnataka (inter-state sales),
	Millennium IT Policy 2000	The lowest taxation; 0.25% on computers and computer peripherals , and 4% work contract tax on the annual maintenance contract on hardware exempt from payment of entry tax and purchase tax on computer hardware, computer peripherals and other capital goods including captive power generation sets, during the implementation stage which can be extended up to five years from the date of commencement of implementation sales tax exemption for a period of 10 (ten) years or deferment for a period of 12 (twelve) years, subject to a ceiling of 200% (two hundred percent) of the value of fixed assets. For IT industry with Captive power generation, total exemption from payment of electricity tax and total exemption from payment of sales tax on fuel used for captive power generation Special incentives for Mega projects (the investment more than

Scheme	Policy	Incentive
		Rs.100 crore)

Source: EMC notification, ESDM Policy 2014, IT Millennium Policy

A.2. Electronic Products under BIS registration

The Department of Electronics and IT (DeitY) has issued the Electronics and Information Technology Goods (Requirements for Compulsory Registration) Order, 2012, bringing into force a scheme for mandatory regime of registration of 15 electronics products. Subsequently, another 15 products were added as per Notification dated 7th November, 2014.

Sl.No.	Product
1	Electronic Games (Video)
2	Laptop/Notebook/Tablets
3	Plasma /LCD /LED Televisions of screen size 32" & above
4	Optical Disc Players with built in amplifiers of input power 200W and above
5	Microwave Ovens
6	Visual Display Units , Video Monitors of screen size 32" & above
7	Printers, Plotters
8	Scanners
9	Wireless Keyboards
10	Telephone Answering Machines
11	Amplifiers with input power 2000W and above
12	Electronic Musical Systems with input power 200W and above
13	Electronic Clocks with Mains Powers
14	Set Top Box
15	Automatic Data Processing Machine
16	Power Adaptors for IT Equipment
17	Power Adaptors for Audio, Video & Similar Electronics Apparatus
18	UPS/Invertors of rating ≤ 5k VA
19	DC or AC Supplied Electronics Control gear for LED Modules
20	Sealed Secondary Cells / Batteries containing Alkaline or other non-acid Electrolytes for use in portable applications
21	Self-Ballasted LED Lamps for General Lighting Services
22	Fixed General Purpose LED Luminaries
23	Mobile Phones
24	Cash registers
25	Point for Sales Terminal
26	Copying Machines / Duplicators
27	Smart Card Readers
28	Mail Processing Machines/Postage Machines/Franking Machines
29	Passport Reader
30	Power Banks for use in portable applications

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A.3. Central and State Scheme for Food Processing Sector

Scheme	Policy	Incentive
Central Scheme	Mega Food Park Scheme	A capital grant at the rate of 50 percent of the eligible project cost (excluding cost of land, preoperative expenses and margin money for working capital)
State Scheme	Integrated Agribusiness Development Policy 011	Exemption from Stamp Duty for MSME, Large and Mega agro based industries and agri infrastructure The exemption of stamp duty and concessional registration charges 100% exemption from payment of Entry Tax on 'Plant and Machinery and Capital Goods' for an initial period of 3 years from the date of commencement of project implementation For 100 % EoU, 100 % exemption from payment of ET on 'Plant & Machinery and Capital Goods' for an initial period of 5 years from the date of commencement of project implementation Exemption of APMC cess / fees for MSME, Large and Mega agro based industries and agri infrastructure One time capital subsidy up to 50% of the cost of effluent treatment plants (ETPs), subject to a ceiling of `100 lakhs by MSME, large and mega agro based industrial unit and `500 lakhs for common effluent treatment plant established as part of agri infrastructure facility All new large and mega agro based industries established shall be offered interest free loan on VAT as prescribed

Appendix B. -Methodology for designing and evaluating railway connections to the proposed new manufacturing nodes

B.1. Methodology

B.1.1 - Concept of Logistics Hubs and their operation

The connection of the proposed manufacturing nodes by rail, and to a lesser extent by road, is vitally dependent upon the efficient operation of centrally located intermodal transfer terminals, or Logistics Hubs, within each node. These Logistics Hubs, which are evaluated in detail in the Logistics section of the Draft Final Report, will facilitate the transfer of cargo between road and rail, as well as the handling, storage and, where necessary, customs clearance, of containerized and breakbulk cargo. They are also the only practical means by which rail can access each node. The same is not true of road transport which can access individual manufacturing establishments within the nodes, via a dense network of local roads which will be provided in each node. Thus, rail connections to the nodes are inextricably linked to the operation of Logistics Hubs and will to a large extent determine the component facilities and layouts of the latter.

B.1.2 - Railway electric traction

Recent discussions between the CBIC Railway team and the Advisor (Infrastructure) to the Indian Railway Board confirmed that the Indian Railways has an expectation of serving each node by electric, rather than by diesel, traction.[57] This is because the Southern and South Central Railways have already electrified most of their networks and the South Western Railway is implementing plans for the rapid electrification of its network.

A major problem which arises in connection with the construction of Logistics Hubs is that the rail sidings for loading/unloading of cargo in the hubs cannot be equipped with overhead catenaries for electric traction. This is due to the potential interference of overhead lines with the operation of high lift cargo handling equipment, such as reach-stackers and top lifting forklifts. Further, en-route changes of traction from diesel to electric are not considered practical, since they will greatly impair rail efficiency and add to operating costs.

Therefore, it will be essential to construct reception sidings just outside the hub boundaries to allow electric locomotives to be repositioned at the rear of their trains and to push back complete train consists (of up to 700 metres in length) into the loading/unloading sidings within the hub. For this purpose, approximately the first 150 metres of track within the hub leading into the loading/unloading sidings would have to be overhead wired. In this way, electric locomotives will be able to enter loading/unloading sidings as far as the second pantograph on each unit, to couple to or uncouple from their trains and to move forward under electric power to the reception sidings.

[57] Meeting between G Pillai, Adviser Infrastructure of the IR Board, and P Hodgkinson and D Vijayaraghavan of the CBIC Rail team in New Delhi. on 13 November 2014.

B.1.3. - Types of traffic to be handled in Logistics Hubs

It is not considered practical to develop logistics hubs to handle any traffic other than containers or break-bulk. The traffic forecasts prepared by the CBIC Railway Team envisage that the outputs of the nodes will, with the exception of those dispatched to short haul destinations, be containerized. In the case of inputs, with the exception of liquid petrochemicals which will be fed into Ponneri and Krishnapatnam by pipeline, almost all inbound tonnage will be steel moved in break-bulk lots, either from the ports by road or from domestic steel plants by rail. [58]

The initial input/output analysis which was based on the land acreage forecasts of the PWC team envisaged that metal manufacturing would take place within all nodes. This is not considered to be realistic in view of the likelihood that it would require transport of coal or other bulk minerals by rail and the creation of large stockpiles of such materials within each node (and possibly hub). Accordingly, the Rail team has modified the forecast to allow only for inputs of manufactured metals for downstream manufacturing processes, such as auto component, machinery or medical equipment manufacture.

B.1.4. - Management and financing of Logistics Hubs

It is assumed that Logistics Hubs will be constructed by the SPV companies established by the Government to act as landlords and developers of the nodes. It is likely that the management and operation of the hubs will be contracted out through a competitive bidding process, to logistics specialists who will be required, at minimum, to invest in and operate cargo handling equipment within the hub. It is possible that the hubs could be run along the lines of the CONCOR model, whereby the entirety of the investment in the hub (in the infrastructure, as well as in the cargo handling equipment) could be the responsibility of the hub operator. In this case, the operator would also invest in specialized container wagons, contract with the railways for the scheduling and haulage of trains, and recover costs through haulage charges on freight customers.

The role of Logistics Hub operators and SPV companies might therefore be clearly defined inside and outside the hub. *Inside the hub*, hub operators might be responsible for:

(i) Construction and maintenance of paving, roads, railway sidings, buildings and utilities; and

(ii) Acquisition, operation and maintenance of reach-stackers, top lifting forklifts, small forklifts in the CFS, racking systems and pallet movers.

Costs incurred in these activities, including the payment of land rent to the SPV company, would be offset by *handling charges* to be paid by freight customers.

Outside the hub, the SPV company might be responsible for:

(i) Construction and maintenance of electrified access lines (connecting to mainline) and reception sidings.

The cost of this investment would be recovered in the land rent chargeable to the hub operator, who in turn would pass this cost on to freight customers as part of the haulage charge.

Outside the hub also, the hub operator might be responsible for:

(i) Acquisition and maintenance of container wagons

(ii) Scheduling and managing the arrival and departure of container and steel trains

(iii) Arranging with the Railways for the scheduling and haulage of container and steel trains

[58] Where steel is moved by road from the ports, it is assumed that it will by-pass Logistics Hub and be transported directly to factories.

In the case of items (iv)-(vi), the hub operator would be required to contract with the Railway and would pay the IR haulage charge, which would be passed directly on to freight customers together with allowances for wagon investment and the payment of land rent to the SPV. In this sense, haulage charges made on freight customers would be revenue neutral, merely recovering costs incurred by the hub operator outside of the hub.

Such an arrangement would have the benefit of providing a clear demarcation between responsibility for infrastructure provision and maintenance *inside* the hub, which would be that of the hub operator and that *outside* of the hub which would be the responsibility of the SPV. In that sense, the responsibility of the SPV will be identical to the SPV's responsibility to provide other infrastructure, including roads, within the node.

With specific regard to the Ponneri Node, it is unclear at this stage whether the SPV would be required to contribute directly or indirectly to the cost of the Minjur-Ennore Port railway line from which the access line to Ponneri would take off. A direct contribution could be in the form of a share of the capital costs of the line, which is currently expected to be financed by Ennore Port (now renamed Kamarajar Port) and possibly Kattupalli Port (whose contribution would fund a siding to their port from the line).

There could also be an expectation of an indirect contribution from the Node via track access charges. While there is an agreement between Kamarajar Port Ltd and IR that no charge would be made for railway traffic to and from the port, there is no similar guarantee that other traffic (e.g. to Ponneri node) would not have to pay for operations on the Minjur – Ennore line.

This access charge would be paid by Indian Railways and transferred to the Hub Operator via the haulage charge. If this is likely to eventuate, it could threaten the viability of the node and should be strongly resisted.

In the light of the likely management and financing arrangements for the logistics hubs (as outlined above), it was decided that the financial appraisal should be undertaken *only in respect of the investment required inside the hub* and therefore to be borne directly by the hub operator. Investments in the railway facilities outside the hub are expected to be recovered from haulage charges made by the hub operator on freight customers.

It should be noted that in the case of steel traffic, rolling stock is supplied by the Railway and is paid for as part of the haulage charge which is also recovered from freight customers.

B.1.5. - Modal share calculations based on input/output forecasts

Manufacturing inputs and outputs will be transported to and from the proposed nodes by road and rail, and in some limited cases, by pipeline. The input/output analysis on which the transport volumes are based was constructed from land area (acreage) forecasts by type of industry prepared by the PWC Regional Development team. This input/output analysis was prepared by the NK Urban/Industry Planning team. The methodology used to translate the acreage forecasts into input and output tonnages for each industry within each of the manufacturing nodes was described in the Industrial Forecasts section of this report.

It was assumed that the input and output volume forecasts prepared by the Urban/Industry Planning team will be indicative of the actual volumes of freight moving into and out of the nodes in each of the forecast years. However, it was found necessary to make some adjustments to the input/output forecasts because they allow for metal manufacturing from raw materials, which is considered to be beyond the scope of the nodes.

From the adjusted base, it was necessary to estimate the Origin/Destination distribution of the traffic, inclusive of the split of traffic between domestic ODs and the ports, and then to estimate the modal share of the traffic between each Origin and Destination. Ultimately, this information will be needed to estimate the proportion of total traffic arriving in or departing from the nodes by road and rail respectively.

B.1.6. - Adjustment of input/output forecasts

The forecast of land area allocation by industry used as a basis for input/output tonnage forecasts was adjusted as follows:

(i) The allocation to "Metallurgy" was changed to Auto Components, Equipment and (where relevant) Medical Equipment manufacture, for the reasons given in Section 1.3 above;

(ii) Only the first two years of the acreage forecast were used to establish the starting input/output tonnages for all nodes and growth in subsequent years was assumed to be at BIS rate of 11.42% as identified in Interim Report 2.

The second of the above changes was made because the average rates of growth derived from the acreage forecasts were greater than 15% per year and thus would neither be realistic nor sustainable over the 20 year forecast timeframe.

The resulting adjusted forecasts of input/output tonnages are as follows:

Appendix 1: Input / Output Tonnage Forecasts (adjusted)

Node	Inputs (tonnes)				Outputs (tonnes)			
	2017/18	2023/24	2027/28	2032/33	2017/18	2023/24	2027/28	2032/33
Ponneri	627,783	1,078,017	1,851,149	3,178,756	538,046	923,922	1,586,541	2,724,376
Tumkur	417,070	716,184	1,229,817	2,111,818	378,213	649,459	1,115,238	1,915,065
Krishnapatnam	553,636	950,693	1,632,511	2,803,314	492,022	844,890	1,450,828	2,491,333

B.1.7. - Origin/Destination estimates

Input/output tonnage estimates for each industry within each node were split by principal OD pairs in two ways.

First, the shares of input and output volumes originating in or bound for the ports were determined on the basis that:

(i) On average about 20-30 per cent of the output tonnages of the Ponneri and Tumakuru nodes and about 40 per cent of Krishnapatnam's output tonnages would comprise containerized exports bound for the ports[59];

(ii) All of the export container volume originating in the Ponneri and Krishnapatnam nodes would be transported by road to nearby ports, while the export container volume from Tumakuru would be split equally between Ennore and Krishnapatnam ports (with a major share of the volume being transported by rail);

(iii) Steel carried in break-bulk form would comprise the major share of input tonnage to all nodes.

(iv) In the case of Ponneri and Krishnapatnam, steel inputs would be split 50:50 between imports through the ports and steel from domestic sources (Salem for Ponneri and Bellary for Krishnapatnam), while all of Tumakuru's steel inputs would be sourced from Bellary.

Second, the 60-80% of output tonnage bound for domestic destinations was assumed to be split 60%:40% between long haul and short haul destinations respectively. New Delhi, being the focus of freight flows to northern India was assumed to account for some 60% of the long-haul tonnage.

B.1.8. - Modal share estimates

In general, the modal share assumptions were as follows:

(i) For freight hauls in excess of 450 km, rail will have a 100% share;
(ii) For freight hauls of 300-450 km, the respective shares of rail and road will be 80%:20%; and
(iii) For freight hauls of less than 300 km, road will have a 100% share.

[59] The share of exports in Krishnapatnam's output was expected to be relatively high owing to the assumed greater capacity of the port to attract mainline container vessel calls in future years.

A comparison of road and rail charges for the haulage of containers in the Chennai-Bengaluru corridor was made as a basis for estimating the likely modal shares in this corridor of 330-350 km. The results of this analysis are given in Appendix 2 below. They indicate that if the inverse relationship between road and rail haulage rates is used to determine the relative modal shares, rail would have nearly an 80% share of the 20ft container volume carried in the westbound direction and a share of greater than 80% of the eastbound volume.

Significant service differences between road and rail could operate to limit the rail share. For example, if rail service delivery is at a lower level than that of road owing to the operational priority given to passenger traffic, rail could suffer a reduction in its modal share of container traffic in the corridor, notwithstanding its price advantage.

This was found to explain why rail had failed to penetrate the market for transport of new cars, despite the introduction of a new auto transport policy which involved investment in new multi-level car transporter wagons and a significant price advantage over road transport (see Interim Report 3).

While it is likely that IR will continue having to give operational priority to passenger traffic, it must be hoped that the proposed expansion of track capacity in certain critical line sections (as outlined in Interim Report 2) will compensate for any negative effects of such a policy on service delivery.

Appendix 2: Comparative analysis of charges for road and rail haulage of containers

1. Comparative distances

Route	Road distance (Km)	Rail distance (Km)
Harbour of Madras - Bengaluru (centre)	342	N/A
Harbour of Madras - Whitefield ICD	322	334

2. Comparative haulage charges

Route		Road		Rail		Ratio rail/road	Inverse ratio	Indicated modal shares	
		Rs.per container	Rs.per container-km	Rs.per container	Rs.per container-km			rail	road
Harbour of Madras - Whitefield	20ft loaded	36,000	111.80	10,200	30.54	0.27	3.66	78.5%	21.5%
	20ft empty	12,000	37.27	7,000	20.96	0.56	1.78	64.0%	36.0%
	40ft loaded	40,000	124.22	16,500	49.40	0.40	2.51	71.5%	28.5%
	40ft empty	18,000	55.90	13,000	38.92	0.70	1.44	59.0%	41.0%
Whitefield - Harbour of Madras	20ft loaded	36,000	111.80	6,800	20.36	0.18	5.49	84.6%	15.4%
	20ft empty	12,000	37.27	4,700	14.07	0.38	2.65	72.6%	27.4%
	40ft loaded	40,000	124.22	10,850	32.49	0.26	3.82	79.3%	20.7%
	40ft empty	18,000	55.90	8,600	25.75	0.46	2.17	68.5%	31.5%

Assumptions:
(1) Like for like comparison (haulage to/from Whitefield ICD by road vs. rail), on basis that road would have to call at Whitefield for customs inspection
(2) Road rates apply irrespective of direction of travel

The modal share assumptions listed above were used to determine rail modal shares of container and break-bulk traffic to and from each of the 3 proposed manufacturing nodes. The results of this analysis, as shown in Appendix .3, reflect the following assumptions:

(i) The rail share of container transport volume is highest for the Tumakuru node where the average haulage distance is significantly greater than 450 km and lowest for the Ponneri and Krishnapatnam nodes where local road hauls of containers between the nodes and the neighbouring ports predominate;

(ii) Steel haulage between Tumakuru and Bellary is 100% by rail, owing to the advantage that rail has with the operation of specialized steel carrying wagons marshalled into long unit trains, despite the haul distance being less than 300 km;

(iii) In the case of Ponneri and Krishnapatnam, steel haulage is split 50:50 between imports through the ports and domestically produced steel, with the result that their steel input volumes are shared equally between road and rail;

(iv) Food grains transported to Tumakuru and Krishnapatnam for food processing industries are likely to be sourced locally and hence will be transported 100% by road;

(v) Computer and defence products are likely to be transported entirely by road to local markets (or to airports) for further processing;

(vi) Since there is a large imbalance between inbound and outbound container flows (with outbound flows being much higher than inbound flows), it will be necessary to re-position empty containers from Ennore and Krishnapatnam ports. This will be done by road in the case of Ponneri and Krishnapatnam nodes and predominantly by rail in the case of Tumakuru;

Appendix 3: Ponneri node - Rail shares of container and break-bulk volume

Traffic category	2017/18	2022/23	2027/28	2032/33
Containers				
- Loaded inbound (TEU)	777	1,334	2,291	3,933
- Loaded outbound (TEU)	18,448	31,679	54,398	93,411
- Empty Inbound (TEU)	26,892	46,178	79,296	1,36,165
Total	46,117	79,191	1,35,984	2,33,510
Containers - rail volume				
- Loaded inbound (TEU)	777	1,334	2,291	3,933
- Loaded outbound (TEU)	11,711	20,110	34,533	59,300
- Empty Inbound (TEU)	0	0	0	0
Total	12,488	21,444	36,824	63,233
Containers - rail share (%)				
- Loaded inbound (TEU)	100%	100%	100%	100%
- Loaded outbound (TEU)	63%	63%	63%	63%
- Empty Inbound (TEU)	0%	0%	0%	0%
Total	27%	27%	27%	27%
Breakbulk				
- Inbound (tonnes)	76,263	1,30,958	2,24,878	3,86,156
- Outbound (tonnes)	2,19,125	3,76,278	6,46,136	11,09,533
Total	2,95,389	5,07,235	8,71,014	14,95,688
Breakbulk - rail volume				
- Inbound (tonnes)	76,263	1,30,958	2,24,878	3,86,156
- Outbound (tonnes)	0	0	0	0
Total	76,263	1,30,958	2,24,878	3,86,156
Breakbulk - rail share %				
- Inbound	100%	100%	100%	100%
- Outbound	0%	0%	0%	0%
Total	26%	26%	26%	26%
Petrochemicals - inbound pipeline (t)	4,63,993	7,96,759	13,68,179	23,49,410

Appendix 4: Tumakuru node - Rail shares of container and break-bulk volume

Traffic category	2017/18	2022/23	2027/28	2032/33
Containers				
- Loaded inbound (TEU)	3,679	6,317	10,848	18,628
- Loaded outbound (TEU)	17,779	30,529	52,424	90,021
- Empty Inbound (TEU)	14,100	24,212	41,576	71,393
Total	35,557	61,058	1,04,847	1,80,042
Containers - rail volume				
- Loaded inbound (TEU)	3,161	5,427	9,320	16,004
- Loaded outbound (TEU)	15,755	27,053	46,456	79,773
- Empty Inbound (TEU)	12,594	21,626	37,136	63,769
Total	31,509	54,107	92,911	1,59,545
Containers - rail share (%)				
- Loaded inbound (TEU)	86%	86%	86%	86%
- Loaded outbound (TEU)	89%	89%	89%	89%
- Empty Inbound (TEU)	89%	89%	89%	89%
Total	89%	89%	89%	89%
Breakbulk				
- Inbound (tonnes)	2,21,033	3,79,553	6,51,761	11,19,191
- Outbound (tonnes)	63,875	1,09,685	1,88,349	3,23,430
Total	2,84,908	4,89,238	8,40,110	14,42,620
Breakbulk - rail volume				
- Inbound (tonnes)	1,65,866	2,84,821	4,89,089	8,39,855
- Outbound (tonnes)	0	0	0	0
Total	1,65,866	2,84,821	4,89,089	8,39,855
Breakbulk - rail share %				
- Inbound	75%	75%	75%	75%
- Outbound	0%	0%	0%	0%
Total	58%	58%	58%	58%
Petrochemicals - inbound pipe+road	1,38,806	2,38,354	4,09,298	7,02,837

Appendix 5: Krishnapatnam node - Rail shares of container and break-bulk volume

Traffic category	2017/18	2022/23	2027/28	2032/33
Containers				
- Loaded inbound (TEU)	528	907	1,557	2,674
- Loaded outbound (TEU)	12,355	21,216	36,431	62,559
- Empty Inbound (TEU)	11,827	20,309	34,874	59,885
Total	24,710	42,431	72,862	1,25,118
Containers - rail volume				
- Loaded inbound (TEU)	528	907	1,557	2,674
- Loaded outbound (TEU)	6,211	10,665	18,314	31,449
- Empty Inbound(TEU)	0	0	0	0
Total	6,739	11,572	19,872	34,123
Containers - rail share (%)				
- Loaded inbound (TEU)	100%	100%	100%	100%
- Loaded outbound (TEU)	50%	50%	50%	50%
- Empty Inbound (TEU)	0%	0%	0%	0%
Total	27%	27%	27%	27%
Breakbulk				
- Inbound (tonnes)	4,68,967	8,05,300	13,82,845	23,74,594
- Outbound (tonnes)	1,90,649	3,27,378	5,62,167	9,65,341
Total	6,59,615	11,32,678	19,45,012	33,39,935
Breakbulk - rail volume				
- Inbound (tonnes)	92,192	1,58,310	2,71,847	4,66,810
- Outbound (tonnes)	0	0	0	0
Total	92,192	1,58,310	2,71,847	4,66,810
Breakbulk - rail share %				
- Inbound	20%	20%	20%	20%
- Outbound	0%	0%	0%	0%
Total	14%	14%	14%	14%
Petrochemicals - inbound pipeline	77,012	1,32,243	2,27,084	3,89,945

A high proportion of the outputs dispatched from the nodes, whether for export through the ports or for transport to domestic destinations, *will be containerized*. In general, only outputs transported by road to local markets will not be containerized.

Among the inputs, only steel, which is typically transported in break-bulk form, or liquid petrochemicals, which are mostly transported by pipeline, are not transported in containers.

The factors used in converting input/output tonnages to TEU volumes, where relevant, are as follows:

Appendix 6: Conversion factors for TEUs

Product	Tones per TEU
Medical Equipment	19
Auto Components	19
Electrical and other machinery	19
Processed Foods	16
Textiles and Apparel	14
Plastics and Pharmaceuticals	17

B.1.9. - Principles for designing railway connections to the nodes

In all cases, railway connection will be via short electrified access lines (single track) linking central logistics hubs within each node to the nearest mainline. The principles adopted for railway operation are as follows:

(i) Separate fixed formation trains comprising 45 BLCA wagons for container traffic and 45 BFNS wagons for break-bulk steel traffic will operate between Logistics Hubs in the nodes and designated ODs without stopping except for technical purposes (e.g. crew and locomotive changes, fueling, sanding, etc);
(ii) A single 4,500 KW (6,035 HP) WAG9 electric locomotive, or equivalent, will be sufficient to haul both container and steel trains;
(iii) Full length trains will directly arrive in and depart from electrified 3 track reception sidings located just outside the hub boundaries;
(iv) On arrival in the reception sidings, mainline locomotives will uncouple and run around their trains, in order to push back into the non-electrified loading/unloading sidings within the hub, using the electrified approach tracks;
(v) After placing their trains, locomotives will return to the reception sidings. When unloading, re-loading and train inspection have been completed, locomotives will pull their trains out of the hub and depart directly for their ultimate destination;
(vi) Train inspection and brake testing will be carried out while trains are loading or unloading cargo.

Planning of the lengths of the reception and loading/unloading sidings is based on the following calculation of train length.

Appendix 7: Train Composition and Length

Train Type	Vehicle Type	No. in consist	Length over couplers (meters)	Overall length (metres)
Containers	WAG 9 electric loco	1	20.50	20.50
	BLCA container flat	45	14.63	658.13
	Brake van	1	15.00	15.00
	Total			693.63
Steel	WAG 9 electric loco	1	20.50	20.50
	BFNS steel wagon	45	14.72	662.22
	Brake van	1	15.00	15.00
	Total			697.72

On this basis the length required between the turnout (switch) and the buffer stop in the loading/unloading sidings has been determined at 700 metres, while in the reception sidings the length will be 750 metres (to allow for some braking distance).

B.1.10 - Principles for designing logistics hubs for the nodes

In each case, railway access to the node will be provided to a "Logistics Hub", which will allow for the handling, storage and, where necessary, customs clearance, of containerized and break-bulk cargo (mainly steel).

The central feature of each node will be a set of tracks (three each for Tumakuru and Ponneri and two for Krishnapatnam) for the loading/unloading of containers and break-bulk cargo. *These tracks must allow for the receipt and dispatch of full length unit trains running between a single origin and a single destination, without being broken up or re-marshalled.* The length and traction type assumptions for the track layout within the hub are given in the preceding sections.

The steel and container handling areas will be separated by a chain link fence, and provided with their own security controlled entrances. In the Ponneri and Tumakuru hubs, a paved container yard would be provided on either side of the rail sidings to allow the discharge and loading of wagons by reach-stacker and heavy duty forklift equipment. In the case of Krishnapatnam a single container stacking area would be provided adjacent to the single container loading/unloading track. The tracks would be embedded in pavement to allow cargo handling equipment to work both sides of a train at the same time. In the case of both container and steel trains, handling equipment would work along a frontage of 600 metres.

The CY and steel storage areas are assumed to be dimensioned with lengths of 600 metres and 400 metres respectively. Their widths are determined by the projected cargo volume in the last year of the forecast period (2032/33). In the case of Ponneri and Krishnapatnam, the container stacks will be three TEU deep, while those in Tumakuru will be two TEU deep, giving widths of 18.3 m and 12.2 metres respectively. Roadways will be provided on either side of the rail sidings to allow direct transfer of containers and steel between wagons and road trailers or trucks.

Other facilities to be provided within each hub include: a Container Freight station (CFS -for the stuffing/unstuffing and of containers and for customs inspection of container cargo); a long term warehouse for storage of cargo beyond the free period of 3 days; a two storey administration building with additional space for rental by service providers, such as freight forwarders; a trailer park; a workshop for the container repair and for the maintenance of cargo handling equipment; and gatehouses (for security at both entrances to the hub).

Owing to the need to accommodate long trains, the Logistics Hubs for all three nodes will have a long thin shape, which will allow additional area for future expansion.

Appendix C. – Power & Renewables

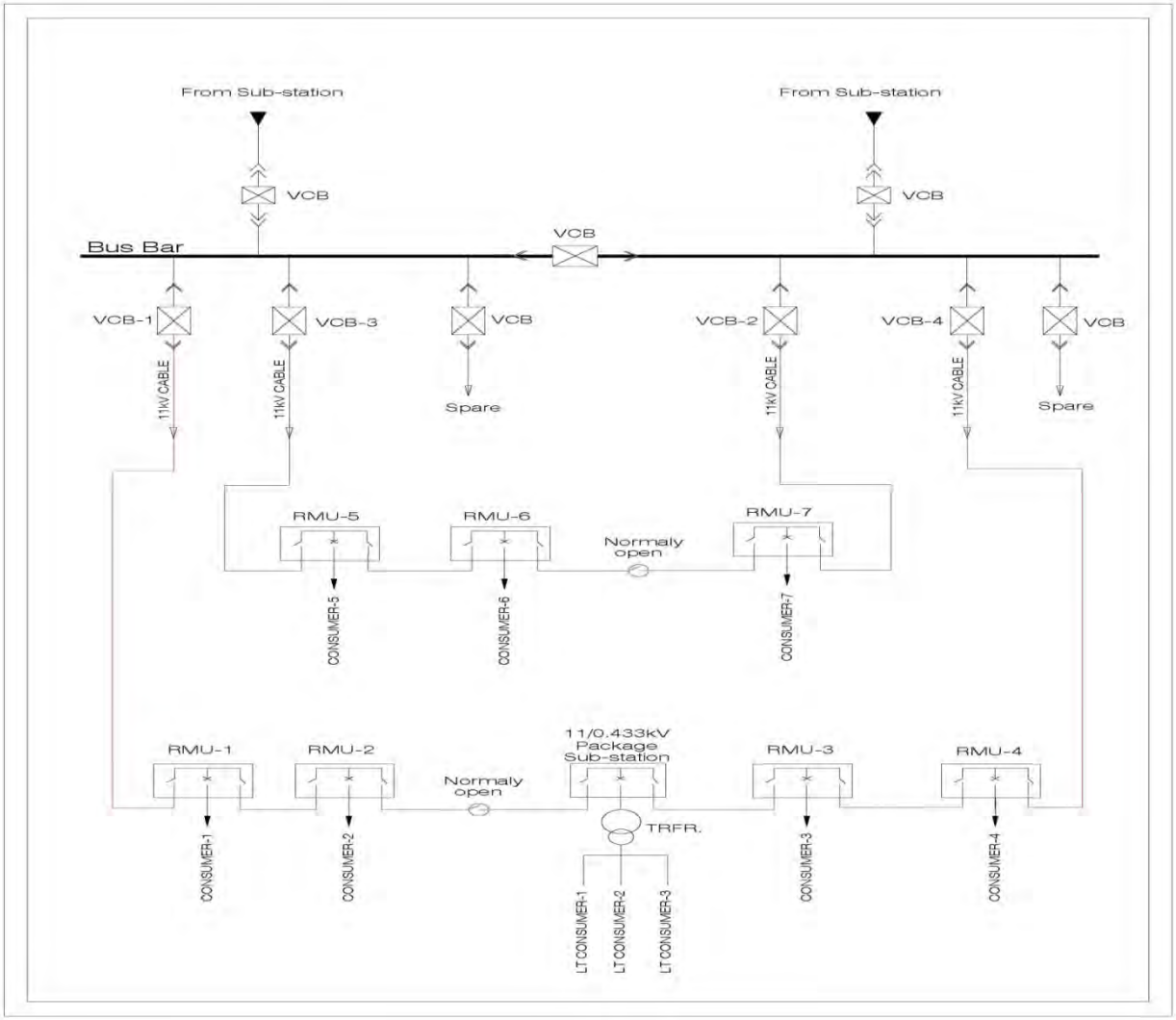
C.1. Assumptions for demand forecast

In order to channelize the study we have made few assumptions which are based on industry standards and norms. Some of the assumptions utilized in the demand forecast model are specified below:

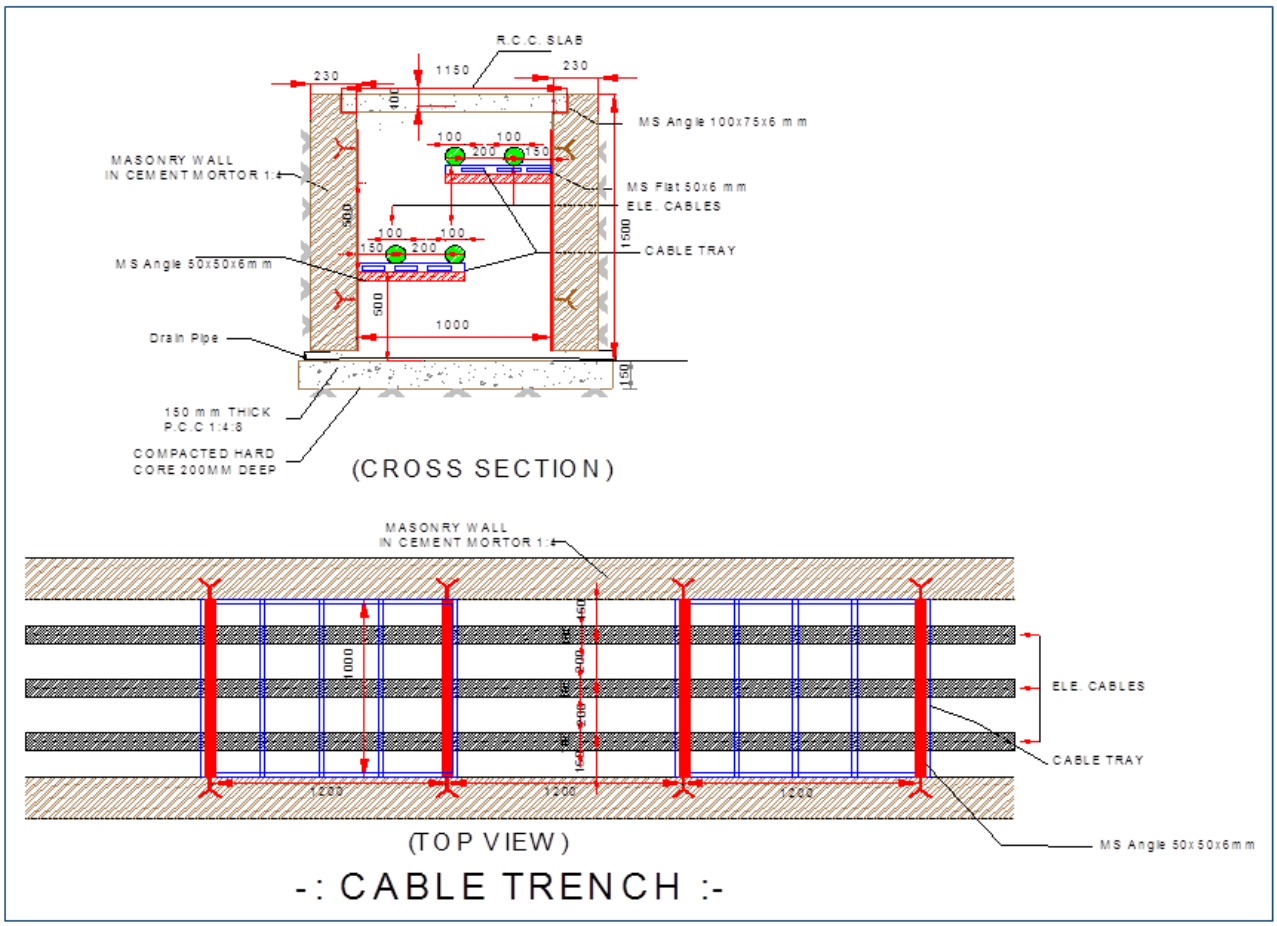
Appendix 8: Assumptions made for demand forecast

Factor	Estimated value	Data source
Load factor	0.66	Industry standards
Conversion factor for km² to Acre	247.11	Standard
Industrial Growth in Andhra Pradesh	8%	Ministry of Commerce & Industry
Direct to Indirect Employment factor	1.50	PwC research
Employment to population conversion factor	0.44	PwC research
Population growth rate of Andhra Pradesh after 10years	1.06%	Office of the Registrar General & Census Commissioner, India
Average per capita consumption growth rate	6.40%	PwC research

C.2. Single Line Diagram for underground distribution network



C.3. Supporting design data on underground distribution system



Proposed Masonry Cable trench on footpath (Cross section)

C.4. Benchmarking demand between SEZs

Power Plant	Capacity (MW)	Area (Acres)	MW/Acres
Mundra SEZ	1300	44,478	0.029
Dahej SEZ	100	4,280	0.023
Kandla SEZ	900	23,408	0.038
Bhilai SEZ	230	4200	0.054
Ponneri	759	21,795	0.034
Krishnapatnam	**301**	**5503**	**0.054**
Tumkur	366	6138	0.059

C.5. Substation Design

Appendix 9: Installed Gas insulated substation: Torrent Power (Agra)

New sub-station design philosophy

In design of a new sub-station, previous learnings from the installations of sub stations need to be incorporated in the smart design. Typically in Indian conditions, we see Air insulated sub stations are used by distribution utilities. However, the conventional Air-insulated substation (AIS) design uses a large number of disconnectors in order to allow for maintenance and repair with a minimum of interruption. The occupied area of AIS is typically large and the maintenance demand of the open-air apparatus is relatively high, particularly in case of severe environmental conditions. Besides, switchgear, its subsystems and components are exposed to aging and wearing during the years of exploitation that leads to the increase in fault events over the years of service. The attempt in the new substation designs is to make them more compact and somewhat protected from the environmental impacts.

Also, the sensing and signal processing in existing substation designs is based on a number of individual sensors being placed in the switchyard and hard-wired directly to the control house. The individual monitoring, control and protection devices that are using those signals for their decision-making are located in the control house. This concept is not facilitating integration of data and signal processing across the substation.

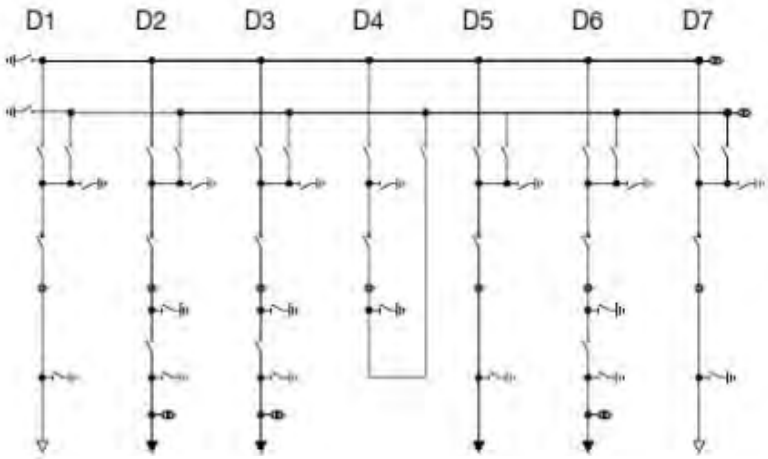
Primary equipment design

The metal-enclosed gas-insulated switchgear inherently follows the criteria for new substation design and offers a higher reliability and flexibility than other solutions. Due to the gas enclosed design, GIS is the most suitable solution for indoor and underground substations. In outdoor and hybrid substations, the occupied area is tremendously reduced by using GIS technology.

GIS configurations can be applied to any type of bus bar arrangements: single busbar, double busbar, single busbar with transfer bus, double busbar with double circuit breaker, one and a half circuit breaker scheme and ring busbar.

The GIS substation also is compact in design and reduces substation area tremendously (at least 70%) compared to the same AIS configuration. This fact allows GIS to become the choice of preference for indoor and underground substation. For a better appearance, an

Appendix 10: Sample SLD for double busbar



Appendix 11: Use of IT in Substation: Torrent Power (Agra)

underground GIS substation can be designed with an aesthetic view that hides its presence

The compact and metal-enclosed design of GIS has prominent advantages and better performance than AIS. However, the high initial investment is a key obstacle in expanding the application of GIS. In remote or rural area, industrial areas or in developing countries, AIS is still the best choice. In places where the cost of land or cost of earthworks is high or where the sceneries cannot be disturbed by AIS, the solution is to use underground or indoor GIS.

Regarding economics, initial capital investment is not enough to evaluate the overall substation project. Life Cycle Cost (LCC) should be considered, including primary hardware cost, maintenance cost, operation cost, outage cost and disposal costs.

The LCC comparison of AIS and GIS is as follows:

1. Primary hardware: For primary equipment, GIS is more expensive than AIS. However, the price of auxiliary equipment such as support, conductors, land, installation, control, protection and monitoring can lead to a cost difference between the two systems being small.

2. Maintenance: The failure rate of circuit breaker and disconnecting switch in GIS is one-fourth of that of AIS and one tenth in case of busbar, thus the maintenance cost of GIS is less than that of AIS over the lifetime.

3. Operation cost: The maintenance cost of GIS and AIS shall be equivalent. The cost for training in GIS is higher than in AIS.

4. Outage cost: Since the failure rate of GIS is lower, the outage cost of AIS shall be greater.

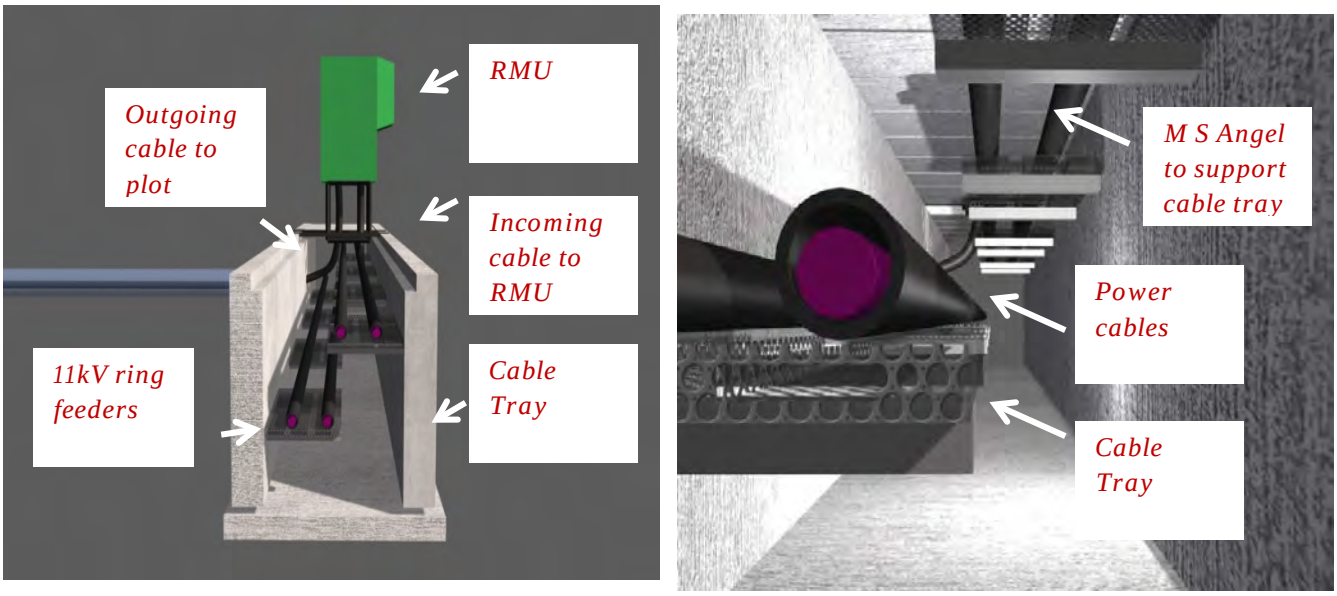
5. Disposal cost: The cost of decommissioning and disposal after use should be capitalized. The value of future expense must be taken into account.

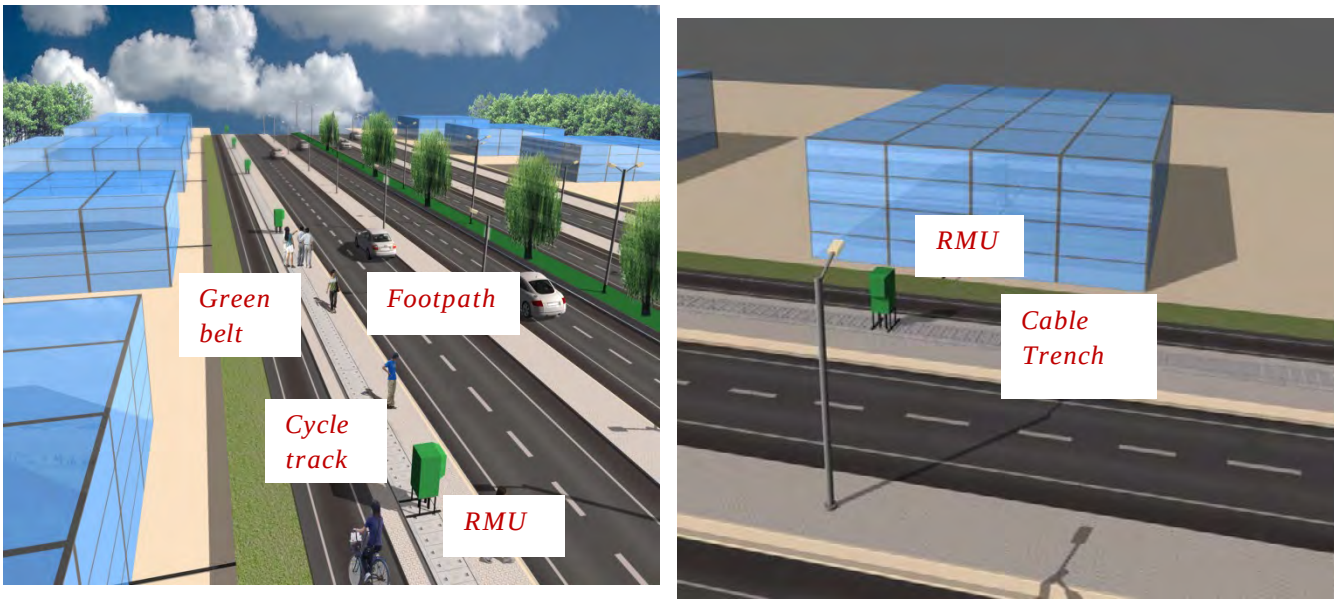
Taking these considerations in mind, we propose installations of Gas insulated sub stations in the node for primary equipment design.

C.6. Underground Distribution Network Design

The illustrative diagrams illustrate the underground distribution network for the node.

Appendix 12: Underground 11kV feeders for node





Appendix 13: Underground feeders with RMU: Sample for illustration *(Source: Naya Raipur Smart City Master Plan- PwC Analysis)*

C.7. Assumptions for Industrial Tariff

	Utility	Category	Tariff, INR/kWh
Karnataka	BESCOM	Industrial	6.82
Tamil Nadu	TANGEDCO	Industrial	7.36
AP	APCPDCL	Industrial	6.20
Gujarat	UGVCL	Industrial	5.88

No.	Particular	Assumption	Units
1	Industrial Load	20	MW
2	Load Factor	0.60	
3	Hours	24	hrs/day
4	Days per month	30	days/month
5	Power Factor	0.80	
6	Units consumed per month	8640000	kWh
7	Taxes and Duties	Not considered	
8	Fuel Surcharge Adjustments	Not considered	
9	AP Charges are for FY 2014-15 and are due to revision in the coming months		

Appendix D- Water Sector

D.1. Applicable Water Quality Standard

Indian Standard Specifications for Drinking Water

Physical and Chemical Quality of Drinking Water

Si.No	Characteristics	Acceptable	Cause for Rejection
1	Turbidity (NTU)	1	10
2	Colour (units on Plantinum Cobalt scale)	5	25
3	Taste and Odour	Unobjectionable	Objectionable
4	pH	7.0 to 8.5	<6.5 or > 9.2
5	Total dissolved solids (mg/l)	500	2000
6	Total hardness (as $CaCO_3$) (mg/l)	200	600
7	Chlorides (as Cl) (mg/l)	200	1000
8	Suiphates (as SO_4) (mg/l)	200	400
9	Fluorides (as F) (mg/l)	1	1.5
10	Nitrates (as NO_3) (mg/l)	45	45
11	Calcium (as Ca) (mg/l)	75	200
12	Magnesium (as Mg) (mg/l)	<30	`150
If there are 250 mg/l of sulphates, mg content can be increased to a mximum of 125mg/l with the reduction of sulphates at the rate of 1 unit per every 2.5 units of sulphates			
13	Iron (as Fe) (mg/l)	0.1	1
14	Manganese (as Mn) (mg/l)	0.05	0.5
15	Copper (as Cu) (mg/l)	0.05	1.5
16	Aluminium (as Al) (mg/I)	0.03	0.2
17	Alkalinity (mg/l)	200	600
18	Residual Chlorine (mg/I)	0.2	>1.0
19	Zinc (as Zn) (mg/I)	5	15
20	Phenolic compounds (as Phenol) (mg/l	0.001	0.002
21	Anionic detergents (mg/l) (as MBAS)	0.2	1
22	Mineral Oil (mg/l)	0.01	0.03
	TOXIC MATERIALS		
23	Arsenic (as As) (mg/l)	0.01	0.05
24	Cadmium (as Cd) (mg/I)	0.01	0.01
25	Chromium (as hexavalent Ct)	0.05	0.05
26	Cyanides (as CN) (mg/l)	0.05	0.05
27	Lead (as Pb) (mg/l)	0.05	0.05
28	Selenium (as Se) (mg/l)	0.01	0.01
29	Mercury (total as Hg) (mg/l)	0.001	0.001
30	Polynuclear aromatic hydrocarbons (PAH) (µg/lo	0.2	0.2
31	Pesticides (total, mg/l)	Absent	Refer to WHO guidelines for drinking water quality Vol I. - 1993
	RADIO ACTIVITY+		
32	Gross Alpha activity (Bq/l)	0.1	0.1
33	Gross Beta activity (Bq/l)	1	1

BACTERIOLOGICAL QUALITY OF DRINKING WATER

Organisms	Guidelines value
All Water intended for drinking	
E.coli or thermotolerant coliform bacteria	Must not be detectable in any 100-ml sample
Treated water entering the distribution system	
E.coli or theromotolerant coliform bacteria	Must not be detectable in any 100-ml sample
Total coliform bacteria	Must not be detectable in any 100-ml sample
Treated water in the distribution system	
E.coli or theromotolerant coliform bacteria	Must not be detectable in any 100-ml sample
Total coliform bacteria	Must not be detectable in any 100-ml sample. In case of large supplies, where sufficient samples are examined, must not be oresent in 95% of samples taken throughout any 12 month period.

Standard for Recycled Water and Facilities Criterion in Japan

No	Characteristics	Standard Value for Touchable Water
1	E.coli	Not detactable
2	Turbidity	2
3	pH	5.8 - 8.6
4	Apparent Condition	Offenseless
5	Color	10
6	Odor	Offenseless
7	Residual Chlorine	Free residual chlorine: 0.1mg/L Combined residual chlorine: 0.4mg/L
8	Facility Criteria	It is necessary to install a coagulating sedimentation tank + a sand filter, or the facilities with as well or better treatment capabilities.

General Standard For Discharge of Environmental Pollutants (Dischare to Inland Surface Water)

No.	Parameter	Standard Value
		Discharge to Inland surface water
1	Suspended solids (SS)	100 mg/L
2	Biochemical Oxygen demand (BOD)	30 mg/L
3	Chemical Oxygen Demand (COD)	250 mg/L
4	Total Nitrogen (T-N)	--
5	Ammonical nitrogen (as N)	50 mg/L
6	Total Kjeldahl Nitrogen (as NH_3)	100 mg/L
7	Free ammonia (as NH_3)	5 mg/L
8	Nitrate Nitrogen	10 mg/L
9	Dissolved Phosphates (as P)	5 mg/L
10	pH Value	5.5 to 9.0
11	Temperature	shall not exceed 5°Cabove the receiving water temperature
12	Oil and grease	10 mg/L
13	Total residual chlorin	1 mg/L
14	Arsenic (as As)	0.2 mg/L
15	Mercury (as Hg)	0.01 mg/L
16	Lead (as Pb)	0.1 mg/L
17	Cadmium (as Cd)	2 mg/L
18	Hexavalent Chromium (as Cr^{+6})	0.1 mg/L
19	Total chromium (as Cr)	2 mg/L
20	Copper (as Cu)	3 mg/L
21	Zinc (As Zn.)	5 mg/L
22	Selenium (as Se)	0.05 mg/L
23	Nickel (as Ni)	3 mg/L
24	Cyanide (as CN)	0.2 mg/L
25	Fluoride (as F)	2 mg/L
26	Sulphide (as S)	2 mg/L
27	Phenoile compounds (as C_6H_5OH)	1 mg/L
28	Radioactive materials:	
	(a)Alpha emitter micro curie/ml.	10^{-7}
	(b)Beta emitter micro curie/ml.	10^{-6}
29	Bio-assay test	90% survival of fish after 96 hours in 100% effluent
30	Manganese (as Mn)	2 mg/L
31	Iron (as Fe)	3 mg/L
32	Vanadium (as V)	0.2 mg/L

D.2. Details of Cost Estimate for Krishnapatnam Node

(1) Construction Cost

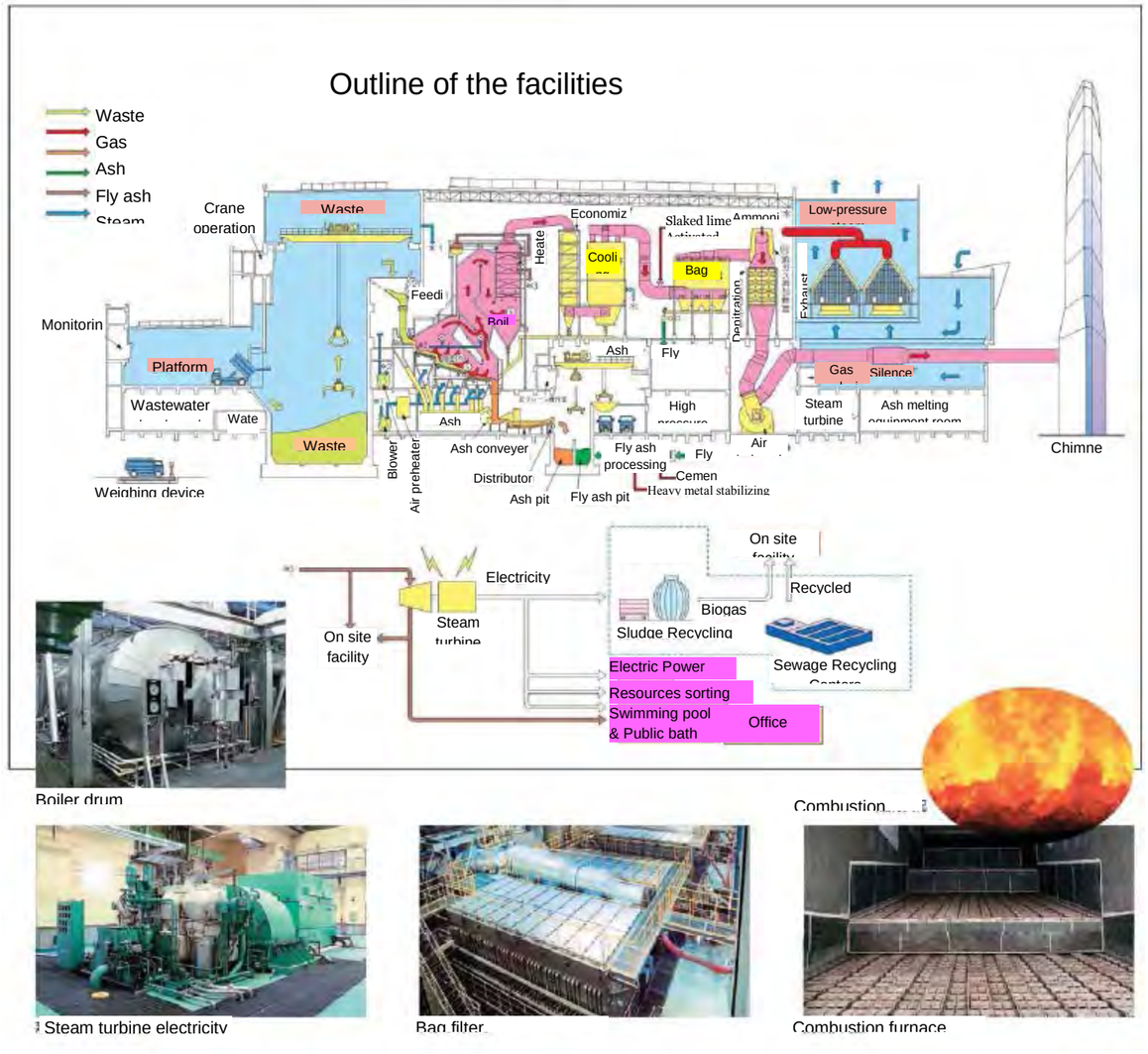
Item	Description		Unit	Unit Rate	Phase 1(2016-2018)		Phase 2 (2019-2023)		Phase 3 (2024-2033)		Total
					Quantity	Cost	Quantity	Cost	Quantity	Cost	
				(INR)		(Million INR)		(Million INR)		(Million INR)	(Million INR)
WATER INFRASTRUCTURES											
1. Potable Water Supply Works	1) Raw Water Treatment System (from Kandaleru Reservoir)	a) Raw water pipe (DCIP, D=1,000mm)	m	83,678	50,000	4,184	0	0	0	0	4,184
	2) Water Treatment System	a) WTP	MLD	10,000,000	19.0	190	30.8	31	28.2	28	249
	3) Potable Water Transmission System	a) Reservoir	ML	7,000,000	9.5	67	15.4	108	14.1	99	273
		b) Pump station	kW	6,000,000	150	900	240	1,440	220	1,320	3,660
		c) Elevated tank	ML	30,000,000	2.00	60	3.20	96	2.95	89	245
		d) Transmission pipe (DIP, D=700mm)	m	45,602	0	0	3,750	171	0	0	171
		e) Transmission pipe (DIP, D=600mm)	m	37,154	0	0	1,980	74	7,430	276	350
		f) Transmission pipe (DIP, D=500mm)	m	27,164	2,600	71	1,500	41	0	0	111
		g) Transmission pipe (DIP, D=400mm)	m	19,061	0	0	0	0	11,130	212	212
		h) Transmission pipe (HDPE, D=300mm)	m	5,441	2,300	13	0	0	0	0	13
	4) Potable Water Distribution System	a) Distribution pipe (HDPE, D=300mm)	m	5,441	19,200	104	0	0	12,900	70	175
		b) Distribution pipe (HDPE, D=200mm)	m	2,054	41,800	86	42,600	88	79,700	164	337
		c) Distribution pipe (HDPE, D=150mm)	m	1,410	25,600	36	70,700	100	86,200	122	257
	Sub-total					5,710		2,147		2,379	10,236
2. Non-Potable Water Supply Works	1) Tertiary Treatment Plant	a) Tertiary treatment plant by RO process	MLD	14,000,000	20.9	293	34.5	483	96.5	1,351	2,127
	2) Non-Potable Water Transmission System	a) Reservoir	ML	7,000,000	10.5	74	17.5	123	48.0	336	532
		b) Pump station	kW	6,000,000	180	1,080	270	1,620	750	4,500	7,200
		c) Elevated tank	ML	30,000,000	2.75	83	3.60	108	8.50	255	446
		d) Transmission pipe (DIP, D=600mm)	m	37,154	0	0	3,000	111	7,500	279	390
		e) Transmission pipe (DIP, D=500mm)	m	27,164	1,450	39	3,500	95	2,000	54	189
		f) Transmission pipe (DIP, D=400mm)	m	19,061	2,500	48	0	0	10,500	200	248
		g) Transmission pipe (HDPE, D=300mm)	m	11,234	0	0	0	0	13,000	146	146
	3) Non-Potable Water Distribution System	a) Distribution pipe (HDPE, D=300mm)	m	5,441	19,200	104	0	0	12,900	70	175
		b) Distribution pipe (HDPE, D=200mm)	m	2,054	41,800	86	42,600	88	79,700	164	337
		c) Distribution pipe (HDPE, D=150mm)	m	1,410	25,600	36	70,700	100	86,200	122	257
	Sub-total					1,842		2,727		7,477	12,046
3. Domestic Sewerage System	1) Sewage Collection System	a) Sewer pipe (RC, D=700mm)	m	12,195	0	0	1,743	21	2,682	33	54
		b) Sewer pipe (RC, D=600mm)	m	7,992	0	0	2,905	23	4,470	36	59
		c) Sewer pipe (RC, D=500mm)	m	6,951	2,285	16	5,810	40	8,940	62	118
		d) Sewer pipe (RC, D=400mm)	m	4,827	9,140	44	11,620	56	17,880	86	187
		e) Sewer pipe (RC, D=300mm)	m	2,640	18,280	48	23,240	61	35,760	94	204
		f) Sewer pipe (RC, D=250mm)	m	1,998	61,695	123	70,882	142	109,068	218	483
		g) Intermediate pump stations	kW	300,000	45	14	125	38	180	54	105
	2) Sewage Treatment Plant	a) Final pump station	kW	2,000,000	20	40	45	90	45	90	220
		b) Sewage treatment plant	MLD	8,000,000	7.7	62	15.3	122	16.4	131	315
	Sub-total					347		594		804	1,745
4. Treated Sewage and Industrial Effluent Collection Works	1) Treated Sewage Transfer System from STP to TTP	a) Transfer pump station	kW	6,000,000	15	90	22	132	65	390	612
		b) Transfer pipe (DIP, D=1000mm)	m	83,678	0	0	0	0	200	17	17
		c) Transfer pipe (DIP, D=700mm)	m	45,602	0	0	200	9	0	0	9
		d) Transfer pipe (DIP, D=500mm)	m	27,164	200	5	0	0	0	0	5
	2) Treated Sewage Transfer from Nellore City to TTP	a) Treated sewage pump station	kW	6,000,000	0	0	0	0	90	540	540
		b) Transfer pipe (DIP, D=1000mm)	m	83,678	0	0	0	0	25,000	2,092	2,092
	3) Treated Effluent Collection and Transfer System	a) Sewer pipe (RC, D=1400mm)	m	40,149	0	0	0	0	894	36	36
		b) Sewer pipe (RC, D=1200mm)	m	32,436	0	0	0	0	2,682	87	87
		c) Sewer pipe (RC, D=1100mm)	m	26,574	0	0	0	0	4,470	119	119
		d) Sewer pipe (RC, D=1000mm)	m	18,603	0	0	1,743	32	6,258	116	149
		e) Sewer pipe (RC, D=900mm)	m	16,812	0	0	2,905	49	8,940	150	199
		f) Sewer pipe (RC, D=800mm)	m	14,580	1,371	20	5,810	85	13,410	196	300
		g) Sewer pipe (RC, D=700mm)	m	12,195	2,285	28	11,620	142	17,880	218	388
		h) Sewer pipe (RC, D=600mm)	m	7,992	9,140	73	17,430	139	22,350	179	391
		i) Sewer pipe (RC, D=500mm)	m	6,951	18,280	127	23,240	162	26,820	186	475
		j) Sewer pipe (RC, D=400mm)	m	4,827	22,850	110	29,050	140	35,760	173	423
		h) Sewer pipe (RC, D=300mm)	m	2,640	38,845	103	34,860	92	75,990	201	395
		k) Intermediate pump station	kW	300,000	100	30	230	69	700	210	309
		l) Final pump station	kW	2,000,000	50	100	75	150	175	350	600
		m) Effluent force main (DIP, D=1200mm)	m	120,494	0	0	0	0	200	24	24
		n) Effluent force main (DIP, D=900mm)	m	67,574	0	0	200	14	0	0	14
		o) Effluent force main (DIP, D=700mm)	m	45,602	200	9	0	0	0	0	9
	Sub-total					695		1,214		5,283	7,193
5. Drainage Works	1) Drainage System	a) Storm water drain	m	20,000	37,500	750	101,520	2,030	138,250	2,765	5,545
		b) Improvement of existing canal	m	12,000	8,510	102	0	0	0	0	102
		c) Improvement of bund of existing water b	m	0	0	0	0	0	0	0	0
		d) Outfall Structures	Nos	1,000,000	1	1	3	3	2	2	6
	Sub-total					853		2,033		2,767	5,654
TOTAL						9,447		8,716		18,710	36,873

(2) Operation and Maintenance Cost

Item	Description		Unit	Charges	Phase 1(2016-2018)		Phase 2 (2019-2023)		Phase 3 (2024-2023)		Total
					Annual	Phase Total	Annual	Phase Total	Annual	Phase Total	
				(%)	(million INR)	(million INR)	(million INR)	(million INR)	(million INR)	(million INR)	(million INR)
WATER INFRASTRUCTURES											
1. Potable Water Supply Works	1) Raw Water Treatment System (from Kandaleru Reservoir)	a) Raw water pipe (DCIP, D=1,000mm)	l.s.	5	209.2	1,046	209.2	1,046	209.2	2,092	4,184
	2) Water Treatment System	a) WTP	l.s.	5	4.8	24	10.3	51	11.7	117	193
	3) Potable Water Transmission System	a) Reservoir	l.s.	5	3.3	17	8.7	44	13.7	137	197
		b) Pump station	l.s.	10	45.0	225	162.0	810	300.0	3,000	4,035
		c) Elevated tank	l.s.	10	6.0	30	15.6	78	24.5	245	353
		d) Transmission pipe (DIP, D=700mm)	l.s.	3	0.0	0	5.1	26	5.1	51	77
		e) Transmission pipe (DIP, D=600mm)	l.s.	3	0.0	0	2.2	11	10.5	105	116
		f) Transmission pipe (DIP, D=500mm)	l.s.	3	2.1	11	3.3	17	3.3	33	61
		g) Transmission pipe (DIP, D=400mm)	l.s.	3	0.0	0	0.0	0	6.4	64	64
		h) Transmission pipe (HDPE, D=300mm)	l.s.	3	0.4	2	0.4	2	0.4	4	8
	4) Potable Water Distribution System	a) Distribution pipe (HDPE, D=300mm)	l.s.	3	3.1	16	3.1	16	5.2	52	84
		b) Distribution pipe (HDPE, D=200mm)	l.s.	3	2.6	13	5.2	26	10.1	101	140
		c) Distribution pipe (HDPE, D=150mm)	l.s.	3	1.1	5	4.1	20	7.7	77	103
	Sub-total				277.6	1,387.8	429.2	2,146.2	607.8	6,078.1	9,612.1
2. Non-Potable Water Supply Works	1) Tertiary Treatment Plant	a) Tertiary treatment plant by RO process	l.s.	20	29.3	146	106.8	534	290.2	2,902	3,583
	2) Non-Potable Water Transmission System	a) Reservoir	l.s.	5	3.7	18	9.8	49	26.6	266	333
		b) Pump station	l.s.	10	54.0	270	189.0	945	495.0	4,950	6,165
		c) Elevated tank	l.s.	10	8.3	41	19.1	95	44.6	446	582
		d) Transmission pipe (DIP, D=600mm)	l.s.	3	0.0	0	3.3	17	11.7	117	134
		e) Transmission pipe (DIP, D=500mm)	l.s.	3	1.2	6	4.0	20	5.7	57	83
		f) Transmission pipe (DIP, D=400mm)	l.s.	3	1.4	7	1.4	7	7.4	74	89
		g) Transmission pipe (HDPE, D=300mm)	l.s.	3	0.0	0	0.0	0	4.4	44	44
	3) Non-Potable Water Distribution System	a) Distribution pipe (HDPE, D=300mm)	l.s.	3	3.1	16	3.1	16	5.2	52	84
		b) Distribution pipe (HDPE, D=200mm)	l.s.	3	2.6	13	5.2	26	10.1	101	140
		c) Distribution pipe (HDPE, D=150mm)	l.s.	3	1.1	5.4	4.1	20	7.7	77	103
	Sub-total				104.6	522.9	345.9	1,729.4	908.6	9,086.2	11,338.6
3. Domestic Sewerage Works	1) Sewage Collection System	a) Sewer pipe (RC, D=700mm)	l.s.	5	0.0	0	1.1	5	2.7	27	32
		b) Sewer pipe (RC, D=600mm)	l.s.	5	0.0	0	1.2	6	2.9	29	35
		c) Sewer pipe (RC, D=500mm)	l.s.	5	0.8	4	2.8	14	5.9	59	77
		d) Sewer pipe (RC, D=400mm)	l.s.	5	2.2	11	5.0	25	9.3	93	129
		e) Sewer pipe (RC, D=300mm)	l.s.	5	2.4	12	5.5	27	10.2	102	141
		f) Sewer pipe (RC, D=250mm)	l.s.	5	6.2	31	13.2	66	24.1	241	338
		g) Intermediate pump stations	l.s.	5	0.3	2	1.6	8	3.9	39	49
	2) Sewage Treatment Plant	a) Final pump station	l.s.	5	1.0	5	4.3	21	8.8	88	114
		b) Sewage treatment plant	l.s.	5	1.5	8	6.1	31	12.5	125	163
	Sub-total				14.5	72.3	40.8	203.9	80.4	803.6	1,079.8
4. Treated Sewage and Effluent Collection and Transfer Works	1) Treated Sewage Transfer System from STP to TTP	a) Transfer pump station	l.s.	5	4.5	23	11.1	56	30.6	306	384
		b) Transfer pipe (DIP, D=1000mm)	l.s.	3	0.0	0	0.0	0	0.5	5	5
		c) Transfer pipe (DIP, D=700mm)	l.s.	3	0.0	0	0.3	1	0.3	3	4
		d) Transfer pipe (DIP, D=500mm)	l.s.	3	0.2	1	0.2	1	0.2	2	3
	2) Treated Sewage Transfer from Nellore City to TTP	a) Treated sewage pump station	l.s.	5	0.0	0	0.0	0	13.5	135	135
		b) Transfer pipe (DIP, D=1000mm)	l.s.	5	0.0	0	0.0	0	104.6	1,046	1,046
	3) Treated Effluent Collection and Transfer System	a) Sewer pipe (RC, D=1400mm)	l.s.	5	0.0	0	0.0	0	1.8	18	18
		b) Sewer pipe (RC, D=1200mm)	l.s.	5	0.0	0	0.0	0	4.3	43	43
		c) Sewer pipe (RC, D=1100mm)	l.s.	5	0.0	0	0.0	0	5.9	59	59
		d) Sewer pipe (RC, D=1000mm)	l.s.	5	0.0	0	1.6	8	7.4	74	83
		e) Sewer pipe (RC, D=900mm)	l.s.	5	0.0	0	2.4	12	10.0	100	112
		f) Sewer pipe (RC, D=800mm)	l.s.	5	1.0	5	5.2	26	15.0	150	181
		g) Sewer pipe (RC, D=700mm)	l.s.	5	1.4	7	8.5	42	19.4	194	243
		h) Sewer pipe (RC, D=600mm)	l.s.	5	3.7	18	10.6	53	19.5	195	267
		i) Sewer pipe (RC, D=500mm)	l.s.	5	6.4	32	14.4	72	23.8	238	341
		j) Sewer pipe (RC, D=400mm)	l.s.	5	5.5	28	12.5	63	21.2	212	302
		h) Sewer pipe (RC, D=300mm)	l.s.	5	5.1	26	9.7	49	19.8	198	272
		k) Intermediate pump station	l.s.	5	0.8	4	3.2	16	10.2	102	122
		l) Final pump station	l.s.	5	2.5	13	8.8	44	21.3	213	269
		m) Effluent force main (DIP, D=1200mm)	l.s.	3	0.0	0	0.0	0	0.7	7	7
		n) Effluent force main (DIP, D=900mm)	l.s.	3	0.0	0	0.4	2	0.4	4	6
		o) Effluent force main (DIP, D=700mm)	l.s.	3	0.3	1	0.3	1	0.3	3	5
	Sub-total				26.6	132.8	77.7	388.7	174.8	1,748.0	2,269.5
5. Drainage Works	1) Drainage System	a) Storm water drain	l.s.	5	37.5	188	139.0	695	277.3	2,773	3,655
		b) Improvement of existing canal	l.s.	5	5.1	26	5.1	26	5.1	51	102
		c) Improvement of bund of existing water bo	l.s.	10	0.0	0	0.0	0	0.0	0	0
		d) Outfall Structures	l.s.	5	0.1	0	0.2	1	0.3	3	4
	Sub-total				42.7	213	144	1,451	283	2,827	4,492
TOTAL					465.8	2,329.1	1,038.0	5,919.7	2,054.3	20,542.7	28,791.5

Appendix E- Solid Waste Management

E.1. Cases of Waste to Energy (Incinerator) in Japan

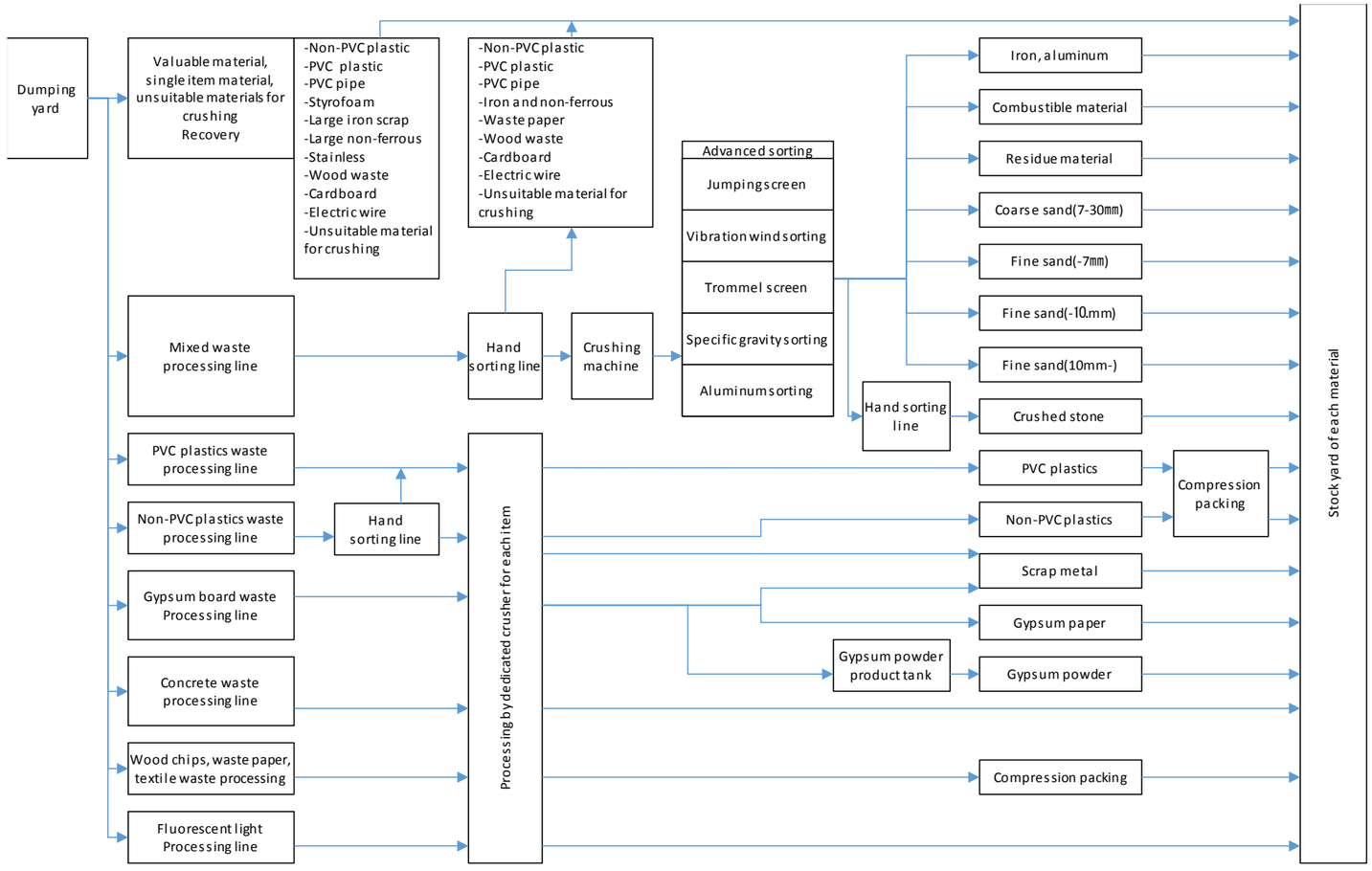


-Capacity: 1200 TPD (400 TPD x 3units)
-Incinerator: Stoker type (3units) 24hr
-Calorific value: kcal/kg: High calorific value: 3,011
Average calorific value: 2,510
Low calorific value: 1,506
-Boiler (3 units): Steam pressure Normal 3,920kPa
Temperature Normal 400℃
-Steam turbine (1unit): Normal 3,730kPa
Power output: 35MW 11,000V
-Exhaust gas treatment system
Demineralizer (bag filter):
Slaked lime and activated carbon injection system
NOx removal equipment:
Catalyst denitration method (ammonia water spraying)
- Ash melting facility: Electric resistance type (1unit)
- Total project cost: 33 billion Rs

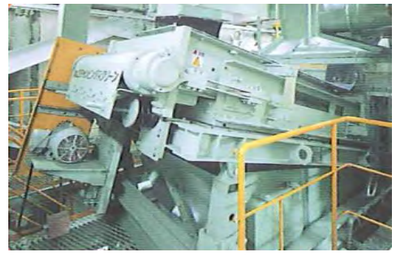
Source: Brochure of Yokohama City.

E.2. Cases of Processing Facility for Construction Waste in Japan

Construction waste in Japan: Specifically, concrete slabs, asphalt-concrete slabs, construction sludge, wood generated from construction works, waste plastic, glasses, concrete chips, ceramics, scrap metals, paper, fiber, rubber, and mixed items of these are defined as construction waste.



Trommel screen
-Sorting by the particle size and wind



Incombustible separation machine
-Sorting by crushed and reclaimed sand

Jumping screen
-Removing the moisture and dust by jumping

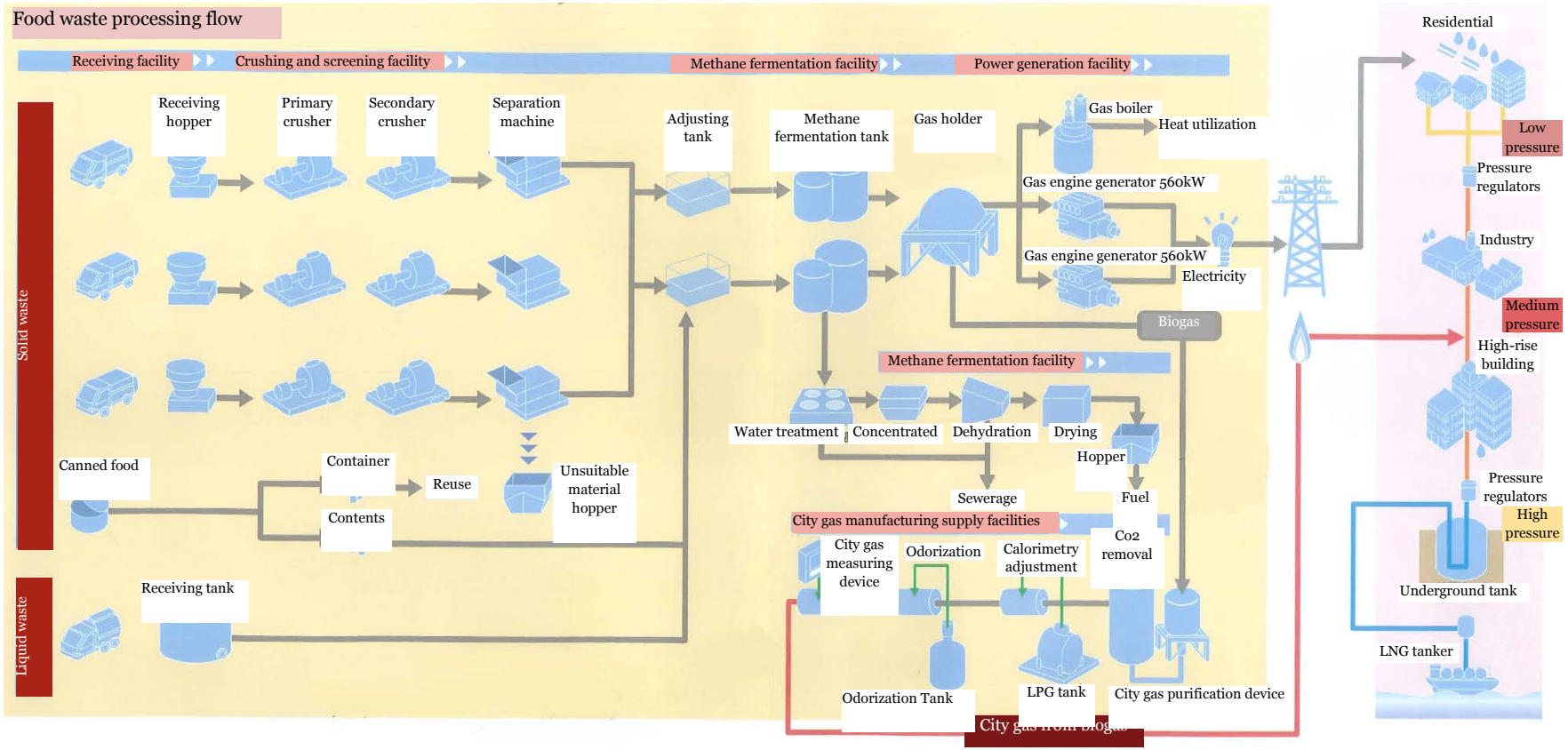
Specific gravity separator
- Sorting by the weight difference

Vibration & wind separator
-Sorting by vibration and wind

Magnetic separator
-Sorting by magnetic forces

Source: Brochure of Takatoshi Co.,Ltd.

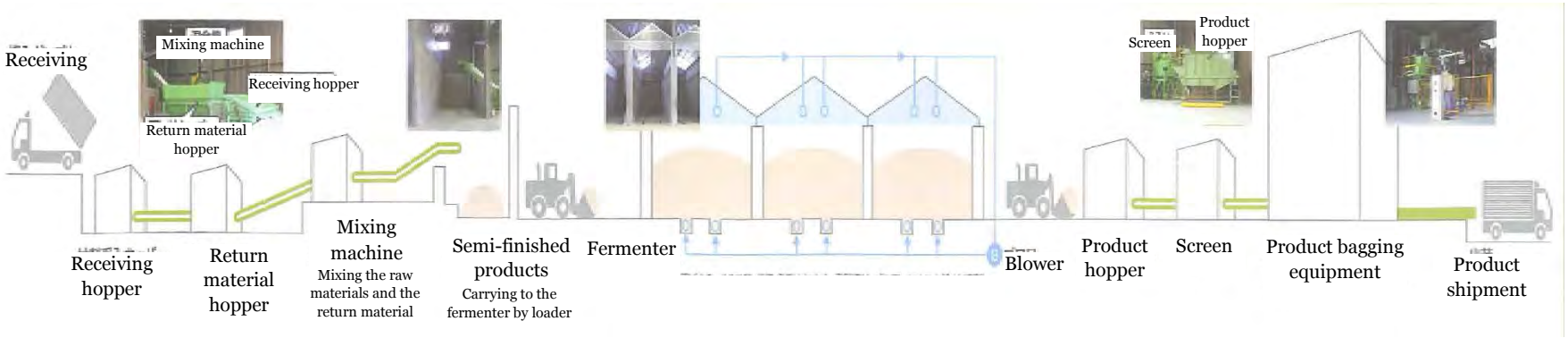
E.3. : Cases of Bio-methanation in Japan



Source: Brochure of BIOERNERGY Co.,Ltd.

This system has the following characteristics.
*High quality of fermentation is secured by crushing the food waste and removing the unsuitable materials at the sorting facility before the methane fermentation process.
*Supplying gas to the consumers by refining

E.4.: Cases of Composting in Japan



Source: Brochure of YORII COMPOST Corporation.

The characteristics of this system is to control odor and water content by the “decompressed parallel fermentation technology” where the air suction is done from the upper part of the facility using a blower and exhaust gas is emitted from the lower part of the facility.

E.5.Indicators of industry waste in Japan

Appendix 14: Indicators of industry waste in Japan

				1.871	JPY/INR
Type of industry		Plants & animal residues, and	animal solid residues	glasses, concrete slabs, ceramics	Debris
Classification of India	Classification of Japan	t/Crore	t/Crore	t/Crore	t/Crore
Food Processing	Textile industry	1.26604	0.05051	0.00393	0.00019
Textiles & Apparels	Textile industry	-	-	0.00131	0.00019
Pharmaceuticals	Chemical industry	0.01628	-	0.02301	0.01534
Chemicals & Petrochemicals	Chemical industry	0.01628	-	0.02301	0.01534
	Petroleum and coal products manufacturing	-	-	0.00636	0.08943
	Plastic Products Manufacturing	-	-	0.00692	0.00019
Metallurgy	Steel industry	-	-	0.22245	0.15098
	Non-ferrous metal manufacturing industry	-	-	0.03461	0.00730
Machinery	General-purpose machinery and equipment manufacturing industry	-	-	0.01684	0.00505
	Production equipment manufacturing	-	-	0.01459	0.02114
Computer, electronic and optical products	Business equipment manufacturing	-	-	0.01684	0.00037
	Electronic components and devices and electronic circuit manufacturing industry	-	-	0.01048	0.00037
	Electrical machinery, equipment manufacturing industry	-	-	0.02470	0.00037
	Information and communication equipment manufacturing	-	-	0.00337	0.00019
Electrical Machinery	Electrical machinery, equipment manufacturing industry	-	-	0.02470	0.00037
Auto	Transportation equipment manufacturing	-	-	0.00711	0.00486
Defence	Transportation equipment manufacturing	-	-	0.00711	0.00486
Medical Equipment	Other manufacturing	-	-	0.08718	0.00412

Source: Survey report of Industrial waste emissions and processing status, in fiscal 2010 (summary version) /March 2013. Ministry of the Environment Japan, Department of waste management and recycling

E.6.Forecase of hazardous waste

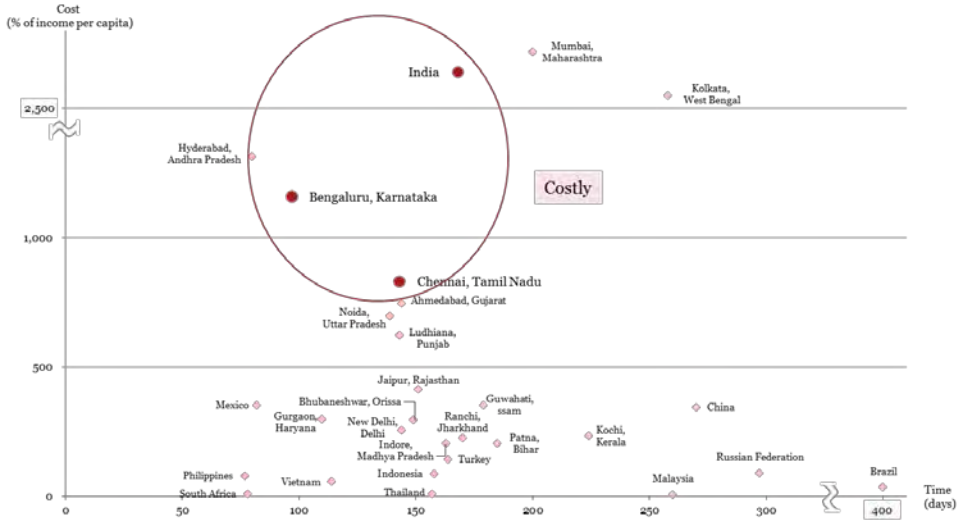
Appendix 15: Forecast of hazardous waste in Kurnool, YSR, Guntur and Prakasam districts

		2013		2016			2018			2023			2033		
		% of HZW	HZW generated	Output Growth Rate Avg.	% of HZW	HZW generated	Output Growth Rate Avg.	% of HZW	HZW generated	Output Growth Rate Avg.	% of HZW	HZW generated	Output Growth Rate Avg.	% of HZW	HZW generated
		%	1,000TPY	%	%	1,000TPY	%	%	1,000TPY	%	%	1,000TPY	%	%	1,000TPY
AP	Total		23.7			51.5			58.6			95.4			287.2
7 dists	Landfillable		22.6			13.3			14.8			23.7			74.4
	Incinerable		1.1			0.1			0.1			0.2			0.7
	AFR		0			17.4			19.9			33.3			106.8
	Recyclable		17.4			20.7			23.7			38.2			105.3
AP	Total	100%	16.3	121%	100%	21.5	135%	100%	25	157%	100%	42.7	302%	100%	128.2
CBIC	Landfillable	60%	9.7		26%	5.6		25%	6.3		25%	10.6		26%	33.2
	Incinerable	1%	0.2		0%	0		0%	0.1		0%	0.1		0%	0.3
	AFR	0%	0		34%	7.3		34%	8.5		35%	14.9		37%	47.7
	Recyclable	39%	6.4		40%	8.7		40%	10.1		40%	17.1		37%	47
	Anantapur		2.1	106%		2.3	111%		2.4	140%		3.3	313%		10.4
	Chittoor		12.6	139%		17.4	164%		20.6	176%		36.2	299%		108.5
	Nellore		1.6	118%		1.9	131%		2.1	155%		3.2	293%		9.3
AP	Total	100%	24.8	121%	100%	30	135%	100%	33.6	157%	100%	52.7	302%	100%	159
except	Landfillable	52%	12.9		26%	7.7		25%	8.5		25%	13.1		26%	41.2
CBIC	Incinerable	4%	0.9		0%	0.1		0%	0.1		0%	0.1		0%	0.4
	AFR	0%	0		34%	10.1		34%	11.4		35%	18.4		37%	59.1
	Recyclable	44%	11		40%	12.1		40%	13.6		40%	21.1		37%	58.3
	Kurnool		14.7	121%		17.8	135%		19.9	157%		31.3	302%		94.4
	Kadapa		0.4	121%		0.5	135%		0.5	157%		0.9	302%		2.6
	Prakasam		5.5	121%		6.7	135%		7.5	157%		11.8	302%		35.5
	Guntur		4.2	121%		5	135%		5.6	157%		8.8	302%		26.6

Source: JICA study team

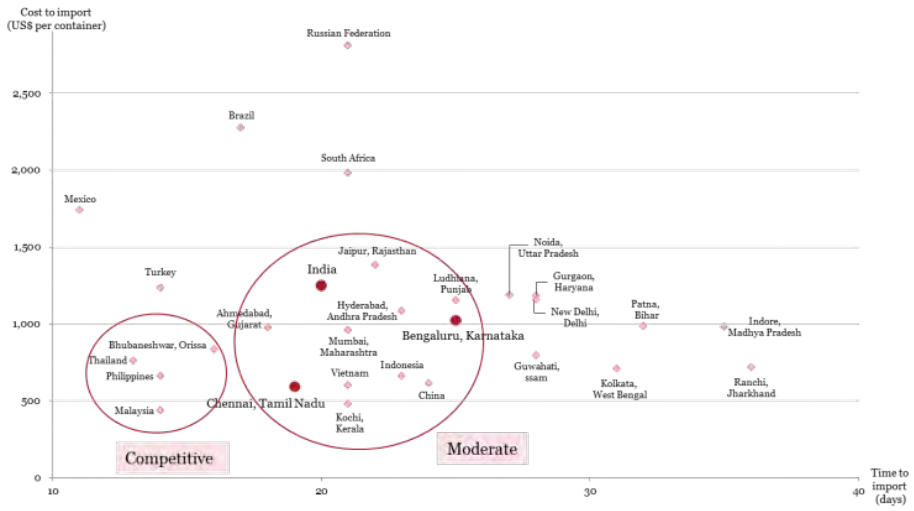
Appendix F. - Investment Environment

The dealing with construction permits is pointed out as a comparative advantage of CBIC in domestic comparison, but is not actually competitive if includes other countries. India, including the 2 cities in CBIC, is categorised as the expensive group. ASEAN countries, i.e., Indonesia, Malaysia, Thailand, Vietnam and Philippines, are very competitive due to the historical competition for attracting foreign trade in the region.



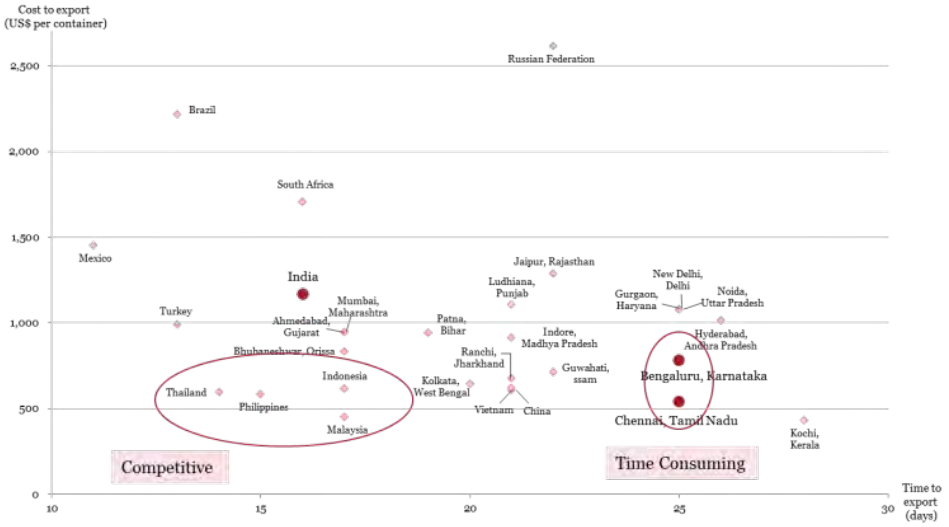
Appendix 16: Dealing with Construction Permits

As for the cost and time for import, the 2 cities in CBIC are in top class in domestic comparison, and competitive in global comparison as well. India is not comparable to the top group of Thailand, Philippines and Malaysia, but almost equal to China, Vietnam and Indonesia. Asian countries are generally advanced in ease of trade due to the competition in the region.



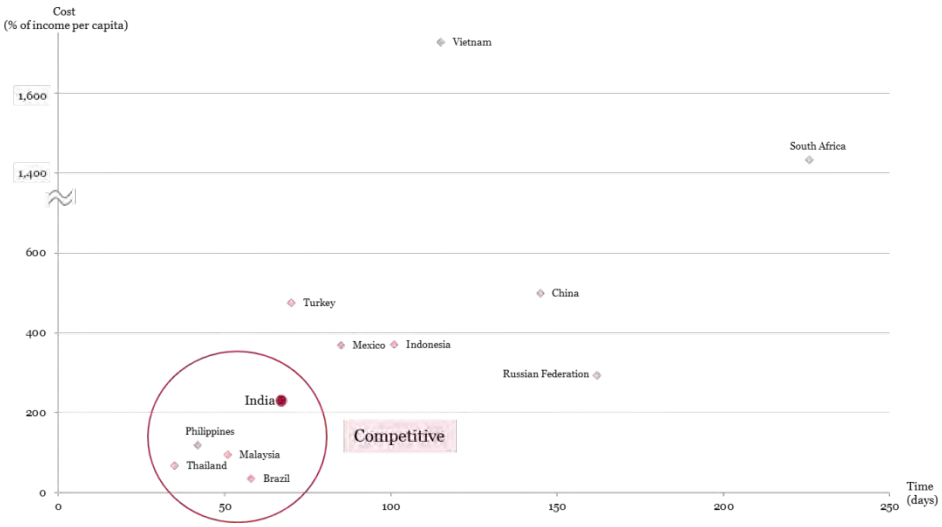
Appendix 17: Trading Across Borders - Import

However, regarding the export, investment climate of CBIC/India saves the cost for investors but requires more time for the procedures. CBIC is significantly inferior to the ASEAN countries in terms of ease of export.



Appendix 18: Trading Across Borders – Export

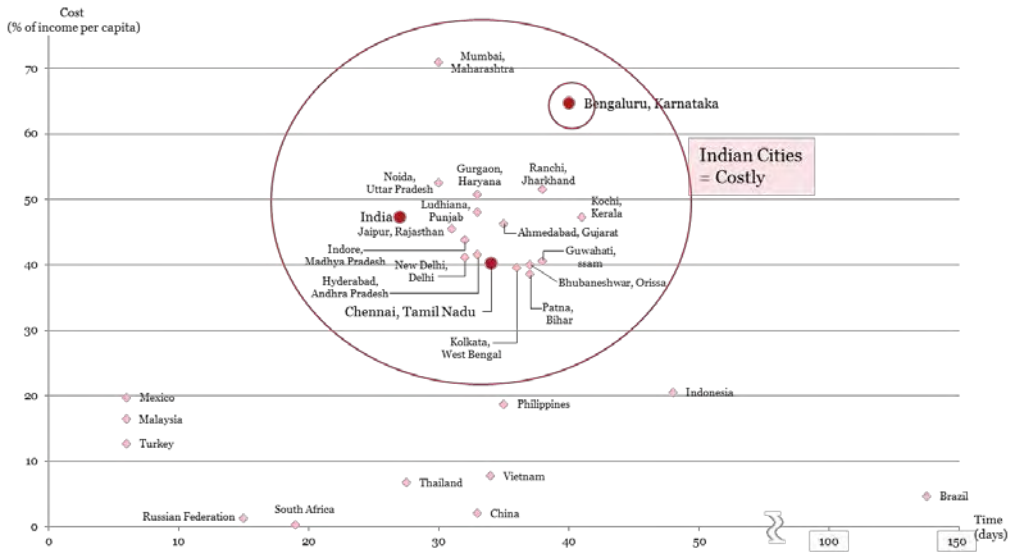
Also, the ease of getting electricity for users could be said as the strength of CBIC. However, it is only true for large scale companies in reality.



Appendix 19: Getting Electricity

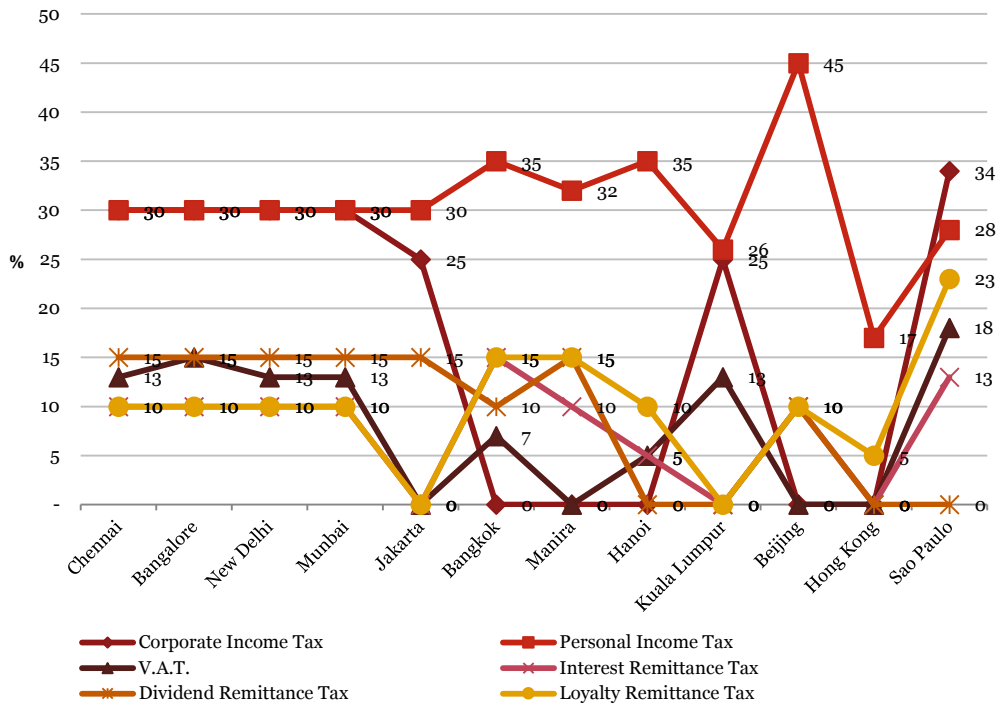
For the next, the analysis takes up the contents evaluated as weaknesses of CBIC, i.e., starting business, paying taxes and enforcing contract.

India requires high cost for investors when they start a business. The environment in Bengaluru is outstandingly expensive following to the most expensive city of Mumbai. On the other hand, the other countries, e.g., China, South Africa, Thailand, Vietnam and Russia, require much lower cost than India.



Appendix 20: Starting a Business

The environment of paying tax in CBIC is at the worst level in all over the world. The corporate tax, which is particularly important for foreign investors, is at very high level, i.e., 30% for domestic and 40% for foreign companies. In addition, V.A.T., dividend remittance tax and other taxes are also expensive.



Source: JETRO

Appendix 21: Tax Rates (2013)

Here are other taxes the investors are levied in CBIC.

Appendix 22: Direct Taxes

Name	Rate	Description
Corporate tax	40%	Plus applicable surcharge and cess. For Domestic company - 30%.
Dividend distribution tax (DDT)	15%	Plus 10% surcharge, 2% education cess, and 1% secondary and higher education cess. A holding company does not have to pay.
Tax on buyback of shares	20%	Plus 10% surcharge, 2% education cess and 1% secondary and higher secondary education cess
Minimum alternate tax (MAT)	18.5%,	Plus applicable surcharge and education cess. Companies whose tax payable under normal income tax provisions is less than 18.5% of adjusted book profits.
Taxation of the know-how fee in the hands of foreign companies	25%	Royalties or technical fees payable to non-residents with a permanent establishment in India are taxed on a net basis. In contrast, they are taxed on a gross basis in the case of non-residents without a permanent establishment in the country.
Taxing dividends received from overseas group companies	15%	Dividends received by Indian companies from specified foreign companies will be taxed
Wealth tax	1%	Both on individuals as well as companies of the amount by which the 'net wealth' exceeds 3 million INR.

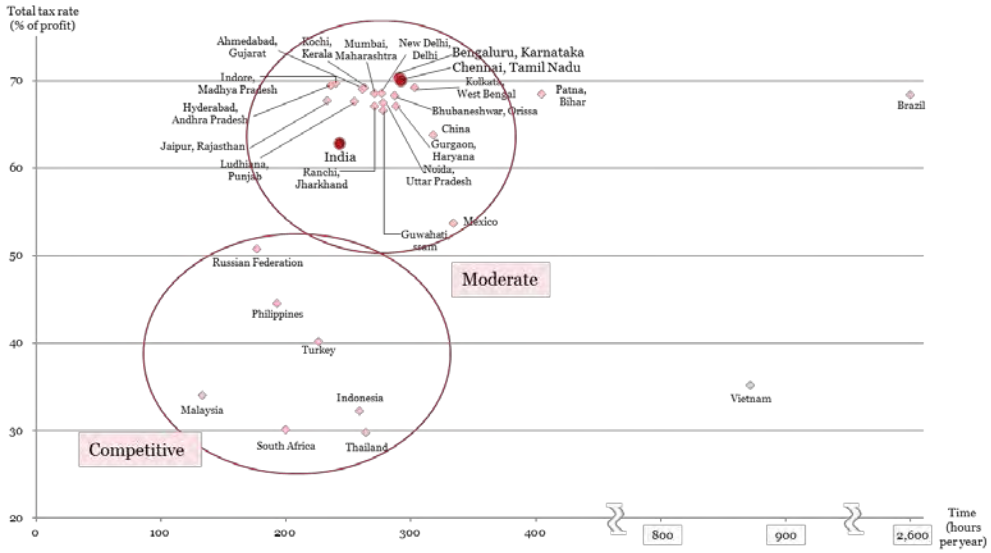
Appendix 23: Indirect Taxes

Name	Rate	Description
Basic Customs Duty (BCD)	0-10%	The rate of customs duty applicable to a product to be imported or exported depends on its classification under the Customs Tariff Act, 1975. Education cess at 2% and secondary and higher education cess at 1% are also levied on the aggregate customs duties. Additional duty of customs at 4% is charged in addition to the above duties on imports, subject to certain exceptions. ADC is calculated on the aggregate of the assessable value of imported goods, the total customs duties (i.e. BCD and CVD) and the applicable EC and SHEC Basic customs duty (BCD) is the basic component of customs duty levied at the effective rate notified under the First Schedule to the CTA and applied to the landed value of the goods (i.e. the CIF value of the goods plus landing charges at 1%) The peak rate of BCD is currently set at 10% for all goods other than agricultural and other specified products. However, the government has the power to exempt specific goods, wholly or in part, from the levy of custom duties. In addition, preferential or concessional rates of duty are available under various bilateral and multilateral trade agreements that India has entered into with other countries.
Countervailing Duty (CVD)	12%	It is charged in lieu of, the excise duty applicable on like goods manufactured in India. CVD is calculated on the landed value of goods and the applicable BCD. However, the CVD on specific consumer goods intended for retail sale is calculated on the basis of the maximum retail price (MRP) printed on their

Name	Rate	Description
		packs after allowing specified abatements.
Central Value Added Tax (CENVAT or Excise Duty)	Approx. 12%	CENVAT is a tax levied by the central government on the manufacture or production of movable and marketable goods in India. The rate of excise duty levied on the goods depends on the classification of the goods under the excise tariff, which is primarily based on the HSN classification adopted so as to achieve conformity with the customs tariff. Education Cess (EC) at 2% and Secondary and higher education at 1% are applicable on aggregate excise duties. There are different product, industry and geographical area specific exemptions available under CENVAT, which present excellent business opportunities to manufacturers in India.
Service Tax	12%	All services are taxable but for the services mentioned in the negative list.EC of 2% and SHEC of 1% of the service tax are levied on taxable services.
Central Sales Tax (CST)	2%	The sale of movable goods in India is chargeable to tax at the federal or state level. The Indian regulatory framework has granted power to state legislatures to levy tax on goods sold within that state. On the other hand, all goods sold in the course of interstate trade are subject to the federal sales tax i.e. central sales tax (CST).
Value Added Tax (VAT)	1-20%	At present, most of state-level sales tax has been replaced by VAT.VAT paid on goods purchased within the state is eligible for VAT credit. The input VAT credit can be utilized against the VAT or CST payable on the sale of goods. This ensures that the cascading effect of taxes is avoided and that only the value addition is taxed. Currently, there is no VAT on goods imported into India. Exports are zero rated.
Entry Tax (Octroi Duty)	n.a.	Entry tax is on entry of specified goods into the state from outside the state for use, consumption or sale therein. Entry tax continues to exist under the VAT regime, though in certain states it has been made Viable and can be set off against the output VAT liability in the state. Entry tax is levied on purchase value, which is defined as the amount of the valuable consideration paid or payable by a person for the purchase of any goods. The value of the specified goods can be ascertained from the original invoice for purchase of such goods. Octroi is a municipal tax levied at the time of the entry of specified goods into the limits of the municipal corporation. Thus, octroi can be levied if there is movement of goods from one city to another in the same state, in the event the cities fall under the jurisdiction of two different municipal corporations.
Stamp Duty	n.a.	Stamp duty is levied at various rates on documents such as bills of exchange, promissory notes, insurance policies, contracts effecting transfer of shares, debentures and conveyances for transfer of immovable property.
Research and Development Cess	5%	Research and redevelopment cess of 5% is levied on all payments made for the import of technology. The term 'technology' includes import of designs, drawings, publications and services of technical personnel.

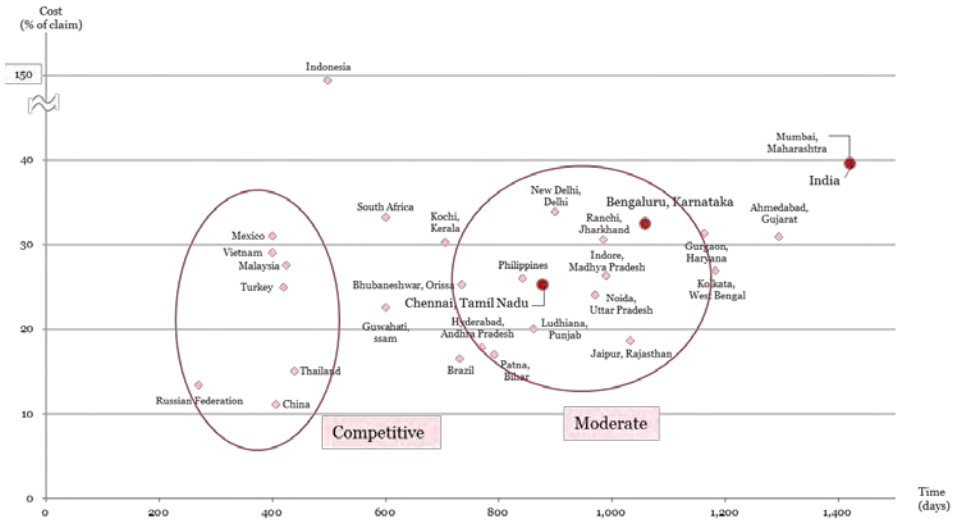
In addition to the tax rate, procedure of paying tax is troublesome and requires time for investors. For example, the time of paying tax per year in China is 9 times, but it is 68 times in Chennai. This means India has still been trapped in the short term and micro view on taxation that higher tax rate brings more budgets to the Government. This kind of superstition prevents CBIC from growing to truly world top investment destination.

On the other hand, long term and macro view on taxation is taken root in China, ASEAN countries as well as globally competitive countries for attracting foreign investors. They aim at encouraging economic growth through setting competitive tax rate in order to attract high valued globally companies.



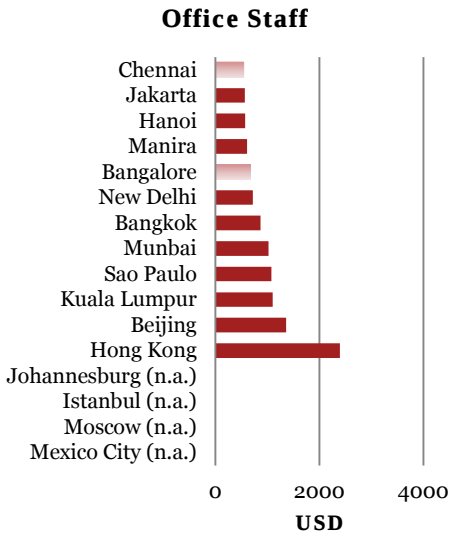
Appendix 24: Paying Taxes

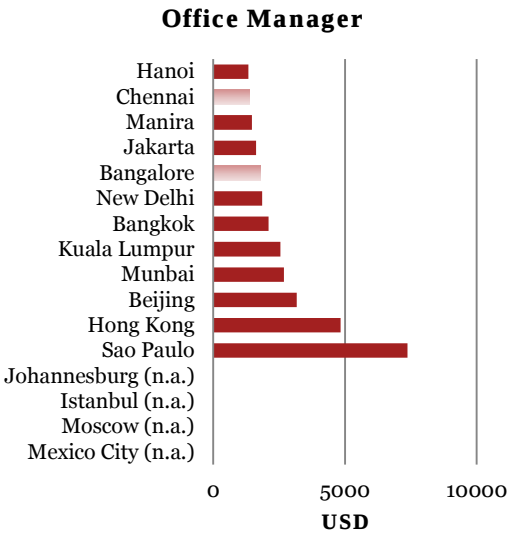
In the aspect of enforcing contract, CBIC is inferior to the other countries regarding the time for procedures. Enforcing contract means the readiness of legal framework when investors get into trouble, as well as time and cost for solving it.



Appendix 25: Enforcing Contract

As for the average wages, the office workers' wages in 2 cities in CBIC are placed in the low level group. Given the level of education in those cities available for white collared persons, it can be said that high quality human resources are available at reasonable price in CBIC. In addition, in India, most of white collared persons are English speakers. In terms of the wages for office workers, Hanoi, Manila, Jakarta and New Delhi are comparable to CBIC.

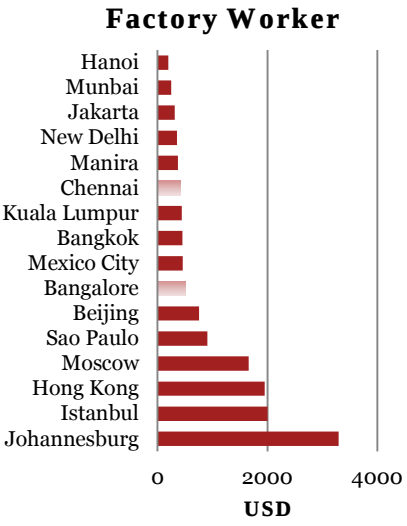


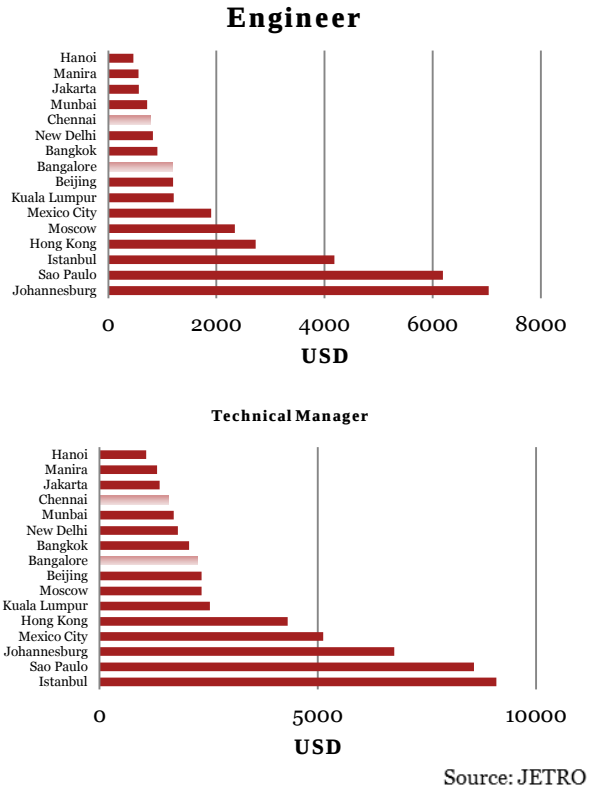


Source: JETRO

Appendix 26: Average Monthly Wages – Service Sector (2012)

In terms of factory workers, CBIC is included in the lower wage group. It is almost equal to Mumbai and Delhi in India, and Hanoi, Manila, Jakarta, Bangkok, Beijing and Kuala Lumpur.





Source: JETRO

Appendix 27: Average Monthly Wages – Industry Sector (2012)

Although the standard of average wages in CBIC is low, the increase rate is very high. CBIC is encountering more than 15 % of wage increase recently, which is almost equal to the rate of Jakarta, Beijing and Istanbul. Wage increase rate is also high in entire India and DMIC.

Recently global companies are shifting their production base from those countries with high wage increase to more cost competitive countries, such as Myanmar, Bangladesh and Lao PDR. In order to make high value added and innovative business taken root in CBIC, the Indian/CBIC Government should strategically construct high quality goods and services market consisting of highly educated Indian workers who deserves the high level of wages.

Appendix 28: Comparison of Ease of Doing Business

Parameter		Singapore [1st]*	Thailand [26th]*	Indonesia [114th]*	Vietnam [78th]*	India [142th]*			
						Best practice	KT / Bengaluru	TN / Chennai	AP / Hyderabad
①Starting a business	Cost (% of income per capita)	0.6	6.6	20.1	5.3	41.1	64.7	40.3	41.6
	Time (days)	2.5	26.5	52.5	34	32	40	34	33
②Dealing with construction permits	Cost (% of income per capita)	0.3	0.1	4.9	0.7	1,314.20	1,158.70	831.7	1,314.20
	Time (days)	26	113	202	114	80	97	143	80
③ Registering property	Cost (% of property value)	2.8	6.3	10.9	0.6	7.7	9.2	10.1	10.5
	Time (days)	4.5	2	25	57	26	28	48	37
④Paying Tax	Payments (no. per year)	5	22	65	32	59	59	68	78
	Time (hrs per year)	82	264	253.5	872	255	291	292	236
⑤Enforcing Contracts	Cost (% of claim)	25.8	15	118.1	29	17.8	32.5	25.3	17.8
	Time (days)	150	440	460	400	770	1,058	877	770
⑥Trading Across	Cost to export (US$ per	460	595	585	610	833.9	783.5	540	1,011.60

Parameter		Singapore [1st]*	Thailand [26th]*	Indonesia [114th]*	Vietnam [78th]*	India [142th]*			
						Best practice	KT / Bengaluru	TN / Chennai	AP / Hyderabad
Borders	container)								
	Time to export (days)	6	14	17	21	17	25	25	26
⑥Trading Across Border	Cost to import (US$ per container)	440	760	660	600	833.3	1,023.90	592.9	1,084.50
	Time to import (days)	4	13	26	21	16	25	19	23
⑦Closing Business	Cost (% of estate)	3	36	22	14.5	7	10	10	7
	Time (years)	0.8	2.7	2	5	7	7.3	6.5	7

Source: World Bank

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