A JOINT VENTURE COMPANY OF	
GAIL (India) Limited	GCGSCL (A GOVT. OF WEST BENGAL ENTERPRISE)

VALIDATION OF DFR PREPARED BY CRISIL

CITY GAS DISTRIBUTION NETWORK

KOLKATA GA

MECON LIMITED
(A Govt. of India Enterprise)
NEW DELHI- 110092

Report No.05/51/MEC/KOL/001-R1 SEPTEMBER 2017

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CHAPTER - 1

INTRODUCTION

1.0 INTRODUCTION

- Greater Calcutta Gas Supply Corporation Limited (GCGSCL) is a State Government Undertaking, 100% owned by Government of West Bengal under the administrative control of the Department of Commerce & Industry, Government of West Bengal and in the business of distribution and marketing of 'Coal Gas' in the city of Kolkata and adjoining areas, since May 25, 1990.

- Hon'ble NGT-EZ bench has directed for early execution of development of CGD network in KOLKATA due to rising pollution.

- For the development of CGD network in Kolkata GA, Govt. of West Bengal on 23.02.2017 has conveyed the decision taken by state govt. to execute the Kolkata CGD network project through joint venture between GAIL and GCGSCL in the proportion of 74 % and 26 % respectively.

- M/s CRISIL Risk and Infrastructure Solutions Limited prepared a Detailed Feasibility Report of Kolkata GA for GCGSCL in April 2016. for supplying City Gas Distribution to Domestic, Commercial, Industrial & Automobile Sectors in Kolkata Geographical Area (GA) comprising of Kolkata, Howrah, Hoogly, Naida, 24 North Paragana and 24 south Paragana district in West Bengal.

- M/s MECON has been asked to validate the DFR prepared by M/s CRISIL for Kolkata GA. The market survey and system design is taken as considered by M/s CRISIL.

1.1 PNGRB AUTHORISATION

- Petroleum and Natural Gas Regulatory Board (PNGRB) vide letter ref. no. S-Infra/11/1/ 2008-Vol.II/Kolkata CGD dated 2nd February 2016 has authorized GCGSCL to develop, expand and operate a CGD network in the Kolkata Municipal Corporation region, and adjoining districts of Nadia, North 24-Parganas, South 24-Parganas, Hooghly and Howrah. PNGRB has also issued GCGSCL targets that GCGSCL needs to achieve in terms of PNG connections to domestic segment, compression capacity, network and infrastructure development, during the first five years, i.e. marketing exclusivity period. (copy of the Authorisation attached as **Annexure - 1**)

The key features of the Kolkata CGD Project as mentioned in MWP set by PNGRB are as below-

- The Geo-graphical Area (GA) covers approx. 1529 Sq.km.in Kolkata city and parts of adjoining districts of North 24 Parganas, South 24 Parganas, Howrah, Hooghly and Nadia ("Kolkata GA")
- Projects Milestones during the period of marketing exclusivity of 5 years set by PNGRB are as follows -

Targets for each year Cumulative	1st year	2nd year	3rd year	4th year	5th year
PNG connections (numbers)	100,000	300,000	600,000	10,00,000	14,17,959
Steel pipeline (inch-km)	500	1500	3000	5000	7296
Compression capacity (kg per day)	50,000	150,000	300,000	500,000	790,200

Total Population within the Geographical Area as per Census 2011				
1.64 Crores (Approx.)				
Total Geographical Area(Sq KMs)	1529		No. of Charge Areas	39
Charge Areas Identification	**Charge Area (CA)**	**District**	**CA SqkM**	**CA Population (Refer Notes below)**
CA-01	Bansberia-Bandel	Hoogly	74.02	550,015
CA-02	Champdani-Chandnagar	Hoogly	48.17	357,934
CA-03	Baidyabati	Hoogly	110.32	819,747
CA-04	Rishra-Uttarpara	Hoogly	79.25	588,878
CA-05	Kalyani	Nadia	53.79	399,694
CA-06	Naihati	North 24 PGS	21.75	161,617
CA-07	Bhatpara	North 24 PGS	8.95	66,505
CA-08	Barrackpur-Khardah	North 24 PGS	48.17	357,934
CA-09	Panihati	North 24 PGS	24.86	184,726
CA-10	Kamarhati-Baranagar	North 24 PGS	26.44	196,466
CA-11	Barasat	North 24 PGS	62.15	461,814
CA-12	Satgachi-South DumDum	North 24 PGS	15.54	115,472
CA-13	Salt lake	North 24 PGS	48.17	357,934
CA-14	Rajarhat	North 24 PGS	59.04	438,705
CA-15	Dumdum	North 24 PGS	74.58	554,177
CA-16	Maheshtala-Pujali-Budge Budge	South 24 PGS	38.85	288,680
CA-17	Falta	South 24 PGS	217.53	1,616,384
CA-18	Rajpur-Baruipur-Sonarpur	South 24 PGS	134.24	997,488
CA-19 to CA-29	HowrahMunicipal Corporation	Howrah	197.75	3,389,147
CA-30 to CA-39	Kolkata Municipal Corporation	kolkata	185.00	4,496,694
	TOTAL		**1,529**	**16,400,011**

Note :

1) The Charge Area is as per authorization accorded by PNGRB dtd. 02.02.16 to M/s GCGSCL for development of CGD network in the state of WB.

2) Population of KMC area is as per Census 2011 data.

3) The population of CA-19 to CA-29 has been considered as 70% of Howrah District population as per Census 2011 (4841638).

4) The Charge Area wise populations for CA 1- 18 has been derived from the population density of this total area (8414159 population in 1146 sq. km) multiplied by the respective Charge Area.

CHAPTER - 2

SALIENT FEATURES OF DFR PREPARED BY CRISIL FOR GCGSCL

2.0 Salient features of DFR prepared by CRISIL for GCGSCL.

2.1 **M/s CRISIL has carried out the market survey, demand assessment, network design and financial analysis for** supplying City Gas Distribution to Domestic, Commercial, Industrial & Automobile Sectors in Kolkata Geographical Area (GA) comprising of Kolkata, Howrah, Hoogly, Naida, 24 North Paragana and 24 south Paragana district in West Bengal.
(The DFR report prepared by CRISIL is attached in Annexure – I1)

2.2 Market Research Methodology adopted by CRISIL

The following approach was adopted to assess the demand opportunity for the proposed CGD network in the target districts. :

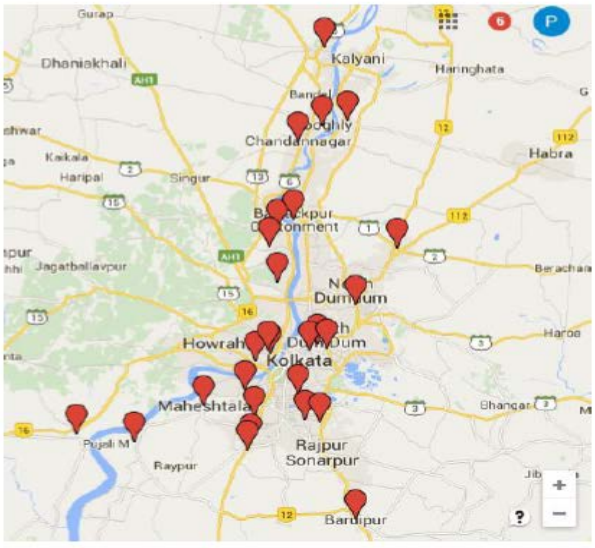
- For secondary research, key industry sources such as RTO, District Economic Survey, Census, and internal databases developed over the last two decades have been relied upon.
- Major industrial and commercial areas have been identified and the type of liquid fuel consumed has been analysed.
- For domestic segment, secondary research has been carried out for estimating the monthly fuel consumption per household on a monthly basis.

The below schematic summarizes the overall approach for data collection that has been followed for estimation of current demand with the help of secondary research methodologies:

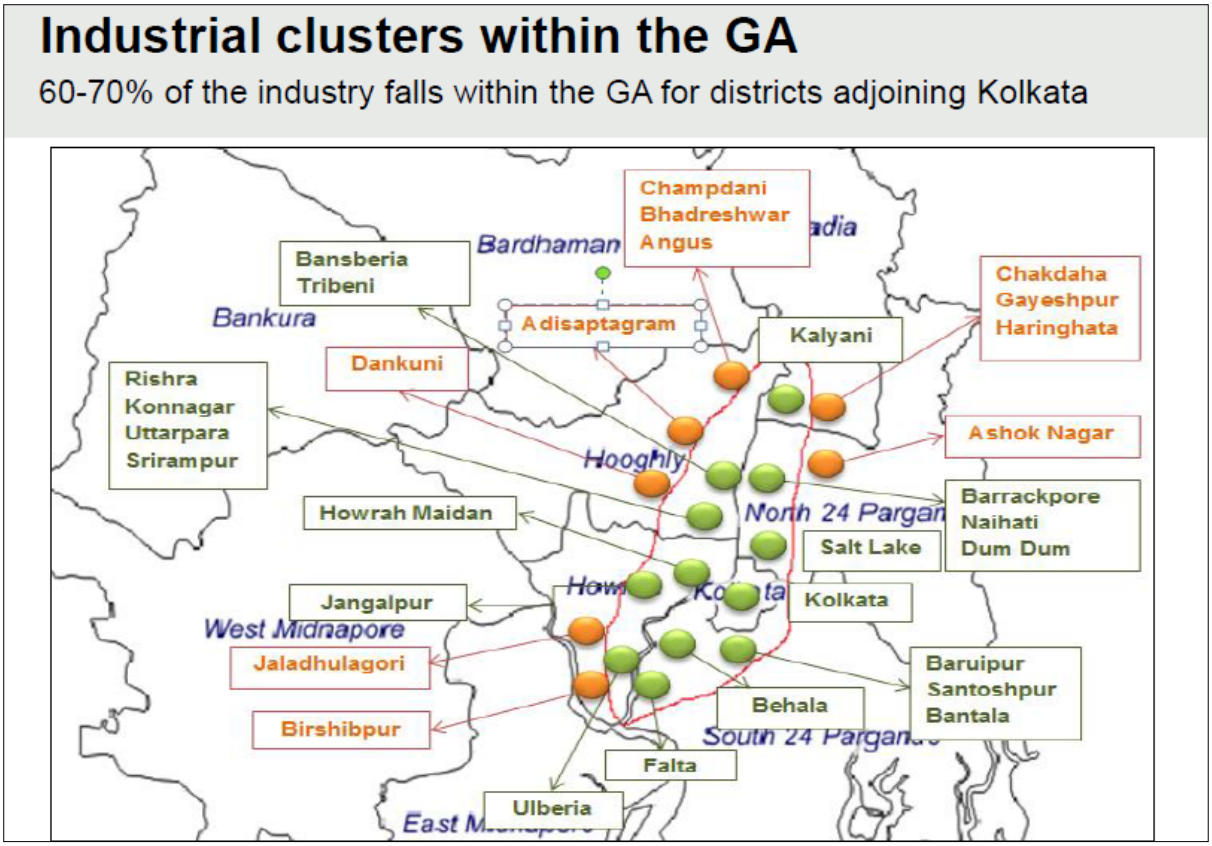
Pipeline coverage in the GA

Key areas in the GA	Network spread in the area
Hooghly area	Singur, Bora, Nabagram, Bangur Park, Rishra, Konnagar, Balyabati road, Balyabati, Mankundu, Chandan nagar, Bandel, Chota Khajuria
North 24 Parganas, Kalyani and Nadia area	Majarhat, Sodhpur Barsat road, HB Town, Dopere, Titagarh, Nilganj, Anandpuri Road, Basudevpur, Ghanshyam Nagar, Habra Road, Naihati, Kachrapara, Kalyani
South 24 Parganas and Howrah area	Howrah tap off at G.T. Road, Kona expressway, Netaji Subhash Chandra Bose road, Bagpura, Belur, Racecourse, AJCB road, G Sarai Road, Park Circus, Price Road, Raipur Road, Gandhi colony, Entaly, Esplanade, Govind Chandra Road, Gariyaghat, Toliganj, Taratala Road, Budge Budge, Bishnupur, Raipur more cross road, Falta
Kolkata Municipality area	KMC tap off, Birati road, Mirhati, Baman ganchi, Dumdum, Rajbari, Rajarhat, Chandpur, Lake town cross road, Jessore, Bidhan nagar, Kukurganchi, Chingrigata, Dhapa road, Bojarhat, Kasba, Gariya, Baruipur

Key commercial clusters within the GA



District	Key commercial clusters
Kolkata	Jadavpur, Ultadanga, Behala, Maniktala, Garden Reach, Ballygunge,Tollygunge
Howrah	Shibpur, Ulberia, Howrah Maidan, Kadam Tala,
Hooghly	Uttarpara, Serampore, Tribeni, Chinsurah, Chandannagar, Rishra
North 24 Parganas	Salt Lake, Dum Dum, Barrackpore, Barasat, Naihati
South 24 Parganas	Baruipur, Santoshpur, Thakurpukur, Maheshtala, Joka, Budge Budge
Nadia	Kalyani



AUTOMOBILE DISTRIBUTION WITHIN THE KOLKATA GA

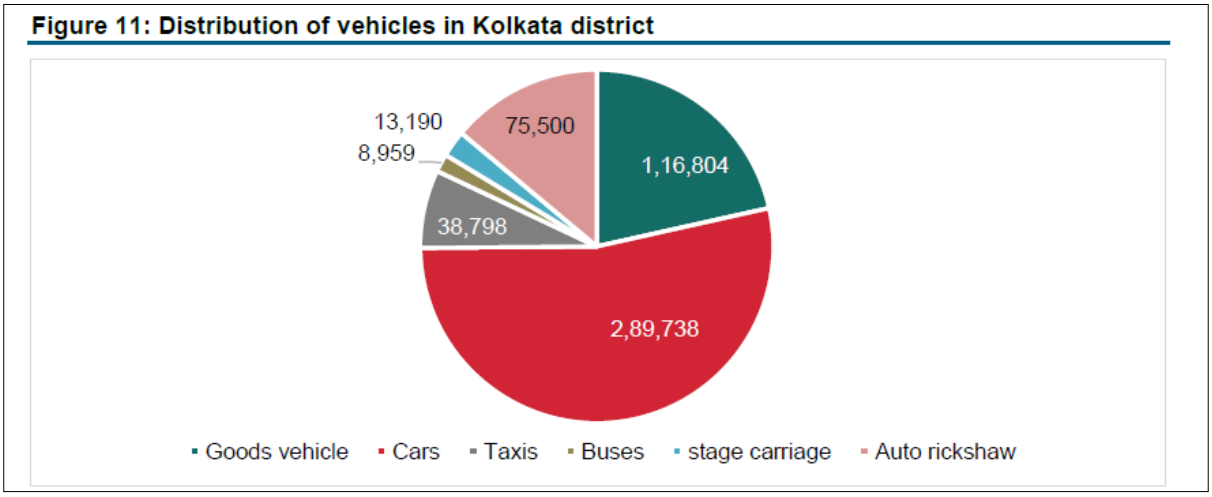


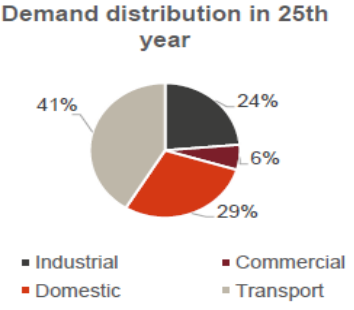
Table 17: Penetration rates in vehicles

Vehicles	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 10	Yr 15	Yr 20	Yr 25
Autos	2%	7%	15%	20%	30%	50%	50%	50%	50%
Taxis	3%	10%	25%	40%	60%	60%	60%	60%	60%
Cars	3%	8%	15%	20%	25%	25%	25%	25%	25%
Buses	2%	5%	10%	12%	15%	15%	15%	15%	15%

Demand Estimation

Consumers to be connected (Cumulative)	Yr 1	Yr 5	Yr 10	Yr 15	Yr 20	Yr 25
Domestic connections	1,00,000	14,17,959	17,40,949	21,00,837	23,45,352	25,02,397
Transport (Vehicles)	11,809	1,43,025	2,21,517	2,64,635	3,16,433	3,78,701
Industrial connections	5	18	44	83	137	179
Commercial connection	10	110	259	337	438	570

Segment (000 SCMD)	Yr 1	Yr 5	Yr 10	Yr 15	Yr 20	Yr 25
Domestic	49	699	802	916	1029	1097
Transport	58	502	912	1089	1303	1559
Industrial	25	91	218	413	687	893
Commercial	4	44	103	135	175	228
Total	**136**	**1530**	**2036**	**2553**	**3193**	**3777**



District wise planned infrastructure (first 5 years)

District	Area of district in the GA	Number of domestic connections	Number of CNG stations
Howrah	182	122147	6
Hooghly	185	65821	8
Kolkata	192	912829	17
Nadia	70	18699	1
24 North Parganas	450	223350	20
24 South Parganas	450	74859	5
Total	**1529**	**1417705**	**57**

2.3 Design basis for the network

The CGD network has been designed in line with the regulations specified by PNGRB in G.S.R. 612 (E), "Technical standard and specifications including safety standard for city and local natural gas distribution network" and G.S.R. 750 (E) "Amendment to technical standards and specifications including safety standard for city of local NG distribution network".

2.3.1 Network structure

The envisaged CGD network structure has been described in the following sections. All pipelines, station piping and mainline valves forming the network have been designed for service life of 25 years.

2.3.1.1 Sub-transmission pipeline

Sub-transmission pipeline is a high-pressure pipeline connecting the main transmission pipeline to the city gate station (CGS) and owned by the CGD entity.
The maximum upstream pressure at the inlet of CGS is considered as 99 barg and maximum downstream operating pressure 49 barg. The sub-transmission pipeline shall be made of steel API 5L Grade X 52.

2.3.1.2 Primary network

The steel network shall have to design pressure of 49 barg to distribute gas to all consumers. This network shall carry gas from the CGS to inlets of various district regulating stations (DRS), industrial consumers and pressure-conditioning skids of CNG stations. The network shall be laid below ground along public roads in geographical area. It will have isolating valves at stipulated intervals and critical crossings. Each branch shall have three valve patterns to ensure flexibility of supply and maintenance.
Route markers shall be installed to mark the route of underground pipelines. It will be catholically protected against corrosion. All valves installed on this network shall be placed in constructed valve chambers for ease of operation. All crossings of major roads, railways and canals shall be cased crossings installed by open cuts or the no-dig technology. The network shall be tested following applicable standard procedures and then thoroughly flushed and cleaned before it is commissioned.

2.3.1.3 Material of pipeline

The sub-transmission pipeline shall be made of steel API 5L Grade X 52.

Land requirement & pipeline dimensions

- 3600 sq.mt. of land at Dankuni for setting up the City Gas Station (CGS)
- 35 meter X 30 meter (1050 sq.mt.) of land for each CNG station that will be company owned and company operated (7 such stations have been planned)
- 6 meter X 6 meter (36 sq.mt.) of land at various locations in residential areas for setting up above ground District Regulating stations (DRS)
- 3 meter of right of way (ROW) along the pipeline route

Pipeline dimension (Steel)	Length (km)
24 inch	197
20' inch	21
16 inch	14
12 inch	36
10 inch	52
8 inch	53
6 inch	132
4 inch	84

Pipeline dimension (MDPE)	Length (km)
125 mm	2468
90 mm	4936
63 mm	7404
32 mm	9872
20 mm	4936

Facility rollout plan

CRISIL INFRASTRUCTURE ADVISORY

CNG rollout	Y1	Y5	Y10	Y15	Y20	Y25	Total
Mother Mega stations (2 X 1600 SCMH)	0	2	1	0	0	0	14
Normal Mother stations (1X1600 SCMH)	8	3	0	0	1	0	43
Total No. of CNG Stations	8	5	1	0	1	0	57
Cumulative No. of CNG Station	**8**	**47**	**52**	**54**	**57**	**57**	**57**

CGD rollout	Y1	Y5	Y10	Y15	Y20	Y25	Total
PE Pipeline (kms)	1200	5016	798	889	358	381	29617
Steel pipeline (kms)	322	10	1	1	1	0	588
Domestic Connections (nos)	**100,000**	**418,000**	**66,519**	**74,064**	**29,792**	**31,787**	**24,68,118**

Classification: EXTERNAL

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CAPEX & OPEX

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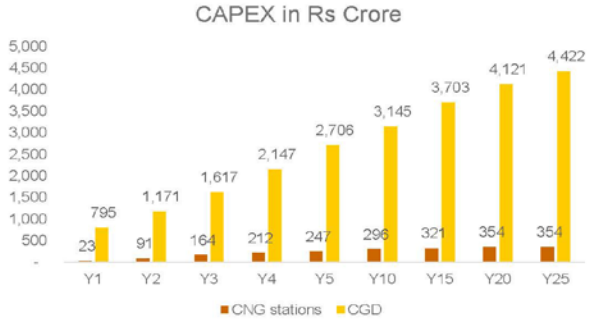

- Total envisaged CAPEX of Rs 4776 Crore over 25 years
- Escalation rate for CAPEX considered at 3% year on year
- Escalation rate for OPEX estimation considered at 6% year on year

OPEX for the CGD project	Y1	Y5	Y10	Y15	Y20	Y25
Operating cost in Rs Lakh	1778	13829	23233	37559	59814	92455

Classification: EXTERNAL

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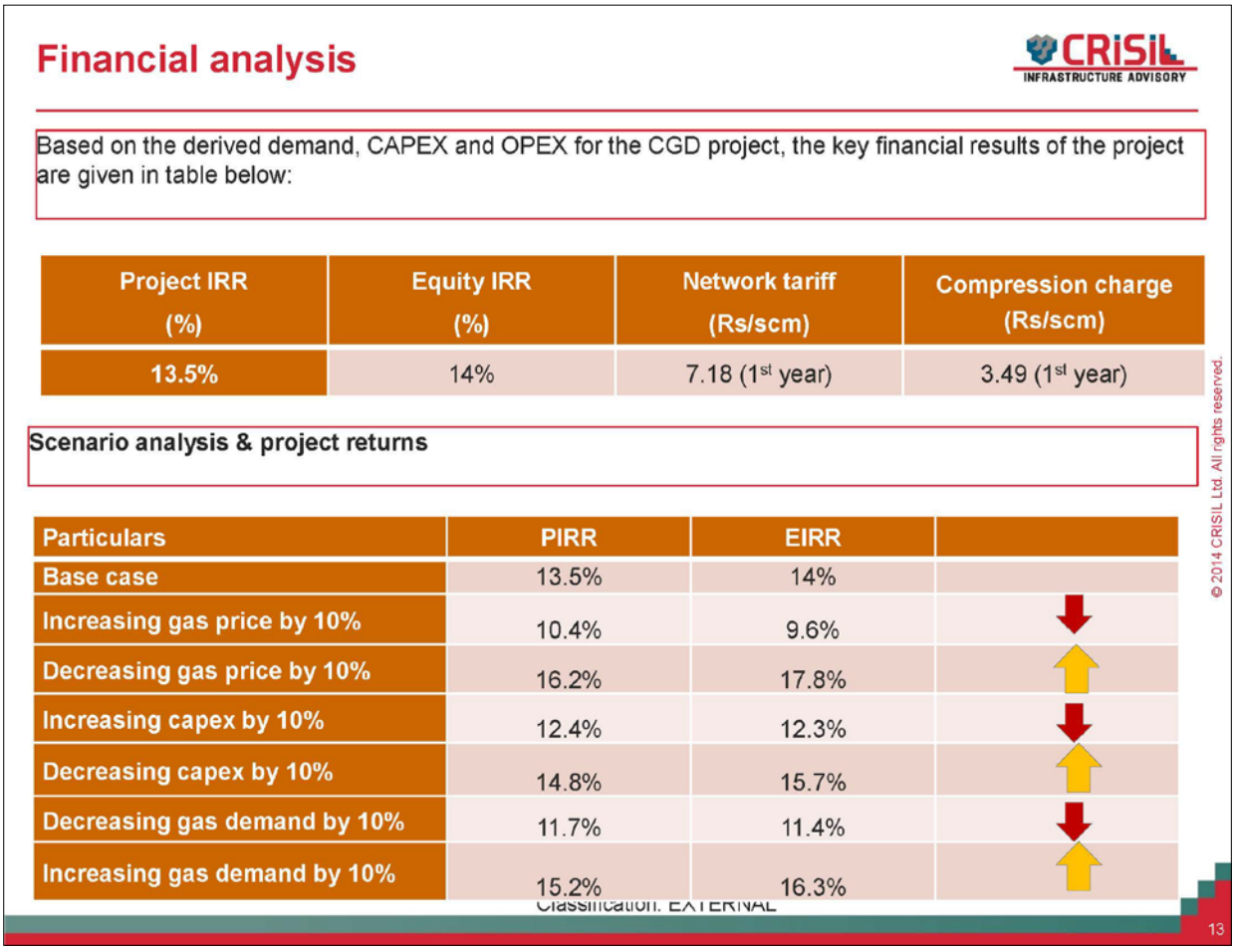

Financial analysis

CRISIL INFRASTRUCTURE ADVISORY

Based on the derived demand, CAPEX and OPEX for the CGD project, the key financial results of the project are given in table below:

Project IRR (%)	Equity IRR (%)	Network tariff (Rs/scm)	Compression charge (Rs/scm)
13.5%	14%	7.18 (1st year)	3.49 (1st year)

Scenario analysis & project returns

Particulars	PIRR	EIRR	
Base case	13.5%	14%	
Increasing gas price by 10%	10.4%	9.6%	↓
Decreasing gas price by 10%	16.2%	17.8%	↑
Increasing capex by 10%	12.4%	12.3%	↓
Decreasing capex by 10%	14.8%	15.7%	↑
Decreasing gas demand by 10%	11.7%	11.4%	↓
Increasing gas demand by 10%	15.2%	16.3%	↑

Classification: EXTERNAL

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CHAPTER - 3

MECON ASSUMPTIONS AND VALIDATION OF REPORT

3.0 MECON Assumptions and Validation of Report

3.1 MECON studied the detail feasibility report prepared by M/s CRISIL and the following assumptions were taken into consideration while validating the DFR.

3.1.1 The market survey conducted by CRISIL and demand projections for domestic, commercial, automobile and industrial sectors in the Geographical Area covered under Kolkata GA have been taken into considered.

3.1.2 It was observed that 14,17,959 Domestic connections have been considered by CRISIL upto the 5th year. However considering the present guidelines set by PNGRB vide Gazette notification no-PNGRB/CGD/BID/4/2013-PRE BID dated 7th April '2014, domestic connection were recalculated based on the population and households of the Kolkata GA awarded by PNGRB. The infrastructure towards domestic connection has been modified accordingly as per the current guidelines of PNGRB.

3.1.3 The 24" dia steel pipeline from Asansol to Dankuni which is around 196.7 km has not been considered as the CGS is proposed to be located near Dankuni.

3.1.4 Another CGS at Karnmadhabpur Near Kalyani express Highway has also been considered to cater to part of the load of Kolkata GA. However around 20 Km of 12" dia. Pipeline has been further considered to cater from the second CGS which was not considered in CRISIL report and further pipeline network distribution to Nadia and other districts.

3.1.5 The Capital cost of Individual Item has been considered as prevalent in the current market scenario.

3.1.6 Currently introduced GST has been considered.

3.1.7 Considering the directives of Government of West Bengal and NGT towards introduction of CNG for curbing of pollution level in Kolkata and adjoining areas, the demand of automobile sector has been proportionately increased by around 44 % from 1.559 to 2.244 MMSCMD.

3.1.8 Further considering the above change it is expected that the government would encourage green fuel in the industrial and commercial sector also, accordingly the demand has been proportionately increased by around 9 % from 1.121 to 1.223 MMSCMD.

3.1.9 The Capital Cost, Operating Cost and Financial analysis has been recalculated accordingly.

3.2 Details of Validation of DFR Prepared by M/s CRISIL

3.2.1 Gas Source

GAIL (I) Limited would be transporting gas to the CGS location by December 19 through JHBDPL, where custody transfer of gas will take place and which is required to meet the demand of Domestic, Commercial, Industrial & Automobile sector in Kolkata GA.

3.2.2 City Gate Station –

The sources of gas indicated above would require City Gate Stations with all the associated facilities. It is assumed that the capacity in the CGS would be utilised progressively to meet the demand requirements up to the 25th year.

Two numbers of CGS are proposed to supply Gas to the entire network of Kolkata GA.

- It is proposed that 1st CGS would be setup near Karnmadhabpur , Village - Natagarh, Tehsil - Barasat-II, Distt- North 24 Pargana and tap-off would be taken from 18" spur line of JHBDPL to Kolkata GA.

- The 2nd CGS would be setup near Dankuni , and tap-off would be taken from 24" main line of JHBDPL going to Haldia.

- Two Metering skids of capacity 0.50 MMSCMD each and Six Metering Skids of 1.0 MMSCMD each have been considered in each CGS along with odorising units.

3.2.3 Domestic connections

The number of domestic connection to be provided have been calculated as follows :-

- The area of Kolkata GA as defined by PNGRB is 1529 sq km

- The population of Kolkata GA as defined by PNGRB considering 2011 CENSUS data is 1.64 crore.

- The family members per households is taken as 4.4 as per CENSUS report of West Bengal / Kolkata. The number of households works out to 1,86,363 considering 5% of total households to be connected in first 5 years as per PNGRB guidelines.

- The average Gas Volume for each Domestic household is taken as 15 SCM per month. The households to be connected as per PNGRB for first five years along with Domestic connections planned year wise is as given below :

Targets by PNGRB (For each year)

Cumulative	1st year	2nd year	3rd year	4th year	5th year
PNG Connection (numbers)	1,00,000	3,00,000	6,00,000	10,00,000	14,17,959
Steel Pipeline (inch-km)	500	1500	3000	5000	7296
Compression Capacity (kg/day)	50,000	1,50,000	3,00,000	5,00,000	7,90,200

Targets As Planned (for each year)

Cumulative	1st year	2nd year	3rd year	4th year	5th year
PNG Connection (numbers)	1000	30,000	1,00,000	1,50,000	2,00,000
Steel+MDPE Pipeline (inch-km)	947	2704	5178	6908	8418
Compression Capacity (kg/day)	1,32,920	3,48,920	5,81,540	8,30,770	10,63,380

Description	No. of Domestic Connections (Cumulative)				
	Yr 5	**Yr 10**	**Yr 15**	**Yr 20**	**Yr 25**
As Planned	2,00,000	4,50,000	7,00,000	9,50,000	12,00,000

The Total Steel Pipeline Infrastructure proposed to be laid for setting up the total network is as detailed below:

Steel Pipeline	**20" Dia**	**16" Dia**	**12" dia**	**10" Dia**	**8" Dia**	**6" Dia**	**4" Dia**
Pipe Length (Km)	20.50	14.00	55.0	52.0	53.0	132.0	84

The total Inch-Km of Steel & PE pipeline envisaged to be laid in first five years and subsequently up to 25 yrs is as follows:

Target	Year 1	Year 2	Year 3	Year 4	Year 5
	Cumulative	Cumulative	Cumulative	Cumulative	Cumulative
Steel pipeline planned (Km)	85	184.5	259.5	314.5	344.5
PE pipeline planned (Km)	12	360	1200	1800	2400
Inch Km of Planned Steel pipeline	920	1894	2478	2858	3018
Inch km of Planned PE pipeline	27	810	2700	4050	5400
Total Inch km of pipeline.	947	2704	5178	6908	8418

Target	Year 10	Year 15	Year 20	Year 25
	Cumulative	Cumulative	Cumulative	Cumulative
Planned in Steel pipeline (Km)	400.5	405.5	410.5	410.5
Planned in PE pipeline (Km)	5400	8400	11400	14400

The total demand for various segments during 1st, 5th, 10th, 15th, 20th and 25th year has been indicated below. The Domestic demand is based on the revised household connections. The Automobile, Commercial and Industrial demand has been increased proportionately from the demand projected by CRISIL from 3.77 to 4.06 MMSCMD.

Segment Wise Realisable Demand (MMSCMD)						
Segments / Years	YR 1st	YR 5th	YR 10th	YR 15th	YR 20th	YR 25th
Domestic	0.00050	0.10000	0.22500	0.35000	0.47500	0.60000
Commercial	0.00058	0.04288	0.11292	0.14691	0.19114	0.24867
Industrial	0.00115	0.08310	0.21623	0.42199	0.73202	0.97455
Automobile	0.00840	0.52662	1.08933	1.43447	1.81569	2.24464
Total	**0.01063**	**0.75260**	**1.64348**	**2.35337**	**3.21385**	**4.06787**

3.2.4 CNG Stations & Design Parameters for CNG Stations

Based on the available projected demand, various facilities planned by CRISIL have been taken into consideration.

The planned Mother Stations shall be helpful in maintaining healthy compression capacity and CNG could be dispensed at the Retail Outlets through cascades till the steel network reaches that place. The Daughter Booster stations would be installed at such retail outlets and would be shifted to other locations where pipeline has not reached.

Table – 05.05

STATIONS	Cap. of compressor in SCMH	No. of CNG Station installations		Year of installation
		Upto 5th year	Upto 25th year (Cum)	
A) Mother Stations		**8**	**14**	
No. of Compressors at locations near Steel grid network in the Charge areas	1200	16	28	Progressively as per Bill of Material.
B) Online Stations		**26**	**72**	
No. of Compressors at locations near Steel grid network in the Charge areas	1200	26	72	Progressively as per Bill of Material
B) Bus Depot		**11**	**15**	

STATIONS	Cap. of compressor in SCMH	No. of CNG Station installations		Year of installation
		Upto 5th year	Upto 25th year (Cum)	
No. of Compressors at locations near Steel grid network in the Charge areas	1200	22	30	Progressively as per Bill of Material
C)Daughter booster Stations (In R.Os)		**12**	**24**	
No. of Compressors at locations near Steel grid network in the Charge areas	650	12	24	Progressively as per Bill of Material

The Compressors shall be operating at 16-19 Kg/cm2 (g) to 255 Kg/cm2 (g). If need be pressure regulators shall be installed at the inlet of Compressor. The space provision for which shall be kept beforehand. The booster compressor will be operated by the LCV carrying mobile Cascades.

The number of compressors has been added over the years to maintain a healthy compression capacity to meet gas demand in Automobile sector for 25th year.

CNG Cascades of 4500 WL capacities are envisaged to be installed at the Mother Stations with adequate number of Bus, Car/ Auto dispensers has been envisaged to maintain a healthy dispensing capacity to gas demand ratio. CNG cascade having 3000 WL capacity are envisaged to be installed at DBS.

The design parameters for the above CNG facilities and number of CNG cascades are as follows:

- Inlet pressure : 16-19 Kg/cm^2(g) for Compressors
- Outlet pressure : 255 Kg/cm^2(g)
- Cascade capacity : 4500 WL & 3000 WL

Average Filling Capacity :

- Bus : 80 kg
- Car : 8 kg
- Auto : 3.5 kg

Average Filling Time/Vehicle:

- Bus : 8 minutes
- Car : 4 minutes
- Auto : 2 minutes

No. of Arms per Dispenser :

- Bus Dispensar : 1 no.
- Car/ Auto Dispensar : 2 nos.

3.2.5 Design Parameters for PNG Distribution Network

The pressure regimes that shall be followed for the system design are:

- DRS to Distribution : 16 ~ 19 bar to 6 bar
- Distribution/ Service Line (Medium Pressure System): 6 bar to 1.5 bar
- Domestic Connection (Low Pressure System): 6 bar to 100 mbar (GI Installation)
- Domestic Connection (Low Pressure System): 100 mbar to 21 mbar (GI/ Copper Installation)
- Supply pressure large commercial consumer: 2 bar *
- Supply pressure small commercial consumer: 300 / 500 mbar *
- Industrial Consumers: 2 bar or as per requirement*

3.2.6 District Regulating Stations (DRS) / Decompression Unit.

It is planned to have common DRSs (as the case may be) for all domestic and commercial connections and for some of the small industrial connections. Considering the vast area coverage of Kolkata GA, DRSs of 5000 & 2500 SCMH capacities have been envisaged at multiple locations distributed among the Charge Areas.

The phasing of DRS is planned as follows:

Period	DRS (Cumulative Nos)	DRS (Cumulative Nos)
	5000 SCMH	**2500 SCMH**
1st – 5th Year	**8**	**29**
Upto 10th Year	**8**	**46**
Upto 25th Year	**8**	**59**

Virtual-pipeline is an alternative method of transporting natural gas to places where there are no pipeline networks available. It is based on a modular system of compression,

transport and decompression natural gas, which communities, industries, gas stations and others can use.

In case of certain charge areas where it is not possible to provide direct connectivity through pipeline or where the providing connectivity is likely to take time, the virtual pipeline system shall be used. These virtual pipelines will be consisting of Decompression units of desired capacities 500 SCMH to 250 SCMH and Stationary Cascades of 4500/3000 WL Capacities to take care of Domestic, Commercial and small Industrial Consumers in such charge areas.

3.3 MDPE Network

It is planned to install MDPE network of following sizes:

- Dia. 125mm, PE 100, SDR 11
- Dia. 90mm, PE 100, SDR 11
- Dia. 63mm, PE 100, SDR 11
- Dia. 32mm, PE 100, SDR 11
- Dia. 20mm, PE 100, SDR 11

The Network would begin from MRS / DRS and enter up to premises of domestic and commercial units. The pipeline would be laid progressively over 25 years, the lengths to be laid over the years is given in Bill of Material attached. The quantity of PE pipes of various sizes required to be laid year wise along with warning mat and PE valves are detailed in Bill of Material attached herewith.

CHAPTER - 4

CAPITAL COST ESTIMATE

04.00 CAPITAL COST ESTIMATE

04.01 General

Capital cost based on the facilities envisaged for steel gridline, online stations and city gas distribution network including charges for domestic, commercial and industrial connections are estimated as **INR 4144.29 Crores** for 25 years and **INR 1284.72 Crores** for initial 5 years**.** The total cost for 25 years and for 5 years of the project are summarised in tables provided in the end of this chapter.

04.02 Major Facilities

Major facilities included in the capital cost estimates are given below:

Sl. No.	Description	Unit	Facilities
I)	**Grid Line in metres**		
	20" x 6.4.mm Steel Pipeline	M	20500
	16"x 6.4mm Steel Pipeline	M	14000
	12" x 6.4mm Steel Pipeline	M	55000
	10" x 6.4mm Steel Pipeline	M	52000
	8" x 6.4mm Steel Pipeline	M	53000
	6"x 6.4mm Steel Pipeline	M	132,000
	4"x 6.4mm Steel Pipeline	M	84,000
II)	**CNG Compressors in Nos.**		
	Mother Compressors 1200 SCMH – Gas driven	Nos	130
	Cascades-4500, 3000 WL	Nos	202
	Car/Auto dispensers	Nos	348
	Bus dispensers	Nos	130
III)	**City Gas Distribution**		
	MDPE Pipe in Kilometres		
	125 mm dia.	KM	1200
	90 mm dia.	KM	2400
	63 mm dia.	KM	3600
	32 mm dia.	KM	4800
	20 mm dia.	KM	2400

Note :- Costs towards technological equipment, associated electrics, spares, erection, civil engineering works and purchase of land are included in the estimate. The estimates are based on the prices for different cost elements prevailing during 2nd quarter of 2017 and do not include any provision for future escalation.

04.03 Assumptions

Following assumptions have been made for working out the capital costs.

04.03.01 Land and ROW/ ROU Compensation

The cost of land for citing CNG stations has been considered at a rate of INR 3 crores per plot for Mother Stations and INR 2 crores per plot for Online Stations. ROU charges have been considered @ INR 1,000/m for the entire pipeline length of Steel Pipeline. In case of MDPE, ROU charge has been considered @ INR 500/m for entire length of 125mm, 90mm dia and 63mm dia pipeline.

04.03.02 Equipment

The costs of equipment, in some areas, are based on LOA/ budgetary offers. However, generally, in house information for equipment installed in other projects has been used.

04.03.03 Civil engineering works

Cost estimates for civil engineering works have been worked out based on preliminary layout and design of grid line and rates generally prevailing for similar work in the area.

04.03.04 Erection

Provision towards erection of equipment has been made on the basis of erection rates as prevailing in the region.

04.03.05 **Freight, insurance, duties and taxes**

For indigenous equipment provision for GST @ 18% and inland freight & transit insurance @ 2% has been made. GST @ 18% has also been considered on cost of Engineering, Supervision etc.

04.03.06 **Engineering, Supervision and Project Management**

A provision has been made towards engineering, supervision and project management services etc., at the rate of 4.0% of capital cost for CGS, City Gas Distribution, CNG Stations & Domestic Connection Expenses. This includes detailed engineering including preparation of drawings, technical specifications, preparation of tender documents and assistance for award of contracts, designer's supervision, project management services and temporary power and water facilities, etc.

04.03.07 **Owner's Management Expenses**

Provision towards owner's management expenses have been kept at the rate of 3.5% of capital cost for all the facilities.

04.03.08 **Contingencies**

A provision of 5% on project cost (excluding expenses for domestic connection) has been made towards contingencies to take care of the unforeseen aspects of the estimate.

04.03.09 **Financing**

It has been assumed that the project cost would be financed in a Debt: Equity ratio of 60: 40. Interest rate on long term loan has been considered as 9.50%

per annum. The repayment schedule for long term loan has been considered as 8 years after considering 2 years moratorium period.

04.03.10 **Connection Charges**

A provision for connection charges has been made in the Capex @ INR 9,000 per connection for about 12,00,000 domestic connections. In case of commercial and industrial connections it has been assumed that full expenses towards connection shall be realised from the consumers. Therefore, no provision for these charges has been kept in the estimates. Interest free deposit of INR 5,000 per connection for domestic consumers has been considered as refundable advance. This amount has to be refunded at the end of project life.

04.04 **Phasing of Expenditure**

Phasing of capital expenditure before interest during construction for the project as **INR 4000.04 Crores** has been worked out on the basis of implementation schedule. The same is shown year-wise and given below.

Phasing of Capital Expenditure –

Year	1st	2nd	3rd	4th	5th	6th
Cost in INR Crore	**197.46**	**283.79**	**322.45**	**234.47**	**201.75**	**190.34**

Year	7th	8th	9th	10th	11th	12th
Cost in INR Crore	**161.65**	**157.85**	**163.55**	**149.87**	**145.68**	**156.33**

Year	13th	14th	15th	16th	17th	18th
Cost in INR Crore	**144.15**	**128.58**	**124.39**	**123.24**	**124.76**	**128.95**

Year	19th	20th	21st	22nd	23rd	24th	25th
Cost in INR Crore	**124.39**	**122.49**	**124.22**	**115.49**	**124.22**	**128.41**	**121.56**

PROJECT CAPITAL COST SUMMARY (Over 25 Years) **(INR Lakhs)**

Sl. No.	Description	Capital Expenditure		
		FC	LC	TOTAL
A)	**Facilities**			
1	City Gate Station	0	1,925	1,925
2	CNG Stations	0	68,626	68,626
3	City gas distribution	0	1,78,221	1,78,221
4	Expenses for Domestic Connection	0	1,08,000	1,08,000
	Sub-Total (A)	**0**	**3,56,772**	**3,56,772**
B)	**Engineering Costs**			
1	Detailed engineering, procurement, construction, supervision & project management	0	14,271	14,271
2	Service tax	0	2,569	2,569
	Sub-Total (B)	**0**	**16,840**	**16,840**
C)	**Owner's Cost, Start- up Expenses**			
1	Owners management expenses	0	12,487	12,487
	Sub-Total (C)	**0**	**12,487**	**12,487**
D)	**Other Costs**			
1	Contingencies	0	13,905	13,905
	Total Cost before IDC	**0**	**4,00,004**	**4,00,004**
E)	Interest During Construction	0	14,425	14,425
	Grand Total	**0**	**4,14,429**	**4,14,429**

CAPITAL COST- City Gate Station (Over 25 Years)

INR Lakhs

Sl. No.	Description	Capital Expenditure		
		FC	LC	Total
A	**Land**			
1	Cost of land (for siting CGS only)	**0**	**360**	**360**
B	**City Gate Station**			
1	Mechanical, Electrical, Instrumentation, Odourising etc	0	1,300	1,300
	Sub-total (B)	**0**	**1,300**	**1,300**
C	**Taxes & Duties**			
	Ocean Freight & Marine Insurance	0	0	0
	Customs Duty incl. CVD	0	0	0
	Port handling	0	0	0
	Inland Freight & Transit Insurance	0	31	31
	GST	0	234	234
	Sub-total (C)	**0**	**265**	**265**
D	**Total CGS**	**0**	**1,925**	**1,925**

CAPITAL COST - CNG Stations (Over 25 Years)

INR Lakhs

Sl. No.	Description	Capital Expenditure		
		FC	LC	Total
A	**Compressors and related facilities**			
1	Compressors, Dispensers & Cascades	0	25,829	25,829
2	GEG Set & Control Panel	0	430	430
3	Fire Fighting System	0	422	422
4	UPS or Battery Banks	0	86	86
5	Miscellaneous	0	4,779	4,779
	Sub-total (A)	**0**	**31,546**	**31,546**
B	**Erection**			
1	Mechanical	0	1,418	1,418
2	Electrical, Instrumentation	0	688	688
3	Civil works	0	18,620	18,620
	Sub-total (B)	**0**	**20,726**	**20,726**
C	**Land**	**0**	**6,200**	**6,200**
D	**Taxes & Duties**			
	Ocean freight & marine insurance	0	0	0
	Customs Duty (incl. CVD)	0	0	0
	Port handling	0	0	0
	Inland Freight & Transit Insurance	0	744	744
	GST	0	9409	4,042
	Sub-Total (D)	**0**	**10,154**	**10,154**
F	**Sub-Total for CNG Stations**	**0**	**68,626**	**68,626**

CAPITAL COST – City Gas Distribution (Over 25 Years)

INR Lakhs

Sl. No.	Description	Capital Expenditure		
		FC	LC	Total
A	**EQUIPMENT**			
	STEEL			
1	Steel Pipes-Main gridline PE Coated	0	10,710	10,710
2	Steel pipe fittings & bends	0	1,499	1,499
3	SCADA	0	325	325
4	SV Stations	0	605	605
5	Cathodic Protection	0	661	661
	MDPE			
6	Pipe MDPE	0	23,400	23,400
7	Pipe, HDPE	0	1,054	1,054
8	MDPE Valves, Fittings, Transition Fittings	0	4,260	4,260
9	DRS	0	1,795	1,795
10	Warning Mat	0	6,480	6,480
	Sub-total (A)	**0**	**50,788**	**50,788**
B	**Erection**			
1	Mechanical, Electrical, Instrumentation etc.	0	64,593	64,593
2	Civil works		204	204
	Sub-total (B)	**0**	**64,797**	**64,797**
C	**Land for SV Stations, ROU for pipeline and MDPE**	**0**	**40,633**	**40,633**
D	**Taxes & Duties**			
	Ocean freight & marine insurance	0	0	0
	Customs Duty (incl. CVD)	0	0	0
	Port handling & Freight	0	0	0
	Inland Freight & Transit Insurance	0	1,199	1,199
	GST	0	20805	20805
	Sub-Total Indirect Costs	**0**	**22,004**	**22,004**
E	**Sub-Total for City Gas Distribution**	**0**	**1,78,221**	**1,78,221**

PROJECT CAPITAL COST SUMMARY (Over 5 Years)

(INR Lakhs)

Sl. No.	Description	Capital Expenditure		
		FC	LC	TOTAL
A)	**Facilities**			
1	City Gate Station	0	1,925	1,925
2	CNG Stations	0	30,488	30,488
3	City gas distribution	0	59,497	59,497
4	Expenses for Domestic Connection	0	18,000	18,000
	Sub-Total (A)	**0**	**1,09,909**	**1,09,909**
B)	**Engineering Costs**			
1	Detailed engineering, procurement, construction, supervision & project management	0	4,396	4,396
2	Service tax	0	791	791
	Sub-Total (B)	**0**	**5,188**	**5,188**
C)	**Owner's Cost, Start- up Expenses**			
1	Owners management expenses including Bank Charges against PBG	0	3,847	3,847
	Sub-Total (C)	**0**	**3,847**	**3,847**
D)	**Other Costs**			
1	Contingencies	0	5,047	5,047
	Total Cost before IDC	**0**	**1,23,991**	**1,23,991**
E)	Interest During Construction	0	4,481	4,481
	Grand Total	**0**	**1,28,472**	**1,28,472**

CAPITAL COST - City Gate Station (First Five Years)

(INR Lakhs)

Sl. No.	Description	Capital Expenditure		
		FC	LC	Total
A	**Land**			
1	Cost of land (for siting CGS only)	**0**	**360**	**360**
B	**City Gate Station**			
1	Mechanical, Electrical, Instrumentation, Odourising etc	0	1,300	1,300
	Sub-total (B)	**0**	**1,300**	**1,300**
C	**Taxes & Duties**			
	Ocean Freight & Marine Insurance	0	0	0
	Customs Duty incl. CVD	0	0	0
	Port handling	0	0	0
	Inland Freight & Transit Insurance	0	31	31
	GST	0	234	234
	Sub-total (C)	**0**	**265**	**265**
D	**Total CGS**	**0**	**1,925**	**1,925**

CAPITAL COST - CNG STATIONS (First Five Years)

(INR Lakhs)

Sl. No.	Description	Capital Expenditure		
		FC	LC	Total
A	**Compressors and related facilities**			
1	Compressors, Dispensers & Cascades	0	12503	12503
2	GEG Set & Control Panel	0	170	170
3	Fire Fighting System	0	182	182
4	UPS or Battery Banks	0	34	34
5	Miscellaneous	0	1947	1947
	Sub-total (A)	**0**	**14836**	**14836**
B	**Erection**			
1	Mechanical	0	679	679
2	Electrical, Instrumentation	0	272	272
3	Civil works	0	7550	7550
	Sub-total (C)	**0**	**8501**	**8501**
C	**Land**	0	2600	2600
D	**Taxes & Duties**			
	Ocean freight & marine insurance	0	0	0
	Customs Duty (incl. CVD)	0	0	0
	Port handling	0	0	0
	Inland Freight & Transit Insurance	0	350	389
	GST	0	4201	3226
	Sub-Total (E)	**0**	**4551**	**4551**
F	**Sub-Total for CNG Stations**	**0**	**30488**	**30488**

CAPITAL COST - City Gas Distribution (First Five Years)

(INR lakhs)

Sl. No.	Description	Amount		
		FC	LC	Total
A	**EQUIPMENT**			
	STEEL			
1	Steel Pipes-Main gridline PE Coated	0	10381	10381
2	Steel pipe fittings & bends	0	1456	1456
3	SCADA	0	325	325
4	SV Stations	0	599	599
5	Cathodic Protection	0	642	642
	MDPE			
6	Pipe MDPE	0	3900	3900
7	Pipe, HDPE	0	176	176
8	MDPE Valves, Fittings, Transition Fittings	0	710	710
9	DRS	0	1045	1045
10	Warning Grid	0	1080	1080
	Sub-total (A)	**0**	**20313**	**20313**
B	**Erection**			
1	Mechanical, Electrical, Instrumentation etc.	0	20703	20703
2	Civil works		201	201
	Sub-total (B)	**0**	**20904**	**20904**
C	**Land for SV Stations, ROU for pipeline and MDPE**	**0**	**10381**	**10381**
D	**Taxes & Duties**			
	Ocean freight & marine insurance	0	0	0
	Customs Duty (incl. CVD)	0	0	0
	Port handling & Freight	0	0	0
	Inland Freight & Transit Insurance	0	479	479
	GST	0	7419	7419
	Sub-Total Indirect Costs	**0**	**7898**	**7898**
E	**Sub-Total for City Gas Distribution**	**0**	**59497**	**59497**

CHAPTER - 5

OPERATING COST

05.00 OPERATING COST

05.01 General

The annual operating costs for the project at 100% capacity is given below.

Annual Operating Cost

S No.	Description	Total Cost (In Rs Lakhs)
A	**VARIABLE COSTS**	
1	Power	2556
2	Odourant	223
3	Gas	5633
	Sub -Total (A)	**8411**
B	**FIXED COSTS**	
1	Manpower	1576
2	Overheads	1000
3	Repair, Maintenance & Insurance	7941
4	AMC for Compressors	3342
	Sub -Total (B)	**13859**
	TOTAL (A+B)	**22271**

The various parameters considered for computing the operating costs are described in the following paragraphs.

Year wise operating cost have been furnished in Table No. 05.01

05.02 Cost of Energy

Electric energy has been considered for CNG Stations & City Gate Stations. The energy cost @ Rs 7.50 per KWH has been considered. In case of Gas Engine driven CNG Compressors, the gas cost has been taken @ Rs 15.95 per SCM. Further, Diesel for Gen. Sets has been considered @ Rs 55.74 per litre.

05.03 Water

Since the water requirement of the project would be negligible, no separate cost towards same has been considered in the operating cost estimate.

05.04 Manpower

Based on salary structure and number of personnel required, direct cost on account of manpower has been worked out as Rs. 5.47 lakhs per person on average basis. It has been assumed that out of total man power of 192 personnel around 2 would be Executives-I with average annual salary of Rs 30.0 lakhs, 94 would be Executive-II with average annual salary of Rs 10.0 lakhs and rest will be contract employees. Indirect cost towards overheads has been considered equivalent to 100% of permanent employee's salaries. Following salary & wage structure (including fringe benefits) has been considered for different category of personnel. In addition, wages for contract labour has also been taken as shown in the operating cost estimate.

Sl. No.	Category	Number of persons	Annual Salary (Rs./ man year) (on average basis)
1.	Regular Manpower (Executives-I)	2	30,00,000
2.	Regular Manpower (Executives-II)	94	10,00,000
3.	Contract Manpower (Supervisors, Assistants, Attendants)	192	3,00,000

	Total	**288**	

05.05 Repair & Maintenance

Provision for repair and maintenance has been kept at the rate of 1% of the capital cost for Steel Grid Line and City Gas Distribution and 5% for CNG stations. AMC has also been considered in addition to 5% of capital cost taken for repair & maintenance for compressors.

05.06 Insurance

Insurance cost at the rate of 0.25% of the capital cost has been considered in the operating cost estimate.

Yearwise Opex

Table-10.01

(In Rs Lakhs)

Item	Unit	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13
Power	Lakh Rs	42.0	165.9	407.3	653.7	921.4	1184.2	1425.7	1581.7	1721.3	1865.9	1967.7	2069.6	2192.7
Gas	Lakh Rs	0.0	152.6	446.7	909.2	1323.9	1918.6	2115.8	2318.0	2525.4	2738.2	2905.5	3075.0	3248.6
Consumables	Lakh Rs	0.6	6.0	15.9	29.1	41.2	57.2	64.9	72.8	81.0	90.0	97.2	104.7	112.4
Manpower	Lakh Rs	62.0	298.0	392.0	424.0	488.0	520.0	584.0	712.0	776.0	776.0	872.0	968.0	1032.0
Manpower Overheads	Lakh Rs	50.0	190.0	260.0	280.0	320.0	340.0	380.0	460.0	500.0	500.0	560.0	620.0	660.0
Repair & Maintenance & Insurance	Lakh Rs	0.0	370.1	1024.5	1737.9	2367.1	2935.6	3444.3	3822.9	4181.5	4576.0	4898.7	5199.3	5555.9
AMC for compressors & Wet Lease for LCVs	Lakh Rs	36.0	272.0	603.0	953.0	1343.0	1714.0	2019.0	2218.0	2396.0	2593.0	2724.0	2833.0	2968.0
Total	Lakh Rs	190.6	1454.6	3149.5	4986.9	6804.6	8669.6	10033.8	11185.5	12181.2	13139.1	14025.1	14869.6	15769.7

Item	Unit	Yr 14	Yr 15	Yr 16	Yr 17	Yr 18	Yr 19	Yr 20	Yr 21	Yr 22	Yr 23	Yr 24	Yr 25
Power	Lakh Rs	2278.1	2320.9	2342.2	2363.6	2384.9	2427.6	2449.0	2470.3	2491.7	2491.7	2513.0	2555.7
Gas	Lakh Rs	3424.7	3604.2	3787.3	3974.2	4165.0	4359.7	4558.7	4762.0	4969.8	5182.3	5399.7	5632.7
Consumables	Lakh Rs	120.5	128.8	137.5	146.6	156.0	165.7	176.0	185.5	194.3	203.4	212.8	222.7
Manpower	Lakh Rs	1032.0	1128.0	1160.0	1256.0	1288.0	1352.0	1416.0	1448.0	1512.0	1512.0	1576.0	1576.0
Manpower Overheads	Lakh Rs	660.0	720.0	740.0	800.0	820.0	860.0	900.0	920.0	960.0	960.0	1000.0	1000.0
Repair & Maintenance & Insurance	Lakh Rs	5848.6	6061.0	6251.4	6431.3	6622.2	6835.1	7025.5	7204.5	7394.7	7539.0	7729.2	7941.4
AMC for compressors & Wet Lease for LCVs	Lakh Rs	3056.0	3100.0	3122.0	3144.0	3166.0	3210.0	3232.0	3254.0	3276.0	3276.0	3298.0	3342.0
Total	Lakh Rs	16419.9	17062.9	17540.5	18115.6	18602.0	19210.2	19757.1	20244.3	20798.5	21164.5	21728.7	22270.6

CHAPTER - 6

FINANCIAL ANALYSIS

06.00 FINANCIAL ANALYSIS

06.01 General

The financial analysis of the project has been carried out based on the capital cost and operating cost as elaborated in Chapters - 09 & 10 respectively and the purchase price of the gas delivered at the tap-off and finally to consumers of the gas for the project. Profit & Loss Statement & Cash Flow Statement have been projected for the project life of 25 years and given in Table - 06.01 & 06.02. Debt-service coverage ratio has been calculated and given in Tables 06.03.
Salient financial indices for the project are given below.

Sl. No.	Description	Unit	Amount
1.	Total Capital Cost	Rs Crore	**4144.29**
2.	Total Operating Cost (at 25th year)	Rs Crore	**222.71**
3.	Post-tax IRR on Capital employed	%	**16.6**
4.	Pre-tax IRR on Capital employed	%	**21.3**
5.	Debt-service coverage ratio (over first 10 years of operation)	Ratio	**1.82**

06.02 Assumptions

Major assumptions considered for financial analysis are given below:-

i) Year wise gas volume considered for sale is as follows:-

(In thousand SCM)

Year	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7
Annual gas volume	3878	39769	106242	194062	274698	381036	432988

Year	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13	Yr 14
Annual gas volume	485404	539876	599870	648063	697957	749663	803297

Year	Yr 15	Yr 16	Yr 17	Yr 18	Yr 19	Yr 20	Yr 21
Annual gas volume	858981	916847	977034	1039691	1104975	1173054	1236583

Year	Yr 22	Yr 23	Yr 24	Yr 25
Annual gas volume	1295550	1356255	1418781	1484772

(ii) The following gas purchase prices at tap-off point and segment wise net selling prices have been considered for working out the financial analysis of the project:

Gas Purchase Prices

- Domestic & CNG Segment : Rs 15.95/SCM
- Industrial and Commercial Segment : Rs 34.96/SCM

The Following has been considered for arriving at Gas purchase price.

1. Domestic Gas (APM) : $ 2.48/MMBTU
2. Long term RLNG : $ 9.10/MMBTU
3. 1 US $: Rs 65.00
4. Domestic gas (APM) has been considered for PNG Domestic & CNG Segments.
5. For Industrial and commercial sectors, RLNG has been considered.

Net Selling Prices

- Domestic Consumers : Rs 23.29/SCM
- Commercial Consumers : Rs 38.36/SCM
- Industrial Consumers : Rs 34.96/SCM
- CNG Consumers : Rs 29.20SCM

For arriving at the net selling prices, taxes & duties have been considered as follows-

- Excise Duty and VAT, for CNG; have been considered @ 14.42% and 14.5% respectively.
- VAT @ 14.5% has been considered for PNG segment

- Dealer Commission @ Rs. 2.65/kg has been considered.

iii) Working capital requirement for the project has been considered equivalent to 3 months' operating expenses.

iv) Implementation Schedule is as given in earlier Chapter.

v) Project life has been considered as 25 years from the date of authorisation for the project.

vi) Salvage value equivalent to 5% of the project cost has been considered at the end of the economic life of the project.

vii) Corporate tax has been considered @ 34.61%.

viii) All estimates are based on the prices prevailing in 2nd quarter of 2017 and no future escalation has been considered.

ix) The project would be financed in the debt : equity ratio of 60:40.

x) It has been considered that an interest free deposit of Rs 5000 per connection from domestic consumers shall be taken. This amount shall be refunded at the end of the project life.

xi) Transmission losses has been considered @ 2% for CNG segment and @ 0.7% for PNG segment.

06.03 Sensitivity Analysis

Sensitivity analysis for the project has been carried out for increase/decrease of capital cost, operating cost, selling price, gas purchase price and gas volume. IRR (post tax) & DSCR for the project have been worked out with changed parameters to assess sensitivity of the project under different scenarios and presented in Table-06.04.

PROFIT AND LOSS STATEMENT

Table 11.01 (a)

(In Rs Lakhs)

Sl. No.	ITEM/YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13
1	ANNUAL GAS COST- CNG	498.9	3619.4	10553.1	21482.3	31277.5	45341.2	49998.3	54773.7	59672.2	64698.6	68645.5	72666.1	76763.1
	ANNUAL GAS COST- PNG	251.0	5122.8	11078.3	16604.1	22053.7	27316.9	33784.9	40160.2	46993.1	55493.8	62174.6	69295.6	76889.0
	ANNUAL OPERATING COST													
a	Consumables & Chemicals	0.6	6.0	15.9	29.1	41.2	57.2	64.9	72.8	81.0	90.0	97.2	104.7	112.4
b	Utilities -(Power & Fuel)	42.0	318.5	854.0	1562.9	2245.4	3102.8	3541.5	3899.8	4246.8	4604.1	4873.2	5144.6	5441.3
c	Salaries	62.0	298.0	392.0	424.0	488.0	520.0	584.0	712.0	776.0	776.0	872.0	968.0	1032.0
d	Repair & Maintenance	0.0	370.1	1024.5	1737.9	2367.1	2935.6	3444.3	3822.9	4181.5	4576.0	4898.7	5199.3	5555.9
e	Gen. Administrative Expences	50.0	190.0	260.0	280.0	320.0	340.0	380.0	460.0	500.0	500.0	560.0	620.0	660.0
f	AMC for compressors	36.0	272.0	603.0	953.0	1343.0	1714.0	2019.0	2218.0	2396.0	2593.0	2724.0	2833.0	2968.0
2	TOTAL ANNUAL OPERATING COST	190.6	1454.6	3149.5	4986.9	6804.6	8669.6	10033.8	11185.5	12181.2	13139.1	14025.1	14869.6	15769.7
3	TOTAL MANUFACTURING EXPENSES	**940.5**	**10196.7**	**24780.9**	**43073.3**	**60135.9**	**81327.7**	**93817.0**	**106119.4**	**118846.5**	**133331.4**	**144845.2**	**156831.3**	**169421.8**
4	EXPECTED SALES	1165.0	12040.0	31504.1	57437.1	81229.6	112453.4	128084.7	143798.8	160201.4	178617.3	193078.1	208112.0	223756.5
	Revenue from CNG	895.2	6494.5	18936.1	38546.9	56123.0	81358.2	89714.7	98283.5	107073.2	116092.3	123174.5	130388.8	137740.3
	Revenue from PNG	269.7	5545.5	12568.0	18890.1	25106.5	31095.2	38370.1	45515.2	53128.2	62525.0	69903.6	77723.2	86016.2
	Domestic	42.5	1274.9	4249.6	6374.3	8499.1	10623.9	12748.7	14873.5	16998.2	19123.0	21247.8	23372.6	25497.4
	Commercial	80.5	648.6	2591.7	4467.5	6003.4	7058.9	9127.9	10773.5	12570.2	15809.9	16664.3	17564.8	18514.0
	Industry	146.7	3622.1	5726.7	8048.3	10604.0	13412.5	16493.5	19868.3	23559.7	27592.1	31991.5	36785.8	42004.9
5	GROSS PROFIT BEFORE INTT.	224.5	1843.3	6723.2	14363.8	21093.7	31125.7	34267.8	37679.4	41354.9	45285.9	48232.9	51280.7	54334.7
6	INTT. ON LONG TERM LOAN	0.0	1163.4	2756.9	4252.6	4878.8	5165.6	5257.1	5064.4	4748.7	4366.4	3804.2	3334.7	3242.2
7	INTERST ON BANK BORROWINGS FOR WORKING CAPITAL	4.8	36.4	78.7	124.7	170.1	216.7	250.8	279.6	304.5	328.5	350.6	371.7	394.2
8	INTEREST ON OVER DRAFT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	TOTAL FINANCIAL EXPENSES	4.8	1199.8	2835.6	4377.2	5048.9	5382.4	5508.0	5344.0	5053.2	4694.9	4154.8	3706.4	3636.5
10	DEPRECIATION	0.0	648.6	1580.8	2639.8	3409.9	4072.6	4697.7	5228.6	5747.0	6284.2	6776.4	7254.8	7768.3
11	OPERATING PROFIT	219.7	-5.1	2306.8	7346.7	12634.8	21670.8	24062.1	27106.8	30554.6	34306.9	37301.7	40319.5	42929.9
12	PROFIT / LOSS BEFORE TAX	219.7	-5.1	2306.8	7346.7	12634.8	21670.8	24062.1	27106.8	30554.6	34306.9	37301.7	40319.5	42929.9
13	PROVISION FOR TAXATION	76.0	0.0	492.3	1567.9	2696.5	5431.7	6157.6	7205.0	8418.6	9739.7	10845.3	11977.9	12952.8
14	PROFIT AFTER TAX	143.7	-5.1	1814.5	5778.8	9938.3	16239.1	17904.4	19901.8	22136.0	24567.1	26456.4	28341.5	29977.1
15	RETAINED PROFIT:													
	(i) CURRENT	143.7	-5.1	1814.5	5778.8	9938.3	16239.1	17904.4	19901.8	22136.0	24567.1	26456.4	28341.5	29977.1
	(ii) CUMULATIVE	143.7	138.5	1953.1	7731.9	17670.2	33909.3	51813.8	71715.5	93851.5	118418.6	144875.0	173216.5	203193.7

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GAIL (INDIA) LTD

GCGSCL (A GOVT. OF WEST BENGAL ENTERPRISE)

VALIDATION OF DFR PREPARED BY CRISIL

CITY GAS DISTRIBUTION KOLKATA GA

MECON LTD

PROFIT AND LOSS STATEMENT

Table 11.01 (b)
(In Rs Lakhs)

Sl. No.	ITEM/YEAR	14	15	16	17	18	19	20	21	22	23	24	25
1	ANNUAL GAS COST- CNG	80939.3	85197.9	89542.0	93974.8	98499.6	103120.0	107839.6	112662.2	117591.7	122632.2	127787.9	133316.4
	ANNUAL GAS COST- PNG	84989.4	93633.7	102861.3	112714.2	123237.5	134479.0	146489.9	156676.1	165024.4	173744.6	182856.9	192382.3
	ANNUAL OPERATING COST												
a	Consumables & Chemicals	120.5	128.8	137.5	146.6	156.0	165.7	176.0	185.5	194.3	203.4	212.8	222.7
b	Utilities -(Power & Fuel)	5702.8	5925.1	6129.5	6337.8	6549.9	6787.4	7007.7	7232.3	7461.5	7674.0	7912.7	8188.5
c	Salaries	1032.0	1128.0	1160.0	1256.0	1288.0	1352.0	1416.0	1448.0	1512.0	1512.0	1576.0	1576.0
d	Repair & Maintenance	5848.6	6061.0	6251.4	6431.3	6622.2	6835.1	7025.5	7204.5	7394.7	7539.0	7729.2	7941.4
e	Gen. Administrative Expences	660.0	720.0	740.0	800.0	820.0	860.0	900.0	920.0	960.0	960.0	1000.0	1000.0
f	AMC for compressors	3056.0	3100.0	3122.0	3144.0	3166.0	3210.0	3232.0	3254.0	3276.0	3276.0	3298.0	3342.0
2	TOTAL ANNUAL OPERATING COST	16419.9	17062.9	17540.5	18115.6	18602.0	19210.2	19757.1	20244.3	20798.5	21164.5	21728.7	22270.6
3	TOTAL MANUFACTURING EXPENSES	**182348.7**	**195894.5**	**209943.8**	**224804.6**	**240339.1**	**256809.1**	**274086.6**	**289582.5**	**303414.6**	**317541.3**	**332373.5**	**347969.3**
4	EXPECTED SALES	240051.2	257038.4	274763.2	293273.5	312620.0	332857.2	354042.6	373607.5	391546.4	410060.9	429179.2	449384.7
	Revenue from CNG	145234.0	152875.5	160670.3	168624.2	176743.4	185034.0	193502.6	202156.1	211001.4	220045.8	229297.0	239217.0
	Revenue from PNG	94817.2	104163.0	114093.0	124649.3	135876.7	147823.2	160540.0	171451.4	180545.0	190015.1	199882.2	210167.6
	Domestic	27622.1	29746.9	31871.7	33996.5	36121.3	38246.0	40370.8	42495.6	44620.4	46745.1	48869.9	50994.7
	Commercial	19514.5	20569.0	21680.6	22852.2	24087.1	25388.8	26760.8	28207.0	29731.3	31337.9	33031.4	34816.5
	Industry	47680.6	53847.0	60540.7	67800.6	75668.3	84188.4	93408.3	100748.9	106193.3	111932.0	117980.8	124356.5
5	GROSS PROFIT BEFORE INTT.	57702.5	61143.9	64819.5	68468.8	72281.0	76048.1	79956.0	84025.0	88131.8	92519.7	96805.7	101415.3
6	INTT. ON LONG TERM LOAN	3129.8	2969.2	2822.5	2696.0	2605.1	2562.6	2508.7	2462.8	2448.3	2394.9	2399.3	2427.1
7	INTERST ON BANK BORROWINGS FOR WORKING CAPITAL	410.5	426.6	438.5	452.9	465.1	480.3	493.9	506.1	520.0	529.1	543.2	556.8
8	INTEREST ON OVER DRAFT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	TOTAL FINANCIAL EXPENSES	3540.3	3395.7	3261.1	3148.8	3070.1	3042.8	3002.6	2968.9	2968.2	2924.1	2942.5	2983.8
10	DEPRECIATION	8241.7	8663.9	9072.4	9477.2	9886.9	10310.4	10718.9	11121.2	11529.2	11908.4	12316.4	12738.1
11	OPERATING PROFIT	45920.5	49084.2	52486.0	55842.8	59324.0	62694.8	66234.5	69934.9	73634.4	77687.2	81546.7	85693.4
12	PROFIT / LOSS BEFORE TAX	45920.5	49084.2	52486.0	55842.8	59324.0	62694.8	66234.5	69934.9	73634.4	77687.2	81546.7	85693.4
13	PROVISION FOR TAXATION	14096.9	15341.5	16677.7	17999.2	19358.5	20668.8	22048.2	23486.3	24918.4	26491.6	27974.4	29546.5
14	PROFIT AFTER TAX	31823.6	33742.7	35808.3	37843.6	39965.5	42026.0	44186.3	46448.6	48716.0	51195.5	53572.3	56146.9
15	RETAINED PROFIT:												
	(i) CURRENT	31823.6	33742.7	35808.3	37843.6	39965.5	42026.0	44186.3	46448.6	48716.0	51195.5	53572.3	56146.9
	(ii) CUMULATIVE	235017.3	268760.0	304568.3	342411.9	382377.4	424403.4	468589.7	515038.3	563754.3	614949.8	668522.1	724669.0

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CALCUTTA GAS

VALIDATION OF DFR
PREPARED BY CRISIL
CITY GAS DISTRIBUTION
KOLKATA GA

MECON LTD

CASHFLOW STATEMENT

Table 11.02 (a)

(In Rs Lakhs)

Sl No	ITEM/YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13
A.	**SOURCES OF FUNDS**													
1.	EQUITY - FIXED CAPITAL	8164.4	11182.1	11963.7	8717.3	7361.2	6888.4	5699.3	5541.5	5777.8	5210.7	5037.2	5478.5	4973.6
2.	PROFIT BEFORE INTT.AND TAX	224.5	1194.7	5142.4	11724.0	17683.8	27053.2	29570.0	32450.8	35607.9	39001.7	41456.5	44025.9	46566.4
3.	DEPRECIATION	0.0	648.6	1580.8	2639.8	3409.9	4072.6	4697.7	5228.6	5747.0	6284.2	6776.4	7254.8	7768.3
4.	TERM LOAN - FIXED CAPITAL	12246.5	16773.2	17945.5	13076.0	11041.9	10332.7	8548.9	8312.3	8666.7	7816.1	7555.7	8217.8	7460.4
	Connection deposits from customers	50.0	1450.0	3500.0	2500.0	2500.0	2500.0	2500.0	2500.0	2500.0	2500.0	2500.0	2500.0	2500.0
5.	INCRE. IN BANK BORROWINGS FOR WORKING CAPITAL	47.6	316.0	423.7	459.4	454.4	466.3	341.0	287.9	248.9	239.5	221.5	211.1	225.0
6	OVER DRAFT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOTAL CASH INFLOW (A)	**20733.0**	**31564.6**	**40556.1**	**39116.4**	**42451.3**	**51313.1**	**51357.0**	**54321.2**	**58548.3**	**61052.2**	**63547.2**	**67688.1**	**69493.8**
B.	**DISPOSITION OF FUNDS**													
1.	CAPITAL EXPENDITURE	20460.9	29405.3	33409.2	24293.3	20903.1	19721.1	16748.2	16353.9	16944.4	15526.8	15092.9	16196.3	14934.1
2.	DECREASE IN LONG TERM LOAN	0.0	0.0	0.0	5870.7	7505.2	8885.4	10177.0	11245.6	12284.6	13368.0	14345.0	9418.8	8811.5
3.	INCREASE IN WORKING CAPITAL	47.6	316.0	423.7	459.4	454.4	466.3	341.0	287.9	248.9	239.5	221.5	211.1	225.0
4.	TOTAL INTT.ON LONG TERM LOAN	0.0	1163.4	2756.9	4252.6	4878.8	5165.6	5257.1	5064.4	4748.7	4366.4	3804.2	3334.7	3242.2
5.	INTT.ON BANK BORROWING FOR WORKING CAPITAL	4.8	36.4	78.7	124.7	170.1	216.7	250.8	279.6	304.5	328.5	350.6	371.7	394.2
6.	REPAYMENT OF OVER DRAFT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.	INTEREST ON OVER DRAFT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8.	PROVISION FOR TAXATION	76.0	0.0	492.3	1567.9	2696.5	5431.7	6157.6	7205.0	8418.6	9739.7	10845.3	11977.9	12952.8
9.	DIVIDEND ON EQUITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOTAL CASH OUTFLOW (B)	20589.4	30921.1	37160.9	36568.4	36608.1	39886.8	38931.8	40436.4	42949.8	43568.8	44659.5	41510.5	40559.9
	NET CASH ACCRUALS (A-B)	143.7	643.5	3395.3	2548.0	5843.1	11426.2	12425.2	13884.8	15598.4	17483.4	18887.8	26177.6	28933.9
	OPENING BALANCE	0.0	143.7	787.1	4182.4	6730.4	12573.6	23999.8	36425.0	50309.8	65908.2	83391.6	102279.4	128457.0
	CUMULATIVE CASH SURPLUS	143.7	787.1	4182.4	6730.4	12573.6	23999.8	36425.0	50309.8	65908.2	83391.6	102279.4	128457.0	157390.9
	Post-tax IRR on Capital Employed, %	**16.6**												
	Pre-tax IRR on Capital Employed, %	**21.3**												

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MECON LTD

ISO 9001 Company

CASHFLOW STATEMENT

Table 11.02 (b)

(In Rs Lakhs)

Sl No	ITEM/YEAR	14	15	16	17	18	19	20	21	22	23	24	25
A.	**SOURCES OF FUNDS**												
1.	EQUITY - FIXED CAPITAL	4328.3	4154.7	4107.1	4170.2	4343.8	4154.7	4076.0	4147.8	3785.8	4147.8	4321.4	4038.1
2.	PROFIT BEFORE INTT.AND TAX	49460.9	52480.0	55747.0	58991.7	62394.1	65737.7	69237.1	72903.8	76602.6	80611.2	84489.3	88677.2
3.	DEPRECIATION	8241.7	8663.9	9072.4	9477.2	9886.9	10310.4	10718.9	11121.2	11529.2	11908.4	12316.4	12738.1
4.	TERM LOAN - FIXED CAPITAL	6492.4	6232.0	6160.7	6255.3	6515.7	6232.0	6114.0	6221.8	5678.8	6221.8	6482.2	6057.1
	Connection deposits from customers	2500.0	2500.0	2500.0	2500.0	2500.0	2500.0	2500.0	2500.0	2500.0	2500.0	2500.0	2500.0
5.	INCRE. IN BANK BORROWINGS FOR WORKING CAPITAL	162.5	160.7	119.4	143.8	121.6	152.0	136.7	121.8	138.6	91.5	141.1	135.5
6	OVER DRAFT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOTAL CASH INFLOW (A)	**71185.7**	**74191.3**	**77706.7**	**81538.2**	**85762.1**	**89086.8**	**92782.8**	**97016.4**	**100234.9**	**105480.7**	**110250.3**	**114146.0**
B.	**DISPOSITION OF FUNDS**												
1.	CAPITAL EXPENDITURE	13320.7	12886.6	12767.9	12925.5	13359.6	12886.6	12690.1	12869.6	11964.6	12869.6	13303.6	12595.2
2.	DECREASE IN LONG TERM LOAN	8363.8	7883.8	7594.2	7325.2	7023.8	6861.3	6695.8	6432.8	6278.0	6176.3	6175.0	6215.2
3.	INCREASE IN WORKING CAPITAL	162.5	160.7	119.4	143.8	121.6	152.0	136.7	121.8	138.6	91.5	141.1	135.5
4.	TOTAL INTT.ON LONG TERM LOAN	3129.8	2969.2	2822.5	2696.0	2605.1	2562.6	2508.7	2462.8	2448.3	2394.9	2399.3	2427.1
5.	INTT.ON BANK BORROWING FOR WORKING CAPITAL	410.5	426.6	438.5	452.9	465.1	480.3	493.9	506.1	520.0	529.1	543.2	556.8
6.	REPAYMENT OF OVER DRAFT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.	INTEREST ON OVER DRAFT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8.	PROVISION FOR TAXATION	14096.9	15341.5	16677.7	17999.2	19358.5	20668.8	22048.2	23486.3	24918.4	26491.6	27974.4	29546.5
9.	DIVIDEND ON EQUITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOTAL CASH OUTFLOW (B)	39484.3	39668.4	40420.2	41542.6	42933.5	43611.6	44573.4	45879.4	46267.8	48553.1	50536.6	51476.1
	NET CASH ACCRUALS (A-B)	31701.4	34522.9	37286.6	39995.6	42828.6	45475.2	48209.4	51137.0	53967.1	56927.7	59713.7	62669.9
	OPENING BALANCE	157390.9	189092.3	223615.2	260901.8	300897.3	343725.9	389201.1	437410.5	488547.5	542514.6	599442.3	659156.0
	CUMULATIVE CASH SURPLUS	189092.3	223615.2	260901.8	300897.3	343725.9	389201.1	437410.5	488547.5	542514.6	599442.3	659156.0	721825.9

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CITY GAS DISTRIBUTION KOLKATA GA

MECON LTD

ESTIMATED BALANCE SHEET

Table 11.03
(In Rs Lakhs)

ITEM/YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13
ASSETS													
Gross Fixed Assets	0.0	20460.9	49866.2	83275.4	107568.7	128471.8	148192.9	164941.1	181294.9	198239.3	213766.1	228859.0	245055.3
Less: Accumulated Depreciation	0.0	648.6	2229.4	4869.2	8279.1	12351.7	17049.4	22278.0	28025.1	34309.3	41085.7	48340.5	56108.7
Net Fixed Assets	0.0	19812.3	47636.8	78406.2	99289.5	116120.1	131143.5	142663.0	153269.8	163930.1	172680.5	180518.5	188946.5
Net Current Assets	47.6	363.6	787.4	1246.7	1701.2	2167.4	2508.4	2796.4	3045.3	3284.8	3506.3	3717.4	3942.4
Cash & Bank	143.7	787.1	4182.4	6730.4	12573.6	23999.8	36425.0	50309.8	65908.2	83391.6	102279.4	128457.0	157390.9
Investments	20460.9	29405.3	33409.2	24293.3	20903.1	19721.1	16748.2	16353.9	16944.4	15526.8	15092.9	16196.3	14934.1
TOTAL ASSETS	**20652.2**	**50368.4**	**86015.8**	**110676.6**	**134467.4**	**162008.4**	**186825.1**	**212123.1**	**239167.8**	**266133.2**	**293559.0**	**328889.2**	**365213.9**
LIABILITIES													
Equity Capital	8164.4	19346.5	31310.2	40027.5	47388.7	54277.2	59976.4	65518.0	71295.7	76506.4	81543.6	87022.1	91995.7
Reserves	143.7	138.5	1953.1	7731.9	17670.2	33909.3	51813.8	71715.5	93851.5	118418.6	144875.0	173216.5	203193.7
Net Worth	8308.0	19485.0	33263.2	47759.4	65059.0	88186.5	111790.2	137233.5	165147.2	194925.1	226418.6	260238.6	295189.4
Debt													
Rupee Term Loan	12296.5	30519.7	51965.2	61670.5	67707.3	71654.5	72526.5	72093.2	70975.2	67923.4	63634.1	64933.1	66082.1
Bank Borrowings for Working Capital	47.6	363.6	787.4	1246.7	1701.2	2167.4	2508.4	2796.4	3045.3	3284.8	3506.3	3717.4	3942.4
TOTAL LIABILITIES	20652.2	50368.4	86015.8	110676.6	134467.4	162008.4	186825.1	212123.1	239167.8	266133.2	293559.0	328889.2	365213.9

ITEM/YEAR	14	15	16	17	18	19	20	21	22	23	24	25
ASSETS												
Gross Fixed Assets	259989.3	273310.0	286196.6	298964.5	311890.0	325249.6	338136.2	350826.3	363695.9	375660.5	388530.0	401833.6
Less: Accumulated Depreciation	64350.4	73014.3	82086.8	91563.9	101450.8	111761.3	122480.2	133601.4	145130.5	157039.0	169355.4	182093.5
Net Fixed Assets	195638.9	200295.7	204109.9	207400.5	210439.2	213488.3	215656.0	217224.9	218565.3	218621.5	219174.7	219740.2
Net Current Assets	4105.0	4265.7	4385.1	4528.9	4650.5	4802.5	4939.3	5061.1	5199.6	5291.1	5432.2	5567.7
Cash & Bank	189092.3	223615.2	260901.8	300897.3	343725.9	389201.1	437410.5	488547.5	542514.6	599442.3	659156.0	721825.9
Investments	13320.7	12886.6	12767.9	12925.5	13359.6	12886.6	12690.1	12869.6	11964.6	12869.6	13303.6	12595.2
TOTAL ASSETS	**402156.9**	**441063.2**	**482164.6**	**525752.3**	**572175.2**	**620378.6**	**670695.9**	**723703.0**	**778244.2**	**836224.5**	**897066.5**	**959728.9**
LIABILITIES												
Equity Capital	96324.0	100478.6	104585.8	108756.0	113099.8	117254.5	121330.5	125478.3	129264.2	133412.0	137733.5	141771.5
Reserves	235017.3	268760.0	304568.3	342411.9	382377.4	424403.4	468589.7	515038.3	563754.3	614949.8	668522.1	724669.0
Net Worth	331341.3	369238.6	409154.1	451167.9	495477.2	541657.9	589920.2	640516.6	693018.4	748361.8	806255.6	866440.6
Debt												
Rupee Term Loan	66710.6	67558.8	68625.4	70055.5	72047.4	73918.2	75836.4	78125.3	80026.1	82571.6	85378.7	87720.6
Bank Borrowings for Working Capital	4105.0	4265.7	4385.1	4528.9	4650.5	4802.5	4939.3	5061.1	5199.6	5291.1	5432.2	5567.7
TOTAL LIABILITIES	402156.9	441063.2	482164.6	525752.3	572175.2	620378.6	670695.9	723703.0	778244.2	836224.5	897066.5	959728.9

DEBT - SERVICE COVERAGE RATIO **Table 11.04**

(In Rs Lakhs)

Year of operation	Inflow				Out flow			Debt - service coverage ratio (DSCR)
	Profit after tax	Deprn & Prel. expenses	Interest on term loan	Total Inflow	Repayment of term loan	Interest on term loan	Total outflow	
1	144	0	0	144	0	0	0	-
2	-5	649	1,163	1,807	0	1,163	1,163	1.55
3	1,815	1,581	2,757	6,152	0	2,757	2,757	2.23
4	5,779	2,640	4,253	12,671	5,871	4,253	10,123	1.25
5	9,938	3,410	4,879	18,227	7,505	4,879	12,384	1.47
6	16,239	4,073	5,166	25,477	8,885	5,166	14,051	1.81
7	17,904	4,698	5,257	27,859	10,177	5,257	15,434	1.81
8	19,902	5,229	5,064	30,195	11,246	5,064	16,310	1.85
9	22,136	5,747	4,749	32,632	12,285	4,749	17,033	1.92
10	24,567	6,284	4,366	35,218	13,368	4,366	17,734	1.99
11	26,456	6,776	3,804	37,037	14,345	3,804	18,149	2.04
AVERAGE	**1,44,875**	**41,086**	**41,458**	**2,27,419**	**83,681**	**41,458**	**1,25,139**	**1.82**

SENSITIVITY ANALYSIS

Table 11.05

Sl. No	Description	Post-Tax IRR (%)	DSCR
1	Base Case	16.6	1.82
2	With increase in Capital cost by 10%	15.1	1.67
3	With decrease in Capital cost by 10%	18.5	2.01
4	With increase in Operating cost by 10%	16.1	1.77
5	With decrease in Operating cost by 10%	17.1	1.87
6	With increase in Gas volume by 10%	18.7	2.01
7	With decrease in Gas volume by 10%	14.5	1.63
8	With increase in Sales price by 5%	19.9	2.11
9	With decrease in Sales price by 5%	13.0	1.52
10	With increase in Purchase price by 5%	14.1	1.61
11	With decrease in Purchase price by 5%	19.0	2.02

A JOINT VENTURE OF			
GAIL (INDIA) LTD	GCGSCL (A GOVT. OF WEST BENGAL ENTERPRISE)	**VALIDATION OF DFR PREPARED BY CRISIL CITY GAS DISTRIBUTION KOLKATA GA**	MECON LTD

ANNEXURE – I

PNGRB AUTHORISATION

पेट्रोलियम एवं प्राकृतिक गैस विनियामक बोर्ड
Petroleum and Natural Gas Regulatory Board
प्रथम-तल, वर्ल्ड ट्रेड सेंटर, बाबर रोड, नयी दिल्ली: 110001
1st Floor, World Trade Centre, Babar Road, New Delhi – 110001
फोन नं./Phone No. 011-23457700/फैक्स नं./Fax No.011-23709151

No. S-Infra/II/1/2008-Vol.II/Kolkata CGD

2nd February 2016

To
Greater Calcutta Gas Supply Corporation Limited,
(Kind Attn: General Manager)
12 A Park Street,
Kolkata- 700071.

Subject: Acceptance of Central Government authorization of M/s Greater Calcutta Gas Supply Corporation Limited (GCGSCL) for Kolkata Municipal Corporation and parts of adjoining districts of North 24 Parganas, South 24 Parganas, Howrah, Hooghly and Nadia for development of City Gas Distribution network (i.e Kolkata CGD Network) in the State of West Bengal.

1. This has reference to our letter No. S-Infra/II/1/2008-Vol.II Dated 26th February, 2013 and all other correspondences on this subject including your letter No. 615/Admn/36/GC/2015 Dated 31.12.2015, PNGRB is pleased to issue acceptance of Central Government authorization to M/s GCGSCL for Kolkata CGD network subject to the terms and conditions mentioned below.

i. GCGSCL shall abide by the provisions of the PNGRB Act, 2006 and relevant regulations including amendments thereof and regulations, if any, framed from time to time.

ii. GCGSCL shall abide by the Technical Standards and specifications including Safety Standards (T4S) for, City and/or Local Natural Gas Distribution Networks Regulations 2008 including the Emergency Response & Disaster Management Plan (ERDMP).

iii. GCGSCL shall abide to Quality of Service standards as per regulations framed under PNGRB Act, 2006.

उत्पलेन्दु चटर्जी/UTPALENDU CHATTERJEE
सचिव/Secretary
पेट्रोलियम और प्राकृतिक गैस विनियामक बोर्ड
Petroleum & Natural Gas Regulatory Board
प्रथम तल, वर्ल्ड ट्रेड सेंटर
1st Floor, World Trade Centre
बाबर रोड, नई दिल्ली-110 001
Babar Road, New Delhi-110 001

iv. The Geographical Area and the Charge Areas shall be as per the attached maps duly signed and stamped by the Board, PNGRB.

v. GCGSCL shall energize or commission the network/sections of the network that meets the provisions of the Petroleum and Natural Gas Regulatory Board (Technical Standards and Specifications including Safety Standards for City or Local natural gas Distribution Networks) Regulations, 2008 only with duly isolating the sections that do not meet the provisions of these Regulations.

vi. The Exclusivity :

a. PNGRB grants Infrastructure Exclusivity for laying building or expansion of the CGD Network during the economic life of the project i.e. 25 years from the date of issue of acceptance of Central Government authorization

and

b. Grant of Exclusivity from the purview of the contract carrier or common carrier shall be for a period of 5 years from the date of issue of acceptance of Central Government authorization.

vii. The Project milestones during the period of marketing exclusivity will be as under:

	Cumm (1st Year)	**Cumm (2nd Year)**	**Cumm (3rd Year)**	**Cumm (4th Year)**	**Cumm (5th Year)**
PNG Dom. Connections (No.)	1,00,000	3,00,000	6,00,000	10,00,000	14,17,959
Steel Pipeline (Inch-KM)	500	1,500	3,000	5,000	7,296
Compression Capacity (Kg/day)	50,000	1,50,000	3,00,000	5,00,000	7,90,200

viii. The Geographical Area accepted for CGD Network Authorization for Kolkata CGD Network GA is as per submitted map enclosed.

ix. The Performance Bank Guarantee submitted shall remain in full force during the project period and shall have to be renewed in a block of three years

2. Violation of any condition/conditions mentioned in clause1 shall be treated as default and shall be dealt with as per the provisions of the PNGRB Act, 2006.

3. The tariff applicability will be as per Section 21 (2) of the PNGRB Act, 2006 and the Judgment of Hon'ble Supreme Court of India in the SLP No. 22273 of 2012 i.e. Civil Appeal No. 4910 of 2015.

The receipt of this letter may please be acknowledged.

Yours faithfully,

Encl: As Above

(Upamanyu Chatterjee)
Secretary

उपमन्यु चटर्जी/UPAMANYU CHATTERJEE
सचिव/Secretary
पेट्रोलियम और प्राकृतिक गैस बोर्ड
Petroleum & Natural Gas Board
प्रथम तल, वर्ल्ड
1st Floor, World
बाहर रोड, नई
Bahar Road, New

HOWRAH REGION CGD NETWORK

(SUB MAP OF KOLKATA AND ITS ADJOINING AREAS / DISTRICTS)
(WEST BENGAL STATE)

Total Population within the Geographical Area as per Census 2001
20.23 Lacs(Approx.)

Total Geographical Area (Sq.KMs)	No. Charge Areas
189	11

Charge Areas Identification	Important location within
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

LEGEND

LANDMARKS

- AIRPORT
- BUS STATION
- COLLEGE/UNIVERSITY
- FACTORY
- FUEL CENTER
- GENERAL
- HOSPITAL
- LOCALITY
- MARKET
- OFFICE
- PARK
- POST OFFICE
- RAILWAY STATION
- RELIGIOUS PLACE
- VILLAGE

VECTORS

- NATIONAL HIGHWAYS
- MAIN ROADS
- OTHER ROADS
- STREETS
- RAILWAYS
- AIRSTRIP
- GA BOUNDARY
- WATER BODIES

VILLAGE POPULATION

- VILLAGE WITH POPULATION 5000 AND ABOVE

REMARKS:-

- Landmarks are indicative in nature
- Each charge area is depicted in different color and is enclosed by physical features such as roads, rivers, railway tracks or administrative boundaries as shown in the map
- This map is a part of application for the Howrah Region Geographical area

MAP SCALE

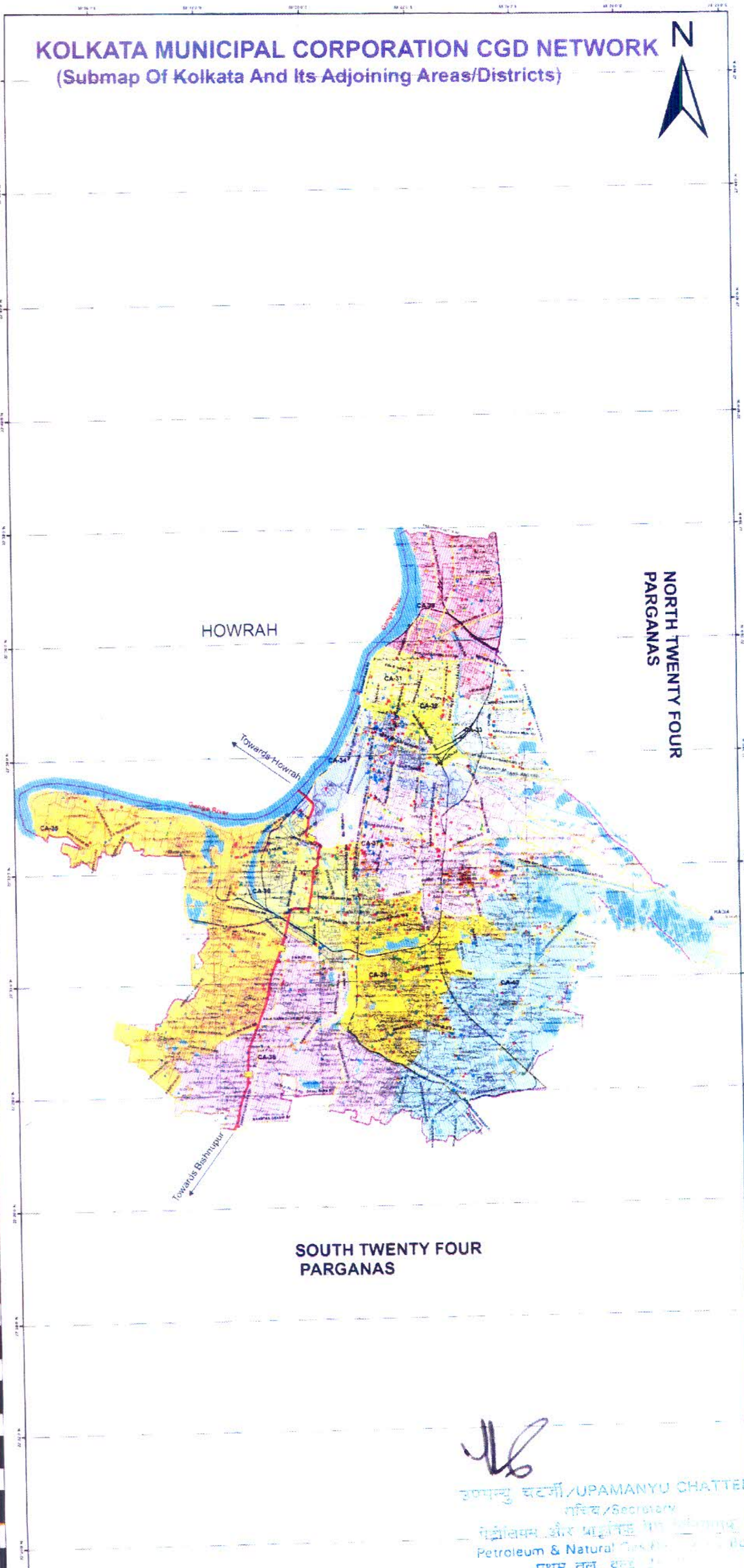
0 1.5 3 6 9 Kilometers

GREATER CALCUTTA GAS SUPPLY CORPORATION LTD.
(A GOVT. OF W.B. ENTERPRISE)
12 A, Park Street, Kolkata-700071

Map Prepared By :

HINDUSTAN PETROLEUM CORPORATION LTD.
A GOVERNMENT OF INDIA ENTERPRISE
8 Church Lane, Kolkata-700001

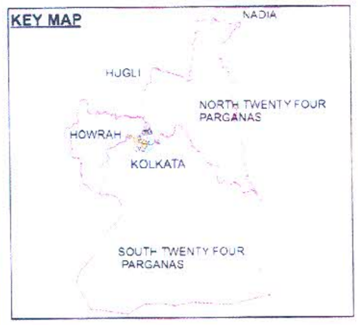
Map No.	GCGSCL/CGD/REG17/01/GA-Howrah Region
Date	September-2010
Map Title	Howrah Region CGD Network (Sub Map of Kolkata and its adjoining Areas / Districts)



उपमन्यु चटर्जी/UPAMANYU CHATTERJEE
सचिव/Secretary
पेट्रोलियम और प्राकृतिक गैस विनियामक बोर्ड
Petroleum & Natural Gas Regulatory Board

KOLKATA MUNICIPAL CORPORATION CGD NETWORK
(SUBMAP OF KOLKATA AND ITS ADJOINING AREAS/DISTRICTS)
(WEST BENGAL STATE)

KEY MAP



Total Population within the Geographical Area as per Census 2001
46.05 Lacs(Approx.)

Total Geographical Area (Sq.KMs)	No. Charge Areas
192	11

Charge Areas identification	Important location within
CA-30	Kashipur - Shyambazar
CA-31	Manik Tala - Shobha Bazar Metro Station
CA-32	Barabazar - Sealdah Railway Station
CA-33	Beliaghata
CA-34	BBD Bag - Esplanade
CA-35	Paharpur - Tiretala - Behala
CA-36	Kidderpore - New Alipore
CA-37	Park Circus - Topsia
CA-38	Sakher Bazar - Thakurpukur
CA-39	Kalighat - Tollygunge
CA-40	South Purbanchal - Dakshin Ray Nagar

LEGEND

LANDMARKS

- AIRPORT
- BUS STATION
- COLLEGE/UNIVERSITY
- FACTORY
- FUEL CENTER
- GENERAL
- HOSPITAL
- LOCALITY
- MARKET
- OFFICE
- PARK
- POST OFFICE
- RAILWAY STATION
- RELIGIOUS PLACE
- VILLAGE

VECTORS

- NATIONAL HIGHWAYS
- MAIN ROADS
- OTHER ROADS
- STREETS
- RAILWAYS
- AIRSTRIP
- GA BOUNDARY
- WATER BODIES

VILLAGE POPULATION

- VILLAGE WITH POPULATION 5000 AND ABOVE

REMARKS:-

i. Landmarks are indicative in nature
ii. Each charge area is depicted in different color and is enclosed by physical features such as roads, rivers, railway tracks or administrative boundaries as shown in the map
iii. This map is a part of document for the **KMC** Geographical area

MAP SCALE

0 1 2 4 6 **Kilometers**

G CALCUTTA GAS

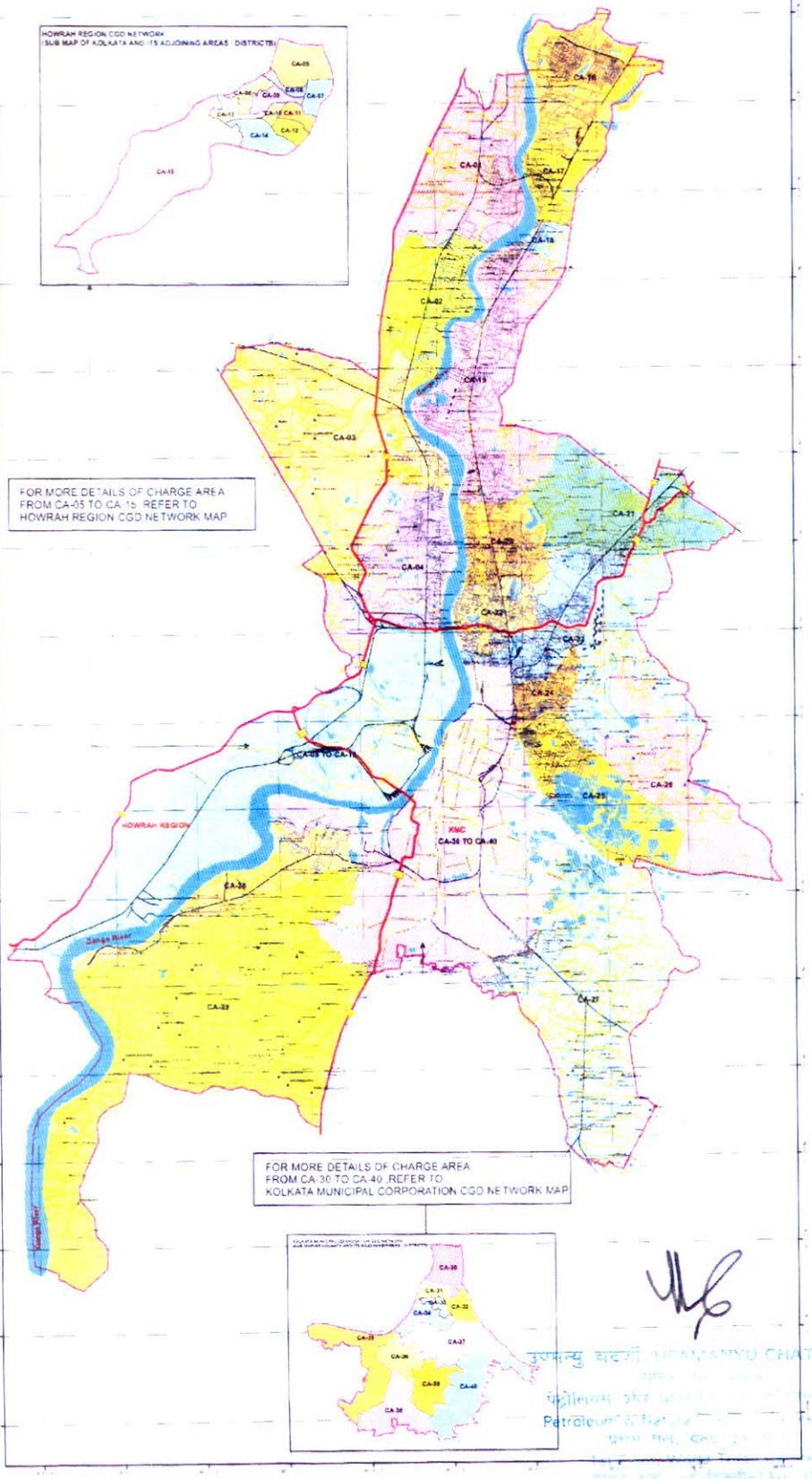
GREATER CALCUTTA GAS SUPPLY CORPORATION LTD
(A GOVT. OF W.B. ENTERPRISE)
12 A, Park Street, Kolkata-700071

Map Prepared By :

HINDUSTAN PETROLEUM CORPORATION LTD.
(A GOVERNMENT OF INDIA ENTERPRISE)
6,Church Lane, Kolkata-700001

Map No.	GCGSCL/CGD/REG17/01/GA- KMC
Date	September-2010
Map Title	Kolkata Municipal Corporation CGD Network (Submap Of Kolkata And Its Adjoining Areas/Districts)

GEOGRAPHICAL AREA OF PROPOSED CITY GAS DISTRIBUTION (CGD) / BUSINESS NETWORK FOR KOLKATA AND ITS ADJOINIGN AREAS / DISTRICTS



FOR MORE DETAILS OF CHARGE AREA FROM CA-05 TO CA-15 REFER TO HOWRAH REGION CGD NETWORK MAP

FOR MORE DETAILS OF CHARGE AREA FROM CA-30 TO CA-40 REFER TO KOLKATA MUNICIPAL CORPORATION CGD NETWORK MAP

GEOGRAPHICAL AREA OF PROPOSED CITY GAS DISTRIBUTION (CGD) / BUSINESS NETWORK FOR KOLKATA AND ITS ADJOINIGN AREAS / DISTRICTS

WEST BENGAL STATE

KEY MAP

Total Population within the Geographical Area as per Census 2001 : 1.37 Crores (Approx.)

Total Geographical Area(Sq KMs)	No. of Charge Areas
1529	40

Charge Areas Identification	Important location within
CA-01	Baneberia-Bandeal
CA-02	Champdani-Chandernagar
CA-03	Baidyabati
CA-04	Hooghly-Uttarpara
CA-05 TO CA-15	Howrah Region
CA-16	Kalyani
CA-17	Naihati
CA-18	Bhatpara
CA-19	Barrackpur-Khardah
CA-20	Panihati
CA-21	Baraset
CA-22	Kamarhati-Baranagar
CA-23	Dumdum
CA-24	Satgachi-South Dum Dum
CA-25	Salt lake
CA-26	Rajarhat
CA-27	Sonarpur-Baruipur
CA-28	Maheshtala-Budge Budge
CA-29	Pata
CA-30 to CA-40	Kolkata Municipal Corporation

LEGEND

LANDMARKS

- AIRPORT
- BUS STATION
- COLLEGE/UNIVERSITY
- FACTORY
- FUEL CENTER
- GENERAL
- HOSPITAL
- LOCALITY
- MARKET
- OFFICE
- PARK
- POST OFFICE
- RAILWAY STATION
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VILLAGE POPULATION

- VILLAGE WITH POPULATION 5000 AND ABOVE

REMARKS:-

Landmarks are indicative in nature.
Each charge area is depicted in different color and is enclosed by prominent features such as roads, rivers, railway tracks or administrative boundaries as shown in the map.
This map is a part of document for the Kolkata Region Geographical area.

MAP SCALE

0 2.5 5 10 15 Kilometers

GREATER CALCUTTA GAS SUPPLY CORPORATION LTD
A GOVT. OF W.B. ENTERPRISE
12 A, Park Street, Kolkata-700071

Map Prepared By :

HINDUSTAN PETROLEUM CORPORATION LTD
A GOVERNMENT OF INDIA ENTERPRISE
6,Church Lane, Kolkata-700001

Map No.	GGGSCL/CGD/REG-1T-01 GA Kolkata Region
Date	September-2010
Map Title	Geographical Area of Proposed City Gas Distribution (CGD) Business Network for Kolkata and its adjoining areas / districts

A JOINT VENTURE OF			
GAIL (INDIA) LTD	GCGSCL (A GOVT. OF WEST BENGAL ENTERPRISE)	**VALIDATION OF DFR PREPARED BY CRISIL CITY GAS DISTRIBUTION KOLKATA GA**	MECON LTD

ANNEXURE – II

BILL OF MATERIAL OF MECON

BILL OF MATERIAL FOR CGD NETWORK IN KOLKATA GA FOR 25 YEARS

MECON मेकान ISO 9001:2000 Company

DATED :12.09.17

			CUMMULATIVE FIGURES																							
Infrastructure for kolkata GA	**Units**	**Total**	**1st year**	**2nd year**	**3rd year**	**4th year**	**5th year**	**6th year**	**7th year**	**8th year**	**9th year**	**10th year**	**11th year**	**12th year**	**13th year**	**14th year**	**15th year**	**16th year**	**17th year**	**18th year**	**19th year**	**20th year**	**21st year**	**22st year**	**23rd year**	**24th year**	**25th year**
Domestic Consumers (as per PNGRB)	Nos.	12,00,000	1000	30000	100000	150000	200000	250000	300000	350000	400000	450000	500000	550000	600000	650000	700000	750000	800000	850000	900000	950000	1000000	1050000	1100000	1150000	1200000
CGS (50 M X 40M)	Nos	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CGS at Karanmadhavpur		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Metering Skid at CGS																											
Capacity 1.00 MMSCMD	Nos	3	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3
Capacity 0.50 MMSCMD	Nos	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Odourising Unit	Nos	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CGS near Dankuni		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Metering Skid at CGS																											
Capacity 1.00 MMSCMD	Nos	3	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3
Capacity 0.50 MMSCMD	Nos	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Odourising Unit	Nos	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
STEEL PIPELINE																											
ROU Acquisition (Steel Pipeline)	KM	410.50	85.00	184.50	259.50	314.50	344.50	374.50	397.50	398.50	399.50	400.50	401.50	402.50	403.50	404.50	405.50	406.50	407.50	408.50	409.50	410.50	410.50	410.50	410.50	410.50	410.50
Steel Pipe (4" x 6.4 mm API5L Coated pipe)	KM	84.00	10	20	30	50	60	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	84	84	84	84	84
Steel Pipe (6" x 6.4 mm API 5L , Coated pipe)	KM	132.00	10	30	50	70	90	110	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132
Steel Pipe (8" x 6.4mm- API 5L coated pipe)	KM	53.00	10	30	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
Steel Pipe (10" x 6.4mm- API 5L coated pipe)	KM	52.00	20	40	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52
Steel Pipe (12" x 6.4mm- API 5L coated pipe)	KM	55.00	15	30	40	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
Steel Pipe (16" x 6.4mm- API 5L coated pipe)	KM	14.00	10	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Steel Pipe (20" x 6.4mm- API 5L coated pipe)	KM	20.50	10	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5
Steel Pipe (24" x 6.4mm- API 5L coated pipe)	KM	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL Steel Pipe	KM	410.50	85.00	184.50	259.50	314.50	344.50	374.50	397.50	398.50	399.50	400.50	401.50	402.50	403.50	404.50	405.50	406.50	407.50	408.50	409.50	410.50	410.50	410.50	410.50	410.50	410.50
Inch KM of Steel Pipeline	InchKM	3366.00	920	1894	2478	2858	3018	3178	3314	3318	3322	3326	3330	3334	3338	3342	3346	3350	3354	3358	3362	3366	3366	3366	3366	3366	3366
INCH KM of PE Pipeline		32400	518	1035	2070	4050	5400	6750	8100	9450	10800	12150	13500	14850	16200	17550	18900	20250	21600	22950	24300	25650	27000	28350	29700	31050	32400
Inch KM of Steel Pipeline + MDPE	InchKM	35766	947	2704	5178	6908	8418	9928	11414	12768	14122	15476	16830	18184	19538	20892	22246	23600	24954	26308	27662	29016	30366	31716	33066	34416	35766
As Per PNGRB (present Norms) Total Inch. Km	InchKM	650	130	325	520	585	650																				
As per PNGRB Award Total Inch Km	InchKM	7296	500	1500	3000	5000	7296																				
Misc Items (Steel)																											
Flanges Fittings etc	LOT	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Warning Grid (1 mm thk)	KM	411	85	185	260	315	345	375	398	399	400	401	402	403	404	405	406	407	408	409	410	411	411	411	411	411	411
HDPE Duct (50 mm)	KM	411	85	185	260	315	345	375	398	399	400	401	402	403	404	405	406	407	408	409	410	411	411	411	411	411	411
OFC Cable	KM	411	85	185	260	315	345	375	398	399	400	401	402	403	404	405	406	407	408	409	410	411	411	411	411	411	411
SV STATIONS ON STEEL GRID (5M X 3 M)																											
SV Stations on 4" Dia Pipe line	Lot	28	3	7	10	17	20	23	24	24	24	25	25	25	26	26	26	27	27	27	28	28	28	28	28	28	28
SV Stations on 6" Dia Pipe line	Lot	44	3	10	17	23	30	37	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
SV Stations on 8" Dia Pipe line	Lot	18	3	10	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
SV Stations on 10" Dia Pipe line	Lot	17	7	13	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
SV Stations on 12" Dia Pipe line	Lot	18	5	10	13	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
SV Stations on 16" Dia Pipe line	Lot	5	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
SV Stations on 20" Dia Pipe line	Lot	7	3	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
SV Stations on 24" Dia Pipe line	Lot	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCADA																											
SCADA with RTU for Gas Actuator valves, OFC cable etc. will be expanded as per the facilities envisaged in different years	Lot	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
MDPE NETWORK																											
ROU Acquisition (PE Pipe laying)	KM	7200	6	180	600	900	1200	1500	1800	2100	2400	2700	3000	3300	3600	3900	4200	4500	4800	5100	5400	5700	6000	6300	6600	6900	7200
Pipe MDPE																											
- dia. 125mm	KM	1200	1.0	30.0	100.0	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	1100	1150	1200
- dia. 90mm	KM	2400	2.0	60.0	200.0	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
- dia. 63mm	KM	3600	3.0	90.0	300.0	450	600	750	900	1050	1200	1350	1500	1650	1800	1950	2100	2250	2400	2550	2700	2850	3000	3150	3300	3450	3600
- dia. 32mm	KM	4800	4.0	120.0	400.0	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800
- dia. 20mm	KM	2400	2.0	60.0	200.0	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
TOTAL PE PIPELINE	KM	14400	12	360	1200	1800	2400	3000	3600	4200	4800	5400	6000	6600	7200	7800	8400	9000	9600	10200	10800	11400	12000	12600	13200	13800	14400
INCH KM of PE Pipeline		32400	27	810	2700	4050	5400	6750	8100	9450	10800	12150	13500	14850	16200	17550	18900	20250	21600	22950	24300	25650	27000	28350	29700	31050	32400
Misc Items (PE)																											
Flanges Fittings etc	Lot	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Warning Grid (1 mm thk)	KM	14400	12	360	1200	1800	2400	3000	3600	4200	4800	5400	6000	6600	7200	7800	8400	9000	9600	10200	10800	11400	12000	12600	13200	13800	14400
HDPE Duct (40 mm)	KM	12000	10	300	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000	7500	8000	8500	9000	9500	10000	10500	11000	11500	12000
MDPE Ball Valves																											
125 mm dia	Nos	1200	1	30	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	1100	1150	1200
90 mm dia	Nos	2400	2	60	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
63 mm dia	Nos	3600	3	90	300	450	600	750	900	1050	1200	1350	1500	1650	1800	1950	2100	2250	2400	2550	2700	2850	3000	3150	3300	3450	3600
32 mm dia	Nos	4800	4	120	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800
DRS / Decompression Unit																											
DRS, 5000 SCM/hr	Nos.	8	1	4	6	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
DRS, 2500 SCM/hr	Nos.	59	3	12	18	24	29	34	39	44	45	46	47	48	49	49	49	52	53	54	54	55	56	57	58	59	59

CNG FACILITIES IN Kolkata GA																											
MOTHER STATION	Nos.	14	0	2	4	6	8	9	10	11	12	13	13	14	14	14	14	14	14	14	14	14	14	14	14	14	14
New Plot size, 40M X 50M	Nos	14	0	2	4	8	10	11	11	12	12	13	13	13	13	14	14	14	14	14	14	14	14	14	14	14	14
1200 SCM/ Hr	Nos.	28	0	4	8	12	16	18	20	22	24	26	26	28	28	28	28	28	28	28	28	28	28	28	28	28	28
Cascades																											
- Capacity : 4500 lts.	Nos.	28	0	4	8	12	16	18	20	22	24	26	26	28	28	28	28	28	28	28	28	28	28	28	28	28	28
Dispenser*																											
Car/Auto	Nos.	84	0	12	24	36	48	54	60	66	72	78	78	84	84	84	84	84	84	84	84	84	84	84	84	84	84
Bus	Nos.	28	0	4	8	12	16	18	20	22	24	26	26	28	28	28	28	28	28	28	28	28	28	28	28	28	28
Online Station.	Nos.	72	2	7	13	20	26	33	36	39	43	46	50	54	58	60	61	62	63	65	66	67	68.00	68.00	69.00	71.00	72.00
Compressor																											
1200 SCM/ Hr,	Nos.	72	2	7	13	20	26	33	36	39	43	46	50	54	58	60	61	62	63	65	66	67	68.00	68.00	69.00	71.00	72.00
Dispenser																											
Car / Auto	Nos.	216	6	21	39	60	78	99	108	117	129	138	150	162	174	180	183	186	189	195	198	201	204	204	207	213	216
Bus	Nos.	72.00	2	7	13	20	26	33	36	39	43	46	50	54	58	60	61	62	63	65	66	67	68.00	68.00	69.00	71.00	72.00
Cascade (4500LWL)	Nos.	72	2	7	13	20	26	33	36	39	43	46	50	54	58	60	61	62	63	65	66	67	68.00	68.00	69.00	71.00	72.00
Bus Depots.	Nos.	15	3	5	7	9	11	12	13	14	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Compressor																											
1200 SCM/ Hr	Nos.	30	6.00	10.00	14.00	18.00	22.00	24.00	26.00	28.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
Dispenser																											
Bus	Nos.	30	6	10	14	18	22	24	26	28	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Cascade (4500LWL)	Nos.	30	6.00	10.00	14.00	18.00	22.00	24.00	26.00	28.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
Daughter Booster Station	Nos.	24	2	5	7	9	12	15	18	20	21	22	23	24	24	24	24	24	24	24	24	24	24	24	24	24	24
650 SCM/ Hr	Nos.	24	2	5	7	9	12	15	18	20	21	22	23	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Cascades																											
- Capacity : 3000 lts. (Stationary)	Nos.	24	2	5	7	9	12	15	18	20	21	22	23	24	24	24	24	24	24	24	24	24	24	24	24	24	24
- Capacity : 3000 lts. (Mobile)	Nos.	48	4	10	14	18	24	30	36	40	42	44	46	48	48	48	48	48	48	48	48	48	48	48	48	48	48
Dispenser	Nos.																										
Car/Auto	Nos.	48	4	10	14	18	24	30	36	40	42	44	46	48	48	48	48	48	48	48	48	48	48	48	48	48	48

A JOINT VENTURE OF			
GAIL (INDIA) LTD	GCGSCL (A GOVT. OF WEST BENGAL ENTERPRISE)	**VALIDATION OF DFR PREPARED BY CRISIL CITY GAS DISTRIBUTION KOLKATA GA**	MECON LTD

ANNEXURE – III

DFR REPORT PREPARED BY CRISIL

CRISIL Risk and Infrastructure Solutions Limited

Greater Calcutta Gas Supply Corporation Limited

Detailed Feasibility Report – Greater Calcutta GA

Final Report

April 2016

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List of abbreviations

Acronym	Definition
AGL	Aavantika Gas Limited
APGDCL	Andhra Pradesh Gas Distribution Corporation Limited
ASME	American Society of Mechanical Engineers
BPCL	Bharat Petroleum Corporation Limited
CAGR	Compounded Annual Growth Rate
CAPEX	Capital Expenditure
CBM	Coal Bed Methane
CESC	Calcutta Electric Supply Corporation
CGD	City Gas Distribution
CGS	City Gas Station
CIL	Coal India Limited
CNG	Compressed Natural Gas
CPRS	Common Pressure Regulating Station
CSE	Centre for Science and Environment
DCF	Discounted Cash Flow
DFR	Draft Feasibility Report
DGH	Directorate General of Hydrocarbons
DIC	District Industrial Corporation
DPRS	District Pressure Regulating System
DRS	District Regulating Station
EBITDA	Earnings Before Interest Taxation Depreciation and Amortization
EHS	Environment Health and Safety
EIRR	Equity Internal Rate of Return
EPC	Engineering Procurement Construction
ERW	Electric Resistance Welded
EVC	Electronic Volume Corrector
FBE	Fusion Bond Epoxy
FMCG	Fast Moving Consumer Goods
FSRU	Floating Storage and Regasification Unit
GAIL	Gas Authority of India Limited
GCGSCL	Greater Calcutta Gas Supply Corporation Limited
GCV	Gross Calorific Value
GEECL	Great Eastern Energy Corporation Limited
GGCL	Gujarat Gas Company Limited
GIS	Geographic Information System
GOI	Government of India
GSDP	Gross State Domestic Product
GSM	Global System for Mobile communication

Acronym	Definition
GSPC	Gujarat State Petroleum Corporation
GSPL	Gujarat State Petronet Limited
HAZOP	Hazard and Operability study
HDPE	High Density Poly-ethylene
HEECPL	H Energy East Coast Private Limited
HNGIL	Hindushtan National Glass and Industries Limited
HPCL	Hindustan Petroleum Corporation Limited
HPL	Haldia Petrochemicals Limited
HRD	Human Resource Development
HSAW	Horizontal Submerged Arc Welded
HSD	High Speed Diesel
HSE	Health Safety and Safety
IOCL	Indian Oil Corporation Limited
IPRS	Individual/Industrial Pressure Regulation Stations
IRR	Internal Rate of Return
ISO	International Standards Organization
ITC	Indian Tobacco Company
JCC	Japanese Crude Cocktail
LDO	Light Diesel Oil
LNG	Liquefied Natural Gas
LPG	Liqufied Petroleum Gas
LSAW	Longitudinal Submerged Arc Welded
LSHS	Low Sulphur Heavy Stock
MAT	Minimum Alternative Tax
MDPE	Medium Density Poly-ethylene
MEIL	Megha Engineering and Infrastructure Limited
MMBTU	Million Metric British Thermal Units
MMTPA	Million Metric Tonnes per Annum
MSME	Medium Small and Micro Industries
NELP	New Exploration and Licensing Policy
NPV	Net Present Value
OEM	Original Equipment Manufacturer
OHS	Occupational Health and Safety
OIDB	Oil Industry Development Board
OPEX	Operating Expenditure
OSID	Oil Industry Safety Directorate
PAT	Profit After Tax
PIRR	Project Internal Rate of Return
PLF	Plant Load Factor
PLL	Petronet LNG Limited

Acronym	Definition
PNG	Piped Natural Gas
PNGRB	Petroleum and Natural Gas Regulatory Board
POL	Petroleum, Oil and Lubricants
PPAC	Petroleum Planning and Analysis Cell
PPE	Plant Property and Equipment
PQR	Procedure Qualification Record
PRS	Pressure Regulating Station
PSC	Production Sharing Contract
QRA	Quick Risk Assessment
RCC	Reinforced Concrete Cement
RGPPL	Ratnagiri Gas and Power Private Limited
RLNG	Regasified LNG
ROW	Right of Way
RPD	Rotary Positive Displacement Meter
RTO	Road Transport Office
SCADA	Supervisory Control and Data Acquisition
SCM	Standard Cubic Metre
SCMH	Standard Cubic Metre per Hour
SDR	Standard Dimension Ratio
SKO	Standard Kerosene Oil
SLM	Straight Line Method
SSD	Safety Shut Off Device
TCP	Temporary Cathodic Protection
THT	Tetrahydrothiophene
UPS	Uninterruptible Power Supply
USA	United States of America
USD	United States Dollar
VAT	Value Added Tax
WBIIDC	West Bengal Industrial Infrastructure Development Corporation
WDV	Written Down Value
WPS	Welding Procedure Specification
YOY	Year-on-year
Conversion	1 KG of natural gas is equal to 1.31 SCM

1. Executive summary

Company received PNGRB authorisation to operate CGD network in Kolkata and adjoining areas

CGD awarded for Kolkata Municipal Corporation, adjoining areas of Nadia, North 24-Parganas, South 24-Parganas, Hooghly and Howrah

City gas distribution (CGD) has gained significance as demand for natural gas grows because of its affordability, efficiency relative to cost, benign impact on the environment compared with fossil fuels, and greater availability. Natural gas has emerged as the most preferred fuel due to its inherent environmentally benign nature, greater efficiency and cost effectiveness. In recent years, the gas market in India has evolved from sole reliance on domestic gas sources for meeting natural gas demand to a mix of domestic and imported gas supplies. As with increasing availability of natural gas through domestic production and increasing imports, development of city gas distribution (CGD) networks across the country has received a significant fillip step towards ensuring access to natural gas for end-consumers.

Petroleum and Natural Gas Regulatory Board (PNGRB) has authorized GCGSCL to operate a CGD network in the Kolkata Municipal Corporation region, and adjoining districts of Nadia, North 24-Parganas, South 24-Parganas, Hooghly and Howrah. PNGRB has also issued GCGSCL targets that GCGSCL needs to achieve in terms of PNG connections to domestic segment, compression capacity, network and infrastructure development, during the first five years, i.e. marketing exclusivity period.

Targets for each year

Cumulative	1st year	2nd year	3rd year	4th year	5th year
PNG connections (numbers)	100,000	300,000	600,000	10,00,000	14,17,959
Steel pipeline (inch-km)	500	1500	3000	5000	7296
Compression capacity (kg per day)	50,000	150,000	300,000	500,000	790,200

Based on the targets, and the potential demand from the industrial, transport, domestic and commercial segments in the region, a feasibility study has been carried out.

Description of the geographical area

Area awarded to GCGSCL for developing the CGD network is Kolkata Municipal Corporation, adjoining areas of

PNGRB has authorized GCGSCL to develop and expand a CGD network in the area of Kolkata Municipal Corporation, and adjoining areas of Nadia, North 24-Parganas, South 24-Parganas, Hooghly and Howrah districts.

Nadia, North 24-Parganas, South 24-Parganas, Hooghly and Howrah districts

Kolkata Municipal Corporation

Kolkata is the capital city of West Bengal. Located on the eastern banks of the river Hooghly, it is the most important commercial, cultural and educational centre of East India. According to Census 2011, the total population of Kolkata district was 4,486,679. It is a major commercial and military port, and is the only city in eastern India to have an international airport. The key industrial units in Kolkata are engineering products, electronics, electrical equipment, cables, steel, leather, textiles, jewelry, frigates, automobiles, railway coaches, wagons, tea, paper, pharmaceuticals, chemicals, tobacco, food products, and jute products.

Nadia

The Nadia district lies to the north of Kolkata and occupies an area of 3,927 sq km, the 11th highest in the state. The total population of Nadia district stood at 5,168,488 according to Census 2011. Nadia's existing large/medium industrial units are mainly engaged in manufacturing cotton yarn, oxygen gas, medicine, chemical items, electrical components, milk and milk products, paper and paper-based products, etc. Kalyani area is the major industrial centre of this district, with a dedicated industrial zone homing numerous industries including Andrew Yule and Company, Kalyani Breweries (UB Group), and Dabur.

North 24-Parganas

The North 24 Parganas district lies to the east of Kolkata district and spans 4,034 sq km. The total population of the district stood at 10,082,852 according to Census 2011. Its existing large/medium industrial units are mainly engaged in the manufacture of jute products, plastics and polymer products, electro optics, ceramic refractories, process control and automation solutions, paper and paper-based products, rubber and rubber-based products, etc. The major established industrial zones in the district are Kanchrapara, Naihati and Barrackpore.

South 24-Parganas

South 24-Parganas is one of the southern-most districts of West Bengal with total population of 8,153,176 according to Census 2011. The major industrial sectors in the district include leather-based products manufacturing, leather tanneries, plastic packaging, jute mills, textile mills, engineering units, paper and newsprint, etc. The district also exports jute diversified products, hosiery and garments, leather and plastic products, machinery and parts.

Hooghly

The district lies on the banks of Hooghly river and is about 15 km from Kolkata. Spanning 3,149 sq km area, Hooghly is one of the most economically developed districts in West Bengal – the hub of the state's jute industry and cultivation. The jute mills are located on the banks of the river Hooghly in Tribeni, Bhadreswar, Champdani and Sreerampur. The other important industries in the district are steel and ferro alloys manufacturing, metal castings, paper mills, wood and wood-based products.

Howrah

Located on the western bank of Hooghly river, Howrah district gained importance in 1854 with the introduction of railways from Howrah. The major large-scale industrial sectors in the district include foundry, re-rolling mills, machinery and spare parts manufacturing, fabrication including agricultural implements, transport machinery and spares manufacturing, rubber and plastic products, and paper and paper products.

Gas sourcing

It is imperative to arrive at an optimum sourcing mix, considering all associated factors such as volumes of gas available, price of gas and timeline for gas availability.

In a CGD network, natural gas sourcing and supply is a critical activity which has to be formulated well in advance so that there are no hindrances during project commissioning and operations. It is imperative to identify sources of natural gas which will be used to feed the CGD network. We have identified five major gas sources that can be considered for feeding GCGSCL's CGD network. The likely gas sources, are tabulated below.

Gas source	Contingent upon
CBM gas from GEECLs Raniganj south block	Pipeline connectivity, pricing of CBM gas
Jagdishpur – Haldia natural gas pipeline	Pipeline connectivity and route layout
FSRU terminal at Digha	FSRU infrastructure development, pipeline connectivity
CBM gas from Essar's Raniganj block	Pipeline connectivity, pricing of CBM gas
LNG sourcing via barges from Petronet LNG	Regasification infrastructure, term of contract

Demand analysis

Demand for industrial, transport, domestic and commercial segments projected over 25 years

Demand analysis

Kolkata region is the third-most populous area after Delhi and Mumbai, and is growing rapidly with the development of infrastructure, technologies, parks, roads, riverside developments, etc. Considering the accelerated growth in and around Kolkata, the demand for natural gas is expected to increase significantly with the advent of natural gas distribution in the region. Natural gas demand for the authorised area (geographical area) has been estimated considering the four consumer segments – industrial, domestic, commercial and transport. The minimum work programme provided by PNGRB for first five years has been considered to assess natural gas demand.

Industrial segment

To estimate industrial demand, the types of industries in the geographical area along with the quantities of liquid fuel used have been analysed. Our study reveals that industries in the region predominantly use high speed diesel (HSD), furnace oil (FO) and LDO as fuel. To calculate fuel demand

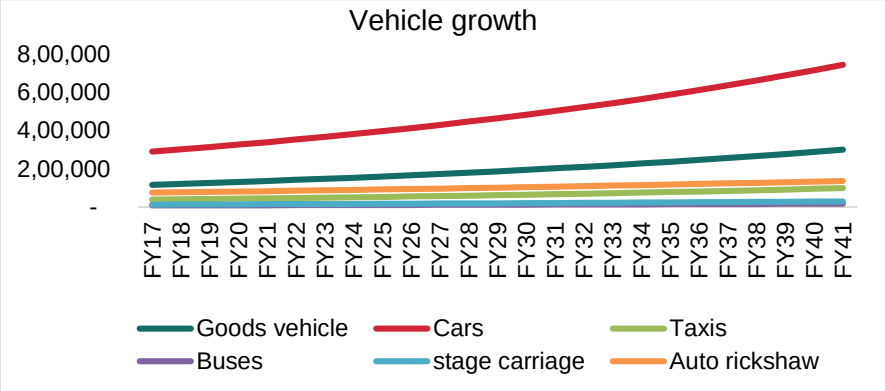
from these industries, conversion potential and gas penetration has been considered; The assumptions considered for deriving the gas demand are:

- Primary liquid fuel sourced by the industrial segment is HSD, followed by FO and LDO. The potential of these fuels' conversion to natural gas is assumed at 7%, 50% and 85%, respectively, which is in line with actual fuel conversion percentages in other areas with CGD networks.
- Penetration percentage has been considered at an average of 60% over the 25-year projection period
- Petroleum, oil and lubricant demand growth rate from the segment has been considered at 5% on-year

Transport segment

To estimated demand from the transport segment, long term growth in the population of vehicles - auto rickshaws, private cars, taxis, and buses - has been considered.

Vehicle population and growth trajectory



Assumptions made to ascertain demand from the segment are:

- Vehicles' growth rates have been considered year-wise, based on historical data sets and vehicle growth rates in metros
- For each vehicle segment, year-wise penetration, which is the percentage of vehicles in a particular category that is expected to convert to CNG, has been considered.
- CNG being economical and cleaner fuel, the retro fitment of auto-rickshaws to CNG along with private car has been given the highest priority to derive the natural gas demand from the transport sector. Similarly, conversion of state operated buses and private buses (school bus, office bus) has been estimated on a long term basis for addition of CNG volumes in the geographical area.

Domestic segment

The cost to exchequer of subsidy of LPG can be minimized by promoting the usage of Natural gas, hence PNGRB concentrates with a minimum work plan with focus on connecting the domestic consumers to PNG in the first five years from date of issuance of license. To derive natural gas demand from

the segment, the provided target numbers of PNGRB have been considered. It is estimated that each household will consume 15 SCM per month of natural gas.

Commercial segment

The Kolkata metropolitan region and its adjoining districts have large shopping malls, major hospitals and schools. Some hotspots that have been identified are Esplanade, Park Street, Park Circus belt, Shibpur, Mandirtala area, Chandannagar, Sector V, Diamond Harbour, Falta and Kalyani.

- Commercial liquefied petroleum gas (LPG) is the alternative fuel. However, with easy availability of piped gas, conversion of commercial establishments to piped natural gas (PNG) is expected to be significant.

Aggregate expected demand from all segments

000'scmd	Year 1	Year 5	Year 10	Year 15	Year 20	Year 25
Domestic	49	699	802	916	1029	1097
CNG	58	696	912	1089	1303	1559
Industrial	25	91	218	413	687	893
Commercial	4	44	103	135	175	228
Total	**136**	**1530**	**2036**	**2553**	**3300**	**3777**

Network design and layout

Network has been designed based on estimated demand and as per requirements laid down by PNGRB regulations.

The city gas distribution (CGD) network has been designed based on the demand of natural gas from each of the four segments and as per the requirements laid down by regulations specified by PNGRB in G.S.R. 612 (E), "Technical standard and specifications including safety standard for city and local natural gas distribution network" and G.S.R. 750 (E) "Amendment to technical standards and specifications including safety standard for city of local NG distribution network".

A facility roll-out plan has been prepared, outlining requirements of infrastructure and equipment in each year, for laying and commissioning. This plan details year-wise, length of steel pipelines, MDPE pipelines, district regulatory stations (DRS) compressors, CNG stations, etc. that are to be installed to meet the demand requirements. The detailed analysis has been provided in the chapter on capital expenditure (capex) and operating expenditure (opex) for CGD network.

Capital cost to develop CGD network estimated at Rs 4,800 crore over 25 year period and operating cost

Capex and OPEX for CGD network

Capital costs

The capex cost estimates are based on primary information obtained from the geographical area and inputs from suppliers and / or existing CGDs. The estimates include cost of equipment, piping, engineering and project management, land and site development, owners' management expenses,

in 25th year Rs 860 crore

and start-up. Estimates also comprise applicable taxes and duties, and thus indicate landed cost for GCGSCL, based on domestic gas purchase.

Major cost heads considered to arrive at the capital cost estimate are: Laying of trunk pipeline from Raniganj to CGS at Dankuni, CNG compressors, dispenses, land, line pipes, MDPE pipes, city gate station, district regulatory stations, mechanical erection, civil works, engineering and engineering, procurement and construction charges, start-up and commissioning and contingencies.

Estimated capex of project over 25 years

(Rs crore)	Year 1	Year 10	Year 15	Year 20	Year 25	total
CNG stations	23	14	0	12	0	378
CGD	774	99	121	55	65	4,401
CGS	21	0	0	0	0	21
Total	**818**	**113**	**121**	**67**	**65**	**4,800**

Operating costs

Opex is estimated based on manpower requirement for operation and maintenance (O&M) cost.

Estimated opex of projects over 25 years

Sr. no	Description	Y1	Y5	Y10	Y15	Y20	Y25
	Opex (Rs crore)	**18**	**134**	**223**	**355**	**560**	**861**

PIRR of 14% and EIRR of 15% over 25 years

Financial analysis

The project's financial analysis is based on estimated capital and operating cost, and purchase price of gas delivered at tap-off and finally to gas consumers. Profit and loss statements, cash flow statements and balance sheets have been projected for 25 years.

- Financials of CGD have the following main components:
  - Capital employed over the project life
  - O&M costs
  - Revenue from:
    - Network tariff
    - Compression charge
    - Gas marketing margins

Key findings of our financial analysis

Project IRR (%)	Equity IRR (%)	Network tariff (Rs/scm)	Compression charge (Rs/scm)
14%	15%	7.01 (1st year)	3.47 (1st year)

Analysis of project profitability has been based on various scenarios.

Scenarios along with returns

Particulars	PIRR	EIRR
Base case	14%	15%
Increasing gas price by 10%	11%	10%
Decreasing gas price by 10%	17%	19%
Increasing capex by 10%	13%	13%
Decreasing capex by 10%	15%	16%
Decreasing gas demand by 10%	12%	12%
Increasing gas demand by 10%	16%	17%

2. Natural gas market in India

Natural gas supplies have lagged demand, hobbled by continuous decline in domestic gas production since the last few years, poor economics of imported gas and a relatively under-developed gas pipeline infrastructure. While 2009-10 saw domestic gas production received a significant boost following commencement of production from the eastern offshore Krishna-Godavari-D6 block, subsequently gas production from the block plunged. The fall in domestic gas production and poor economics of imported gas in the power sector resulted in under-utilisation of gas-based power plants. India's pipeline network has been operating at low utilisation levels mainly because of issues related to gas availability and affordability. Petroleum and Natural Gas Regulatory Board (PNGRB) authorised the construction of several cross-country gas pipelines. However, the projects have yet to materialise due to lack of anchor customer demand, which has caused viability and financing concerns.

To fix these impediments and develop the market, the government has employed a two-pronged strategy – encourage private sector entry in the exploration and production (E&P) segment and introduce policies for the laying transnational pipelines, and encouraging liquefied natural gas (LNG) and E&P of coal bed methane (CBM) sources.

Recently, the government also undertook initiatives to revive stranded gas-based capacities in the power and fertiliser sectors by making LNG affordable. In the power sector, it is providing subsidy through a reverse bidding scheme to allow stranded power assets to operate at 30% plant load factor (PLF) and service the lenders. Also, the power sector is expected to source higher re-gassified LNG (R-LNG) on spot basis as it is relatively cheaper. In the fertiliser sector, it aims to increase urea production by 3.7 million metric tonnes per annum (mmtpa) by 2018-19 through a gas pooling policy, i.e. uniform delivery cost by averaging domestic gas and LNG prices.

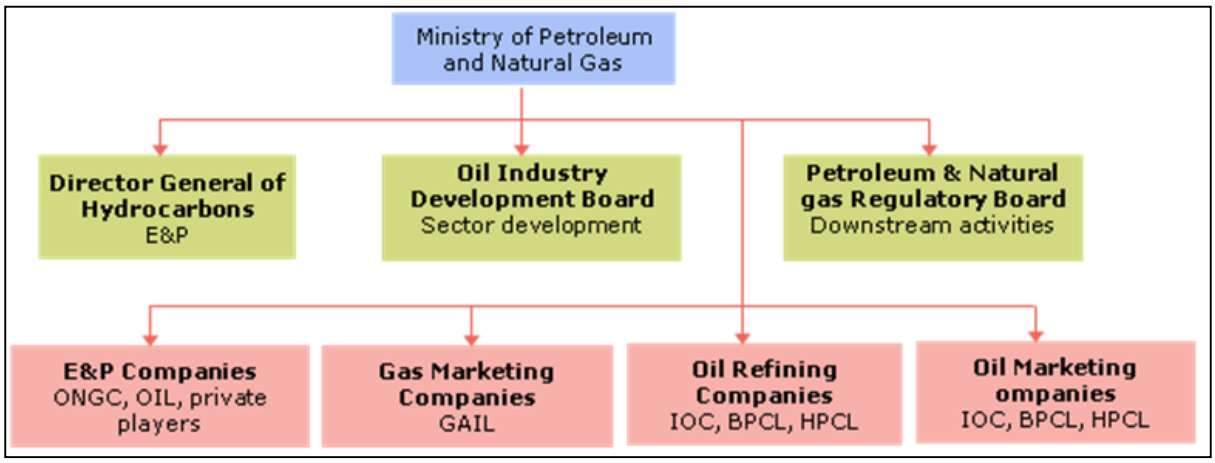
India has the infrastructure to annually import and re-gassify 25 mmtpa of LNG through four terminals: Dahej - 10 mmtpa; Hazira - 5 mmtpa; Dabhol - 5 mmtpa; and Kochi - 5 mmtpa. There are several Greenfield and brownfield LNG projects at different stages of conceptualisation and development on the eastern and western coasts. Their viability and development is predicated on the emergence of a robust domestic gas market.

City gas distribution (CGD) has received a fillip as well, as natural gas through domestic production and imports rise. Currently, more than 50 cities have been covered by retail gas distribution. PNGRB has conducted six rounds of CGD bidding, and is expected to commence the seventh round in June 2016.

2.1 Natural Gas Regulatory Set up

Five regulatory bodies look into various aspects of the oil and gas industry in India: Ministry of Petroleum & Natural Gas (MoPNG), Director General of Hydrocarbons (DGH), Oil Industry Development Board (OIDB), PNGRB and Empowered Group of Ministers (EGoM).

Table 1: Gas regulatory set-up and roles of entities



Source: CRIS Analysis

- **DGH:** Is the upstream regulator. It is responsible for implementation of NELP, handling matters related to production-sharing contracts (PSCs) of discovered fields and exploration blocks, promotion of E&P investments, monitoring of committed E&P schedule, opening up of unexplored areas for exploration, and development of non-conventional hydrocarbon energy sources such as CBM, gas hydrates and oil shale.
- **OIDB:** Provides financial and other assistance for development of the hydrocarbon sector, and looks at conservation of petroleum products and energy security of the country.
- **PNGRB**: Regulates the midstream and downstream sectors. It promotes competitive markets.
- **EGoM:** Is a ministerial committee headed by Finance Minister of India. It was set up to address issues of national importance, which impact multiple sectors and a large number of consumers.

The natural gas sector is regulated by the **Petroleum and Natural Gas Regulatory Act, 2006**. On October 1, 2007, the PNGRB (or the board) was constituted and notified by the GOI w.e.f. 1 October 2007.

1. **Scope of the regulatory board** is *'to regulate the refining, processing, storage, transportation, distribution, marketing, and sale of petroleum, petroleum products, and natural gas, excluding production of crude oil and natural gas, so as to protect the interest of consumers and entities engaged in specified activities and to ensure uninterrupted and adequate supply needed to promote competitive markets.'* The following fall under its purview:
   - Authorisation of new infrastructure projects
   - Declaration of pipelines as common or contract carriers
   - Right of first use
   - Unbundling of marketing and transmission activities
   - Marketing authorisations
   - Marketing services obligations
   - CGD
   - Technical and HSE standards
   - Period of exclusivity for CGD networks

Since coming into existence, PNGRB has notified, approved and come out with draft regulations for CGD, natural gas transmission pipelines and LNG terminals.

Table 2: Important PNGRB regulations

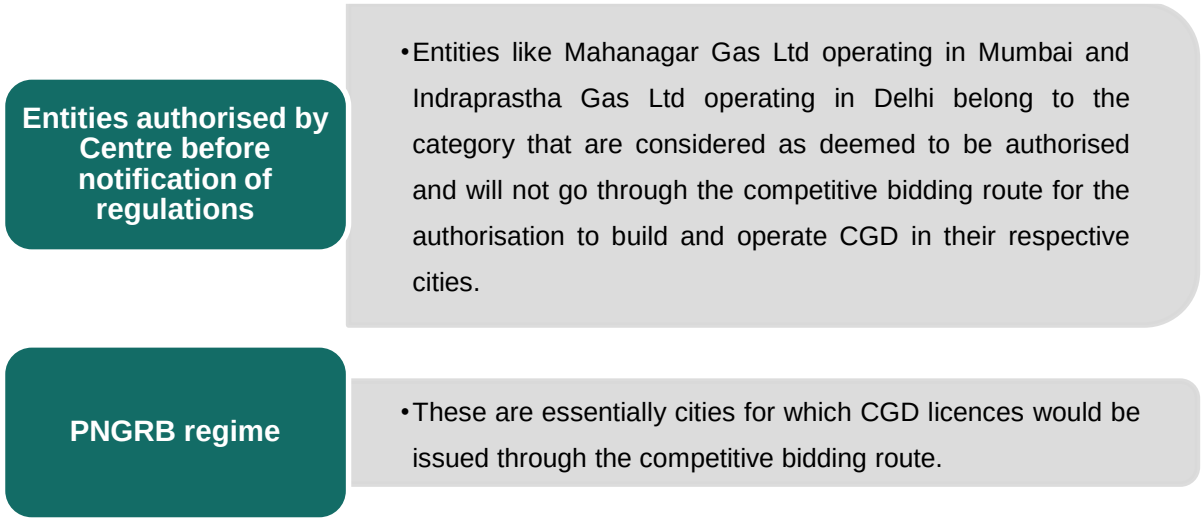
City gas distribution regulations (Notified Reg.)	▪ Regulation for Access Code (F.No. S-Admn./II/8/2010 29/03/2011) ▪ Regulation for Authorization (GSR196(E) 19/03/2008) ▪ Regulation for Tariff Determination (GSR 197(E) 19/03/2008) ▪ Regulation for Exclusivity (GSR 198(E) 19/03/2008)
Transmission regulations (Notified Reg.)	▪ Regulation for Access Code (GSR 541(E) 17/07/2008) ▪ Regulation for Authorization (GSR 340(E) 06/05/2008) ▪ Regulation for Tariff Determination (GSR 807(E) 20/11/2008) ▪ Regulation for Common Carrier (GSR 273(E) 21/04/2009)

Source: CRIS Analysis

There has been a concerted effort to improve access of natural gas to users across the country. Development of CGD networks in India is a key step in this direction.

2.2 CGD segment

Figure 1: History of CGD authorisation/award in India



2.3 PNGRB authorization

PNGRB issued guidelines for CGD entities authorised before the appointed date, as per Clause 17 of the Petroleum and Natural Gas Regulatory (Authorizing Entities to Lay, Build, Operate or Expand City or Local Natural Gas Distribution Networks Regulations) Regulations, 2008.

Excerpts of the Regulations:

Clause 17. Entity authorized by central government for laying, building, operating or expanding CGD network before appointed day

1. The entity shall submit relevant information along with supporting documents in the form as in Schedule H within 180 days from the appointed day.
2. The entity shall abide by the terms and conditions of the authorisation by the central government, including obligations, if any, imposed by the government.
3. The entity shall abide by the relevant regulations for technical standards and specifications, including safety standards and the quality of service standards as specified under regulation 15.
4. The board may consider to grant exclusivity on such terms and conditions as per the provisions in the Petroleum and Natural Gas Regulatory Board (Exclusivity for City or Local Natural Gas Distribution Networks) Regulations, 2008.
5. The network tariff and the compression charge for compressed natural gas (CNG) shall be as determined under the Petroleum and Natural Gas Regulatory Board (Determination of Network Tariff for City or Local Natural Gas Distribution Networks and Compression Charge for CNG), Regulations 2008.
6. The activities of the entity may be subject to such other regulations as may be applicable as per the provisions of the Act.

2.4 Authorised CGD entities in India

2.4.1 Authorised under Regulation 5

It was issued in 2008, giving exclusive rights to an entity to lay, build, operate or expand city or local gas distribution network.

Table 3: CGD entities authorised under Regulation 5 of PNGRB regulations

S. no.	Name of CGD	Area covered	Entity authorised
1	Sonipat CGD Network	Sonipat	Gail Gas Ltd
2	Meerut CGD Network	Meerut	Gail Gas Ltd
3	Kakinada CGD Network	Kakinada	Bhagyanagar Gas Ltd
4	Dewas CGD Network	Dewas	Gail Gas Ltd
5	Kota CGD Network	Kota	Rajasthan State Gas Ltd Gail Gas Ltd
6	Mathura CGD Network	Mathura	JV of DSM Infratech Pvt Ltd and Saumya Mining Pvt Ltd
7	Chandigarh CGD Network	Chandigarh	IOCL-AGL
8	Allahabad CGD Network	Allahabad	IOCL-AGL
9	Jalandhar CGD Network	Jalandhar	Jay Madhok Energy Pvt Ltd
10	Jhansi CGD Network	Jhansi	Central UP Gas Ltd

S. no.	Name of CGD	Area covered	Entity authorised
11	Bhavnagar CGD Network	Bhavnagar	Gujarat Gas Company Ltd
12	Jamnagar CGD Network	Jamnagar	GSPC Gas Company Ltd
13	Kutch CGD Network	Kutch (West)	GSPC Gas Company Ltd
14	Bengluru Rural and Urban CGD Network	Bengluru Rural and Urban Districts	GAIL Gas Ltd
15	Kutch CGD Network	Kutch (East)	Jay Madhok Energy Pvt Ltd
16	Daman CGD Network	UT of Daman	Indian Oil-Adani Gas Pvt Ltd
17	Panipat CGD Network	Panipat	Indian Oil-Adani Gas Pvt Ltd
18	Raigarh CGD Network	Raigarh District (Maharashtra) excluding area already authorised	Mahanagar Gas Ltd
19	Dadra Nagar Haveli CGD Network	UT of Dadra & Nagar Haveli	GSPC Gas Company Ltd
20	Thane CGD Network	Thane District (Maharashtra) excluding area already authorised	GGCL
21	Amritsar CGD Network	Amritsar District (Punjab)	GSPL
22	Pune CGD Network	Pune District (Maharashtra) excluding area already authorised	Mahesh Resources Pvt Ltd and Others
23	Ludhiana CGD Network	Ludhiana	Jay Madhok Energy Pvt Ltd
24	East Godavari District (excluding area already authorised) CGD Network	East Godavari District	Proposed Consortium of APGDCL and HPCL (CAH)
25	West Godavari District CGD Network	West Godavari District	Proposed consortium of APGDCL and HPCL (CAH)
26	Udham Singh Nagar CGD network	Udham Singh Nagar	IndianOil-Adani Gas Pvt Ltd
27	Haridwar CGD Network	Haridwar	GAIL Gas Ltd
28	Tumkur CGD Network	Tumkur	MEIL
29	Dharwad CGD Network	Dharwad	IndianOil-Adani Gas Pvt Ltd
30	Krishna District CGD Network	Krishna District (excluding area already authorised)	MEIL
31	Belgaum CGD Network	Belgaum	MEIL
32	Ernakulam District (Kerala)	Ernakulam District (Kerala) GA	Indian Oil-Adani Gas Pvt Ltd

Source: PNGRB

2.4.2 CGD players authorised under Regulation 17

Table 4: CGD entities authorised under Regulation 17 of PNGRB regulations

S. no.	Name of CGD	Area covered	Entity authorised
1	Agartala CGD Network	Agartala CGD Network	Tripura Natural Gas Ltd
2	Upper Assam CGD Network	Upper Assam CGD Network	Assam Gas Company Ltd
3	Firozabad GA (Taj Trapezium Zone)	Firozabad GA (Taj Trapezium Zone) in the state of UP	Gail Gas Ltd
4	Agra CGD Network	Agra	Green Gas Ltd
5	Hyderabad CGD Network	Hyderabad	Bhagyanagar Gas Ltd
6	Indore CGD Network	Indore including Ujjain	Aavantika Gas Ltd
7	Gwalior CGD Network	Gwalior	Aavantika Gas Ltd
8	Ghandhinagar Mehsana Sabarkantha CGD Network	Ghandhinagar Mehsana Sabarkantha	Sabarmati Gas Ltd
9	Pune City including Pimpri Chichwad CGD Network	Pune City, including Pimpri Chinchwad along with adjoining contiguous areas of Hinjewadi, Chakan and Talegaon GA	Maharashtra Natural Gas Ltd
10	Kanpur CGD Network	Kanpur GA	Central UP Gas Ltd
11	Bareilly CGD Network	Bareilly GA	Central UP Gas Ltd
12	Delhi CGD Network	National Capital Territory of Delhi	Indraprastha Gas Ltd
13	Mumbai CGD Network	Mumbai and Greater Mumbai	Mahanagar Gas Ltd
14	Vijaywada CGD Network	Vijaywada GA	Bhagyanagar Gas Ltd
15	Mumbai CGD Network (GA-2)	Thane City & adjoining areas like Mira Bhayender, Navi Mumbai, Ambernath, Bhiwandi,Kalyan, Dombivily, Badlapur, Ulhasnagar, Panvel, Kharghar and Taloja	Mahanagar Gas Ltd
16	Kolkata CGD Network	Kolkata Municipal Corporation and parts of adjoining districts of North 24 Parganas, South 24 Parganas, Howrah, Hooghly and Nadia	Greater Calcutta Gas Supply Corporation Ltd
17	Lucknow CGD Network	Lucknow GA	Green Gas Ltd

Source: PNGRB

2.4.3 Authorised under Regulation 18(1)

It was issued to grant authorisation to entities that were not authorised by the central government.

Table 5: CGD entities authorised under Regulation 18(1) of PNGRB Regulations

S. No.	Name of CGD	Area covered	Entity authorised
1	Anand	Anand area, including Kanjari and Vadtal villages (in Kheda District)	Charotar Gas Sahakari Mandali Ltd
2	Valsad	Valsad GA	GSPC Gas Company Ltd
3	Hazira	Hazira GA	GSPC Gas Company Ltd
4	Rajkot	Rajkot GA	GSPC Gas Company Ltd
5	Surendranagar	Surendranagar GA	GSPC Gas Company Ltd
6	Navsari	Navsari GA	GSPC Gas Company Ltd
7	Nadiad	Nadiad GA	GSPC Gas Company Ltd
8	Khurja	Khurja GA	Adani Gas Ltd
9	Moradabad	Moradabad GA	Siti Energy Ltd
10	Surat-Bharuch-Ankleshwar	Surat-Bharuch-Ankleshwar GA	Gujarat Gas Company Ltd

Source: PNGRB

A brief summary of CGD authorization regulations is given in table below:

Table 6: CGD authorization regulations summary

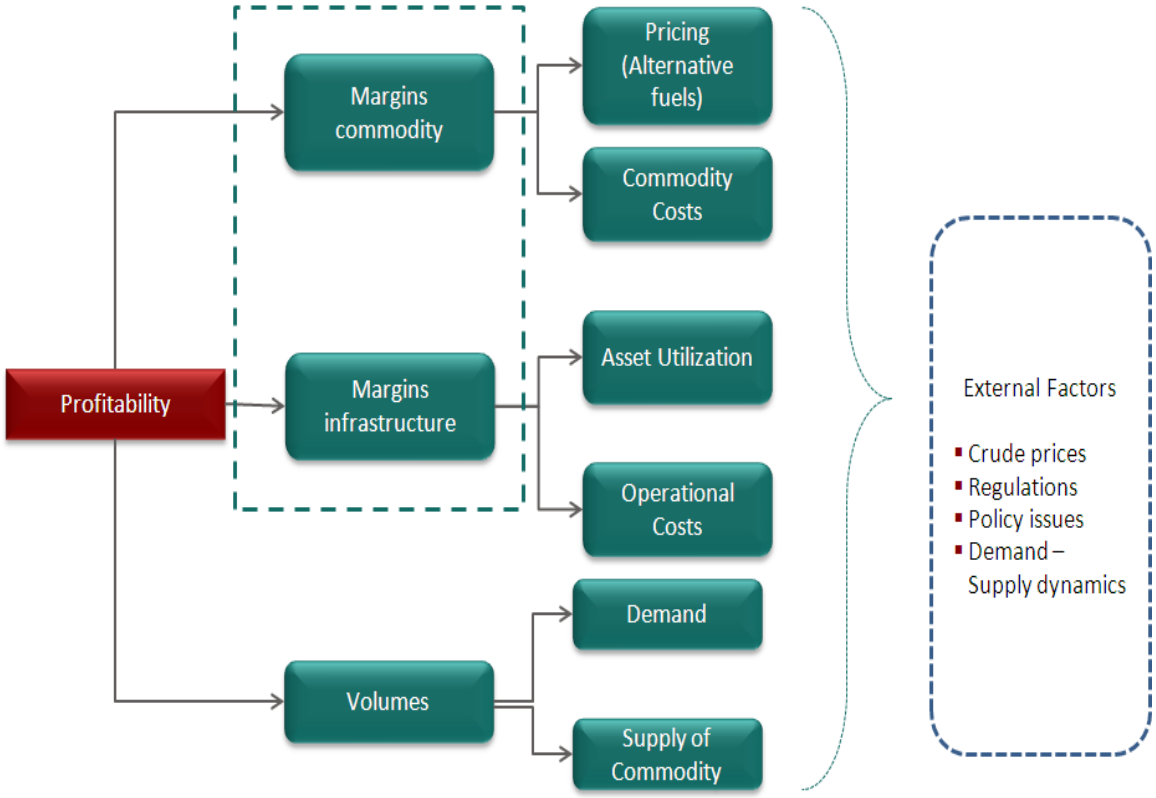
Authorization under regulation 5	Authorization under regulation 17	Authorization under regulation 18 (1)
Entities authorized to operate CGD networks under regulation 5 are awarded cities via the bidding route.	Entities authorized to operate CGD networks under regulation 17, are entities which were authorized initially by central government for operation CGD networks. These entities were in operation before the formulation of PNGRB act.	Entities authorized to operate CGD networks under regulation 18, are entities which were not authorized by central government, but were authorized by respective state governments for operation CGD networks. These entities were also in operation before the formulation of PNGRB act.

2.5 Profitability of CGD business in India

Supply and pricing of natural gas from domestic sources or through imports is crucial in determining marketing margins, and therefore profitability / returns from the CGD business. Revenue in a CGD business are derived from marketing margins on volumes sold and tariff than an entity charges from consumers for investments made in laying the physical infrastructure for transporting the gas within the network and dispensing it to consumers. Volume of gas sold is also a critical variable to determine the profitability of a business.

The following figure shows various components of business returns from CGD business and also the factors affecting its profitability:

Figure 1: Key components of returns from CGD business



2.6 Domestic gas scenario

The availability of domestic natural gas at low prices ensured healthy profitability of the CGD business. However, the domestic gas price is now getting aligned with market rates.

The Cabinet Committee on Economic Affairs approved revision of domestic gas prices, as per the Rangarajan Committee recommendations on June 28, 2013. As per the committee's recommendations, domestic gas prices will be determined every quarter for five years, starting from April 1, 2014. The formula recommended by the committee uses long-term and spot liquid gas (LNG) import contracts as well as international trading benchmarks to arrive at a competitive gas price for India.

Hence, the price revision of natural gas can be seen as an attempt by the government to align domestic gas price with international level, going forward. Once domestic-international price parity is achieved, LNG will increase manifold.

2.6.1 2014 gas price revision

On October 18, 2014, the government announced its decision on gas pricing reform, based on modifications to the Rangarajan formula. Two price benchmarks were removed from the formula – the volume-weighted average of netback prices to producers at the exporting country wellhead (for LNG), and the volume-weighted average producers' netback price of gas in Japan. Instead, two new components were introduced in the formula – the Alberta (gas) Reference price weighted by the volume

of Canadian gas consumption, and the Russian domestic gas price weighted by the total annual volume of natural gas consumed in Russia.

Under the new reforms:

- Prices will be reviewed every six months, based on trailing price and volume data for the previous four quarters, with a lag of one quarter. Therefore, the first case of pricing under the new reform (applicable from November 1) was based on prices prevailing between July 1, 2012 and June 30, 2013, and was revised on April 1, 2015.
- The price is set on the basis of gross calorific value vis-à-vis net calorific value under the previous system of gas pricing.

Based on the latest formula, the price of domestic gas has been set as mentioned below.

Table 7: Domestic gas price in 2014-16 as per latest formula

Period	Gas price ($/mmBtu) on GCV basis
November ’14 – March ‘15	5.05
April ’15 – September ‘15	4.66
October ’15 – March ‘16	3.82
April’16- September’16	3.06

- All new discoveries in deep-water blocks would be treated differently, and command a premium over normal blocks. Also premium would be paid only on fields that have been discovered after October 2014. However, the government rejected a proposal from oil & gas producers to allow premium pricing on gas produced from difficult deep-water and ultra-deep-water blocks that were discovered prior to November 2014, but are yet to be developed.
- A new gas pricing policy has been approved by the cabinet in March 2015, for gas discoveries made in difficult to access areas. According to the policy the formula will be based on a year weighted average price of fuel oil, coal and naphtha. The new pricing formula will be applicable to fields that have more than two thirds of their appraisal and development wells lying in difficult areas such as deep water/high pressure high temperature/ultra-deep water etc.

2.7 R-LNG scenario

The price of natural gas (domestic / R-LNG) vis-à-vis the price of alternate fuels sourced by end-users remains crucial to the overall business viability of CGD networks. With domestic natural gas production in India falling in recent years, availability and pricing of R-LNG has become an important factor in assessing demand and overall potential of the CGD business.

2.7.1 Global LNG market

Global LNG trade has historically been restricted to specific regions, i.e. LNG demand from a particular region is largely met by LNG supply from the same region. The key LNG demand centres globally have been North America, Europe and Asia–Pacific (largest demand centre for LNG). Typical LNG trade routes in the past have been Trinidad and Tobago (Atlantic LNG) to North America; Middle East (ME) and Asia–Pacific to Asia–Pacific; and equatorial region (North Africa and West Africa) to Europe and the US. Trade has, thus, been either in the Atlantic basin or Pacific basin, with little cross trade.

However, with the emergence and rise of spot trading, the trade routes over the last few years have cut across regions, based on the demand and supply situation at the particular time. Another major shift in LNG that has affected the trade dynamics is the rise of unconventional gas in the US, which has potentially converted North America from an importer of LNG to an exporter of LNG. It is expected that the traditional trade routes will be challenged over the next few years, particularly as the US emerges as a large supply source and as integrated oil companies ink deals with consumers. Despite these changes, the long-term trade of LNG will still be very much regional in nature, with most of the Asia–Pacific demand being met by supplies from the Asia–Pacific and ME regions.

LNG prices in recent times have seen a rapid declining trend due to falling crude oil prices. Spot LNG prices have come down from $ 12 – 13 /mmbtu over a year ago to $ 6 – 7 /mmbtu currently. Decline in spot LNG prices have also led to renegotiation of long term contract prices between buyers and sellers. There has also been a shift in benchmark for pricing of LNG contracts from crude link prices to Henry Hub based LNG prices. These contracts take prices at US based henry hub as a reference for pricing of LNG contracts.

2.7.2 LNG in India

India began importing LNG in 2004. The prices for companies that purchase and market LNG (Petronet LNG and GAIL) are determined either by contracts or by the spot market. The major LNG contracts that India has signed are:

- Under India's first long term contract, Qatar's RasGas agreed to supply 5 million tonnes per annum (mtpa) of LNG to Petronet LNG Ltd (PLL) from 2004, at a contracted price of $2.53/mmBtu for five years, with a further 2.5 mtpa from January 2010. The period of fixed prices ended in 2009, and a five-year transition began to 100% linkage with crude oil.
- In 2012, PLL signed a contract with Exxon Mobil to import 1.44 mtpa of LNG from Gorgon in Australia, beginning 2015. The price agreed was 14.5% of JCC. At a JCC price of $80/barrel, and added costs for shipping ($0.75), insurance ($0.0017), customs duty ($0.636) and regasification ($0.64) this results in a total price of $13.63/mmBtu.
- A break from JCC-linked pricing occurred when a contract was signed between GAIL and Cheniere Energy (USA) for import of 3.5 mtpa from Cheniere's Sabine Pass terminal beginning in 2017, for 20 years. The pricing formula comprised 115% of Henry Hub plus a fixed capacity charge of $3/mmBtu. Thus, for Henry Hub at $3.71 (average over 2013), the landed price of LNG in India, assuming a shipping cost of $2, would be around $9/mmBtu (plus regasification costs of around $0.50/mmBtu).

2.7.3 Re-gasification of LNG

The current LNG re-gasification capacity in India stands at **~24 mmtpa** with the following LNG terminals on the western coast:

Table 8: Existing LNG terminals in India

S. no.	Terminal	Capacity (mmtpa)	Location
1	Dabhol, LNG Terminal, RGPPL	5	Maharashtra
2	Dahej LNG Terminal, Petronet LNG Ltd	10	Gujarat
3	Hazira LNG Terminal, Shell Ltd	3.6	Gujarat
4	Kochi LNG Terminal, Petronet LNG Ltd	5	Kerala

Source: Secondary research

Owing to the decline in domestic natural gas production and increase in gas supply from the US going forward, several LNG terminals have been proposed on the eastern coast of India. One of these terminals, which would serve as a potential gas source for the Greater Calcutta CGD network, is the floating storage and regasification unit (FSRU) being set up by a consortium of H-Energy Private Ltd and Excelerate Energy. The letter of award was sent to the consortium for setting up the **4 mmtpa** re-gasification unit in the offshore Digha region of West Bengal, India.

2.8 Recent developments

2.8.1 New guidelines on gas allocation to CGD entities

On November 14, 2013, MoPNG issued guidelines for the uniform supply of domestic natural gas to all CGD entities for domestic and vehicular use. The guidelines follow the order of the Gujarat High Court, upheld by the Supreme Court in September 2013, to supply domestic gas to Ahmedabad at the same rate at what was being supplied to Delhi and Mumbai, and not discriminate between the CGD operators for gas allocation.

Revised guidelines were issued by MoPNG on February 3, 2014. The allocation of natural gas as per these guidelines was increased to 8.32 million metric standard cubic metre per day (mmscmd) to cover the demand of natural gas of CGD entities for supplying gas to compressed natural gas (CNG) users and domestic piped natural gas (PNG) users. This allocation was based on average consumption of natural gas in CNG (transport) and PNG (domestic) segments in the first half of 2013-14 that stood at 8.32 mmscmd.

MoPNG revised the guidelines on August 20, 2014 for allocation / supply of domestic natural gas to CGD entities for CNG and PNG, and keeping in view the periodical exercise of revising the domestic gas allocations of CGD entities for CNG and PNG segments, GAIL has been authorised to divert domestic gas from non-priority sector to meet the requirement of CNG and PNG segments as per their actual consumption, subject to:

- The allocation exercise will be undertaken by GAIL after the end of every six months. PPAC shall, within completion of 20 days of a half year, submit the average consumption of gas by each CGD entity in CNG and PNG segments. To meet fluctuation in demand of CGD sector, GAIL is authorised to supply domestic gas at 10% above the 100% requirement of CNG and PNG of individual CGD entity, as per the last half-yearly consumption.
- The gas shall be supplied at uniform base price to each CGD entity.
- Additional requirement of gas, if any, between the two review periods shall be sourced by individual CGD entities.
- Only those CGD entities in their respective geographical areas will be considered for allocation who have been allocated domestic gas as per the MoPNG guidelines dated February 3, 2014.
- The guidelines will be applicable till divertible gas from non-priority sector is available with GAIL, and GAIL shall submit statement on cuts imposed on the non-priority sector for meeting the requirement of CNG and PNG segments.
- The guidelines shall not be applicable to Tripura Natural Gas Company and Assam Gas Company, in view of operational issues.

2.8.2 Amendment in minimum work programme for CGD entities

During the pre-bid meeting held by PNGRB on December 17, 2013 with potential bidders under fourth round of CGD bidding, potential bidders expressed that the minimum work programme for PNG domestic connections and inch-km of steel pipeline per sq km as per the regulations was very high and requested reducing the same. Subsequent to the pre-bid meeting, on April 7, 2014 PNGRB vide public notice issued ***amendments in the regulations***.

Excerpts from the regulation

In the Petroleum and Natural Gas Regulatory Board (Authorizing Entities to Lay, Build, Operate or Expand City or Local Natural Gas Distribution Networks) Regulations, 2008:

(a) In Regulation 7,

(i) Sub-regulation (1),

(A) For clause (c) the following shall be substituted, namely:

"(c) Minimum work programme for infrastructure for PNG domestic connections and inch-km of pipeline to be laid by the successful bidder.

Infrastructure for PNG domestic connections *– The board shall work out the target for infrastructure for PNG domestic connections as 5% of the households of the respective geographical area, to be achieved by the successful bidder during the first five years from the date of grant of authorisation in Schedule D as under:*

i. The successful bidder shall achieve 15%., 50%., 70% and 100% of this target by end of second year, third year, fourth year and fifth year, respectively, and

ii. The board may consider carry forward of the target from one year to another within the period of five years.

Inch-km of pipeline *– The board shall work out the target for inch-km of pipeline, for which both steel pipeline and MDPE pipeline shall be considered, as per the following, namely:*

(i) For geographical areas having an area of less than or equal to 1,000 sq km, product of 0.65 and the area in sq km of the respective geographical area;

(ii) For geographical areas having an area of more than 1,000 sq km and less than or equal to 5,000 sq km, product of 0.36 and the area in sq km of the respective geographical area subject to a minimum of 650 inch-km of pipeline;

(iii) For geographical areas having an area of more than 5,000 sq km, product of 0.07 and the area in sq km of the respective geographical area subject to a minimum of 1,800 inch-km of pipeline.

The target for inch-km of pipeline worked out as per the above shall be achieved by the successful bidder during the first five years from the date of grant of authorisation in Schedule D, namely:

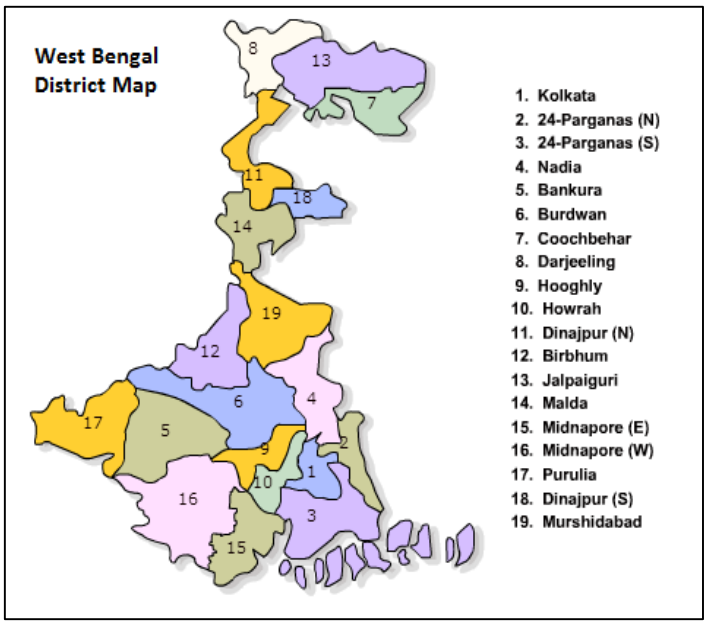
(i) The successful bidder shall achieve 20%., 50%., 80%., 90% and 100% of this target by the end of first, second, third, fourth and fifth years, respectively, covering all charge areas; and

(ii) The board may consider carry forward of the target from one year to another within the period of five years."

3. Description of the geographical area

3.1 West Bengal

West Bengal has the fourth largest population in the country. The state, which covers an area of ~88,750 sq. km, shares its borders with the states of Odisha, Jharkhand, Bihar, Sikkim and Assam, and with Bangladesh. The state's economy is dependent on agriculture, and medium and small size industries. However, the service industry and large scale industries have shown a significant increase in their contributions to the economy.



Key industries in the state are tea, petroleum and petrochemicals, leather. iron and steel, information technology, mineral resources, automobile and auto components, biotechnology, fisheries, jute products and textiles.

According to Census 2011, the total population of West Bengal was 91,347,736, accounting for ~7.5% of India's population.

West Bengal is the sixth largest contributor to India's net domestic products. It recorded a gross state domestic product (GSDP) of $132.86 billion in 2014-15. Notably, the state's GSDP expanded at a compound annual growth rate (CAGR) of 11.06% from 2004-05 to 2014-15. The service industries, i.e. the tertiary sector, is the largest contributor towards the state's GSDP, accounting for 57.8% share as against the primary sector's (i.e. agriculture, mining, forestry, etc) contribution of 24%.

Majority of the state's industries are in the Kolkata region, mineral-rich western highlands and the Haldia port region.

3.2 Kolkata

Kolkata is the capital city of West Bengal. Located on the eastern banks of the river Hooghly, it is the most important commercial, cultural and educational centre of East India. It is spread over an area of 185 sq. km. According to Census 2011, the total population of Kolkata district was 4,486,679.

The city is the main commercial and financial hub of East and North-East India, and home to the Calcutta Stock Exchange. It is a major commercial and military port, and is the only city in eastern India to have an international airport. Key industrial units with headquarters in Kolkata are engineering products, electronics, electrical equipment, cables, steel, leather, textiles, jewellery, frigates, automobiles, railway coaches, wagons, tea, paper, pharmaceuticals, chemicals, tobacco, food products and jute products. Recently, the city has also seen significant development in the IT, banking and finance sectors.

Majority of the city's population (~83.69%) is employed in the tertiary sectors, while 15.49% are in the secondary sectors and a low 0.81% in the primary sector.

The Garden Reach and Taratala areas near Kolkata district are home to a number of large industries such as Garden Reach Shipbuilders and Engineers, Marathon Electric Motors India, Videocon Glass and Appliances Factory, Hindustan Unilever, CESC, Ingersoll Rand (India), Britannia Industries. etc.

3.3 Greater Kolkata region

Apart from Kolkata district, Greater Kolkata comprises the following five districts, which are a part of the Kolkata Metropolitan Development Authority:

1. Nadia District
2. North 24-Parganas
3. South 24-Parganas
4. Hooghly District
5. Howrah District

3.3.1 Nadia

Nadia district lies to the north of Kolkata and covers an area of 3,927 sq km. It shares its borders with Bangladesh in the east, North 24 Parganas and Hooghly districts in the south, Bardhaman in the west, and Murshidabad in the north. The district's total population stood at 5,168,488, according to the Census 2011.

Large/medium industrial units are mainly engaged in manufacture of cotton yarn, oxygen gas, medicine, chemical items, electrical components, milk and milk products, paper and paper-based products etc. The major industrial centre is Kalyani, which has a dedicated industrial zone.

3.3.2 North 24-Parganas

North 24 Parganas district lies to the east of Kolkata district, occupying an area of 4,034 sq km. It shares its borders with Nadia in the north, Bangladesh (Khulna Division) in the north and east, South 24 Parganas in the south and, Howrah and Hoogly in the west. Barasat is the district headquarters of North 24 Parganas. North 24-Parganas falls within the new alluvium sub-region of the lower Gangetic Plain (Zone-III) considered to be the most fertile region for crop production. The total population of the district stood at 10,082,852, according to Census 2011.

Large/medium industrial units are mainly into the manufacture of jute products, plastics and polymer products, electro optics, ceramic refractories, process control and automation solutions, paper and paper-based products, and rubber and rubber-based products.

Major established industrial zones in the district are Kanchrapara, Naihati and Barrackpore. The major industrial areas in Barrackpore are Ishapore Rifle Factory, Exide and Nicco. A 97.38-acre industrial park is being developed at Naihati.

3.3.3 South 24-Parganas

South 24-Parganas is one of the southern-most districts of West Bengal, and shares its borders with Kolkata City and North 24-Parganas in the north and Bay of Bengal in the south. Covering an area of 9,960 sq km, it is the largest district in West Bengal by area and second largest by population. According to Census 2011, the district's total population is 8,153,176.

Major industries in the district include leather-based products manufacturing, leather tanneries, plastic packaging, jute mills, textile mills, engineering units, and paper and newsprint. The district also exports diversified jute products, hosiery and garments, leather products, plastic products, and machinery & parts. A 75-acre industrial growth centre is under development in the Falta region.

3.3.4 Hooghly

The district, covering about 3,149 sq km, lies on the banks of the Hooghly river and about 15 km from Kolkata. It is surrounded by Nadia in the east, Burdwan in the north, Bankura in the west and Paschiim Midnapore in the south. The district headquarter is located in Hooghly-Chinsura. The total population of the district is 5,520,389, as per the Census 2011.

Hooghly is one of the most economically developed districts in West Bengal. It is the main jute cultivation, jute manufacturing and jute trade hub in the state. Jute mills are along the banks of the river Hooghly in Tribeni, Bhadreswar, Champdani and Sreerampur. The other key industries in the district are steel and ferro alloys, metal castings, paper and wood and wood-based products. There are several industrial complexes. The Hindustan Motors plant in Uttarpara is one of the largest car manufacturing plants in India.

3.3.5 Howrah

Howrah district gained importance with the setting up of a railway network in 1854. It is located on the western bank of Hooghly river and covers an area of 1467 sq. km. It shares its borders with North 24-Parganas and South 24-Parganas in the east, with the Hooghly district in the north (Arambagh and Shrirampur sub-divisions), with Midnapore East district (Tamluk sub-division) in the south and Ghatal sub-division of Midnapore West district in the west. The total population of the district is 4,841,638, as per the Census 2011.

Large industries in the district include foundry and re-rolling mills, machinery and spare parts manufacturing, fabrication, including agricultural implements, transport machinery and spares manufacturing, rubber and plastic products, and paper and paper products.

Major industrial growth centres / industrial complexes in the district are WBIIDC Growth Centre, Balitikuri Industrial Estate, Bauria Industrial Estate, Jalan Industrial Park and Jalan Industrial Complex.

4. Gas sourcing

In a CGD network, sourcing and supply of natural gas has to be formulated well in advance so that there are no hindrances during project commissioning and operation. There can be one gas source or multiple sources, which needs to be explored depending upon long-term gas availability and pricing. We have explored various gas sourcing options for supply of natural gas/CBM for the CGD network. These sources are:

- CBM gas from Great Eastern Energy Corporation Ltd's (GEECL) Raniganj gas blocks
- CBM gas from Essar's Raniganj gas blocks
- R-LNG from H-Energy's FSRU at Digha
- Gas from GAIL's Jagdishpur-Haldia natural gas pipeline
- LNG from Petronet Ltd

4.1 CBM from GEECL's Raniganj (South) block

GEECL, a public limited company, was incorporated in 1992 to explore, develop, distribute and market CBM gas in India. The company entered into a licence agreement in December 1993 with Coal India Ltd (CIL) for exploration and development of CBM in an area covering approximately 210 sq km (approximately 52,000 acres) in West Bengal. The PSC has been effective from November 9, 2001 following granting of the Petroleum Exploration Licence by the West Bengal government, which provides for a five-year initial assessment and market development phase, followed by a five-year development phase and subsequently a 25-year production phase, extendable with the approval of the Centre. GEECL received a mining lease for mining CBM from the Raniganj block on September 4, 2008 from the state government. The mining lease agreement was signed between the state and the company on June 5, 2014 and is valid for 20 years, with effect from September 4, 2008.

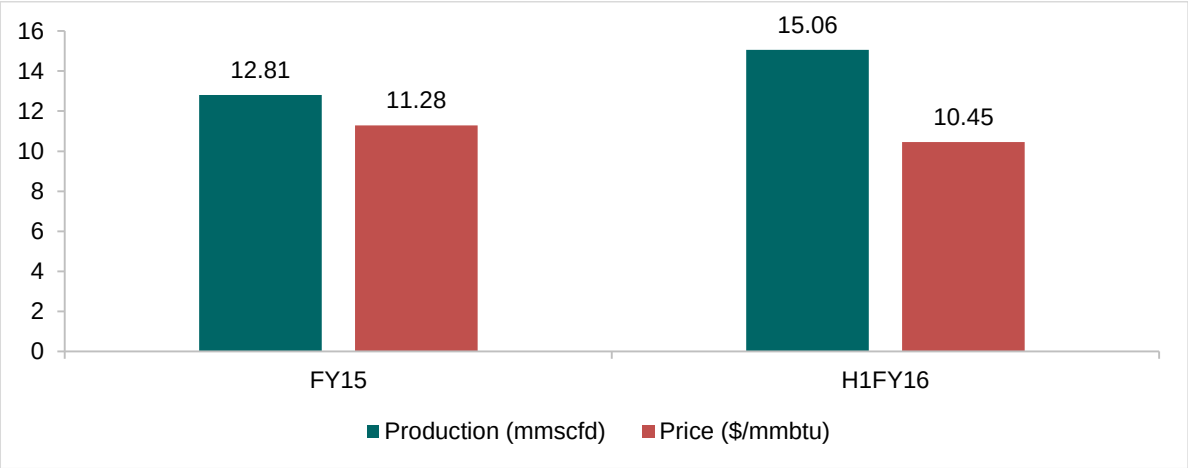
Major highlights of the block

Sr. no.	Highlight
1.	Area of the block 210 sq km
2.	2.62 tcf of gas in place
3.	156 wells drilled, including 56 deviated wells
4.	150 wells de-watering/ producing gas
5.	144 additional wells planned to be drilled
6.	Production of 15.26 mmscfd, as on November 2015

Presently GEECL, is supplying CBM gas to the industries located in the industrial areas of Durgapur, Asansol, and Raniganj. It also caters to the transport segment through supply of CNG in Asansol & Durgapur via franchisee agreements with Indian Oil & BPCL for its CNG operations GEECL operates its own pipeline network of around 80 kms in the Raniganj-Durgapur region, where it has been selling the gas produced from its fields.

Gas production and sales from GEECL's Raniganj block has been on the rise, with gas production increasing more than 20% in FY16 over FY15. The figure below shows the average gas production and sales price in the same period.

Figure 2: Production and price of gas



Source: GEECL corporate presentation

However, a pipeline of ~ 180 Kms needs to be laid for connecting the gas source either from Raniganj or Durgapur to the gas landfall (CGS- Dankuni) for receiving the coal bed methane gas in the CGD network. Along with an upfront investment of more than 500 Cr, permissions & clearances and physical laying of pipeline would require at least 1 to 2 years.

4.2 Jagdishpur Haldia natural gas pipeline

GAIL plans to connect Jagdishpur in Uttar Pradesh with Haldia in West Bengal with a 2,050 km natural gas pipeline. The project is slated to benefit four states and 17 major cities that are along the route, namely Varanasi, Allahabad, Patna, Gaya, Chhapra, Siwan, Gopalganj, Mujaffarpur, Bettiah, Bhagalpur, Bokaro, Dhanbad, Ranchi, Jamshedpur, Asansol, Durgapur and Kolkata. The pipeline will be built at an estimated cost of Rs 10,000 crore. The 36-inch diameter pipeline will comprise a 922-km mainline and 1,128-km spur lines and feeder lines of between 12 and 30 inches diameter, and will have a capacity of 16 mmscmd. The pipeline will have a compressor station at Haldia.

Figure 3: Indicative route map of Jagdishpur Haldia natural gas pipeline

Source: CRIS analysis

In the first phase, GAIL plans to spend about Rs 4,000 crore to build about 341 km of mainline and 414 km of spur lines to carry about 7.44 mmscmd of natural gas. The first phase is scheduled to be completed by December 2018. The company has started activities related to detailed engineering and land liaison surveys for the pipeline route.

Construction of the first phase began on July 25, 2015, which consists of laying a 341-km trunk pipeline from Phulpur (Allahabad) to Dobhi (Gaya) and a 228-km spur pipeline to Barauni and Patna from Dobhi.

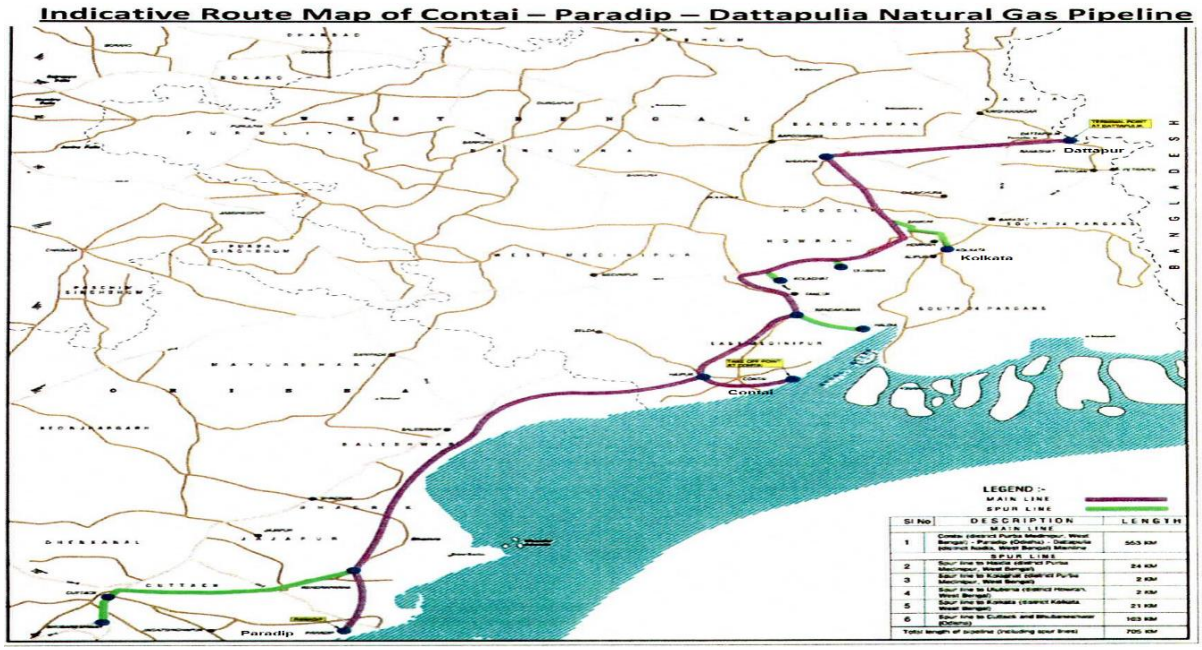
Further, GAIL is envisaging to connect cities in Orissa by extending the trunk pipeline to the proposed LNG terminal in Dhamra in the second phase. This will ensure availability of LNG to the connected demand centres across the route of the pipeline. Extension of pipeline till Haldia will be carried out in the third phase, thus the geographical area of Kolkata and adjoining area will be connected to the main pipeline post the completion of the third phase.

4.3 FSRU terminal at Digha

H-Energy East Coast Pvt Ltd (HEECPL), a subsidiary of H-Energy Pvt Ltd, is planning to set up a 4 million tonne per annum (mtpa) LNG FSRU project on India's eastern coast, offshore of Digha in West Bengal. The landfall point for R-LNG is likely to be at Petuaghat, Contai in West Bengal. The R-LNG will be transported from the FSRU to the onshore receiving facility at Contai through a 28-inch, 115-km sub-sea pipeline. The terminal is expected to be commissioned in the first quarter of 2019.

R-LNG will be evacuated through the proposed Contai-Paradip-Duttapulia pipeline and GAIL's Jagdishpur-Haldia pipeline (connectivity to any other proposed trunk pipeline in the vicinity may be considered). PNGRB has invited expressions of interest for laying of the Contai-Paradip-Duttapulia pipeline. However, as per our analysis LNG will be available post commissioning of the FSRU and the pipelines which require another 3 years. The figure below shows the indicative route map of the pipeline:

Figure 4: Route map of Contai-Paradip-Dattapulia natural gas pipeline



4.4 CBM from Essar's Raniganj block

Essar Oil is the largest producer of CBM gas in India, and is producing close to 0.7 mmscmd of CBM from its Raniganj block. The company holds a 100% participating interest in the block, which covers an area of 500 sq km. The estimated reserves in the block, as ascertained by Swell and Associates, are 113 billion cubic feet (bcf) or 18.8 million barrels of oil equivalent.

Essar Oil received phase III environmental clearance for the block in 2013, which allowed the company full field development, excluding forest areas. Phase III clearance will allow Essar Oil to achieve planned peak production in the next few years, which is projected to be 2.5-3.0 mmscmd.

Table 9: Key operational highlights of Raniganj block

Parameter	Highlight
Area of the block	500 sq km
Wells drilled	120 producing wells; drilling of 142 additional wells are at various stages of completion
Total drilling programme	650 wells
Current production	0.7 mmscmd; will be ramped up to 1.2 mmscmd in the next few months
Planned peak production	3.0-3.2 mmscmd
Customer tie-ups	Local industrial units in the area; 20-year gas supply contract of 1.2 mmscmd to be ramped up to 2.5 mmscmd with Matix Fertilizers located in Panagarh, West Bengal

Source: Essar Oil

Our analysis of gas availability from the block reveals that Essar Oil has already entered into long term gas contracts with industrial consumers. The company has also entered into a 20-year gas contract with Matix Fertilizers and Chemicals for 1.2 mmscmd of CBM, which will be ramped up to 2.5 mmscmd.

Matix Fertilizers is building a 3 mmtpa Greenfield fertiliser complex in Pangarh, West Bengal. The plant is a one of a kind as it will be relying entirely on CBM gas sourced from Essar's Raniganj block.

Thus, as per our analysis, there is an availability of close to 0.5 mmscmd of CBM gas from Essar Oil's Raniganj block, and can be seen as a long term sourcing option by GSCGCL. However, laying of pipeline from the gas source to the CGS landfall would be required, for which the CAPEX and timelines will be approximately same as mentioned above for the gas sourcing options from GEECL CBM gas blocks.

4.5 RLNG from Petronet LNG Ltd.

Petronet LNG Ltd. (PLL) operates two RLNG terminals at Dahej and Kochi. While the Dahej terminal operates at more than 100% of its capacity of 10 MMTPA, the recently commissioned Kochi terminal of 5 MMTPA capacity is running at very low utilization rates of around 2-3%. This is due to a lack of pipeline connectivity of the RLNG terminal with demand centers across the country. In order to increase utilization of its Kochi terminal, PLL is planning to move LNG via small ships and barges to locations where there is a demand for natural gas. One such location identified location is the Haldia port from where RLNG can be transported to demand centers in the eastern parts of India.

In case of long term available demand, PLL plans to setup a small regasification facility at the Haldia port along with storage tanks of 1000 m3 capacity. LNG will be transported from the Kochi terminal via small ships and barges to Haldia and regassified LNG will be stored on the port in storage tanks. The stored gas will be taken to the CGD network via a natural gas pipeline, which will have to be constructed. PLL plans to create infrastructure for such an arrangement only if there is a long term contract of more than 10 years is made between the interested parties.

4.6 Gas availability timelines and estimated volumes

Source	Expected availability from	Estimated available volumes
Jagdishpur Haldia pipeline	2019-20	More than 4 mmscmd
GEECL Raniganj south block	2018	0.4 mmscmd
Essar Raniganj block	2017	0.5 mmscmd
H-Energy FSRU at Digha	Q1 2019	More than 4 mmscmd
RLNG from PLL	2018	1-1.5 mmscmd in short term

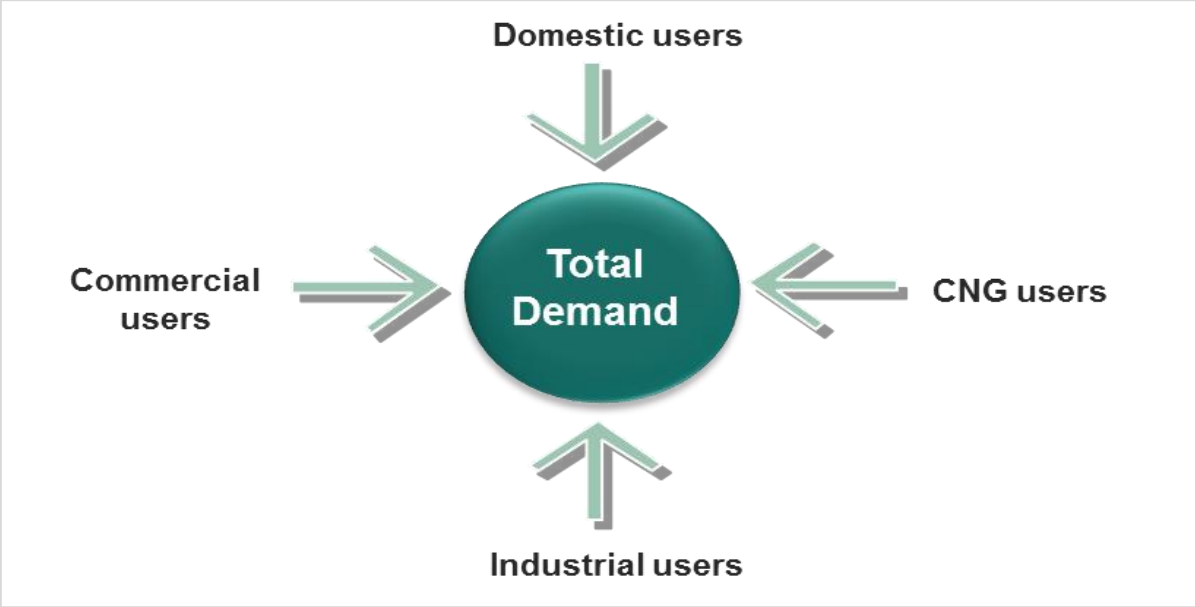
Source: CRIS analysis

5. Approach for demand estimation

5.1 Demand Assessment for CGD networks

The demand has been estimated for the charge areas within the Kolkata geographical area for the four customer segments namely domestic, CNG, commercial and industrial segments.

Figure 5: Demand Estimation-End user segments



Source: CRIS analysis

The total demand potential for any natural gas consumer segment has been understood in terms of the following three levels of demand.

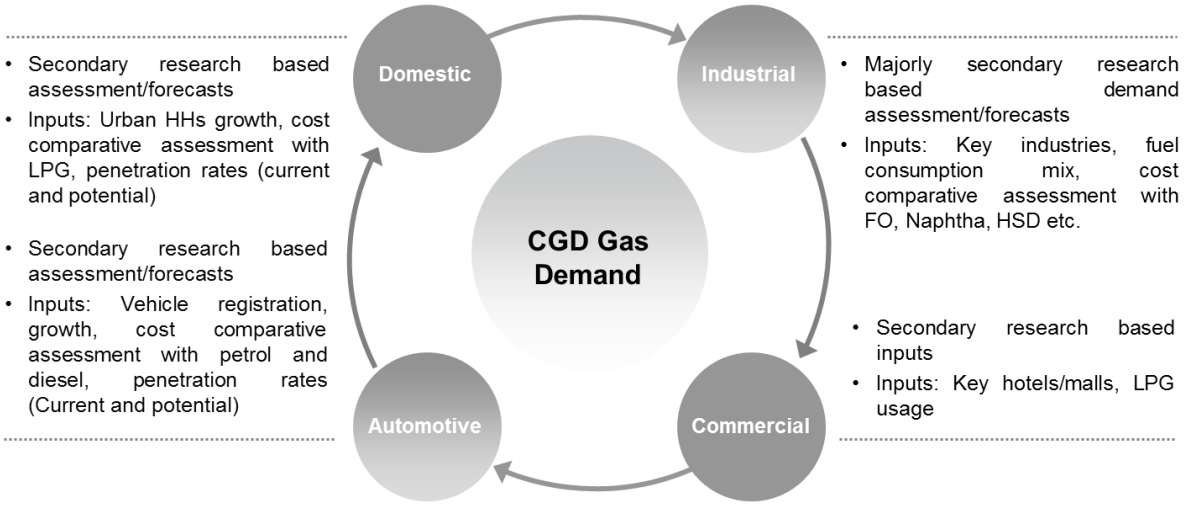
Table 10: Different levels of demand for a user segment

Demand Type	Description
Demand Potential	The overall demand potential that a customer segment holds
Realizable Demand	The demand that can be actually achieved after taking into consideration all the constraints such as geographical terrain, non- willingness of end-consumers to convert.
Demand Penetration	The phasing of Realizable Demand on a year-on-year basis, to be catered by CGD

Source: CRIS analysis

Further, in order to arrive at the current demand estimates, secondary sources of information and CRIS's in-house coverage of Natural Gas Industry and key end-user industries have been relied upon. The overall approach for demand estimation for the four user segments has been depicted in the figure below.

Figure 6: Present demand estimation – Overall Approach



Source: CRIS analysis

For all the user segments, mainly secondary research has been used to arrive at the present demand estimation.

The estimated present demand for the end user segment has then been projected going forward taking into account the linkages of the end-use sector's demand with key macro-economic factors as well as the variations likely in the demand growth of each end-use sectors, alternate fuel pricing, policy movement, etc.

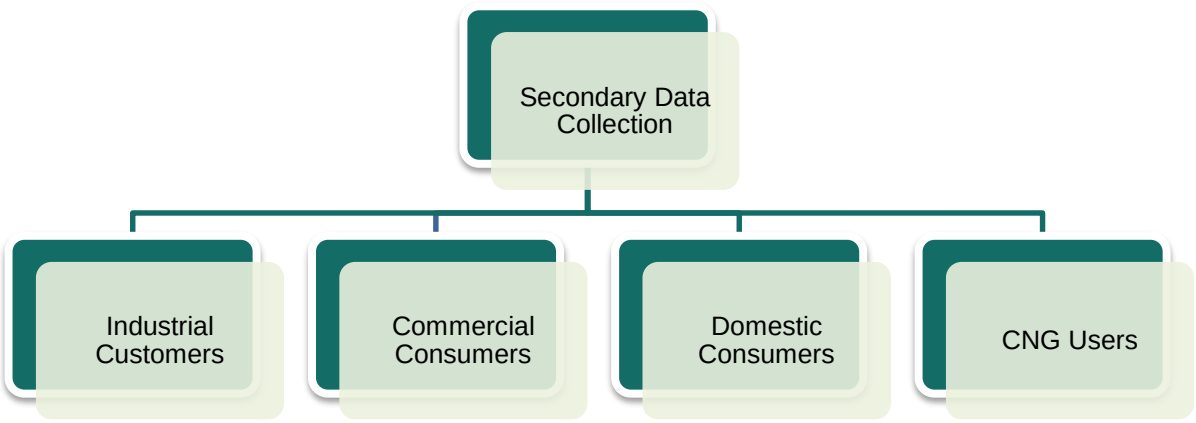
5.2 Research Methodology

The following approach has been adopted to assess the demand opportunity for the proposed CGD network in the target districts.

- For secondary research, key industry sources such as RTO, District Economic Survey, Census, and our internal databases developed over the last two decades have been relied upon.
- Major industrial and commercial areas have been identified and the type of liquid fuel consumed has been analysed.
- For domestic segment, secondary research has been carried out for estimating the monthly fuel consumption per household on a monthly basis.

The below schematic summarizes the overall approach for data collection that has been followed for estimation of current demand with the help of secondary research methodologies.

Figure 7: Approach for data collection for demand assessment



Source: CRIS analysis

5.3 Segment Wise Demand Assessment

The demand estimation methodology used for the different user segment has been described below.

5.3.1 Domestic segment

The demand arising out of the domestic user segment has been estimated following the methodology described below:

STEP 1: Obtain the number of Households (Urban and Rural) for the charge areas (CA) constituting the geographical area (GA) as per the 2011 census.

The households (HH) population has been considered for demand estimation as against the overall population.

STEP 2: For first five years, targets as provided by PNGRB considered for demand estimation and later based on household conversion potential to natural gas

For the first five years, targets provided by PNGRB has been considered for demand estimation. After the first five years, the penetration and conversion potential has been taken in to account. Census presents data on households segregated into the Urban and Rural households. For the purpose of demand estimation the extent of LPG penetration has been considered to arrive at the realistic level of demand that can be captured through the process of replacement of LPG by natural gas. The remaining households are expected to be consuming other fuels like kerosene, wood etc. These households have a low probability of converting to natural gas and therefore have not been considered for the purpose of demand estimation.

A conversion factor has been considered for domestic demand estimation arising out of the Urban and Rural households owing to the possible replacement of LPG by Natural gas. 100% conversion of all the households consuming LPG to the usage of natural gas is not always practically possible given the

different factors like variations in the geographical terrain and the level of willingness of the users etc. Therefore, the number of approachable households has been estimated after considering the percentage of slums and also considering the safety factor for the laying of the pipelines in the GA.

STEP 3: Compute per Household demand based on average cylinder consumption per Household.

Based on our understanding of the GA and prior sector experience and based on the consumption pattern of cooking gas consumption in households average gas consumption per household has been estimated and used for estimation of natural gas demand for households.

STEP 4: Estimate the Realizable Natural gas demand emerging out of the households going forward considering suitable penetration rates

Future natural gas demand potential for various Charge Areas has been estimated by applying the average gas consumption per household to the number of eligible households considered for demand estimation going forward. This demand has been projected for the next 25 years applying the historical population growth rate in the state to the number of households considered for demand estimation and considering appropriate penetration rates in order to arrive at the realizable natural gas demand from the domestic user segment. For arriving at the appropriate penetration rate, we have considered the PNGRB prescribed limits for the initial 5 years. Thereafter a reasonable penetration rate has been assumed considering our understanding of the GA

5.3.2 Commercial Segment

The demand arising out of the commercial establishments has been estimated following the methodology described below:

STEP 1: Obtain alternate fuel consumption data

Alternate Fuel consumption data was collected for the commercial units covering the different charge areas. The fuel consumption details included the consumption levels of commercial LPG, HSD and LDO in various different types of commercial units.

STEP 2: Convert alternate fuel consumption into equivalent gas consumption

Natural gas demand potential has been established based on the alternate fuel consumption for various commercial units. The consumption of HSD and LDO has not been converted to NG equivalent demand as HSD and LDO are used typically used for Power Generator sets; which are back-up units and hence not operational 24 hrs. Similarly the consumption of solid fuels like wood etc. has not been converted to NG equivalent demand as the fuel is considerably cheaper than NG. The economics of converting such units to NG is not very encouraging and therefore the probability of such conversions is quite low.

STEP 3: Extrapolate the demand in order to account for the demand arising out of the commercial units

The natural gas demand arrived at in step 2 for the commercial units using the alternate fuel consumption data has been further extrapolated to consider the possible natural gas demand for the commercial units present in the GA. As targeting this entire demand is not expected to be practically possible due to factors like lack of willingness to convert on the part of some users or difficult geographical terrain etc., the realizable demand has been estimated considering appropriate penetration rates. The penetration rates have been arrived at based on the data for consumption norms

and conversion percentage of commercial sector for various locations. For projecting demand, year wise penetration rates have been estimated based on conversion and penetration percentage and demand has been estimated over the period of twenty five years.

5.3.3 CNG User segment

The demand arising out of the CNG user segment has been estimated following the methodology described below:

STEP 1: Obtain vehicle (by type) data for all the target district

The district level data (available from RTO) was obtained for the number of motor vehicles within different categories like 3-Wheelers, Taxis, Buses, Private vehicles (Cars).

STEP 2: Estimate percentages for maximum conversions possible under different categories of vehicles.

Auto Rickshaw (3-wheeler) and Buses usually convert to natural gas in cases where Govt. mandates all public vehicles to convert to CNG once it is available. However the conversion for the Buses and 3-Wheeler segment has not been considered at 100% because even in the presence of a Govt. mandate, some vehicles (typically ~30%) may not convert due to the absence of CNG stations on the routes at which they run.

Typically the average kilometers covered per day by the Taxis and Pvt. Vehicles is lesser than the Auto Rickshaw (3-wheeler) and Buses. This results in a better economics for the Auto Rickshaw (3-wheeler) and Buses with respect to the usage of CNG. Therefore the maximum possible conversion level for taxis and Pvt. Vehicles is usually significantly lower than that for the Auto Rickshaw (3-wheeler) and Buses.

STEP 3: Estimate the per day gas consumption of each category of vehicles

Based on the industry standards assumptions with respect to average gas consumption, mileage, average run per day for each vehicle segment have been taken.

STEP 4: Project future demand based on growth rate of future vehicle population

Future demand has been projected for the next 25 years assuming a growth rate that is in line with the historical growth rate in the number of motor vehicles in Kolkata GA.

5.3.4 Industrial Segment

The demand arising out of the Industrial units has been estimated following the methodology described below:

STEP 1: Establish demand based on alternate fuel consumption in the Charge Areas

Most of the Industrial units today consume fuels like Furnace Oil, LSHS, Naphtha, HSD, LDO and Pet-coke. They have an incentive in replacing these fuels completely or partially by natural gas due to economic/environmental reasons and convenience. This makes all the industrial units consuming alternate fuels (liquid), a potential consumer of natural gas supplied through the CGD network. The demand for the alternate fuels among industries within the geographical area has been established with the help of the alternate fuel Consumption Data collected.

STEP 2: Convert alternate fuel consumption into equivalent gas consumption.

The alternate fuel consumption has been converted into equivalent gas consumption based on the possible conversion of industries from Alternate fuel to Natural Gas.

STEP 3: Extrapolate the demand in order to account for the demand arising out of the industrial units

The natural gas demand arrived at in step 2 for the industrial units using the alternate fuel consumption data has been further extrapolated to consider the possible natural gas demand for the industrial units present in the GA. As targeting this entire demand is not expected to be practically possible due to factors like lack of willingness to convert on the part of some users or difficult geographical terrain etc., the realizable demand has been considered taking into account a penetration ceiling of the total demand potential estimated for the GA.

6. Demand summary

Kolkata is the third most populous city in the country, after Delhi and Mumbai. Considering the rapid growth of the city, the demand for natural gas is expected to accelerate with the advent of natural gas distribution in the region. PNGRB has authorised GCGSCL to establish a CGD network in Kolkata and five adjoining districts: Howrah, Hooghly, Nadia, South 24-Parganas and North 24-Parganas.

Natural gas demand for the authorised area (geographical area) has been estimated considering the four consumer segments – industrial, domestic, commercial and transport. The minimum work programme prescribed by PNGRB for first five years has been taken into consideration while estimating the natural gas demand for the domestic market.

6.1 Industrial segment - Overview and demand

Kolkata and its adjoining districts like Tangra, Kasba, Khidderpor, Ultadanga, Maniktala and Taratala have a healthy presence of multiple industries manufacturing textiles, glass, ships, rail locomotives, industrial furnaces, leather, cotton yarn, oxygen gas, chemicals, etc.

The region houses several small and medium-scale industries and some major industries that manufacture electrical and engineering products. The below shows the list of key industries located in the region.

Table 11: Companies located in the geographical area

Sr. no.	Company name
1	Garden Reach Ship Builders', Garden Reach, Kolkata
2	India Tobacco Co Ltd, Garden Reach, Kolkata
3	Paharpur Cooling Towers Ltd, Garden Reach, Kolkata
4	General Electricals Co Ltd, 10 Paharpur, Kolkata
5	India Foils Ltd, Taratala, Kolkata
6	Hindusthan Development Corpn Ltd, Tiljala, Kolkata
7	Kilburn Engg Co Ltd, Majherhat, Kolkata
8	Siel Hardmetal Ltd, Behala, Kolkata
9	Indian Oxygen Ltd, Taratala, Kolkata
10	Williamson Magor Ltd, Majherhat, Kolkata
11	Modern Bread Industry Ltd, Taratala, Kolkata
12	Eveready Battery, Taratala, Kolkata
13	Britannia Industries Ltd, Hide Road, Kolkata
14	Balmer Lawrie & Co Ltd, Hide Road, Kolkata
15	Calcutta Chemical Co Ltd, Bandel Road, Kolkata
16	Boroline Industries, Chiriamore, Kolkata
17	Usha Fan Industries Ltd, Bansdroni, Kolkata
18	Bharat Brakes & Valves, S. M. Avenue, Kolkata
19	Rescon India (P) Ltd, Behala, Kolkata
20	Hindustan Unilever Ltd., Garden Reach, Kolkata

Sr. no.	Company name
21	Polar Fan Industry Ltd, Behala, Kolkata
22	Central Inland Water Transport Corpn, Dock Yard Road, Kolkata
23	British Engg Pumps Ltd, Taratala, Kolkata
24	Bharat Process & Mechanical Engg, Ultadanga, Kolkata
25	Greaves Foseco Ltd, Taratala, Kolkata
26	HM Biscuits Industries
27	Gitanjali Gems Ltd

Source: DIC

In addition, the region has MSME clusters manufacturing a wide range of products - metal and engineering, jute, hosiery, readymade garments, leather, gems and jewellery, drugs and pharmaceutical, cosmetic, petrochemical, plastic, handloom, handicraft and marine products.

Table 12: Major MSME industrial clusters in the geographical area

City	Industrial cluster/area
Kolkata	Fan manufacturing, leather (Topsia)
Howrah	Re-rolling mill (Jagatballavpur), foundry (Amta), metal spare parts (Bargachhia)
Nadia	Gold & silver ornaments (Ranaghat), brass & bell metal (Nakashipara),
North 24 Parganas	Leather shoe and chappal (Bamangachhi), surgical bandage gauge (Basirhat), bamboo products (Baduria),
South 24 Parganas	Zari embroidery (Budge Budge), silver filigree (Mograhat), surgical instruments (Baruipur)
Hooghly	Agro based industries, cotton textile, jute, chemicals and electrical and transport equipment manufacturing units

Source: CRIS analysis

Table 13: Major medium and small-scale industrial clusters in the geographical area

Industrial area	Highlights	Industry types
Garden Reach / Taratala	Large industries like Garden Reach Shipbuilders and factories of ITC Ltd and Britannia are located in this belt. Being located right in the city, it is well connected.	FMCG products, engineering, cooling towers, shipbuilding
Jalan Complex / Bamungachi	Some of the prominent companies in the area include Skipper Steels Ltd, Jindal India Ltd, Hindalco Industries Ltd and Larsen & Toubro. Being located in Howrah municipality, the area is well connected through National Highway No. 2 & 5.	Forging, casting, steel fabrication, construction, pressure die casting, aluminium products

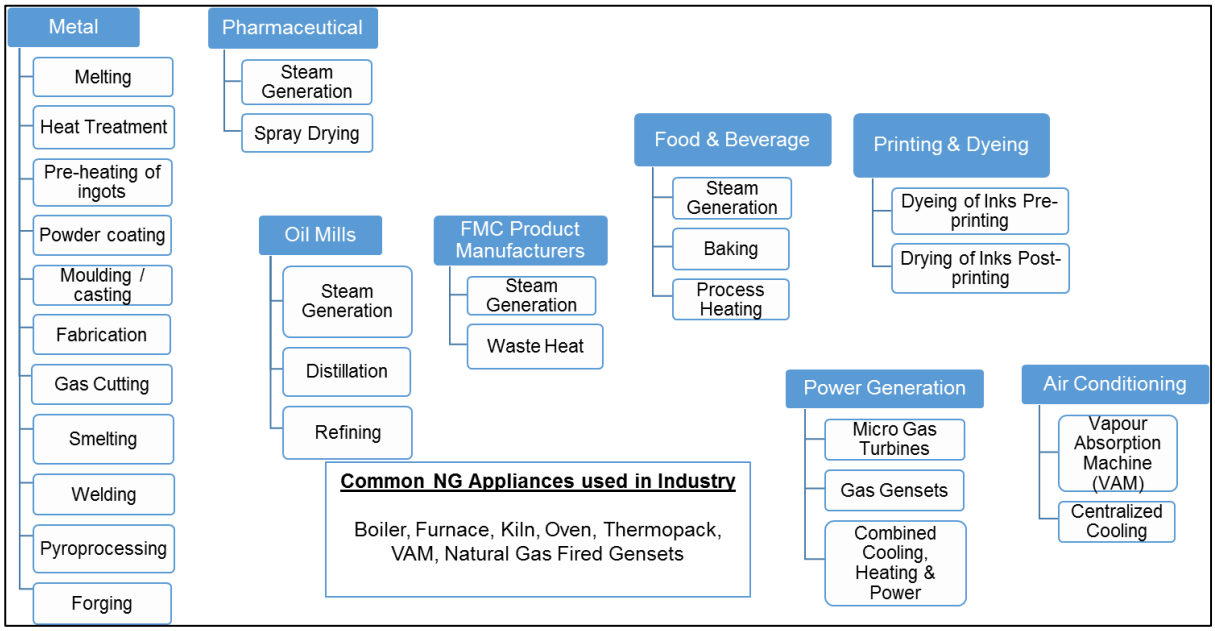
Industrial area	Highlights	Industry types
Rishra / Singur	Jayshree Textiles has a large factory in this area. Some other names are Himadri Chemicals Ltd and Tribeni Tissues. HNGIL has a fairly large glass manufacturing factory at Rishra. This area also houses 6-7 jute mills and some downstream units of HPL.	Textiles, paper, glass manufacturing, petroleum products, flour mills, chemical products
Barrackpore / Shyamnagar	There are around 63 electronic units in Salt Lake Electronics Complex. Some well-known names are Andrew Yule & Co, Stone India Ltd, PepsiCo, Nicco, and RPG Enterprises (power generation plant at Titagarh).	Power generation, beverage, cable manufacturing, rubber & plastic products, downstream processing industries for oil & gas and engineered products
Pailan / Noorpur	Bantala has is a large belt of tanneries & leather product manufacturing industries. Some prominent names are Gontermann-Peipers India Ltd and Kohinoor Paper & Newsprint Ltd.	Paper, jute, leather goods, pipe manufacturing
Kalyani	Some reputed companies in the area include Indian Oil Corporation Ltd, Allenbarry Industrial Oxygen Gas, Andrew Yule & Co and Dabur. Kalyani is well connected by rail & road.	Textiles, industrial gas, breweries, spinning mills, chemicals, electrical goods

Source: DIC

6.1.1 Primary usage of natural gas in industries

Natural gas is mainly used in industries for heating, cooling, power generation, processing and manufacturing. Some other application areas are shown in the figure below.

Table 14: Natural gas usage in industries



Source: CRIS analysis

Some benefits of natural gas usage across the consumer segments are:

- Uninterrupted supply through pipelines without any storage issues
- One of the safest fuels due to its narrow flammability range. The mixture of natural gas and air does not ignite if the mixture is leaner than 5% and richer than 15% of the air-fuel ratio required for ignition.
- A versatile fuel with multiple applications - domestic and commercial. It can be used as a cooking fuel, for water heating, space heating, air conditioning, etc.
- One of the cleanest burning fossil fuels. Natural gas combustion results in virtually no atmospheric emissions of sulphur dioxide, and far lower emissions of carbon monoxide, reactive hydrocarbons and carbon dioxide (CO^2), than other fossil fuels. Natural gas (per scf) has an emission factor of 53.06 kg CO^2/mmBtu compared with LPG at 61.71 kg CO^2/mmBtu, naphtha at 68.02 kg CO^2/mmBtu, residual fuel oil at 72.93 kg CO^2/mmBtu and kerosene at 75.20 kg CO^2/mmBtu.
- No spillage and pilferage. In case of piped natural gas (PNG), these losses are invariably done away with, for it is supplied through pipes.

6.1.2 Demand analysis

Natural gas is primarily used as a fuel for heating purpose and can replace alternate fuels - solid or liquid. However, for analysis of natural gas demand from the industrial segment, only liquid fuel consumption across industries in the region is considered.

The following table provides the consumption pattern of petroleum products by Industrial units:

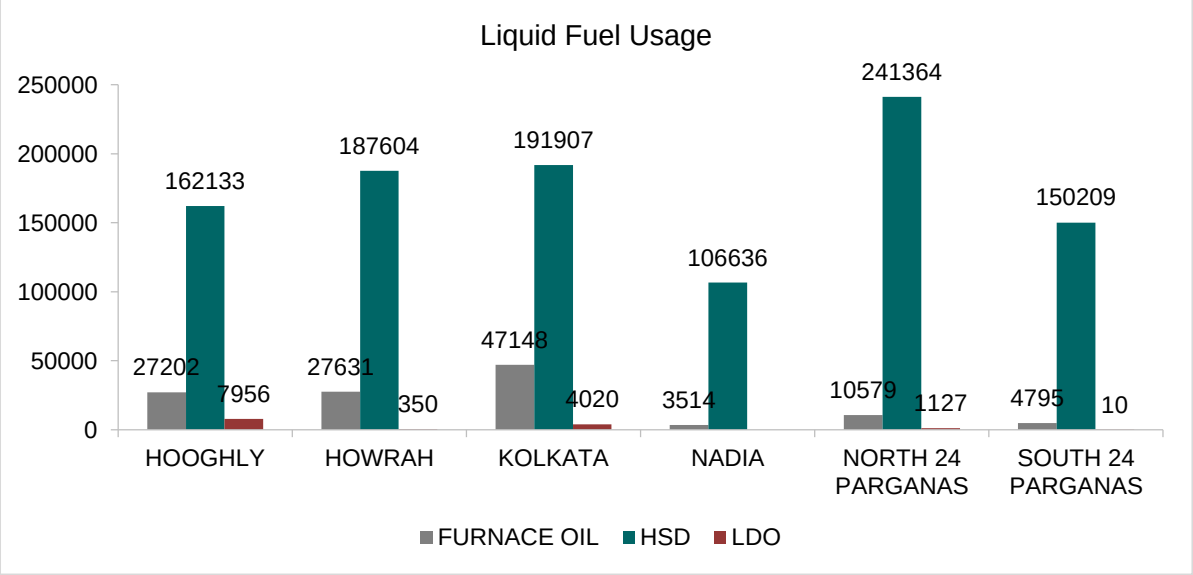
Table 15 Industry Units – Alternate Fuel Consumption

Industry Type	Fuel Usage	Remarks
Agro Processing	Coal/Coke/Lignite SKO; Electricity	Coal/Coke Lignite is used for boiler.
Food Processing	LPG; LDO; FO/LSHS; Husk/Wood; Electricity; HSD	LDO is used for boiler and Furnace. FO/LSHS is used for boilers and other appliances. HSD is used for boiler
Automobile Parts	HSD; LPG Electricity; LDO	HSD is used for boiler and oven. LDO is used for furnace. LPG is used for oven and furnace.
Electrical & Electronics	Electricity; FO/LSHS HSD; SKO; LDO Electricity	Electricity is used to power other appliances while FO/LSHS is used mainly for boilers. LDO is used for boiler.
Ceramics	FO/LSHS; LDO LPG; Electricity	FO/LSHS is mainly used for the boilers. LDO too is used for boiler. LPG is used for oven. Electricity is used for other appliances.
Plastics	FO/LSHS	FO/LSHS is mainly used for the boilers.
Paper & Paper Based Products	Electricity; HSD; LDO	HSD and LDO are used for boiler.
Cement	Electricity Coal/Coke/Lignite	Coal/coke/lignite is used for furnace.
Rubber	LDO; Electricity LPG; HSD	The usage of LDO is for boilers while electricity is used for other appliances. LPG and HSD are used for oven.
Chemicals	LDO; LPG; FO/LSHS Electricity;HSD	LDO is used for boilers and LPG for ovens. FO/LSHS is used for oven. HSD is used for oven.
Pharmaceuticals	LDO; HSD	HSD and LDO are mainly used for the boilers.
Cotton Yarn- Spinning	Electricity	
Cold Storage	FO/LSHS; HSD Electricity	FO/LSHS is used for boiler.
Steel	LPG; Electricity HSD; Coal/Coke/Lignite	HSD is used for boiler. Coal/Coke/Lignite is used for furnace and oven.
Sponge Iron Units	FO/LSHS; Electricity	FO/LSHS is used for boiler and furnace.
Engineering/ Fabrication	LPG; FO/LSHS HSD; Electricity Coal/Coke/Lignite LDO; LPG	FO/LSHS, Coal/Coke/Lignite, LDO and LPG and HSD are used for boilers. HSD and LPG is also used for oven. FO/LSHS and LDO are used for furnace.
Wood and Wood Based	Electricity; LDO	Electricity is used to power other appliances in this industry while LDO uses furnaces.

Source: Secondary research & Data from other informal sources

The district wise usage of liquid fuel is given in figure below:

Figure 8: Liquid fuel usage pattern in the geographical area in MT



Source: CRIS analysis

- In the GA, consumption of HSD is the maximum, followed by furnace oil and LDO in industries for liquid fuels. Based on our analysis close to 7%, 50% and 85%, of HSD, furnace oil and LDO respectively is used in industries as a source of fuel, the rest of it is used for other than industrial consumption purposes.
- The average penetration percentage across industries has been considered at close to 50%, for the entire 25-year projection period. Penetration percentage has been kept at a moderate level of 50% because, as many industries in and around Kolkata rely on coal as a source of fuel and may not find it economical to convert to natural gas due to cheaper coal prices.
- Petroleum products (POL) – Industries growth rate has been considered at 5% to arrive at the demand potential from the industrial segment.

The following table presents the base case demand from the industrial segment in the geographical area.

Table 16: Base case industrial demand in '000 scmd

Industrial demand	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 10	Yr 15	Yr 20	Yr 25
	25	39	55	72	91	218	413	687	893

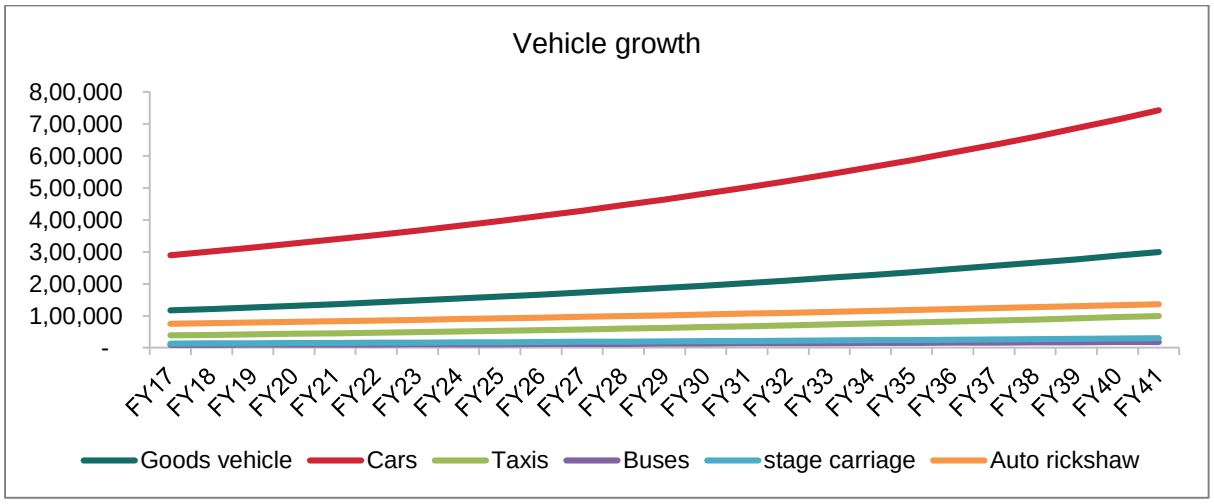
The overall demand from the industrial segment over the 25-year period would be approximately 0.89 mmscmd, which is around 23% of the entire demand from the geographical area. The gas demand is expected to reach 91,000 standard cubic metres per day (scmd) by the fifth year. With the expansion of network and availability of natural gas, the demand is expected to surge by 140% and reach 218,000 scmd by the end of the 10th year and 893,000 scmd at the end of the 25th year

6.2 Transport segment - Overview and demand

In a 2013 survey conducted by the International Association of Public Transport, Kolkata stood first among the six cities surveyed in India, in terms of public transport system. In the geographical area, buses are the most commonly used mode of transport and are run by government agencies and private operators. Other public conveyances include auto rickshaws and metered taxis. In addition, there are contract / commercial carriages. Despite abundant presence of public transportation, privately owned vehicles are common in Kolkata. The city's main bus terminals are located at Esplanade, Karunamoyee and Babughat. Kalyani, Barrackpore, Baruipur / Sonarpur, etc, are some of the main transport hubs.

Based on the historical trend of the growth in these vehicles, the gas demand from the transport segment in the geographical area can be projected.

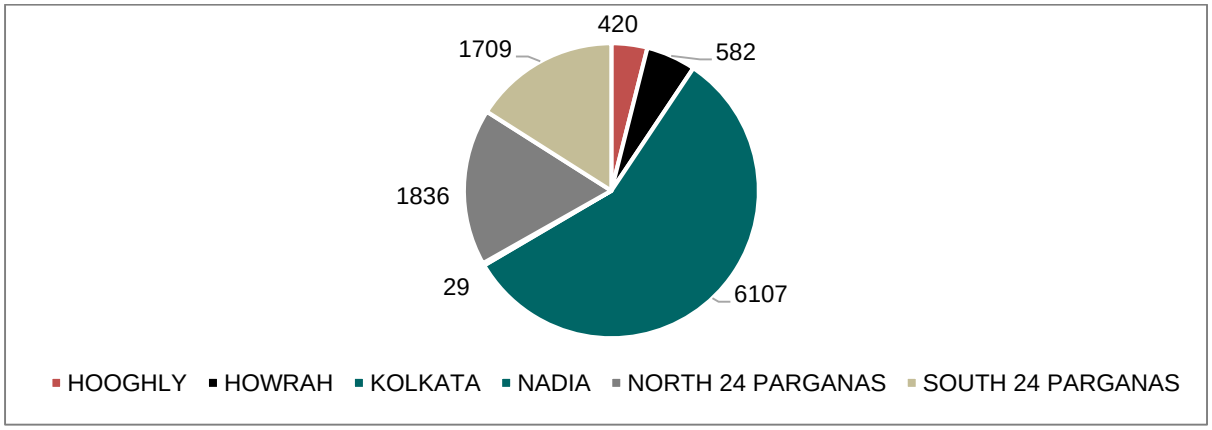
Figure 9: Vehicle growth trend in the geographical area



Source: Transport department, Kolkata, CRIS analysis

The graph shows a steady growth pattern for buses/mini buses and stage carriages. There is a minor increase in the number of auto rickshaws and taxis, these being more personalised versions of public transport. Private vehicles show a promising growth through the entire period, which indicates good prospects for CNG conversion.

Figure 10: LPG usage in in auto rickshaws in the 6 districts in MT



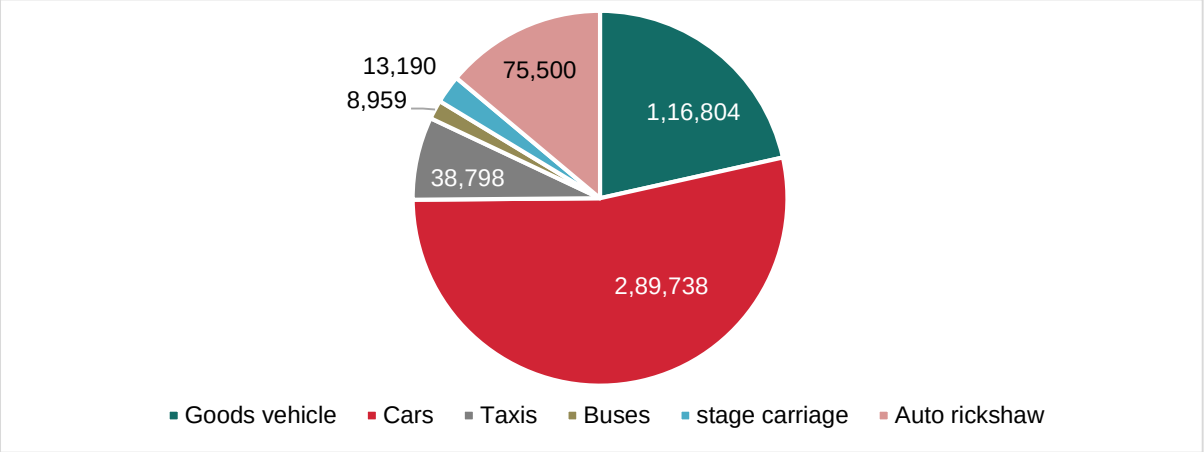
Source: CRIS analysis

Conversion to CNG can be achieved through retrofitting or OEMs. Petrol driven cars can be retrofitted with CNG kits, while diesel driven vehicles requires modifications in the car engine. Once CNG stations are set up, authorised workshops can be set up for retrofitting. Subsequently, vehicle manufacturers such as Maruti, Hyundai, Tata, Mahindra, Eicher and Ashok Leyland will start promoting OEM fitted CNG vehicles.

Options for fuel switch in petrol or diesel variants will have to be explored once retrofitters and OEMs establish their base in the geographical area. There are several areas such as Salt lake, Moulali, Minto Park, Dunlop Bridge, Lal Bazar, Cossipore, Behala Chowrasta, Kasba with very high vehicle density and exceeding permissible air pollutant levels are (as per CSE report, 2010): Thus, for a better air quality index there will be efforts on part of government to promote cleaner fuel in the way of CNG.

Similar to Kolkata, Howrah district has a multimodal transport system. Road-based mass and para transport services are most suitable for the daily urban and rural passenger movement. Apart from personalised vehicles and taxies, bus is the only mode for mass transport on Rabindra Setu and Vidyasagar Setu (bridges) connecting Howrah with Kolkata. Trekker services are prevalent in Udaynarayanpur, Bagnan and Shyampur, where bus services are infrequent. Auto rickshaws dominate the short distance movement in urban areas and in the core city of Howrah. Majority of the autos ply in the Howrah and Bally municipalities.

Figure 11: Distribution of vehicles in Kolkata district



Source: Transport department

6.2.1 Demand analysis

The following aspects of the transport segment of the entire geographical area are taken into consideration, based on the current and projected scenario:

- Vehicles growth rates have been considered year wise based on historical data sets, and vehicle growth rates in metros
- Average daily consumption for autos, private buses, private cars and taxis have been considered as 3.5, 51, 4 and 6 scmd respectively.
- For each of the vehicle segment a year wise penetration which is the percentage of vehicles in that category which have converted to CNG.

Table 17: Penetration rates in vehicles

Vehicles	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 10	Yr 15	Yr 20	Yr 25
Autos	2%	7%	15%	20%	30%	50%	50%	50%	50%
Taxis	3%	10%	25%	40%	60%	60%	60%	60%	60%
Cars	3%	8%	15%	20%	25%	25%	25%	25%	25%
Buses	2%	5%	10%	12%	15%	15%	15%	15%	15%

The overall gas demand from the transport segment generated over the 25-year period would be approximately 1.6 mmscmd, which is around 39% of the entire demand from the geographical area. The transport segment with most potential segment in the geographical area. The propensity to convert from liquid fuels like motor spirit is significantly high in the auto segment. The fuel economics is a major factor for retro fitment of CNG vehicles.

The table below shows the demand build-up over 25 years from the transport segment.

Table 18: Base case demand from transport segment in '000 scmd

Transport demand	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 10	Yr 15	Yr 20	Yr 25
	58	169	354	496	502	912	1089	1303	1559

Source: CRIS analysis

6.2.2 Benefits of using CNG

CNG is a fossil fuel substitute for other transportation fuels such as petrol, diesel and auto LPG. CNG is natural gas that compressed and dispensed to vehicles usually at a high pressure of 200 bar, to enhance the vehicle on-board storage capacity.

Table 19: Benefits of using CNG

Economical & lower operational cost	▪ It is easier on the pocket. ▪ The operational cost of vehicles running on CNG, compared with those running on other fuels, is significantly low. ▪ CNG does not contaminate or dilute crankcase oil, thereby increasing the life of lubricating oils and the engine.
Eco-friendly	▪ The use of CNG significantly reduces harmful vehicular exhaust gas emissions like carbon dioxide, carbon monoxide and other suspended particles. ▪ It has a lower emission factor and protects the environment by reducing the effects of global warming. ▪ Absence of lead or benzene in CNG eliminates the chances of lead fouling of spark plugs, and lead or benzene pollution.
Safe	▪ CNG is less likely to autoignite on hot surfaces, since it has a high autoignition temperature (540 degrees centigrade) and a narrow flammability range (5%-15%) It means that if CNG concentration in the air is below 5% or above 15%, it will not burn. This high ignition temperature and limited flammability range makes accidental ignition or combustion very unlikely.

6.3 Domestic segment - Overview and demand

The natural gas demand from the domestic segment is mainly for domestic cooking and heating purposes. LPG penetration is Kolkata and adjoining areas is lower compared with other metros. One reason for lower LPG penetration can be poor accessibility of LPG, i.e., lower number of distributors. With the introduction of PNG in the area, PNG demand is expected to increase exponentially, as PNG is comparatively safe and hassle free compared with LPG.

As per our analysis, the areas with higher population density in Kolkata are Alipore, Kalghat, Salt Lake, Tallygunge, Khidirpur, Dhakuria Ultadanga, Bhawanipur, Maniktala and Beniapukur. The most populous areas with high rise buildings should be targeted first for domestic connections.

PNGRB frames the minimum work programme in terms of number of domestic connections for the initial five years from the date of issuance of licence for the respective geographical area. Thus, for deriving the natural gas demand from the domestic segment, the target numbers in the minimum work programme have been considered.

Table 20: Year-wise domestic connections planned

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 10	Yr 15	Yr 20	Yr 25
100000	300000	600000	1000000	1417959	1626928	1857524	2085746	2254443

Source: CRIS analysis

More than 14 lakh households will be given PNG connections over five years, supplying 0.70 mmscmd. The gas volume supplied to the domestic segment is expected to reach 1.10 mmscmd over 25 years. Thus, the domestic segment will contribute to 30% of the total demand of natural gas.

- 15 scm per month of natural gas consumption per household has been assumed for estimating the total demand from the domestic segment.

Table 21: Base case demand from domestic segment in '000 scmd

Domestic demand	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 10	Yr 15	Yr 20	Yr 25
	49	148	296	493	699	802	916	1029	1097

Source: CRIS analysis

6.4 Commercial segment - Overview and demand

Kolkata metropolitan region and its adjoining districts have several large shopping malls, hospitals and schools. Classification of key commercial units is given in table below:

Table 22: Commercial Units - Classification

Commercial Units Type		
Hotel & Lodging/Boarding	Restaurant	Offices
Hospital & Nursing Home	School & College hostel	Others
Bakery	Cinema Hall / Multiplex	
Temple / Shrine	Super Market / Store / Mall	

Source: CRIS Analysis

Some hotspots in the geographical area are Esplanade – Park Street – Park Circus belt, Shibpur – Mandirtala area, Chandannagar, Sector V, Diamond Harbour – Falta, and Kalyani.

- Commercial LPG is an alternative fuel for this segment, and with the availability of piped gas, the conversion of commercial establishments to PNG is significantly high. Table below shows the fuel consumption in commercial units.

Table 23 Commercial Units – Fuel Consumption

Establishment Type	Remarks
Hotels	LPG is used for gas stove; Coal/Coke/Lignite for Tandoors; LPG for Dominex
Restaurants	Other fuels are used for Stove; Coal/Coke/Lignite for Tandoor, LPG for gas stove

Source: Secondary research and Data from other informal sources

- The demand from the commercial segment is expected to reach 0.23 mmscmd by the end of 25 years. However, this demand is just 6% to the overall natural gas demand.

Table 24: Base case demand from commercial segment in '000 scmd

Commercial demand	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 10	Yr 15	Yr 20	Yr 25
	4	16	28	37	44	103	135	175	228

Source: CRIS analysis

6.5 Consolidated demand

In this section we have presented the consolidated demand from all four segments. We have also developed two more scenarios for analysis purpose, namely realistic and optimistic case. While the base case demand has been estimated on a conservative basis, realistic scenario gives a picture of the realizable demand from the GA. Optimistic case describes the case when all demand segments witness a higher growth rate than that which is presently envisaged.

We have also described in detail the assumptions made for arriving at base, realistic and optimistic case demand.

6.5.1 Base case demand

The following table summarizes the assumptions made for estimating demand from the base case:

Table 25: Assumptions for demand estimation for base case

Demand segment	Assumptions made
Transport	▪ Penetration rates in the 25th year ◆ For cars: 25% ◆ For taxis: 60% ◆ For Buses: 15% ◆ For Autos: 50%

Demand segment	Assumptions made
Industrial	For liquid fuels the conversion potential to natural gas considered for analysis are: ▪ Furnace oil: 50% ▪ Diesel: 7% ▪ Light diesel oil: 85% Penetration rates considered in the districts in the 25th year: ▪ Kolkata: 53% ▪ Hooghly: 50% ▪ Howrah: 50% ▪ Nadia: 50% ▪ North 24 Parganas: 50% ▪ South 24 Parganas: 53%
Domestic	▪ PNGRB targets considered for household connection in first 5 years ▪ Per household consumption considered at 15 SCM per month ▪ 40% of total households to be connected at the end of 25th year
Commercial	▪ Conversion potential to natural gas for packed LPG considered at 10% ▪ Penetration rates considered at 80% in all the districts in the 25th year.

Source: CRIS analysis

The total demand from all four segments for base case for the geographical area is given in the table below.

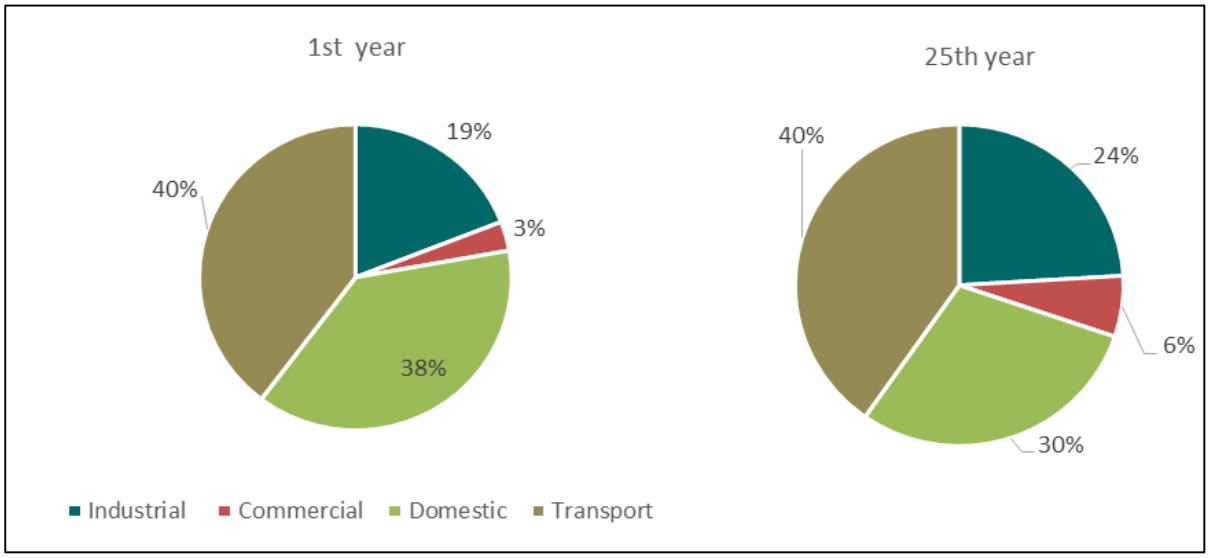
Table 26: Segment-wise base case demand in '000 scmd

	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 10	Yr 15	Yr 20	Yr 25
Domestic	49	148	296	493	699	802	916	1029	1097
Transport	58	169	354	496	502	912	1089	1303	1559
Industrial	25	39	55	72	91	218	413	687	893
Commercial	4	16	28	37	44	103	135	175	228
Total	**136**	**372**	**733**	**1104**	**1530**	**2036**	**2553**	**3193**	**3777**

Source: CRIS analysis

The figure below shows the percentage demand from each segment at the end of 25th year

Figure 12: Percentage demand from each segment in 1st year and at the end of 25th year



Source: CRIS analysis

As can be seen from the above figure, ~ 40% demand comes from the transport segment at the end of 25th year followed by the domestic segment at 30% and industrial segment at 24% of the total gas demand

6.5.2 Realistic case demand

The following table summarizes the assumptions made for estimating demand from the realistic case:

Table 27: Assumptions for demand estimation for realistic case

Demand segment	Assumptions made
Transport	▪ Penetration rates in the 25th year ◆ For cars: 30% ◆ For taxis: 60% ◆ For Buses: 25% ◆ For Autos: 55%
Industrial	For liquid fuels the conversion potential to natural gas considered for analysis are: ▪ Furnace oil: 70% ▪ Diesel: 8% ▪ Light diesel oil: 85% Penetration rates considered in the districts in the 25th year: ▪ Kolkata: 53% ▪ Hooghly: 50% ▪ Howrah: 50% ▪ Nadia: 50%

Demand segment	Assumptions made
	▪ North 24 Parganas: 50% ▪ South 24 Parganas: 53%
Domestic	▪ PNGRB targets considered for household connection in first 5 years ▪ Per household consumption considered at 15 SCM per month ▪ 45% of total households to be connected at the end of 25th year
Commercial	▪ Conversion potential to natural gas for packed LPG considered at 10% ▪ Penetration rates considered at 80% in all the districts in the 25th year.

Source: CRIS analysis

In case of the realistic scenario, the total penetrated demand for natural gas from the geographical area is estimated to be 4,404,000 scmd at the end of the 25th year.

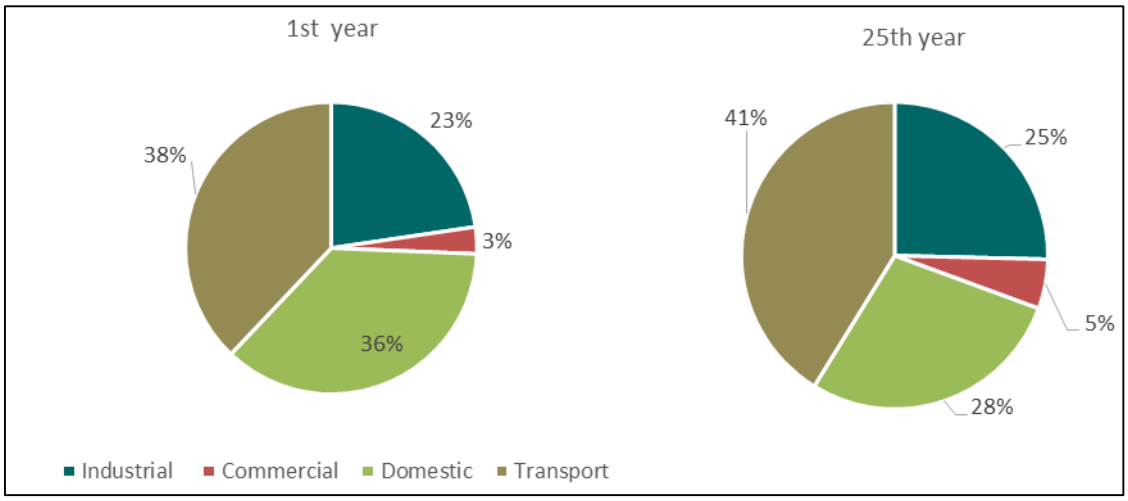
The following table presents the segment-wise demand from the geographical area over the economic life of the CGD network under the realistic scenario.

Table 28: Segment-wise realistic case demand '000 scmd

	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 10	Yr 15	Yr 20	Yr 25
Domestic	49	148	296	493	699	859	1036	1157	1234
Transport	58	169	354	502	696	1075	1283	1533	1832
Industrial	31	48	68	90	114	271	513	853	1110
Commercial	4	16	28	37	44	103	135	175	228
Total	**142**	**382**	**746**	**1122**	**1552**	**2308**	**2966**	**3718**	**4404**

Source: CRIS analysis

Figure 13: Percentage demand from each segment in 1st year and at the end of 25th year



Source: CRIS analysis

As can be seen from the above figure, ~ 41% demand comes from the transport segment at the end of 25th year followed by domestic segment at 28% & industrial segment at 25% of the total gas demand.

6.5.3 Optimistic case demand

The following table summarizes the assumptions made for estimating demand from the optimistic case:

Table 29: Assumptions for demand estimation for optimistic case

Demand segment	Assumptions made
Transport	▪ Penetration rates in the 25th year ◆ For cars: 30% ◆ For taxis: 60% ◆ For Buses: 28% ◆ For Autos: 60%
Industrial	For liquid fuels the conversion potential to natural gas considered for analysis are: ▪ Furnace oil: 90% ▪ Diesel: 9% ▪ Light diesel oil: 85% Penetration rates considered in the districts in the 25th year: ▪ Kolkata: 53% ▪ Hooghly: 50% ▪ Howrah: 50% ▪ Nadia: 50% ▪ North 24 Parganas: 50% ▪ South 24 Parganas: 53%
Domestic	▪ PNGRB targets considered for household connection in first 5 years ▪ Per household consumption considered at 15 SCM per month ▪ 56% of total households to be connected at the end of 25th year
Commercial	▪ Conversion potential to natural gas for packed LPG considered at 10% ▪ Penetration rates considered at 80% in all the districts in the 25th year.

Source: CRIS analysis

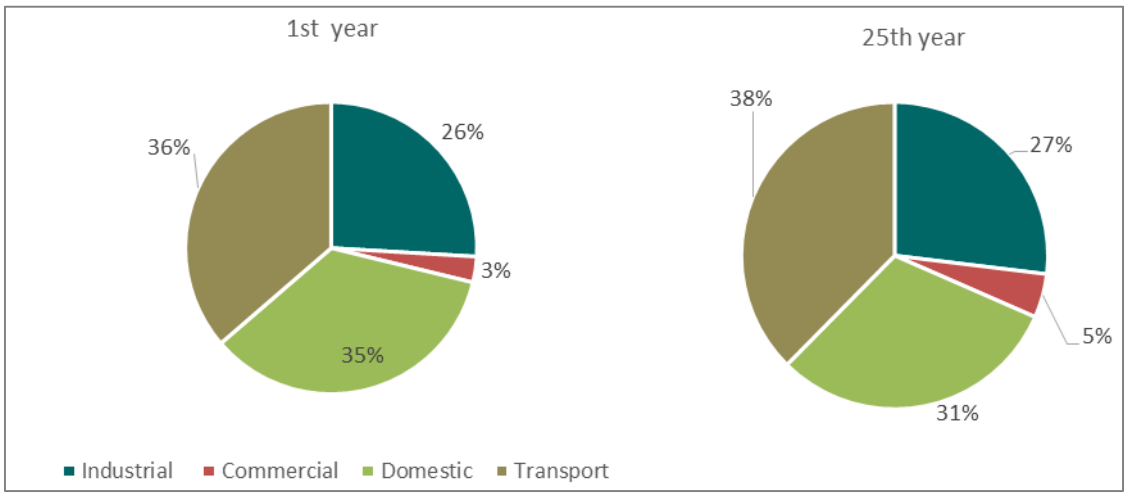
In case of the optimistic scenario, the total natural gas demand from the geographical area is estimated to be 4,929,000 scmd at the end of the 25th year. The following table summarises the segment-wise demand from the geographical area over the economic life of the CGD network under the optimistic scenario.

Table 30: Segment-wise optimistic case demand in '000 scmd

Segment	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 10	Yr 15	Yr 20	Yr 25
Domestic	49	148	296	493	699	915	1156	1425	1521
Transport	58	169	354	502	696	1075	1326	1582	1889
Industrial	37	58	81	107	136	324	613	1020	1327
Commercial	4	16	28	37	44	103	135	175	228
Total	**148**	**391**	**760**	**1139**	**1574**	**2417**	**3229**	**4203**	**4965**

Source: CRIS analysis

Figure 14: Percentage demand from each segment in 1st year and at the end of 25th year



Source: CRIS analysis

As can be seen from the above figure, ~ 38% demand comes from the transport segment at the end of 25th year

6.5.4 Demand for Capex estimation

For capex estimation and financial analysis, base case demand scenario has been considered, based on the following.

Table 31: Demand scenario

Sr. no.	Segment	Description
1.	Domestic	PNGRB domestic connection targets considered for first five years
2.	Transport	Demand estimates under the base case scenario considered
3.	Industrial	Base case scenario considered
4.	Commercial	Base case scenario considered

Segment-wise demand considered for capex estimation and financial analysis is presented in the following table.

Table 32: Demand considered for capex estimation and financial analysis in '000 scmd

Charge Area	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10	Year 15	Year 20	Yr 25
Domestic	49	148	296	493	699	802	916	1029	1097
Transport	58	169	354	496	502	912	1089	1303	1559
Industrial	25	39	55	72	91	218	413	687	893
Commercial	4	16	28	37	44	103	135	175	228
Total	**136**	**372**	**733**	**1104**	**1530**	**2036**	**2553**	**3193**	**3777**

Source: CRIS analysis

7. Design basis for the network

The CGD network has been designed in line with the regulations specified by PNGRB in G.S.R. 612 (E), “Technical standard and specifications including safety standard for city and local natural gas distribution network” and G.S.R. 750 (E) “Amendment to technical standards and specifications including safety standard for city of local NG distribution network”.

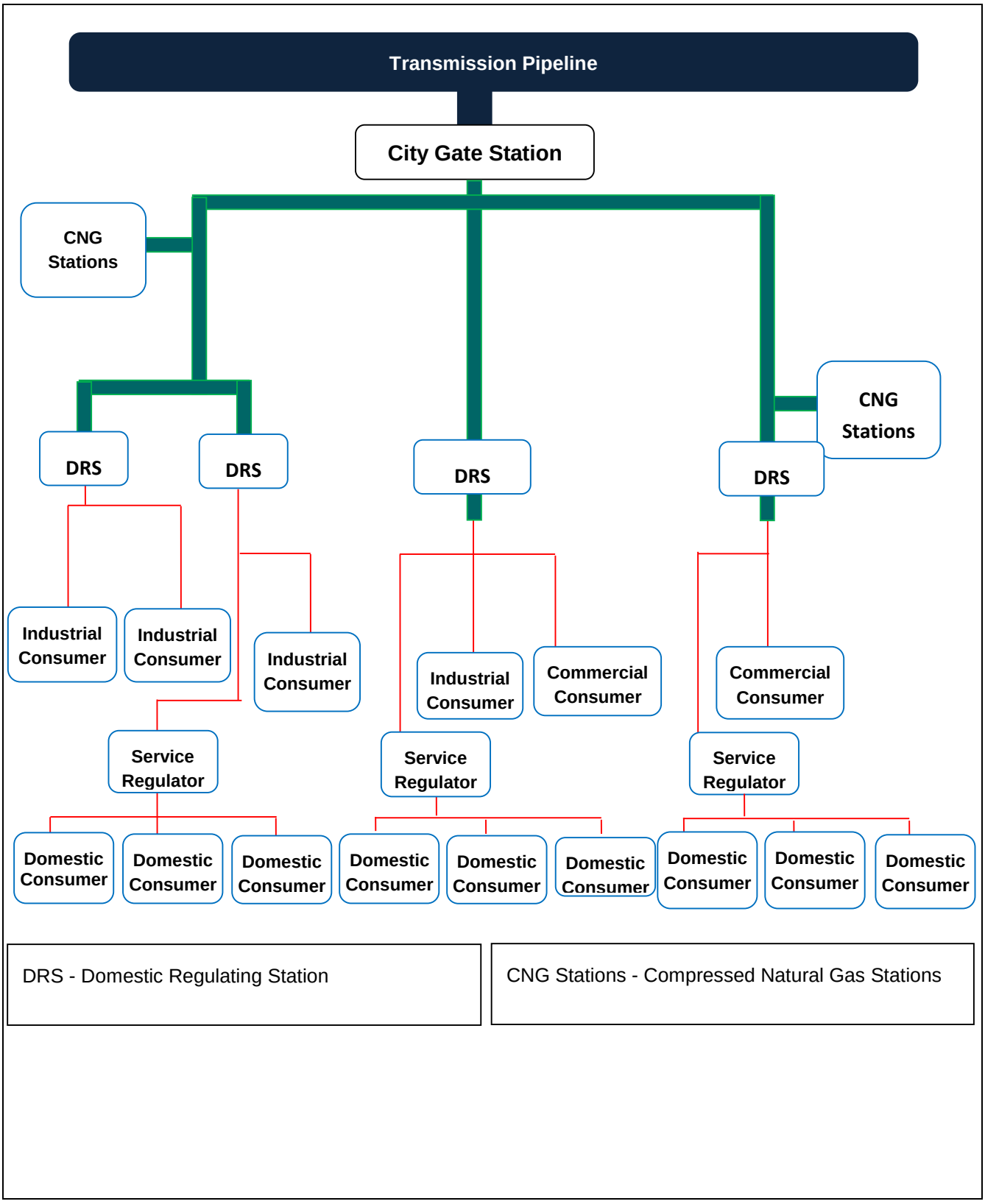
7.1 Network structure

The envisaged CGD network structure has been described in the following sections. All pipelines, station piping and mainline valves forming the network have been designed for service life of 25 years.

7.1.1 Structure and pressure level

The basic CGD system structure is shown below:

Figure 15: Structure of CGD network and pressure level



Source: CRIS analysis

7.1.2 Sub-transmission pipeline

Sub-transmission pipeline is a high-pressure pipeline connecting the main transmission pipeline to the city gate station (CGS) and owned by the CGD entity.

The maximum upstream pressure at the inlet of CGS is considered as 99 barg and maximum downstream operating pressure 49 barg. The sub-transmission pipeline shall be made of steel API 5L Grade X 52.

7.1.3 Primary network

The steel network shall have to design pressure of 49 barg to distribute gas to all consumers. This network shall carry gas from the CGS to inlets of various district regulating stations (DRS), industrial consumers and pressure-conditioning skids of CNG stations. The network shall be laid below ground along public roads in geographical area. It will have isolating valves at stipulated intervals and critical crossings. Each branch shall have three valve patterns to ensure flexibility of supply and maintenance.

Route markers shall be installed to mark the route of underground pipelines. It will be catholically protected against corrosion. All valves installed on this network shall be placed in constructed valve chambers for ease of operation. All crossings of major roads, railways and canals shall be cased crossings installed by open cuts or the no-dig technology. The network shall be tested following applicable standard procedures and then thoroughly flushed and cleaned before it is commissioned.

7.1.3.1 Material of pipeline

The sub-transmission pipeline shall be made of steel API 5L Grade X 52.

7.1.3.2 Cathodic protection (CP) system

All primary network pipelines must be duly protected against corrosion by cathodic protected for efficient and satisfactory functioning of the main grid line system as specialized by T4S.

External protection through corrosion coating and cathodic protection techniques shall be provided to prevent pipeline corrosion. Conventional coating of pipelines by three-layer polyethylene (PE)/ FBE shall be used as "passive" protection.

Complete corrosion protection cannot be achieved practically by coating, as it is impossible to avoid minor defects such as pores or cracks in the coating. Welded pipelines are particularly subject to corrosion at coating holidays because of their low longitudinal resistance, i.e., they practically do not resist the flow of current through the pipeline. At these holidays, dangerous pitting corrosion is initiated. Because of the high-corrosion current density, this phenomenon often causes rapid corrosion failure.

Cathodic protection on the other hand protects pipes reliably even at undetected coating holidays. The protective current supplies electrons to the structure and protects it.

Based on the experience and other relevant data as well as indigenous availability, PE/ FBE coating shall be provided for the pipeline.

Salient features of the CP system proposed for the main grid line are described as follows:

- The proposed main grid line shall be cathodically protected by an impressed current CP system as a permanent facility.
- Necessary measures shall be adopted to mitigate stray current interference in the proposed line and the existing lines (protected and unprotected that may exist in and around the ROW).

- Temporary cathodic protection (TCP) shall be provided during the construction phase of the proposed line by suitable means.
- All the used road/ rail crossings shall be fitted with proper isolating spacers, end seals, and drain and vent pipes. The casing pipes shall be independently shielded by sacrificial anodes, wherever necessary.
- Minor crossings would not be isolated but extra care in their protection shall be exercised.
- Test stations shall be installed for monitoring, at intervals not exceeding 1km in normal cases, and at intervals of 250 meter in congested areas. Additionally, test points shall be provided at all crossings and near insulating joints. A central monitoring station shall be located at the CGS to monitor remote terminal units.
- Interference effects, wherever suspected or observed, shall be duly investigated and remedial measures provided, wherever necessary.
- Insulating joints shall be provided on the proposed line at all necessary locations where electrical isolation is desirable such as at CNG stations and DRSs. Grounding cells/ spark gap arresters will also be installed across insulating joints.

7.1.3.3 Temporary cathodic protection (TCP)

A temporary cathodic protection system with sacrificial anodes shall be installed to ensure adequate protection of pipelines or mains from external corrosion, from the time the pipeline or main is laid in the trench till when the permanent cathodic protection system is commissioned.

The temporary cathodic protection system comprising of sacrificial anodes for small segments shall preferably be installed alongside the pipeline. Portable Impressed current system shall be deployed to protect long sections which may remain unconnected.

The criteria for temporary cathodic protection of steel and cast iron pipelines are as follows:

- A cathodic voltage of at least -0.85 volt as measured between the structure surface and saturated copper-copper sulfate reference electrode contacting the electrolyte. This voltage is to be determined with the proactive current applied.
- A minimum cathodic voltage shift of -300 MV (millivolts), produced by the application of proactive current. The voltage shift is measured between the structure surface and a saturated copper-copper sulfate reference electrode contacting the electrolyte. This criterion of voltage shift applies to structure not in contact with dissimilar metals.
- A minimum cathodic polarisation voltage shift of -100 MV (millivolts) measured between the structure surface and a saturated copper-copper sulfate reference electrode contacting the electrolyte. This polarisation voltage shift is to be determined by interrupting the protective current and measuring the polarisation decay. When the current is initially interrupted, an immediate voltage shift will occur. The voltage reading after this shift shall be used as a base reading to measure polarisation decay.

7.1.3.4 Corrosion control records

The CGD network company shall also maintain the following records / documents related to corrosion control:

- Cathodic protection design documents
- Soil resistivity survey report

- Electrical interference report
- Inspection and maintenance reports
- Material certification including dimension, metallurgy, performance and functional report
- Material test reports
- Approved drawings/documents

7.1.4 Secondary network

The secondary network of the CGD system operates at less than 4 barg pressure. Pipelines forming part of this network will be called medium-pressure distribution mains – designed to ensure uninterrupted supply to the tertiary network or to industrial consumers through service lines. This network shall be laid underground with minimum 1.0 mtr cover from top of pipeline. To protect it from third party activity a warning tape/mat shall be laid all along the pipeline. The warning tape shall be yellow polyethylene sheet printed with Caution - Gas line below and Contact numbers of CGD company control room. Line markers/Route markers also shall be provided all along the network.

These distribution mains are usually constructed using thermoplastic piping (PE) and connect DPRS to various service regulators at commercial, industrial, and domestic consumers. This network shall be laid underground with minimum 1.0 mtr cover from top of pipeline. To protect it from third party activity a warning tape/mat shall be laid all along the pipeline. The warning tape shall be yellow polyethylene sheet printed with Caution - Gas line below and Contact numbers of CGD company control room. Line markers/Route markers also shall be provided all along the network. The main features of this system are as follows:

- Polyethylene resin: Polyethylene resin used for manufacture of thermoplastic fittings shall be virgin, cadmium-free pigmented compound.
- The network shall be designed for normal operating pressure of 4 barg. The walls of the PE line pipes shall not be less than 2.3 mm thick and will accord with the standard dimension ratio (SDR).
- PE pipes shall be welded using electro fusion welding technologies and electro fusion accessories; the latter comprise injection-moulded polyethylene accessories equipped with a heated element designed to transform electrical energy into heat to create self-welding.

7.1.5 Tertiary network

Tertiary network of the CGD system operates at 110 m.barg pressure. Pipelines forming part of this network to Service Pressure Distribution System shall be designed to ensure uninterrupted gas supply to service lines.

A service pressure distribution system comprises service lines, service regulators and customer / consumer meter set assemblies, constructed using a combination of thermoplastic (MDPE) piping and galvanised iron / copper tubing components.

The plastic pipe and fittings shall be laid underground and shall not be exposed. The above-ground service pipes shall be of galvanised iron or copper tubes. Transition fittings shall be used for transition from PE to galvanised iron pipes.

7.2 Network sectionalisation

7.2.1 Primary network sectionalisation

The primary network (steel main) is subdivided into sections, as per guidelines of T4S issued by PNGRB, which require inter-distances to be adequately spaced valves (should normally not be more than 3 km) to enable isolation of a section for repair works or in case of an upset. All sectionalising valves shall have provision for venting and be manually operated.

The main criteria to define the number and location of sectionalising valves are based on the following principles:

- Minimise the number of end-users that may be directly affected, when a section of steel main needs to be put out of service.
- Assure continuity of gas service to other end-users that are not directly supplied to from the isolated section, by diverting gas flow through other feasible sections of the network.
- Cater to anticipated future development.
- Be flexible in operating/ maintaining the facilities.

7.2.2 Secondary network sectionalisation

As per the guidelines of T4S issued by PNGRB, in secondary network sectionalisation, inter-distances must be adequately spaced valves (should normally not be more than 1 km) to ensure flexibility of supply, maintenance or in case of an upset; further, all sectionalising valves should be manually and locally operated.

The number and location of the isolating valves shall be guided by the following principles:

- The possibility to isolate the pipe section of the gas distribution network in case of an emergency or accidental damage caused to the pipeline and related unforeseen repair interventions
- Such isolation to not affect end-customers not supplied gas through the concerned pipe section

7.3 Piggability

No permanent pigging facility has been proposed. However, a steel grid has been designed so that the Sub transmission pipeline from tap off point to city gate station can be pigged. For steel network in downstream of CGS skid pigging is not required as filtered and clean gas flows through it. Though it can be pigged when and to the extent required in small single diameter segments by arranging detachable pig launching and receiving system. The details of the same will be analyzed in detail during the implementation stages of the project..

To allow pigging of sub transmission pipeline and large diameter pipeline segments in the network, if ever necessary, the network shall consider the following:

- Bend radius shall not be normally below five times the nominal diameter, and preferably six times the nominal diameter. The dimensions of the same will be as per the recommendations of PNGRB as provided in T4S notified regulation.
- Valves in the line shall be “full-bored” ball-valves.

- Branching tees shall be equipped with “guide-bars,” to allow pigs to go through the tees following the desired branch.

7.4 Clean-up

- **Dirt:** Composition of natural gas is not likely to produce dirtiness in transmission/distribution. Despite careful cleaning of the transmission/distribution system before start-up, some residual dirt may still persist, which may later travel in the gas network. Subsequent works performed later on the network may also introduce some dirt. Removal of such residual or newly introduced quantities of dirt is ensured by providing for filtration of gas at the city gate station and each DRS.
- **Liquids:** The risk of condensation being relatively limited, no specific provision is considered in the design of the network for removal of condensation liquids.

7.5 Stations

The following stations are provided as interface between different pressure levels in the system:

- City gate station (CGS)
- CNG stations
- District regulating system (DRS)
- Individual/industrial pressure regulation stations (IPRS) for industrial consumers
- Service regulators (SR)

7.5.1 City gas station

The facility for receiving, measuring and conditioning the gas received for distribution in a city is called city gate station (CGS) because of its location. The equipment installed at CGS measure the quantity of gas received and regulate its pressure to 26 barg or less for safe distribution to consumers.

CGS is the basic interface between a sub-transmission pipeline and primary network. The following are the main functionalities of CGS:

- Termination of high-pressure sub-transmission pipeline
- Filtration
- Pressure reduction system
- Pre-heating (if required)
- Metering with volume corrector and GSM modem for remote communication
- Odorisation
- Gas dispatch to the downstream network
- Gas chromatographer
- System to reduce pressure to 26 barg

7.5.2 CNG station

CNG station is an inter-connected facility, designed to compress natural gas to a high pressure (up to 210 barg) and either store the gas (if the site is equipped with storage facility) or dispense it directly to a natural gas vehicle for refuelling.

7.5.3 District regulatory system

DRS is the interface between primary and secondary networks. DRSs shall be located at appropriate places where demands of domestic, commercial and industrial consumers of a particular area can be met. DRSs shall be provided with manual isolating valves to facilitate shutdown of the CNG station in case of emergency requirement. DRSs are standardised in terms of capacities, i.e., 1,000 SCMH, 2,000 SCMH, etc. The number and capacity of DRSs will be decided as per the demand of each CA.

Along with venting provision, a DRS will have facilities for filtration and pressure reduction, and a spool piece for provision of RPD meter.

7.5.4 Individual pressure regulation system

Individual/industrial pressure regulation stations (IPRS) are located at the premises of individual customers and have similar facilities as a DRS; however, active monitor regulators may or may not be provided. Facilities provided at an IPRS may include:

- Pressure regulator
- Measurement equipment to determine volume, mass or energy flow and properties of gas (if necessary) with electronic volume corrector (EVC) and GSM modem for remote communication
- Isolating valves
- Recorders and loggers
- Gas preheating (if necessary)

Industrial connections are supplied through a secondary network through IPRSs. The flow and pressure requirement will be of specific type, depending on the gas consumption.

Different types of meters – diaphragm, RPD and turbine – used for industrial connections are G16, G25, G40, G65, G100, G160, G250, G400 and G650.

7.5.5 Service regulators

Service regulators are usually installed outside customer premises to maintain supply pressure and safe conditions even in the event of rupture in the regulator downstream section. Service regulators reduce gas pressure from 4 barg to 100 milli barg and ensure flow of gas at constant pressure at all times.

These regulators feed gas into service lines of domestic consumers. One service regulator can supply peak demand of 750 to 1,000 domestic consumers and 20 to 25 commercial consumers.

7.6 Safety

Safety is the chief concern while designing a CGD network.

7.6.1 Safety in design

The following features have been taken into account for safety:

- Design factor to be 0.4 as suitable for Location Class 4, for determining the wall thickness of steel pipes under various situations; minimum thickness to not be below 6.4 mm
- Hazardous area classification for electrical installation is as per API RP 500; zone 2 (Division 2) of 7.5 m shall be considered around fencing on the high pressure side for full outdoor equipment.
- Electrical equipment according to EN 60079 – 10 and together with code of practice for earthing as per IS 3043 and lightening protection as per BS 6651.
- Instruments and control system shall in general meet the requirement of API RP 551 to 556.
- There will be built-in safety devices in the gas regulators (EN 334) Safety Shut Off Device (SSD) and/ or monitor regulator.
- CGS shall be preferably located at the periphery of a populated area, to the extent possible.
- Minimum prescribed distances between equipment / fencing / control room /electrical sub-station/ gas-fired heaters (if provided) in the CGS
- Maximum depth of cover 1 meter for buried pipeline as per T4S specifications of PNGRB>
- Provision for venting, purging and draining of pipeline sections
- Gas detectors in strategic locations
- Pressure relief valves, over-pressure shut-off valves, isolation valves with locking arrangements in open position
- Gas leak detectors-cum excess flow shut-off valves with detection sensitivity of 1 cc / sec or better, before gas application in kitchens of domestic consumers
- Consigns under rail, highway, road and street crossings as per API 1102
- PE should not be laid above ground and to be joined by electro-fusion technique only.
- PE service line and above-ground galvanised iron pipe for transition fitting
- Above-ground service piping of galvanised iron, copper or carbon steel shall be protected by anti-corrosive coating.
- Piping from consumer meter to appliance shall be made either of galvanised iron or copper, with flexible braided hose connection (=< 1.5m) to the appliance in the kitchen
- Fire extinguisher and firefighting system shall be incorporated

7.6.2 External

Except if, otherwise adequately protected, high-pressure equipment shall be located at reasonable distance (minimum 2 meters) between fencing and nearest building/structure (from outside fences in order to prevent the communication of a fire from outside the fencing to regulator and shutting-off the gas flow equipment) as T4S provided by PNGRB.

Where feasible, outdoor above-ground high-pressure equipment should not be closer than 15m from the domain freely accessible to the public. Special safety precautions shall be implemented during exceptional hazardous activities (e.g. piping).

7.7 Network basis

The following basis has been considered to design the CGD network.

CGS is designed for the pressure as mentioned in table below.

Table 33: Design pressure for CGS

Segment	Pressure
Upstream	Up to 99 barg
Downstream	Up to 49 barg

District regulating station (DRS) is designed for the pressure as mentioned in table below.

Table 34: Design pressure for DRS

Segment	Pressure
Upstream	Up to 49 barg
Downstream	Up to 4 barg

Service regulator is designed for pressure as mentioned in table below.

Table 35: Design pressure for service regulator

Segment	Pressure
Upstream	Up to 4 barg
Downstream	Up to 100 milli barg

7.8 Equipment details

The equipment envisaged for the CGD network are loaded at CGS, DRS and at CNG stations. Some details are tabled below.

Table 36: Details of filtration units

Filtration unit	
Design pressure	99 barg
Design temperature (min / max)	-20 / + 60^0 C
Operating pressure	99 barg
Operating temp.	(-5 to 50^0 C) Ambient
Filtration type	Cartridge
Degree of filtration	> 5 microns meter particle size
Number of streams	2

Table 37: Details of heating units

Heating unit	
Design pressure	99 barg
Design temperature (min / max)	-20 / + 60^0 C

Heating unit	
Operating pressure	99 barg
Operating temperature	(-5 to 50^0 C) Ambient
Number of streams	2

Table 38: Pressure reduction details

Pressure reduction details	
Design pressure	49 - 99 barg
Design temperature (min / max)	-20 / + 60^0 C
Upstream pressure	Up to 99 barg
Downstream pressure	Up to 49 barg
Operating temperature	(-5 to 50^0 C) Ambient
Number of streams	2

Table 39: Metering unit details

Metering units	
Design pressure	99 barg
Design temperature (min / max)	-20 / + 60^0 C
Operating pressure	Up to 99 barg
Operating temperature	(-5 to 50^0 C) Ambient
Number of streams	1

Table 40: Odorising skid details

Odorising skid	
Design pressure	49 – 99 barg
Design temperature (min / max)	-20 / + 60^0 C
Operating pressure	99 barg
Operating temperature	(-5 to 50^0 C) Ambient
Odorisation agent	THT, Mercaptan,
Dosing rate	5 to 15 ppm

Table 41: DRS details

DRS details	
Capacity	2500 SCMH*
Design pressure	49 barg
Design temperature (min / max)	-20 / + 60^0 C
Upstream pressure	Up to 49 barg
Downstream pressure	Up to 4 barg
Operating temp	(-5 to 65^0 C) Ambient
Degree of filtration	5 micron
Number of streams	2

DRS capacity has been considered as 2500 SCMH considering the volume of gas to domestic consumer. Each DRS will supply gas to around 20,000 households and commercial and industrial consumers in that area.

Table 42: CNG compressor details

CNG compressor details	
Driver type	Electrical motor / Gas engine-driven
Capacity	1,600 SCMH
Suction pressure	49 barg
Discharge pressure	210 barg (max)
Cascade capacity	3000 -4500 LWS

Table 43: Bus dispenser details

Bus dispenser details	
Number	1
Capacity	75 kg/min
Number of arms	1

Table 44: Auto and car dispenser details

Auto and car dispenser details	
Number	2
Capacity	15 kg/min
Number of arms	2

7.9 Network configuration

CGD is a facility set up for supplying PNG to domestic, commercial, industrial users, while compressed natural gas is supplied to automobile users. The system receives high-pressure, deodourised gas through the sub-transmission pipeline from the tap-off point, which is supplied to the CGD network after filtration, pressure reduction, odourization and custody metering at CGS.

Pressure will be reduced in four stages within the CGD network, before the natural gas reaches consumers (for automobiles, pressure is reduced at one stage only).

The first pressure reduction is carried out at the CGS, second at the district regulation station (DRS), third at service regulator and fourth and final at customer premises. The odourisation for imparting odour to gas is installed at CGS. Major assets in the network are CGS, the underground steel distribution pipeline network, PRS, CPRS, DRS, medium-density polyethylene (MDPE) network, individual pressure regulating station (IPRS), service regulators (SR), galvanized iron (GI) network and customer connections. The size, rating and type of major and sub-assets are selected based on the pressure rating, capacity and other applicable criteria. These are considered for the CGD system to meet current and future gas demand, health and safety of employees, customers and the public at large besides ensuring protection of the environment.

The design of the CGD network will comply with statutory, legal requirements, national/ international technical and safety standards/ practices and regulations of the PNGRB.

The main objective of the distribution company is to ensure safe and uninterrupted gas supply, by manning the control room round the clock, by deploying a team of competent engineers and technicians for handling customer complaints about gas leak/escape, queries and for carrying out planned operation & maintenance activities, as per the annual plan to ensure round-the-clock gas supply and integrity of the network.

The description of the CGD network should include a specific description of the primary, secondary and tertiary networks with respect to design specifications, length and major installations. The major assets of the CGD network with functional & technical details are following such as:

- **Sub-transmission line:** Carrying high pressure gas from main transmission line to CGS
- **City gate station:** It receives high pressure gas through the sub-transmission pipeline and carries out filtration, heating (if required), pressure reduction, metering and odourisation before dispatching gas to the steel distribution network
- **Steel distribution network:** It carries gas at 10-27 barg pressure from the CGS downstream and takes it up to the IPRS/DRS and CNG stations.
- **DRS:** It receives gas through the steel network and carries out filtration, at up to 49 barg upstream and up to 4 barg downstream pressure and dispatches gas to the MdPE distribution network.
- **IPRS:** It carries gas at 4 barg and supplies to industrial customers at the specified required pressure.
- **Domestic consumer connection:** Consists of a regulator, meter, GI / copper pipeline and a neoprene tube.
- **Commercial consumer connection:** Consists of a regulator, meter, GI / copper pipeline and a neoprene tube. The gas pressure will be specific as per consumer requirements.
- **Industrial consumer connection:** Consists of a filter, regulator, meter, polyethylene/ carbon steel (PE/CS) pipeline. The gas pressure will be specific as per consumer requirements.

Table 45: Pressure regime in the proposed CGD network

Sr. no.	Network component	Upstream pressure	Downstream pressure
1	Sub transmission pipeline	Up to 99 barg	Up to 99 barg
2	City gate station	Up to 99 barg	Up to 49 barg
3	Steel network	Up to 49 barg	Up to 17 barg
4	CNG station	Up to 49 barg	Up to 210 barg
5	DRS	Up to 49 barg	Up to 4barg
6	Service regulator	Up to 4 barg	Up to 100 m.barg
7	Commercial regulator	Up to 1 – 4 barg	Up to 30 – 100 m.barg
8	Domestic regulator	Up to 75 milli barg	Up to 30 milli barg

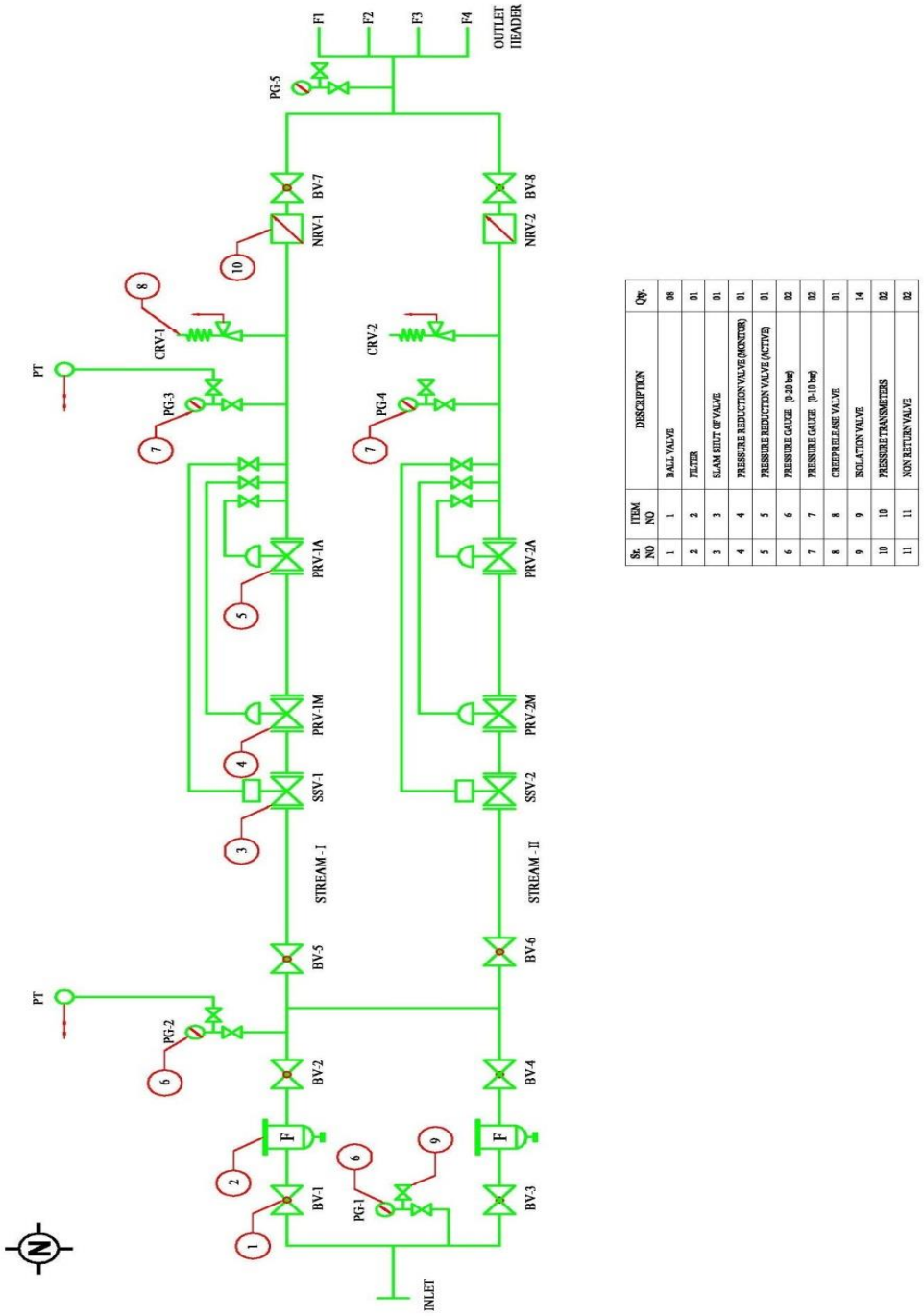
7.10 City gas station

The proposed city gas station comprises:

- Filtration skid
- Heating system
- Pressure reduction skid
- Metering unit
- Odorisation skid
- Office-cum-control room
- Battery / UPS room
- Fire-fighting & safety equipment

The typical Piping and Instrumentation Diagram of City Gate Station is shown in figure below:

Figure 16: Piping and instrumentation diagram of a CGS



Sr. NO	ITEM NO	DISCRIPTION	Qty.
1	1	BALL VALVE	08
2	2	FILTER	01
3	3	SLAM SHUT OF VALVE	01
4	4	PRESSURE REDUCTION VALVE (MONITOR)	01
5	5	PRESSURE REDUCTION VALVE (ACTIVE)	01
6	6	PRESSURE GAUGE (0-20 bar)	02
7	7	PRESSURE GAUGE (0-10 bar)	02
8	8	CREEP RELEASE VALVE	01
9	9	ISOLATION VALVE	14
10	10	PRESSURE TRANSMITTERS	02
11	11	NON RETURN VALVE	02

7.11 Primary network

The primary network of steel pipelines will link the CGS to various CNG stations and the DRS. The steel network for GA is designed based on the demand estimated for 25 years.

7.11.1 Steel pipeline

The primary network comprises a steel pipeline which carries gas at a pressure 27-10 barg. It originates from the CGS located at the open land near Coal India Ltd's Dankuni plant. Natural gas is distributed through pipelines of varying diameters and thicknesses as per the PNGRB T4S (Technical Standard for Design and Safety). This network links the CGS to the inlets of various DRSs, industrial consumers and pressure conditioning skids of CNG stations. This network shall be laid below the ground along public roads in whole the geographical area. Possibility of interconnectivity of forming a ring can be explored at a later stage. Considering the geography of the GA, interconnectivity has not been considered as a river crossing is also envisaged in the initial DFR preparation.

The steel pipeline would be externally coated, so as to fulfil the following requirements:

- Good electrical isolation between external surface of the pipe and environment.
- Resistance to moisture transmission.
- Sufficient ductility to resist cracking.
- Good mechanical strength or otherwise be protected to resist damage due to normal handling (including concrete coating application where applicable) and soil stress.
- Compatibility with cathodic protection system and field joint coating.

7.11.2 Sectionalising in steel network

Steel pipelines are subdivided into sections in order to have isolating valves at stipulated intervals and critical crossings in the steel pipeline network. As stipulated by the PNGRB, each branch shall have valve patterns and inter-distances shall be adequately spaced valves (should normally not be more than 3 km) to ensure flexibility of supply, or maintenance in case of an upset. All sectionalising valves are manually operated.

Route markers shall be installed for underground pipelines. It will be cathodically protected against corrosion. All valves installed on this network shall be in constructed valve chambers for ease of operation. All crossings of major roads, railways and canals shall be cased crossings installed by open cut or through the 'no dig' technology. The network shall be tested as per applicable standard procedures. Tested networks shall be thoroughly flushed and cleaned before commissioning.

7.12 CNG stations

Natural gas shall be transported from the CGS to CNG stations through the main grid pipeline as described above.

Table 46: Details of CNG compressors

Equipment	Specification
Capacity of CNG compressor	1600 SCMH
Type	Reciprocating
Driver	Electric motion driven/Gas engine driven
Suction pressure	10-19 barg
Discharge pressure	210 barg

Two types of stations cater to demand from the automobile segment:

- CNG mother station
- CNG on-line stations

7.12.1 CNG mother station

Mother stations are CNG outlets on the steel pipeline network that run throughout the geographical area. Mother stations are used to fill CNG into mobile storage trailers besides direct refuelling of natural gas vehicles. Mother stations will always be located adjacent to the steel pipeline. These stations provide mobile-cascade filling facilities (which are transported to daughter stations through cascade) along with stationary cascades for dispensing CNG to automobiles.

The following units have been envisaged in CNG mother station:

A. Main equipment

- Mother compressors along with auxiliaries
- Dispenser for buses
- Dispensers for cars and three-wheelers (autos)
- Daughter cascade
- Metering skid
- Loading facility for mobile cascades
- Stationary cascades
- DG Set, UPS & battery bank, AVR, electrical control panel
- Instrument air & water facilities
- Fire-fighting equipment and safety sign

Stainless steel tube connecting compressor, dispenser & cascades laid in U/G trenches

B. Other Facilities

- Office-cum-control room
- RCC forecourt, canopy over dispenser island and signage and passenger assembly area
- Stainless steel tube connecting compressor, dispenser and cascades laid in underground trenches
- Underground drainage and sewerage network
- Approach/ exit road, boundary wall etc.
- Toilet block, drinking water facilities
- Compressed air for tyres

7.12.2 CNG online station

The following units have been envisaged in each online station:

A. Main equipment

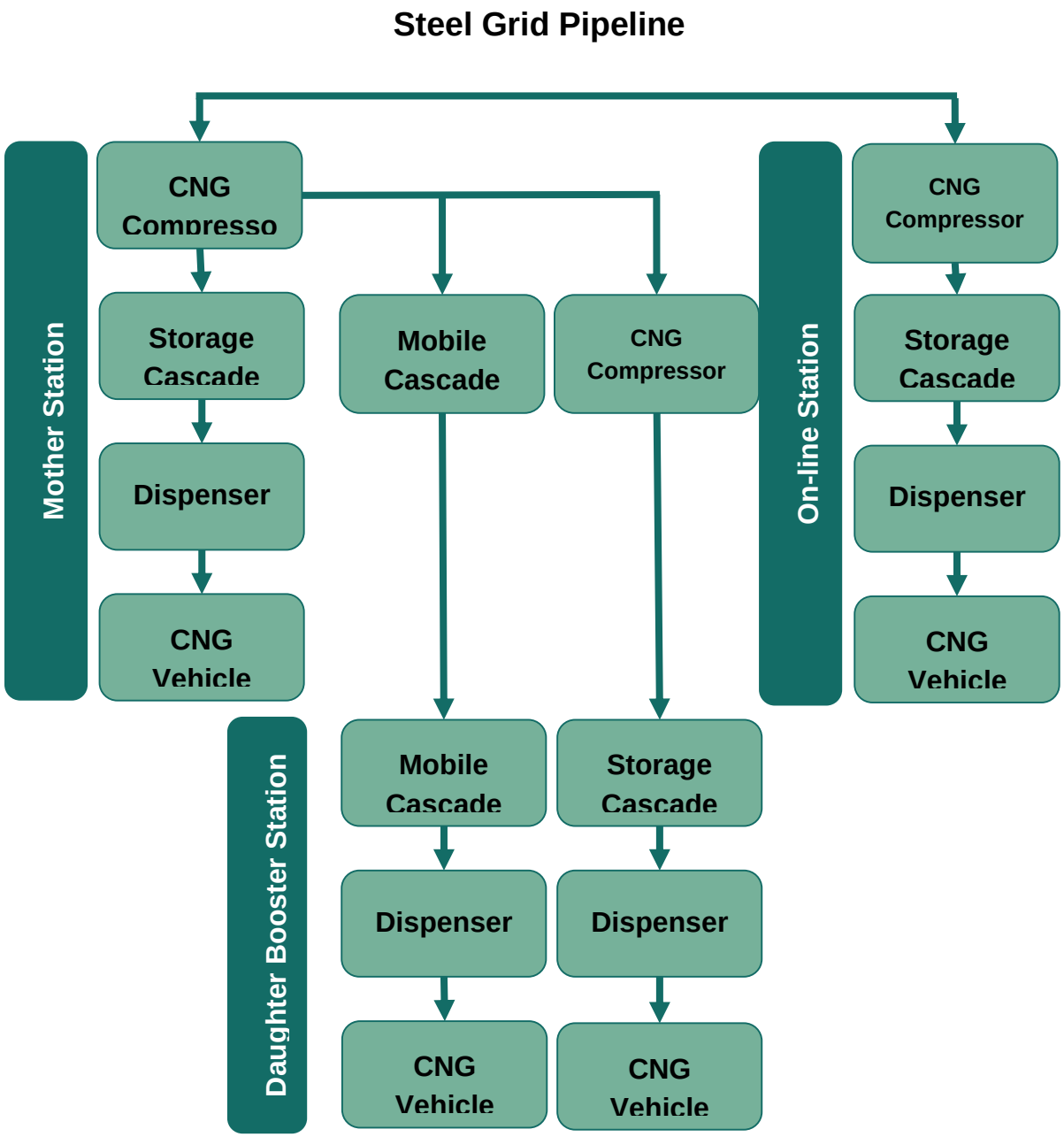
- On-line compressor along with auxiliaries
- Dispensers for buses (only in case of 1200 SCMH compressor)
- Dispensers for cars and three-wheelers (autos)
- Stationary cascades
- DG sets, UPS & battery bank, AVR, electrical control panel
- Instrument air & water facilities
- Fire-fighting equipment and safety sign

B. Other facilities

- Office-cum-control room
- RCC forecourt, canopy over dispenser island and signage and passenger assembly area
- Stainless steel tube connecting compressor, dispenser and cascades laid in underground trenches
- Underground drainage and sewerage network
- Approach/ exit road, boundary wall etc.
- Toilet block, drinking water facilities
- Compressed air for tyres

Typical plan of CNG mother station and online station at retail outlet is shown in figure below:

Figure 17: Layout of a typical CNG station



Source: CRIS Analysis

8. Project Rollout

Basic configuration of the CGD network has been designed considering the projected demand of natural gas.

8.1 Prioritization of network

The CGD network is designed to cater to the projected demand of natural gas for domestic, commercial, industrial and transport sectors over a horizon of 25 years in the GA. The rollout strategy for the proposed network is based on the following criteria:

- Roll out should start with focus on the nearest City Gas Station
- Connectivity of steel network to the high demand centers in the initial years of construction should be prioritized
- Priority should be given to connect high demand consumers viz. Industrial, Mega CNG stations for transport sector and high demand commercial and domestic consumers in initial years
- Existing vendors should be identified or new vendors should be developed for construction of the network according to the planned roll out
- Steel network laying activities should not be performed during monsoon period

Based on the various activities to be done in the project, the rollout plan envisages that the CGS would be installed in year one. The entire steel network shall be laid in the first five years. All the domestic connections are planned to be completed by the Year 12. By year 25, the projection indicates steel network and domestic connections will reach their saturation point. The DRS and CNG Stations shall also be rolled out as the demand builds up.

8.2 Procurement and construction plan

8.2.1 Procurement prioritization

Procurement of long-lead items should be initiated first. This should be followed by procurement of critical items, bulk purchase items and general stores items. Presently, following items have been identified as long-lead items:

- CNG Compressor
- Steel Ball Valves
- Filtration and Metering Skids
- District Regulating Stations
- Individual Pressure Regulating Stations
- Line Pipes
- Insulating Joints
- MDPE Valves & Fittings

8.2.2 Procurement of major items for CGD

Major items for City Gas Distribution and CNG Stations would have to be identified along with the vendors for the supply of such items. The major items for City Gas Distribution network are Steel Network and PE Network.

Major items for Steel Network of PNG include:

- Coated Line Pipes
- Ball Valves and Globe Valves
- Metering Skid
- Pressure Let Down Skids
- Filtration skids
- Pressure Control Valves
- Insulating Joints
- CS Fittings & Flanges
- Cathodic Protection System
- OFC
- HDPE Duct for OFC

Major Items for CNG Stations:

- CNG Compressors
- Gas Cascade
- Dispensers – Cars & Bus
- SS Tubes, Valves & Fittings
- Fire Fighting Systems
- Electrical Fittings and UPS

The major critical items for Steel Networks of PNG would be:

- Ball Valves and Globe Valves
- Coated Lines Pipes – HSAW / LSAW /Seamless / ERW
- Metering Skids
- CS Fittings & Flanges

The list critical of pre-operational approvals required before commencement of construction are listed below

- Right of Way / Right of Use
- Clearance from Pollution Control Agencies
- Permission to lay hydrocarbon pipeline

8.2.3 Construction of CGD network

Construction plan of City Gas Distribution Network Includes construction of City Gate Station, Steel Network, CNG Stations and City Gate Distribution (PE Network).

The construction of CGS includes the following:

- Identification and purchase of suitable land plot
- Basic engineering of civil and Mechanical activities
- Award of works contract to contractors
- Construction, testing and commissioning

The construction of Steel Network the following activities

- Configuration and design of pipelines
- Acquisition of RoU/RoW for pipeline route
- Basic and detailed engineering
- Procurement of pipes and fittings
- Construction (Laying of pipes)
- Testing and commissioning
- Cathodic protection

The construction of CNG Stations includes the following activities

- Identification of suitable locations
- Basic and detailed engineering as per demand
- Statutory approvals
- Award of purchase orders and works contract
- Land development and civil construction
- Compressor, cascade and dispenser erection
- Connection with steel mains
- Electrical works
- Testing and commissioning and beginning of CNG sales

The construction of PE Network should start along with steel network. The DRS and SR should be installed at selected locations. The main activities to be carried out are as follows:

- Survey and route finalization
- Basic & detailed engineering
- Laying of PE pipes
- Erection of DRS and SR
- Testing and commissioning of PE network
- Installation of GI pipe connection in consumer's premises

The PE network laying and installation of GI pipe connection are ongoing activities in line with market penetration.

9. Operations and maintenance of CGD network

The O&M philosophy, systems and organisation will be planned for safe and reliable operation of the CGD network. It should be flexible to reckon local conditions and the type of customers.

Reckoning the requirements stipulated in PNGRB'sT4S (G.S.R. 750 (E) dated October 2009) and the Code of Practice for Quality of Service for City or Local Natural Gas Distribution Networks Regulations (G.S.R. 720 (E) of September 2010). Additionally, the following national and international standards should also be considered:

- OSID 226 - Natural gas transmission pipeline and CGD network
- ASME B31.8 – Gas transmission and distribution piping systems
- OSID 179 – Safety Regulations on the compression, storage, handling of refuelling of natural gas for use in automobiles
- ISO-4437 – Buried PE pipes for supply of gaseous fuels

9.1 Objective

The O&M policy and programme mainly aim to ensure the long-term system integrity for safe and reliable/ uninterrupted supply of gas and economic performance of the CGD network. A CGD network shall have an effective health, safety and environment (HSE) management system and management of change to ensure overall safety during operation and emergencies.

The O&M policy basically requires a:

- HSE system
  - An emergency management plan to safely handle emergencies with minimal risks.
  - A Disaster Management Plan encompassing offsite and onsite emergency response plans and a mutual aid system
  - Hazard identification process such as HAZOP and control measures
  - Quick risk assessment (QRA)
  - Safety and technical competency system
  - An operational health and safety legal applicability matrix as well as operational health and safety (OH&S) legal compliance matrix.
  - An environmental legislative register showing permits, authorizations or license required and from whom and how these are obtained.
  - Periodic workplace inspection of all critical activities by the senior management, implementation of behaviour-based safety programmes and safety intervention systems should be considered to improve the organisation's safety culture.
- A written O&M plan
- GIS-based asset management system
- Approved work procedures

- Periodical review and amendment of the plan to incorporate changes as per experience gained
- Ready availability of tools, equipment, spare parts, procedures and skilled workforce
- Citification of employees and contractors
- Maintenance of records concerning implementation of plan and tracking training of employees.

9.1.1 Health Safety and Environment systems in CGD

The HSE Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the HSE Guidelines to facilities will involve the establishment of site-specific targets, with an appropriate timetable for achieving them.

The applicability of the HSE Guidelines will be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment .The exercise of professional skill, diligence, prudence and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances in India.

The applicability of specific technical recommendations will be based on the professional opinion of qualified and experienced persons and regulation on HSE.

The HSE Guidelines for Gas Distribution Systems will include information relevant to the distribution of low pressure natural gas from the city gate to residential, commercial, and industrial users.

9.1.1.1 Environment

Distribution pipeline construction impacts greatly depend on the location of proposed pipeline installation. In already developed urban areas, environmental impacts are considerably different than in suburban or mixed use areas. Common impacts may include noise and vibration caused by the operation of earth moving and excavation equipment, and materials transport and delivery; dust emissions generated by a combination of on-site excavation and movement of earth materials, contact of construction machinery with bare soil, and exposure of bare soil and soil piles to wind; mobile emissions from exhaust of diesel engines for earth moving equipment; and hazardous materials and waste handling, including oil spills associated with heavy equipment operation and fueling activities. In newly developed areas, impacts may also include soil erosion resulting from excavated areas prior to the reestablishment of vegetation. In urban areas, impacts may include noise, traffic interruption, disposal of contaminated soil, and presence of archeological artifacts. Recommendations for prevention and control of construction related impacts are addressed in the General EHS Guidelines. Environmental issues that may occur during gas distribution projects include the following:

- Habitat Alteration
- Air Emission

9.1.1.2 Occupational health and safety

Occupational health and safety (OHS) issues in the construction phase include potential exposures to dust, noise, physical strain, and trenching excavation hazards. Recommendations for the management of construction phase hazards are addressed in more detail in the General EHS Guidelines. Occupational health and safety hazards associated with the construction and operation of gas distribution systems may also include:

- occupational exposure to gas leaks and explosions
- confined spaces
- electrocution

Additional recommendations for operational phase OHS issues also applicable to gas distribution activities are also addressed in the General EHS Guidelines.

Occupational exposure to gas leaks and explosions Excavation, construction, and repair of gas distribution systems may result in accidental pipeline rupture or leakage and consequent exposure of workers to harmful gases and an explosive gas atmosphere. In addition, excavation by non-gas utility personnel may result in accidental ruptures and exposure of untrained workers to explosion hazards. Recommended techniques to prevent and control exposure to gases and explosive atmospheres caused by accidental gas line ruptures and / or leaks include:

- Training of employees and contractor personnel in safety procedures, together with provision of appropriate tools and equipment;
- Identification and location of existing gas and other buried utility infrastructure prior to excavation for installation or repair of gas pipelines. Installation of visual marking of gas lines as part of installation, and updating as necessary on an ongoing basis;
- Removal of sources of ignition prior to gas venting for maintenance and repair activities. Purging of gas from pipeline or pipe components prior to welding or cutting activities;
- Installation of gas lines and components using sufficient separation distance and appropriate pipe protection layering to minimize potential interference with other underground infrastructure. Separation of plastic pipes from sources of heat;
- Odourization of gas to facilitate detection of gas leakage
- Training of gas utility workers in procedures for emergency preparedness and response involving appropriate public authorities, in addition to emergency shutdown and pressure reduction in the pipeline system. Further recommendations for emergency preparedness and response are addressed in the General EHS Guidelines.
- Accumulation of natural gas in a confined space is a potentially fatal condition. Entry by workers into confined spaces and the associated potential for accidents may vary among gas distribution project phases and facilities. Specific and unique areas for confined space entry may include excavation trenches during construction and regulating stations and vaults, both above and below ground, which may also contain equipment (e.g. safety valves, filters) that may emit fugitive emissions of gas and create a potential for oxygen deficient and explosive atmospheres. Gas distribution companies should develop and implement confined space entry procedures as described the General EHS Guidelines, and including the following:
    - A combustible gas in a distribution line must contain a natural odorant or be odorized so that at a concentration in air of one-fifth of the lower explosive limit, the gas is readily detectable by a person with requiring work permits for all confined space entries;
    - Installation of appropriate access controls for unauthorized personnel including signage to alert workers to the hazards of confined spaces;
    - Use of ventilation and oxygen / explosive level detection and alarm equipment prior to access.

- Excavation, construction, and repair of gas distribution systems may result in workers' exposure to existing aboveground or underground utilities, including aerial or buried electric transmission lines. Identification and location of all relevant existing underground utilities should be undertaken prior to any construction and excavation activities.

9.1.1.3 Community health and safety

Community health and safety hazards associated with the construction and operation of gas distribution systems include public exposure to gas leaks and explosions. Additional recommendations for community health and safety issues common to most industry sectors are addressed in the General EHS Guidelines.

The presence of gas distribution systems within populated areas may expose the public to hazards from gas leaks and explosions. Gas leakage may result from accidental rupture of pipelines during installation and repair or from contact during excavation unrelated to the gas system. Gas utility operators should inform and advise affected communities, schools, businesses/commercial facilities, and residents about the potential hazards presented by gas infrastructure. Gas distribution system operators should establish an emergency preparedness and response plan and communicate this plan to the public as necessary. As part of the plan, gas system operators should implement a telephone notification system to respond to reports of leaks or questions of general safety from the affected community and other interested parties. Operators should also provide a pipe location service to assist outside contractors and the general public to determine the location of gas infrastructure prior to construction works proximate to gas pipelines. Improper operation of natural gas fuelled appliances and equipment may expose the user and the public to gas leakage and explosion hazards. Gas distribution system operators should make information available to customers (e.g. through flyers and internet-based information) regarding the safe operation of gas fueled appliances and equipment. This information should address issues of proper and safe use of gas-fired appliances, which in the case of residential use, may include the following issues:

- Proper location, installation, and maintenance of appliances and equipment such as natural gas fired heating units. For example, installation in areas with adequate ventilation to ensure dispersion of residual carbon monoxide. Poor combustion in a natural gas fired appliance or piece of equipment may expose the user and the public to carbon monoxide exposure, especially in confined spaces;
- Recognition of potential hazards or operating problems. For example, recognition of the hazards of poor ventilation or identification of gas surges requiring action by the gas utility (identifiable when flame color in natural gas burning appliances is orange or yellow rather than blue), and how to respond to possible accumulation of gas vapors when odor is detected with instructions on proper response procedures. These procedures may include avoiding sources of ignition (e.g. electrical switches, lighters), ventilating area of gas accumulation, and calling the emergency contact number of the local gas utility from a safe location.

9.1.1.4 Environmental monitoring

Environmental monitoring programs for this sector should be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during normal operations and upset conditions. Environmental monitoring activities should be based on direct or indirect indicators of emissions, effluents, and resource use applicable to the particular project.

Supervisory Control and Data Acquisition (SCADA) systems may be another useful means of monitoring system volume flows, especially in new system installations. Monitoring frequency should be sufficient to provide representative data for the parameter being monitored.

Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Additional guidance on applicable sampling and analytical methods for emissions and effluents is provided in the General EHS Guidelines. Though all precautions shall be planned for safe operation of the proposed CGD network in UT of Daman GA, possibilities of accidental situations arising cannot be ruled out. In view of this, it is imperative to prepare a Disaster Management Plan. This Plant shall provide a guide for assuring safety for the public and maintaining facilities in satisfactory condition during emergency conditions. This shall also help in imparting knowledge of potential hazards and facilities available for controlling the same in a well-coordinated manner to all the employees and also train them beforehand. These hazards will include, but are not limited to, the following:

- Under pressure in the gas system
- Overpressure in the gas system
- Uncontrolled escaping of gas
- Fire or explosion near or directly involving a pipeline facility
- Any leak considered hazardous
- Danger to major segment(s) of the system

The hazards also include:

- Natural disasters (floods, tornadoes, hurricanes, earthquakes, etc.)
- Civil disturbances (riots, etc.)
- Load reduction conditions (result in voluntary or mandatory reduction of gas usage).

Disaster Management Plan is prepared by CGD Company as per PNGRB guidelines and implemented to ensure mitigation of risks and manage disaster arising due to its activity.

9.2 O&M philosophy

The O&M philosophy will essentially have the following features:

- A lean and effective organization
- Continuous improvement through training and other HRD interventions
- Leveraging technology for enhanced safety, service reliability and cost-effectiveness through reduced manpower and higher efficiency
- Outsourcing bulk of activities
- Vital equipment maintenance by original equipment manufacturers (OEMs)
- Compliance with regulatory stipulations, standards and codes of practices
- Development and implementation of programmes and procedures on:

- Preventive maintenance plans and procedures in accordance with OEMs' recommendations
- Calibration of meters, gauges and other instruments, at regular, pre-defined intervals
- Functional testing of pressure regulating and control equipment
- Isolation scheme consisting drawing shows with the orientation of facilities, location of major services, power switches, entry and emergency exits, fire assembly points including their identification number
- Limits of operating parameters e.g. pressure, temperature, flow, level, etc.
- Alarm (an audible/visible indication of equipment or process malfunction or abnormal condition) management system
- Work permits for maintenance personnel to protect property from damage and fire, etc.
- Logging O&M activities
- Personal protective equipment (PPE) to be used by all operating personnel
- Periodic inspections along steel pipelines or mains to be well-designed
- Materials management
- Human resource development, including induction programmes and periodic refresher courses
- Revenue collection
- Liaison with external agencies – other utility companies, gas suppliers, fire authorities, police, local administration, health authorities mutual and agencies, factory inspectorate, city / district / state disaster management authorities
- Do's and don'ts and safety precautions during O&M

9.3 Key activities

The key activities pertaining to O&M of city-gas distribution networks includes operation of the distribution network, maintenance and upkeep of the equipment and procedures to ensure safety aspects in the all related activities.

The key O&M activities of a city gas distribution network are:

- **Operations**
  - HSE management systems
  - Managing gas receipt
  - Management of pressure reduction stations
  - Metering of gas consumed by domestic, commercial and industrial customers
  - Gas measuring and billing including energy balance
  - Compliance of regulatory/legal measures
- **Maintenance**

- Regular planned / preventive maintenance and prompt breakdown / corrective maintenance
- Regular inspection, testing and maintenance of pressure limiting and pressure regulating stations, valves and vaults, plastic pipes, etc.
- Route patrolling to detect gas leakages and contain third-party damages
- Maintenance of safety provisions such as relief & stop / isolation valves, gas detection and alarm systems
- Controlling external corrosion
- Handling customer complaints

- **Safety**
  - Safety includes offsite and onsite emergency (facility failure and other emergency) plans
  - Mutual aid plan to seek assistance for equipment / manpower, etc. from identified industries / organisations in the neighborhood, to manage an emergency
  - Disaster management plan
  - HSE management system
  - Risk analysis and risk assessment process
  - Safety and technical competency system
  - Procedure for periodic workplace inspection of critical activities in CGD networks
  - Behaviour-based safety programmes
  - Safety intervention system, including safety audits
  - Management of change system to ensure safe control of operations

9.4 Metering, billing and collection in CGD

Meter reading, billing and payment collections are key activities under O&M. There will be a one district-level billing officer who will monitor and control of these activities. Billing activities will be done every month by taking meter-reading to realisation of payment against bills from commercial and domestic customers and depositing the collected money in owner's bank account and updating the entry in the billing software including reconciliation of gas purchase /sales against revenue collected software including reconciliation of gas purchase / sales against revenue collected with due care of customer services, billing accuracy (zero errors) are proposed to be outsourced.

9.5 Documentation

Efficient discharge of various O&M functions require an efficient and responsive documentation system. The record-keeping of various O&M activities plays an important role in smooth operation and control of the CGD network.

The documentation in the CGD network can be segregated into three categories i.e. operating manuals, reports and approval documents. The various documents that shall be maintained are mentioned below:

9.5.1 Manuals

The O&M manual includes:

- Periodic inspection and maintenance of:
  - City gate station
  - Individual pressure regulating station
  - District regulating station
  - End-consumer facilities
  - Sectionalising valves
  - Vaults
  - Steel and PE pipelines
- Patrolling to safeguard against third party damages of the network – steel and the PE pipeline.
- System schematic and its description
- Composition, properties and safety against harmful effects of natural gas
- Handling odourants
- Calibration, testing and certification of measuring instruments and gauges
- Organisation structure with roles and responsibilities
- Competency requirement and training
- Onsite and offsite emergency and safety plans
- Environment, health and safety plans.
- Mutual aid
- Disaster management plan

9.5.2 Reports

The reports contains test reports of commissioning, annual maintenance reports for record-keeping and daily performance reports of different equipment. The reports includes:

- Order copy with details for construction of stations and the whole network
- P&IDs, plot plans and GADs of CGS
- Hydraulic test and Pneumatic test reports of the whole network including Steel, PE pipeline and other equipment.
- Commissioning reports for the network
- Alignment sheets for primary network of the steel pipeline and other installation and its test records
- Surveillance inspection and maintenance records
- Performance and functional test reports of all equipment
- Compliance audit reports.

- Material certification reports detailing dimension, metallurgy, performance and functional aspects.
- Inspection and maintenance reports.
- Log book and daily records
- Pipe book for steel grid pipeline
- As-built drawings of complete steel & PE network.
- History card of every equipment and instruments.

9.5.3 Approval documentation

Various approvals are required to set up the CGD network. These include safety approvals, work permits from various departments and work orders, etc. A detailed list is as follows:

- All approved drawings and documents related to construction of the CGD network.
- Testing certificates, material certificates, calibration records and inspection release notes of all items, equipment used
- Material certification including dimension, metallurgy, destructive and non-destructive testing records of all equipment used
- Welding records comprising PQR, WPS and welder qualification records.
- Records of non-conformance / deviation
- Calibration records of inspection, measuring, metering and equipment testing
- Statutory clearances from different departments
- HAZOP / risk assessment reports and compliance to recommendations of such reports.
- Manuals containing O&M of equipment.
- Design documents of cathodic protection.

9.6 Organisation structure

The organisation structure as defined in the chapter provides for successful implementation, operation and marketing of CGD project in the city. The organisation structure both for implementation and subsequent operations has been finalised based on the following principles:

- Core functions to be undertaken by CGD professionals
- Some of the middle management professionals may be inducted on contract for specific operations
- During the project implementation phase, engineering & project management consultancy services will be hired;
- A third-party inspection agency will be hired to support the quality assurance & quality control departments during the project implementation phase;
- After the high activity period of 2-3 years, the CGD network's operations shall require a very small, focused task-oriented team adequately supported by Outsourced agency;

- All non-core activities to be outsourced to competent service provider;
- Phase-wise organisational structure has been considered, taking into account the project development as well as operations and marketing requirement in future
- As the CGD company matures, there organisation structure has to be flexible in future

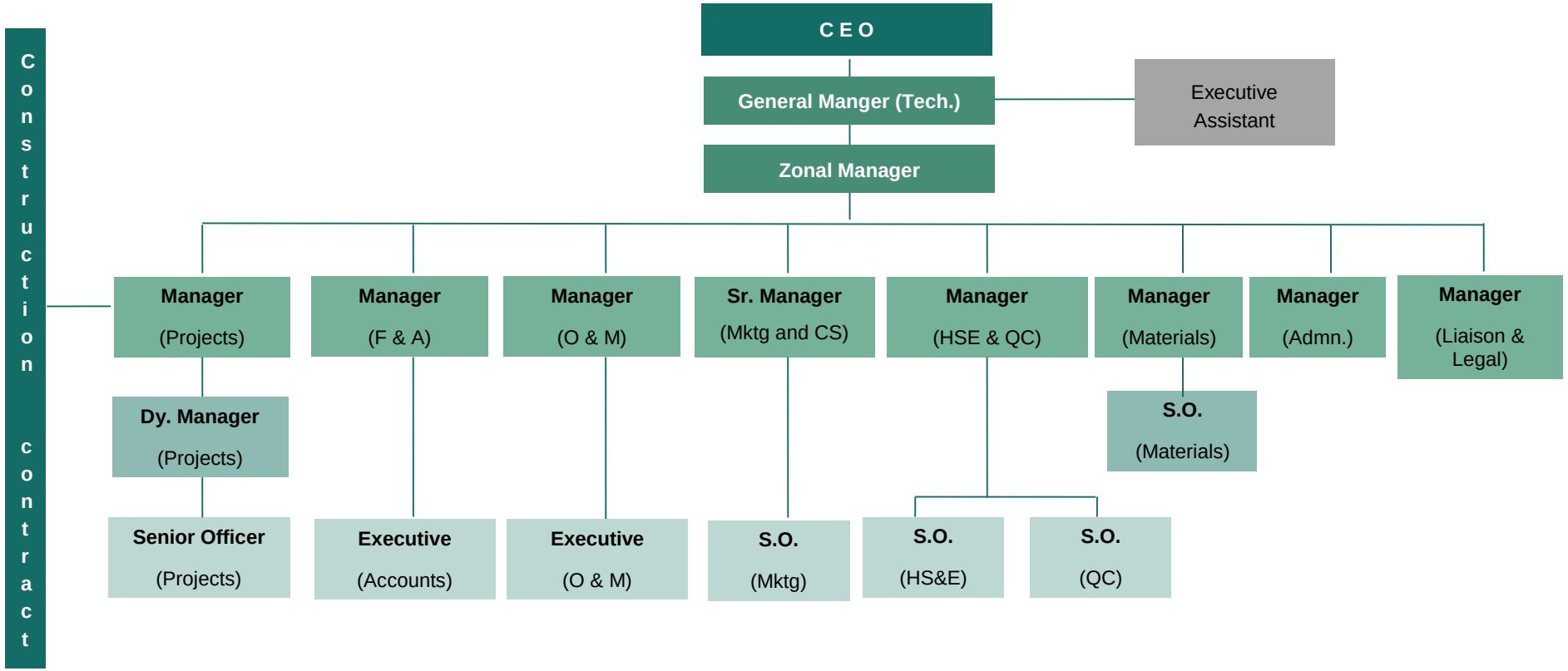
9.6.1 Manpower requirement for project implementation

During the project implementation phase, a core team of experienced engineers would be placed to oversee all aspects of project implementation: procurement, material management and construction. The quality and safety aspects during the project shall be managed by experienced quality control and safety professionals. This team would be supported by the administration & liaison department for procuring clearances and approvals for timely implementation of the project. A marketing team with two associates is also needed during the project implementation phase, which would understand, appreciate and nurture the market, especially Industrial consumers and household CNG consumers.

During the project implementation stage, following functions would be carried out:

- Planning
- Materials management
- Contract management/ finance
- Project progress monitoring
- Liaison with the government authorities/ agencies
- Quality assurance and safety management
- Understanding of the market so as to ramp up demand for natural gas in the shortest possible time
- Customer response cell to address frequent questions from user groups

Figure 18: Organization setup for project implementation



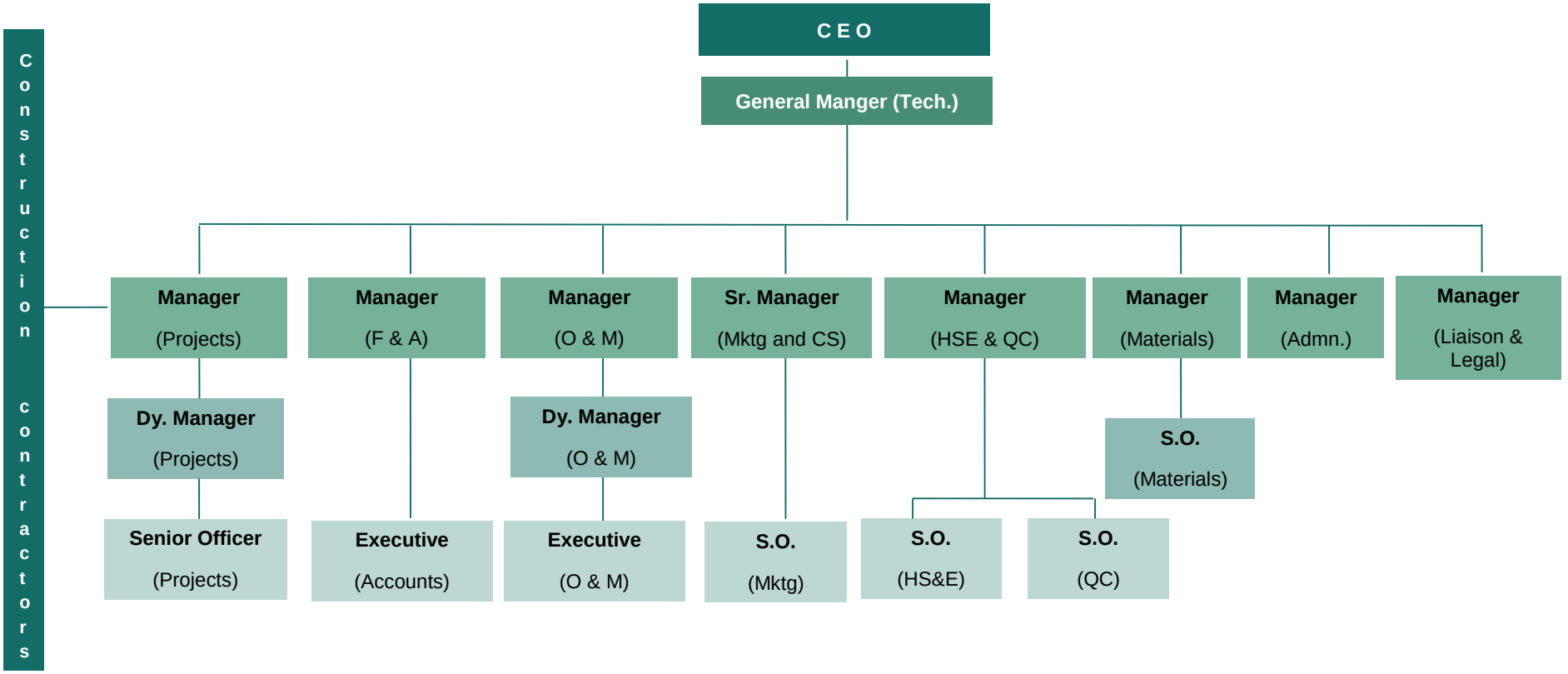
9.6.2 Manpower requirement for O&M and marketing

During the operational and marketing phase, following functions have been proposed:

- Operations and control room functions
- Marketing and consumer services
- Procurement & contracts
- Finance (revenue, accounts and regulatory)
- HR & administration
- Quality assurance/quality control and safety

A core team of experienced engineers would be placed to oversee all aspects of project operations and the O&M phase, which include procurement, material management, O&M, finance and regulatory, marketing, HR, etc. The quality and safety aspects during the project and operations phase shall be managed by experienced quality control and safety professionals.

Figure 19: Organizational set-up for Operation and Marketing phase



10. Capital expenditure / operating expenditure of CGD project

10.1 Basis of cost estimates

The capital expenditure (capex) cost estimates are based on primary information obtained for the geographical areas and other inputs from suppliers and / or existing recent installations in existing CGDs. The cost estimates include the cost of equipment, piping, engineering and project management, land & site development, owner's management expenses, start-ups, etc. The cost estimates includes applicable taxes and duties and hence indicates the landed cost for Greater Calcutta Gas Supply Corporation Ltd (GCGSCL) based on domestic purchases.

10.1.1 Major equipment

The cost estimates for major equipment such as compressors, dispensers, cascades, pumps, instrument air systems and other miscellaneous equipment are based on the cost data available in house with updated with latest figures from GCGSCL using recent orders and/or budgetary quotes.

Overall project cost estimates are arrived at by adding the following cost elements:

1.) **CNG compressors:** The landed cost of CNG compressors has been considered at Rs 263 lakh for two compressors at each online station. All compressors are assumed to be motor-driven.

2.) **CNG dispensers:** Landed cost of CNG dispensers in each mother station has been considered as Rs 86 lakh.

3.) **CNG cascades:** Landed cost of CNG storage cascade has been considered as Rs 24 lakh each.

4.) **Land for CNG stations:** We have considered seven CNG stations that will be established under the company owned company operated model.

5.) **Line Pipes:** Landed cost of line pipe, laying charges, restoration charges and coating has been considered as Rs 2.69 crore per km for a 24'' line, Rs 2.27 crore per km for a 20" line, Rs 1.65 crore per km for a 16" line, Rs 1.18 crore for 12" line, Rs 94 lakh per km for 10" line, Rs 77 lakh for an 8" line, Rs 60 lakh for a 6" line and Rs.44.6 lakh per km for 4" line

6.) **MDPE Pipes:** Capital expenditure for MDPE pipes has been considered as:

Pipeline diameter (mm)	Material + Laying + restoration charges (Rs/meter)
125	1117
90	723
63	480
32	334
20	324

7.) City gas station (CGS): The cost of CGS includes the cost of land, mechanical equipment, erection cost. It has been considered at Rs 20.31 crore. The CGS for the network is planned

at Dankuni, as this area is most suitable for connecting the CGD network with the various gas sources for supplying gas to the network.

8.) **Metering & regulating units**: These units have been considered separately for domestic, industrial and commercial customers.

9.) **District regulating stations (DRS):** The landed cost of DRS has been considered as Rs 20 lakh.

10.) **Cathodic protection:** Set up cost of a SCADA / cathodic protection has been considered as Rs 2 lakh per km for steel pipelines.

11.) **Bulk materials:** Bulk materials include pipes, electrical and instrumentation items and are provided based on MTOs and estimated by using in house cost data.

12.) **Line pack:** The line pack volume for the steel grid line has been included in the relevant capital expenditure plan. The cost of line pack is the cost of gas at the CGS. The line pack cost has not been reckoned in the financial analysis as the same is negligible.

13.) **Mechanical erection:** Mechanical erection charges have been considered for each type of facility wherever applicable.

14.) **Civil works and plant buildings:** Civil works include equipment foundations, plant buildings, pavement, etc.

15.) **Indirect costs:** These include work contract tax, and insurance costs. However, statutory taxes and duties are not included as costs on capital expenditure have been estimated post tax and duties.

16.) **Engineering and EPC charges:** A provision of 5% on plant & machinery cost has been made for detailed engineering. Procurement services, construction supervision and project management are based on conventional execution methodology.

17.) **Land:** Land has been provided for the mother station and DRS (this includes cost of acquisition and site development works).

18.) **Owner's management expenses:** A provision of 1% on plant & machinery cost excluding contingencies has been made in the cost estimate for owner's management expenses that include owner's establishment, travel, training, communication, rent, taxes, other miscellaneous and pre project expenses during project execution.

19.) **Start up and commissioning:** Start-up and commissioning expenses include all costs required for successfully commissioning the project and include costs for vendor servicemen, commissioning assistance and utilities/consumables required for starting the plant. Provision for these expenses comprises 1% of engineering and EPC charges based on past trends in handling similar works.

20.) **Contingencies:** A provision of 5% on plant & machinery cost has been made for contingencies to take care of unforeseen costs during project execution.

10.1.2 MDPE network

The MDPE network consists of polyethylene pipes of diameters 125mm, 90mm, 63mm, 32mm and 20mm. The twelve meter average length per domestic connection is also considered for commercial & industrial connections, as commercial units along with some industrial units will also be present in the

residential areas. Costing is based on in house data bank and the lengths of MDPE pipes per connection is taken as under:

Table 47: Length of MDPE pipeline per connection

MDPE Size	Meter/Connection
125 mm	1
90 mm	2
63 mm	3
32 mm	4
20 mm	2

10.2 Facility roll-out plan

The construction plan as per the proposed phasing and implementation is reflected below:

Table 48: CNG station roll-out plan

PARTICULARS	Y1	Y2	Y3	Y4	Y5	Y10	Y15	Y20	Y25	Total
Mother Mega stations (2 X 1600 SCMH)	0	2	2	4	2	1	0	0	0	**14**
Normal Mother stations (1X1600 SCMH)	8	12	12	2	3	0	0	1	0	**43**
Total No. of CNG Stations	8	14	14	6	5	1	0	1	0	**57**
Cumulative No. of CNG Station	**8**	**22**	**36**	**42**	**47**	**52**	**54**	**57**	**57**	**57**

Source: CRIS Analysis

Table 49: CGD roll-out plan

City Gas Distribution	Y1	Y2	Y3	Y4	Y5	Y10	Y15	Y20	Y25	Total
DRS 2500 SCMH (Nos.)	5	20	10	5	5	1	1	0	0	**69**
Steel Grid -24" (In Km)	16.7	0	0	0	0	0	0	0	0	**16.7**
Steel Grid -20" (In Km)	10	10.5	0	0	0	0	0	0	0	**20.5**
Steel Grid -16" (In Km)	10	4	0	0	0	0	0	0	0	**14**
Steel Grid -12" (In Km)	15	15	5.5	0	0	0	0	0	0	**35.5**
Steel Grid -10" (In Km)	20	20	12	0	0	0	0	0	0	**52**
Steel Grid -8" (In Km)	10	20	23	0	0	0	0	0	0	**53**
Steel Grid -6" (In Km)	50	50	32	0	0	0	0	0	0	**132**
Steel Grid -4" (In Km)	10	10	10	20	10	1	1	1	0	**84**
Domestic Connections	100,000	200,000	300,000	400,000	418,000	66,519	74,064	29,792	31,787	24,68,118
125mm MDPE Pipeline Network (In Km)	100	200	300	400	418	67	74	30	32	**2468**
90mm MDPE Pipeline Network (In Km)	200	400	600	800	836	133	148	60	64	**4936**
63mm MDPE Pipeline Network (In Km)	300	600	900	1200	1254	200	222	89	95	**7404**
32mm MDPE Pipeline Network (In Km)	400	800	1200	1600	1672	266	296	119	127	**9872**

City Gas Distribution	Y1	Y2	Y3	Y4	Y5	Y10	Y15	Y20	Y25	Total
20mm MDPE Pipeline Network (In Km)	200	400	600	800	836	133	148	60	64	**4936**

Source: CRIS Analysis

10.3 Operating expenditure (opex)

Opex is estimated based upon the manpower required for the O&M activities. Organisational development at all levels will be in tune with the expansion of the CGD network. The O&M philosophy will essentially have the following features:

1.) Lean organisation

2.) Uninterrupted supply of natural gas to ensure customer satisfaction

3.) Technology development / absorption for safety, service reliability and cost effectiveness

4.) Outsourcing most activities

5.) Equipment maintenance, largely through contracts, preferably with original equipment manufacturers (OEMs)

6.) Maximum leveraging of technology to minimise man-power and maximise efficiency.

7.) Complying with regulatory stipulations, standards and codes of practices

The basis for operating expenses has been taken as below:

1.) O&M expenses for piped natural gas (PNG) have been taken as 1% of capital cost of the CGD network

2.) Overheads have been considered at Rs 0.50 per standard cubic metre (scm) of gas sales

3.) O&M charges for CNG dispensation has been considered at 4% of CNG capex.

4.) Power cost has been considered at Rs 0.74 per scm.

5.) Administrative charges have been taken as Rs 0.08 per scm of gas sales.

10.4 Indirect cost

The following Indirect costs have been considered at the prevailing rates as under:

Works contract tax : 4%

Insurance : 1% of capital cost

No other taxes, duties, levies, etc, have been considered for working out cost estimates.

10.5 Summary of capex / opex

Year-wise capital expenditure for the CGD network is given in the table below (in crore):

Table 50: Year-wise capital expenditure for the network

	Year 1	Year 2	Year 3	Year 4	Year 10	Year 15	Year 20	Year 25	total
CNG stations	23	72	76	55	14	0	12	0	363
CGD	774	376	445	530	99	121	55	65	4,401
CGS	21	0	0	0	0	0	0	0	21
Total	**818**	**448**	**522**	**585**	**113**	**121**	**67**	**65**	**4,800**

Source: CRIS Analysis

The total capital cost for the project is estimated at Rs 4,800 crore (with escalation), spread over 25 years.

The O&M expenses for the CGD project have been segregated into CGD and CNG-related expenses, as shown below:

Table 51: Opex for CGD project (Rs lakh)

S No	Description	Y1	Y2	Y3	Y4	Y5	Y10	Y15	Y20	Y25
1	Total Manpower cost	309	375	446	437	639	1262	2359	4411	8245
2	Administration Charges	40	115	240	384	564	1004	1685	2821	4466
3	Overheads	248	720	1503	2400	3525	6276	10532	17630	27912
4	O&M of CGD network	795	1242	1817	2557	3416	5313	8373	13395	17905
	Total opex	**1392**	**2452**	**4006**	**5878**	**8144**	**13856**	**22950**	**40802**	**58529**

Source: CRIS Analysis

For estimation of manpower cost, the assumption is mentioned below:

Table 52: Assumptions for estimation of manpower cost at peak demand

Type of manpower	Assumptions (numbers)	Annual cost (Rs Lakh)
Regular manpower		
Executives	6	15
Non executives	12	10
Contractual manpower		
CGS	8	4
Steel grid line	6	4
Domestic & commercial connection	17	4
Industrial connection	5	4
Security guard	6	1.2
CNG station manager	7	1.5
Technical & emergency support	30	1.2
Customer grievance	10	1.2

Table 53: Opex for CNG project (Rs lakh)

Sr No	Description	Y1	Y2	Y3	Y4	Y5	Y10	Y15	Y20	Y25
1	O&M charges	129	435	795	1088	1351	2149	3101	4547	6085
2	Power	157	471	1016	1480	2114	3213	4450	6169	8559
3	Other CNG expenses	64	196	436	654	962	1687	2697	4315	6911
4	Dispensing cost	53	164	363	545	801	1406	2247	3596	5759
5	Manpower cost	0	1.7	3.9	8.7	14.8	32.4	60.5	113.2	211.6
	Total opex	402	1267	2614	3776	5243	8487	12557	18741	27525
	OVERALL OPEX	**1795**	**3719**	**6620**	**9654**	**13387**	**22343**	**35507**	**56070**	**86054**

Source: CRIS Analysis

An annual escalation of 6% has been considered for arriving at the operating cost.

11. Financial analysis

The project's financial analysis has been carried out based on capital and operating cost as elaborated in the above section and the purchase price of gas delivered at the tap-off and finally to consumers of gas for the project. Profit & loss statement, cash flow statement and balance sheet have been projected for the project's lifespan of 25 years.

11.1 Methodology of financial feasibility

The methodology for assessing financial feasibility of the CGD network in the geographical area has been presented below:

1.) A CGD network's financials comprise:
   a) Capital employed over the project life (25 years)
   b) O&M cost over the estimated life of the project
   c) Revenue from
      (i) Network tariff
      (ii) Compression charge
      (iii) Gas marketing margin
2.) Setting up a CGD network is a capital intensive business and a necessity for efficient management of all safety, O&M aspects
3.) Capital employed in a CGD network covers feeder pipeline(s) if any, city gate station(s), gas distribution pipelines (steel and polyethylene), district regulating station, distribution related equipment / facilities (determination of network tariff) and on-line compressor together with associated metering, power standby / backup and fire-fighting equipment (for determination of compression charge). These assets are called 'regulated assets'.
4.) Investments in setting up CNG stations, which include cost of land, cascades (stationery and mobiles), dispensers, instrumentation and control, power generation / back-up, civil structures, electrical installations and other miscellaneous facilities are considered as un-regulated assets
5.) O&M cost includes cost of consumables, utilities (power, fuel and water), salaries and wages, repair and maintenance, insurance premium on fixed assets and administrative overheads (commensurate with the level of operation in the CGD network)
6.) Capital employed includes base costs (including engineering, owner's management, escalation & contingencies, preliminary / pre-operative costs), working capital and interest during construction (less accumulated depreciation)
7.) Capital employed in assets together with their respective O&M costs are considered to calculate the network tariff and compression charge for each year based on reasonable rate of return as project's internal rate of return (IRR) (not exceeding 14% post-tax) using the discounted cash flow methodology.
8.) **Business returns:** Project IRR (PIRR) and equity IRR (EIRR) are computed separately considering overall capital investment in the CGD project and O&M cost

9.) The delivered price of gas to end-consumers comprises cost of gas at CGS, network tariff and gas marketing margin to industrial, commercial and domestic consumers and additional compression charge for CNG consumers

10.) It has been assumed that supply to the geographical area would come from two sources:

a) Domestic sources for CNG and domestic consumers

b) R-LNG for industrial and commercial consumers

11.2 Financial assumptions

11.2.1 Debt-equity

As capital investments in a CGD project takes place over 25 years, it would not be prudent to assume debt financing for 25 years. The capital expenditure is assumed to be funded through a debt-equity ratio of 70:30, till the time the business is able to generate sufficient internal accruals.

Table 54: Key financing assumptions

Particulars	Unit	Values
Equity	%	30%
Debt	%	70%
Term loan from financial institutions		
Rate of interest for long term debt	Per annum	12.50%
Period of Moratorium	Years	2
Term of loan after moratorium	Years	8

11.2.2 Key economic and accounting assumptions

The key economic and accounting assumptions considered for the CGD project have been presented in the table below.

Table 55: Economic and accounting assumptions

Particulars	Values
Base year exchange rate	Rs 66 / USD
Depreciation rate (Book Depreciation - SLM)	
Pipelines	5.28%
CNG	6.33%
Depreciation rate (WDV)	
Pipelines	15%
CNG	15%

11.2.3 Tax rate assumptions

The key tax related assumptions considered for the CGD project have been presented in the table below.

Table 56: Tax rate assumptions

Particulars	Values
Corporate tax	
Corporate tax Rate	30.00%
Surcharge	12%
Education cess (3% on summation of Corporate tax rate plus surcharge)	3%
Total Corporate tax	**34.61%**
Minimum Alternate Tax	
MAT rate	18.50%
Surcharge	12%
Education cess	3%
MAT Tax Rate	**21.3%**

11.2.4 Working capital assumptions

Table 57: Key working capital assumptions

Particulars	Values
Normative working capital (days of operating cost excl. depreciation)	20
Margin money for working capital	25%
Bank Borrowings for working capital	75%
Interest rate for working capital borrowings	13%

11.2.5 Commodity tax assumptions

Table 58: Key commodity tax assumptions

Particulars	Values
Sales tax – Domestic	13.50%
Sales tax – Commercial, Industrial and CNG	13.50%
Excise Duty – CNG	14.42%
VAT on Gas purchase	13.50%

11.2.6 Escalation rates

The various escalation rates considered for financial analysis of the CGD project have been tabulated below:

Table 59: Escalation rates

Particulars	Values
Capital Cost	3%
Operating Cost	6%

11.3 Selling price assumptions

The assumptions used for projecting the selling price of natural gas for different end-consumers have been tabulated below.

Table 60: Selling price assumptions

Segment	Alternative fuel	Price of alternate fuel (Rs)	Discount offered
Domestic	Domestic LPG (14.2 kg)	421	10%
Commercial	Commercial LPG (19 kg)	1006.5	10%
Industrial	Bulk LPG (MT)	41,563	20%
CNG	HSD (per Liter)	50.75	20%

Table 61 : Discount rates (year 1 to year 25)

Discount to alternate fuel	Alternate fuel	Y1	Y5	Y10	Y15	Y20	Y25
Domestic	Domestic LPG	10%	10%	10%	10%	10%	10%
Commercial	Commercial LPG	10%	10%	10%	10%	10%	10%
Industrial	Bulk LPG	20%	20%	20%	20%	20%	20%
CNG	Diesel	20%	20%	20%	20%	20%	20%

Source: CRIS Analysis

11.4 Gas purchase cost assumptions

It has been assumed that domestic gas supplies would be able to only cater to demand from the domestic and 80% of the CNG (automobile) segment. This is as per the guidelines issued recently by the MoPNG on allocating domestic natural gas. Hence, to cater to demand from industrial and commercial segments, the entity would need to rely on R-LNG and CBM gas from GEECL's Raniganj fields.

Considering India's energy deficit and the inability of existing CGD networks to get requisite quantities of domestic gas, it has been assumed that the government would strive to provide at least a volume of domestic gas equivalent to 80% of total demand from the CNG segment and domestic segment from CGD networks to meet their demand. Additional demand would need to be catered to by utilising R-LNG and CBM from GEECL's Raniganj fields.

Pricing structures for both these sources have been provided below:

Table 62: Gas purchase price assumptions

Element	Unit	Domestic gas	R-LNG	CBM from GEECL/Essar
Basic price	USD/mmBtu	3.06	7.50	10
Price in Rs/MMBTU	Rs/mmBtu	201.96	495	660
Marketing margin	Rs/mmBtu	4.54	10.72	-
Regasification charges	Rs/mmBtu	-	71.50	-

Element	Unit	Domestic gas	R-LNG	CBM from GEECL/Essar
Transportation	Rs/mmBtu	50	50	50
Service tax on transportation	%	14.50%	14.50%	14.50%
VAT	%	5%	5%	5%

Source: CRIS Analysis

Over and above the basic price of gas, there are other taxes and duties that are considered for arriving at the final price gas purchase price. We have explained these other items below which impact the final gas purchase price.

- Marketing margin: A seller of gas charges a marketing margin over and above the basic price of gas.
- Regasification charge: In case of LNG, it needs to be regassified back to gaseous state from liquid state. This charge is levied to cover the regasification cost.
- Transportation: Transportation tariff is the charge that a customer needs to pay the shipper of the gas for using its pipeline infrastructure.
- Service tax: It is applicable on the sale of a commodity or a service and is a central level tax.
- VAT: VAT charges are levied on the final price of gas sold. This is a state level tax and varies from state to state.

11.5 Financial projections

Financial projections based on all the economic, financial and commercial assumptions have been summarized below. Key financial ratios such as gross profit margin, EBITDA margin and net profit margin have also been presented below:

Table 63: Key financials

Particulars	Units	FY1	FY2	FY3	FY4	FY5	FY10	FY15	FY20	FY25
Net revenue	**Rs cr**	114	319	641	981	1390	2184	3169	4574	6248
Less: Gas cost	Rs cr	76	200	389	587	823	1333	1996	2978	4109
Gross profit	Rs cr	39	119	252	394	568	851	1173	1597	2139
Gross margin	**Percentage**	34%	37%	39%	40%	41%	**39%**	**37%**	**35%**	**35%**
Less: Opex	Rs cr	18	37	68	101	144	223	355	561	861
EBITDA	Rs cr	21	82	185	292	424	628	818	1036	1279
EBITDA margin	**Percentage**	**18%**	**26%**	**29%**	**30%**	**31%**	**29%**	**26%**	**23%**	**20%**
Less: Interest	Rs cr	0	86	113	135	155	62	0	0	0
Less :Depreciation	Rs cr	45	70	98	129	161	187	217	139	82
Less: Tax	Rs cr	0	0	0	6	23	107	229	319	413
PAT	Rs. cr	-25	-73	-26	22	85	272	371	578	784
PAT margin	**Percentage**	**N.A.**	**N.A.**	**N.A.**	**2%**	**6%**	**12%**	**12%**	**13%**	**13%**

Source: CRIS Analysis

While the business margin is expected to be low in the initial years of operations as sales volume and revenue build up gradually, margin is likely to improve over the medium to long term with expansion of volumes in the geographical area. Net profit margin is expected to be about 13% by the 25th year of operations.

11.6 Business returns

Project internal rate of return (PIRR) and equity IRR (EIRR) are commonly-used indicators for the project's financial feasibility. These indicators have been briefly discussed below along with the output of financial analysis have also been provided in terms of these indicators.

11.6.1 Project IRR

Project IRR represents the project's yields regardless of the financing structure. It is the discounted rate which makes the net present value (NPV) of all cash flows from the project to zero. It is the sum of NPVs of net cash flows over the project life (25 years). Considering the assumptions mentioned above, the PIRR for this project is 14%.

11.6.2 Equity IRR

Equity IRR, a leveraged version of the Project IRR, considers net cash flows from operations (PAT plus depreciation), debt inflow minus capital expenditure, working capital changes and debt repayments. Considering the assumptions mentioned above, the EIRR for this project is 15%.

11.7 Computed tariffs

The tariff determination as per the PNGRB regulations is based on discounted cash flow (DCF) methodology, considering the reasonable rate of return on the capital employed to be the project's internal rate of return.

- The **DCF** methodology refers to equating the inflows from the projected revenue out of CGD network tariff/compression charge and with the outflows of capital and operating expenditure over the economic life of the project by discounting these flows at the project's reasonable rate of return. Volumes and outflows are estimated over the project's lifecycle, which results in determination of CGD Network tariff and compression charge, required to be earned by the project to achieve the IRR.
- **The reasonable rate of return** is the rate of return on the capital employed of 14% post-tax as provided in the regulations. Pre-tax rate of return on capital employed is to be computed by grossing up 14% by the nominal rate of income tax applicable for corporate bodies.
- **Economic life of the CGD network** is taken to be 25 years from the date of authorization as per the regulations.

11.7.1 Network tariffs

Individual components of the network tariff computation by DCF methodology have been described below:

- **Revenue from network tariff** (@ reasonable returns)- This component considers the revenue expectation from the CGD network operations given the reasonable rate of return of 14% on the capital employed and the economic life of the CGD network i.e. 25 years.
- **Capital investment –** This component covers the capital investment that goes in to setting up the CGD network and includes the investments in fixed assets.
- **Change in working capital requirements –** This component covers the change in working capital requirement from one year of CGD network operation to the next based on the normative working capital requirement for each year.
- **Operating costs –** Operating cost component covers the cost requirements for the day to day CGD network operations. This is the cost associated with the O&M activities.
- **Volume to be considered –** Volumes expected to be sold to each consumer segment, viz domestic, CNG, commercial and industrial to be considered for network tariff computations.

Based on the estimated capital expenditure and other assumptions set out in this report the Network tariff for first year is expected be Rs 7.01 per scm.

The year wise network tariffs are shown in the following table:

Table 64: Year-wise network tariff

Year	YOY tariff (Rs/scm)	YOY tariff (Rs/mmBtu)
Year 1	7.01	187.23
Year 2	7.22	192.85
Year 3	7.44	198.63
Year 4	7.66	204.59
Year 5	7.89	210.73
Year 6	8.13	217.05
Year 7	8.37	223.56
Year 8	8.62	230.27
Year 9	8.88	237.18
Year 10	9.15	244.29
Year 11	9.42	251.62
Year 12	9.70	259.17
Year 13	9.99	266.95
Year 14	10.29	274.95
Year 15	10.60	283.20
Year 16	10.92	291.70
Year 17	11.25	300.45
Year 18	11.59	309.46
Year 19	11.93	318.75
Year 20	12.29	328.31
Year 21	12.66	338.16
Year 22	13.04	348.30
Year 23	13.43	358.75

Year	YOY tariff (Rs/scm)	YOY tariff (Rs/mmBtu)
Year 24	13.83	369.52
Year 25	14.25	380.60

Source: CRIS Analysis

11.7.2 Compression charge

The individual components of the network tariff computation by DCF methodology have been described below:

- **Revenue from compressions charges (@ reasonable returns) –** This component considers the revenue expectation from the compression charges given the reasonable rate of return of 14% on the capital employed and the economic life of the CGD network, i.e. 25 years.
- **Capital investment –** This component covers capital investment that goes in to setting up the CNG operations and includes investments in fixed assets.
- **Change in working capital –** This component covers the change in working capital requirement from one year of CNG operations to the next based on the normative working capital requirement for each year.
- **Operating costs –** The operating cost component covers the cost requirements for the day to day CNG operations. This is the cost associated with O&M activities.
- **Volume to be considered –** Volumes expected to be sold to the CNG consumer segment to be considered for compression charges computations.

Based on estimated capital expenditure and other assumptions set out in this report, the compression charge for first year is expected to be Rs 3.47 per scm and Rs 4.55 per kg.

Table 65: Year-wise compression charge

Year	YOY tariff (Rs/scm)	YOY tariff (Rs/kg)
Year 1	3.47	4.55
Year 2	3.57	4.68
Year 3	3.68	4.82
Year 4	3.79	4.97
Year 5	3.91	5.12
Year 6	4.02	5.27
Year 7	4.14	5.43
Year 8	4.27	5.59
Year 9	4.40	5.76
Year 10	4.53	5.93
Year 11	4.66	6.11
Year 12	4.80	6.29
Year 13	4.95	6.48
Year 14	5.10	6.68
Year 15	5.25	6.88
Year 16	5.41	7.08

Year	YOY tariff (Rs/scm)	YOY tariff (Rs/kg)
Year 17	5.57	7.29
Year 18	5.74	7.51
Year 19	5.91	7.74
Year 20	6.08	7.97
Year 21	6.27	8.21
Year 22	6.46	8.46
Year 23	6.65	8.71
Year 24	6.85	8.97
Year 25	7.05	9.24

Source: CRIS Analysis

11.8 Scenario analysis

The following scenarios have been compared for the purpose of the CGD project's financial assessment.

Table 66: Business scenarios

Scenarios	Description
Base case	Scenario with all base-case assumptions
Increasing gas price	Increasing gas price by 10%
Decreasing gas price	Decreasing gas price by 10%
Decreasing capex	Capex to be reduced 10% compared with estimates considered in the base case
Increasing capex	Capex to increase 10% compared to the estimates considered in the base case
Decreasing gas Demand	10% reduction in demand for natural gas
Increasing gas demand	10% increase in demand for natural gas

The comparison of the CGD project's equity IRR and project IRR in Kolkata and the adjoining districts in the GA considering the abovementioned scenarios has been shown in the table below:

Table 67: Scenario analysis results

Particulars	PIRR	EIRR
Base case	14%	15%
Increasing gas cost by 10%	11%	10%
Decreasing gas cost by 10%	17%	19%
Increasing capex by 10%	13%	13%
Decreasing capex by 10%	15%	16%
Decreasing gas Demand by 10%	12%	12%
Increasing gas demand by 10%	16%	17%

Source: CRIS Analysis

12. Key risks & mitigation measures

The proposed CGD project is supported by demand for natural gas and the natural gas supply infrastructure that is expected to be in place once authorisation is awarded. However, there are certain risk areas that may impact the successful execution and the expected financial returns. These risks have been listed below.

Table 68: Risks & mitigation

Risk type	Risk description	Potential mitigation measures
Risk of securing gas	**Availability:** As domestic supplies of natural gas are scarce, the alternative is LNG, whose prices are linked to crude prices. This implies lower margin on the commodity. Currently, there are uncertainty because of lack of transmission infrastructure in the geographical area (GA),	▪ There is an allocation of domestic gas for meeting full requirement of CNG and PNG for existing CGD networks. This would result in allocation of domestic gas for the proposed CGD network also. ▪ Other sources such as CBM from nearby Raniganj fields could be evaluated.
Margin Risk	**Purchase prices:** GCGSCL does not have a control on variability of prices of gas that it sources. However, while distributing gas, the end-use segments, such as domestic and CNG remain very price sensitive.	▪ GCGSCL could educate / give indications to consumers about possibility of change in prices based on market dynamics.
	Infrastructure margin: Non-regulated or regulated costs could increase much more than envisaged thereby pulling down margin	▪ GCGSCL could benchmark costs and establish robust procurement policies
Market Risk	**Domestic:** Risk of conversion from LPG owing to subsidies on the fuel. Issue of non-payment (it is applicable on all segment, but can be higher in domestic owing to issues such as relocation etc.)	▪ Communication plans to be in place for imparting information related to safety-related aspects of gas usage to consumers ▪ Deposits (already in place) ▪ Diligence before connections
	CNG: Risk of low conversion owing to ▪ Lower savings (especially of input gas price increases) ▪ Barriers owing to purchase of kits ▪ No major difference on environment considering Euro IV norms Risk of other players catering to CNG consumers as a result of CNG operations	▪ Assistance in conversion, communication on conversion benefits, streamlining operations so as to eliminate inconvenience to converting consumers ▪ Regulatory representation needed for creating a level playing field

Risk type	Risk description	Potential mitigation measures
	being put out of the purview of the CGD network	
	Commercial / Industries: Risk of tapping of key anchor consumers post the exclusivity period by gas suppliers / shippers	▪ Long-term contracts need to be entered into with the consumers ▪ Additional services i.e. for conversion may be provided ▪ Robust marketing team needs to be in place
Regulatory/ Policy/ Statutory Risk	**Imposition of penalties:** Risk of not meeting desired connections as committed to regulator	▪ Plan for laying network in areas awarded for establishing CGD network ▪ Plan for securing land for implementation of CGD networks ▪ Appropriate documentation on reasons for delay/ slippages ▪ Process for addressing consumer delays ▪ Timely representation to regulator on any slippages
	Changes in regulations: Changes in regulations that impact margins, right to infrastructure exclusivity or put un-envisaged burden	▪ Strong regulatory team that responds to public consultations and is aware of international regulations
Contractual Risk	**Mismatch of terms:** GCGSCL would source gas on ToP basis for a longer term, whereas in case of sales to domestic and CNG consumers there may be no back-to-back terms	▪ Inclusion for swing / interruptible end-users, robust sourcing plan (including flexibilities)
Disruptions	**No Supplies:** GCGSCL would supply natural gas to domestic, CNG users where supply disruptions could disruption day-to-day life	▪ Planning for such emergencies including alternatives such as R-LNG
Consumer Liabilities	**Reputation, Publicity:** Any accident involving gas and loss (including of life) could be attributed to GCGSCL and involve litigation	▪ Adherence to safety, Communication on safety ▪ Compensation post such issues, ▪ Safety audits need to happen, ▪ Sourcing of quality components, safety diligence before connections, appropriate insurances

Risk type	Risk description	Potential mitigation measures
GCGSCL internal team & processes	**Scaling Up:** Scarcity of resources as CGD sector is evolving	▪ Benchmarking compensation, training, building robust processes needed
	Setting up processes: Inadequate processes to intensify procedural risks	▪ Setting up the processes required

Source: CRIS Analysis

13. Summary

Developing a CGD network hinges on four factors: Gas supply, infrastructure, regulations and economic drivers. The CGD industry has a natural advantage in building the market by replacing conventional fuels in domestic (liquefied petroleum gas and kerosene), industrial, commercial, and transportation (petrol and diesel) segments. However, this would depend on the relative price of gas with respect to other fuels.

Total demand for natural gas in areas governed by the Kolkata Municipal Corporation and adjoining areas is expected to increase from 1.53 mmscmd in the fifth year to 3.78 mmscmd by the 25th year based on the demand assessment for the geographical area. For the planned CGD network, majority of construction of the steel pipeline network is expected to be completed in the first five years based on the detailed technical assessment for the geographical area. The PE network and compressors for CNG would be augmented in accordance with the gas demand projections. Supply of gas to consumers in the industrial, commercial, domestic and transportation segments is likely to commence in the first year. However, preparatory work would be necessary to develop vendor and contractors, particularly for PE network, to implement the project as per the planned schedule. The total capital cost for the project is estimated at Rs 4,800 crore (with escalation) over 25 years. The operational expenditure for the 25th year is estimated at Rs 861 crore.

Based on the estimated capital expenditure and other assumptions set out in this report the Network tariff for first year is expected to be Rs 7.01 per scm and PV of the weighted average unit network tariff for each year of the economic life of the project using the discount rate of 14% is (PV Rs 1539/mmBtu).

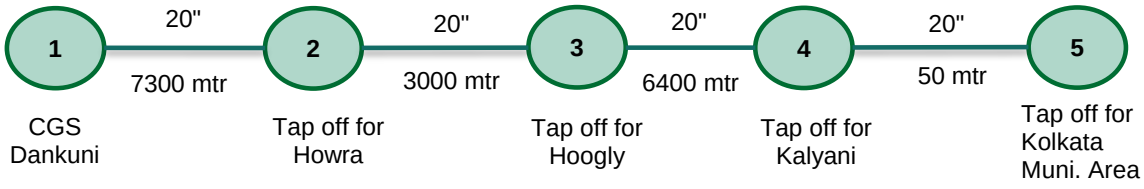
Based on the estimated capital expenditure and other assumptions set out in this report the compression charge for first year is expected to be Rs 3.47 per scm i.e. Rs 4.55 per kg and PV of the compression charge for each year of the economic life of the project using the discount rate of 14% is Rs 37.37 per kg.

Moreover, based on the various economic, accounting, commercial and financial assumptions discussed in this report, the project internal rate of return for the CGD project is estimated to be 14%, while the equity rate of return is estimated to be 15%.

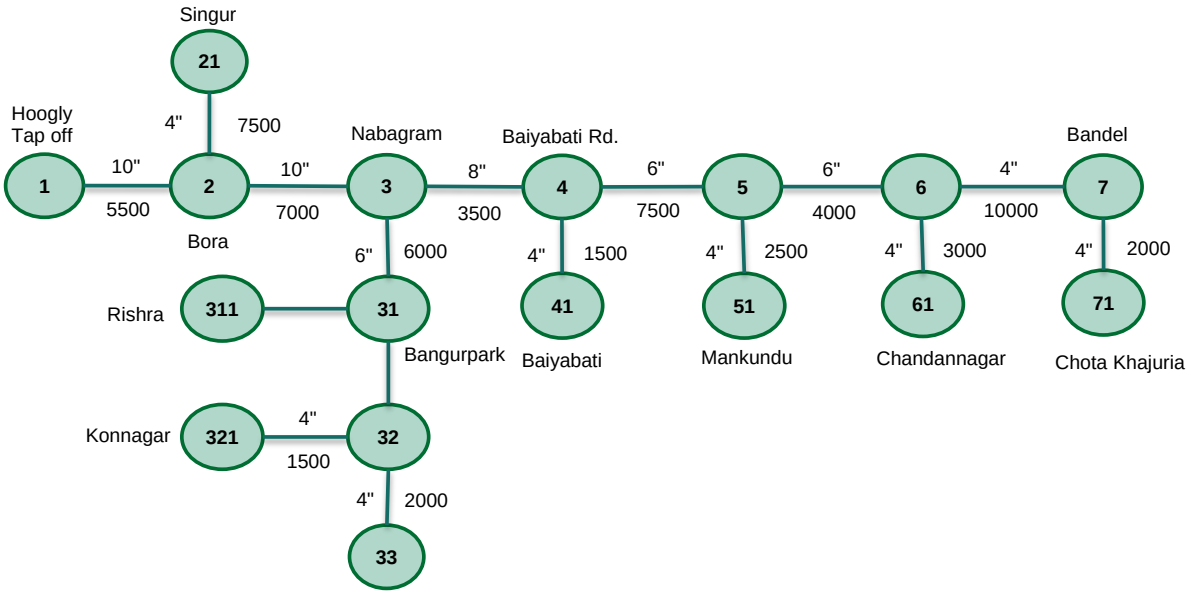
14. Annexure

Main pipeline Header from Dankuni CGS

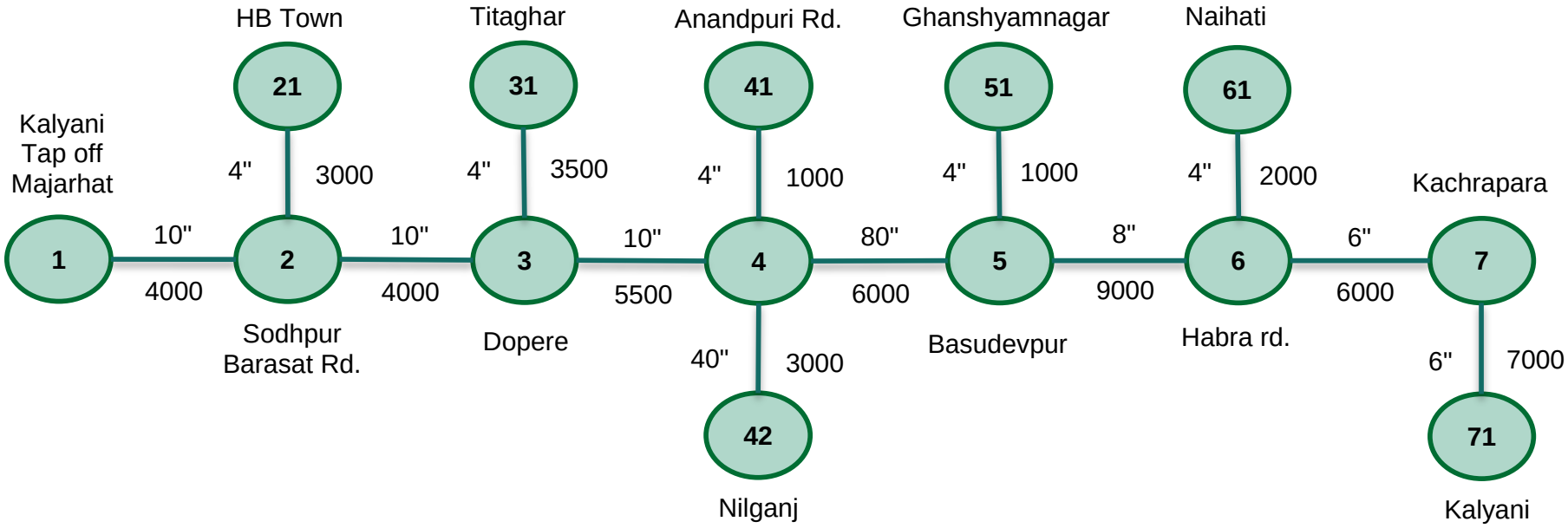
(Revised demand)



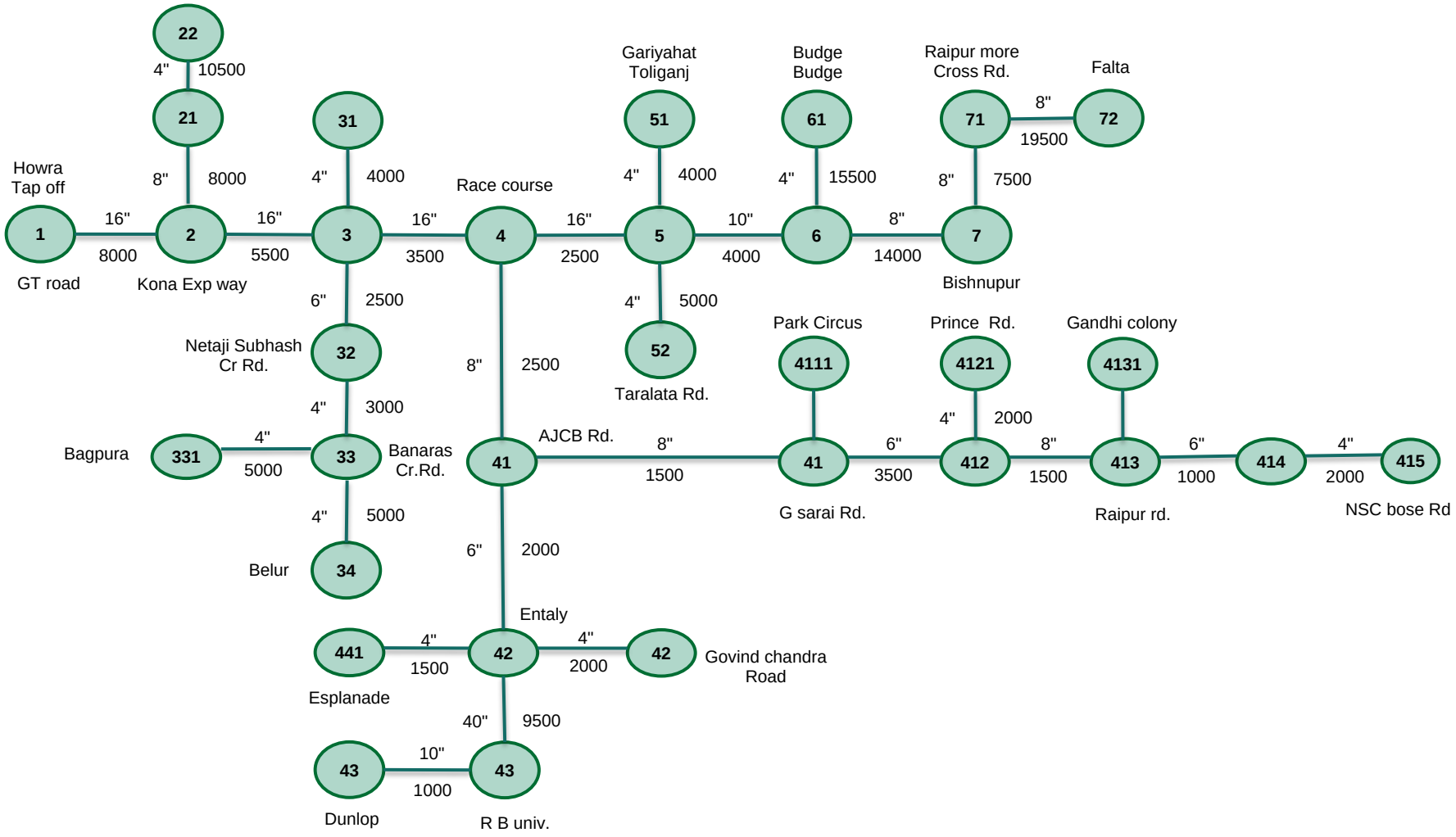
Hoogly area Network



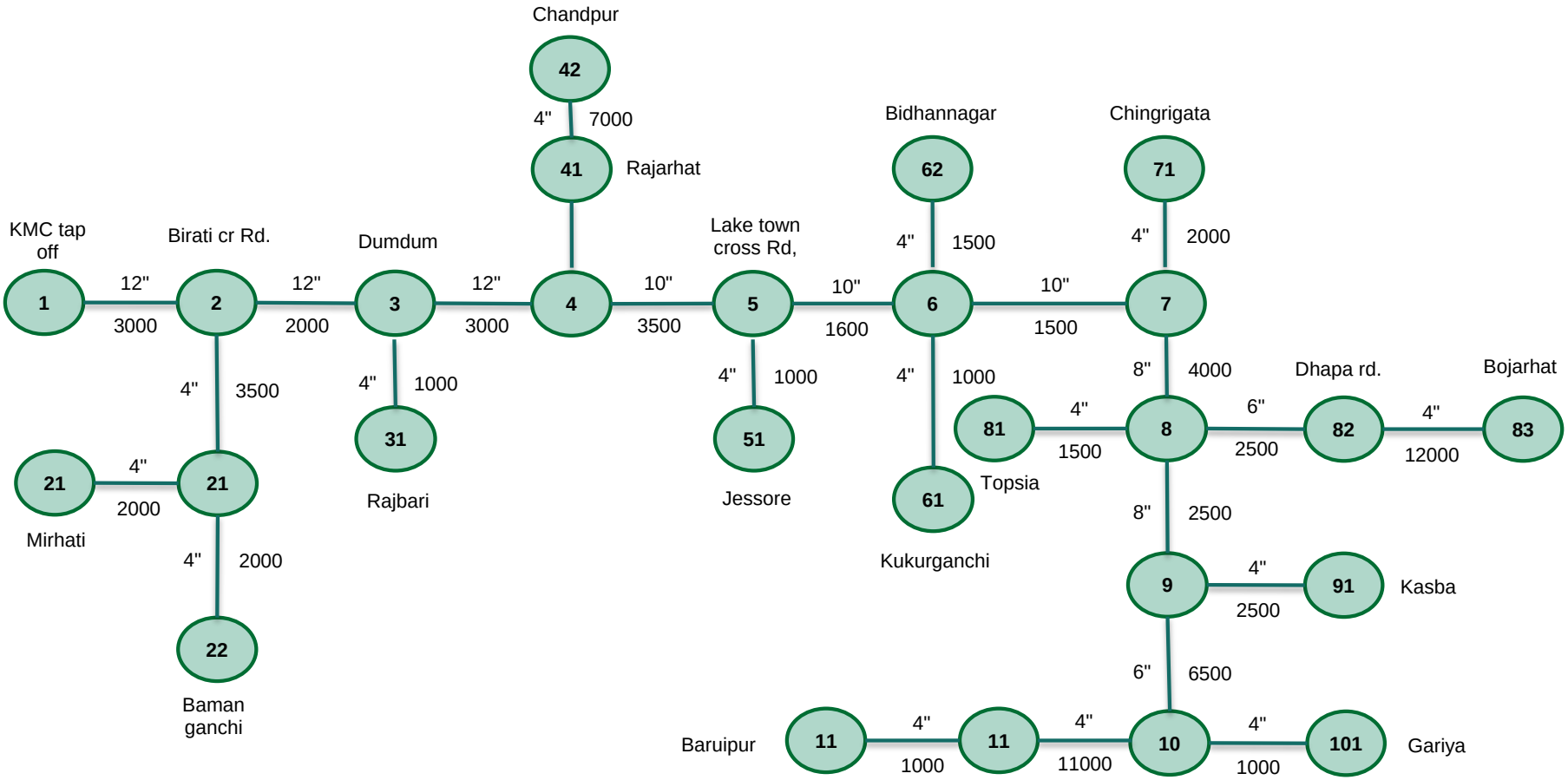
Kalyani area Network



Howra Area Network (As Annexure)



Kolkata Municipality Area



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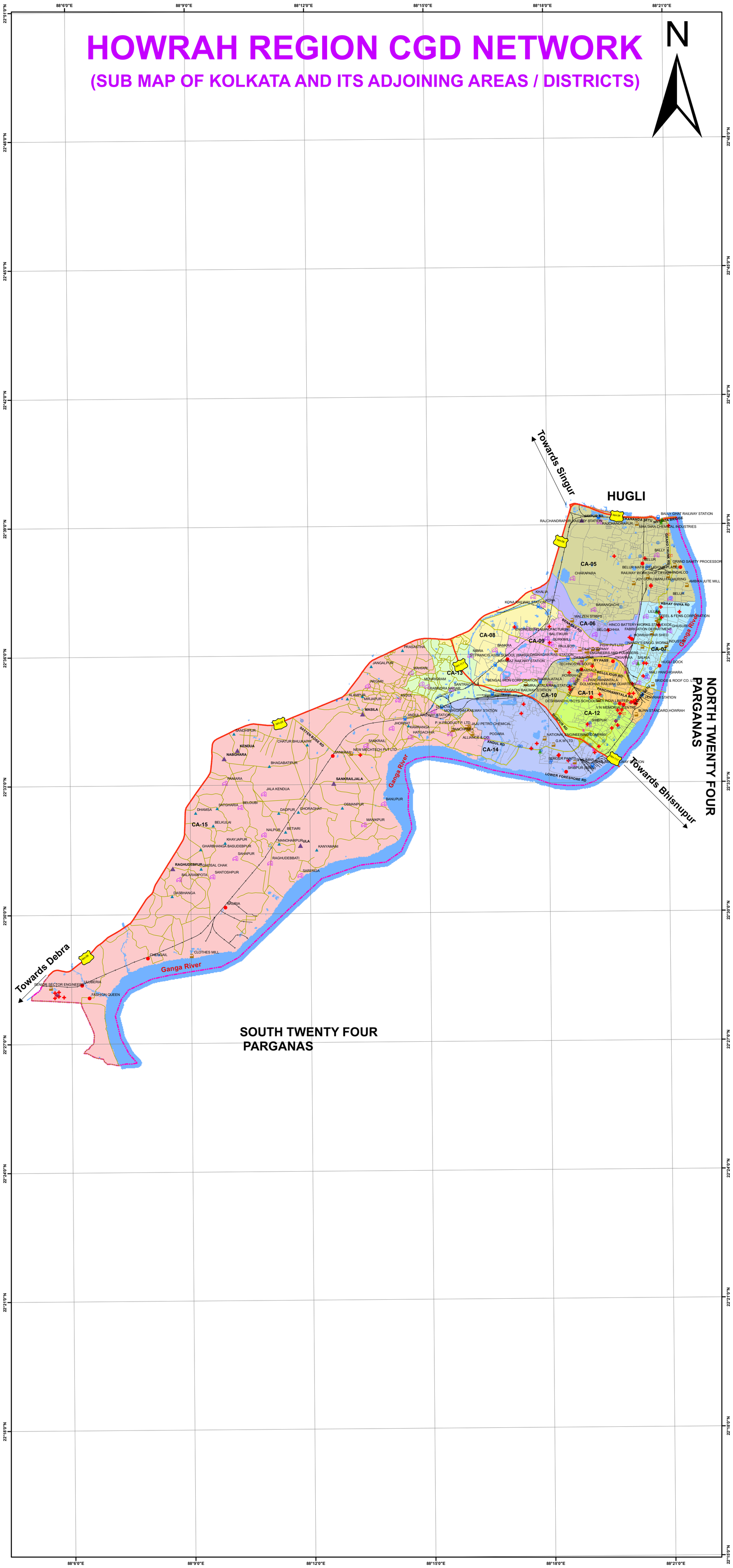
A JOINT VENTURE OF			
GAIL (INDIA) LTD	GCGSCL (A GOVT. OF WEST BENGAL ENTERPRISE)	**VALIDATION OF DFR PREPARED BY CRISIL CITY GAS DISTRIBUTION KOLKATA GA**	MECON LTD

ANNEXURE – IV

MAPS

HOWRAH REGION CGD NETWORK

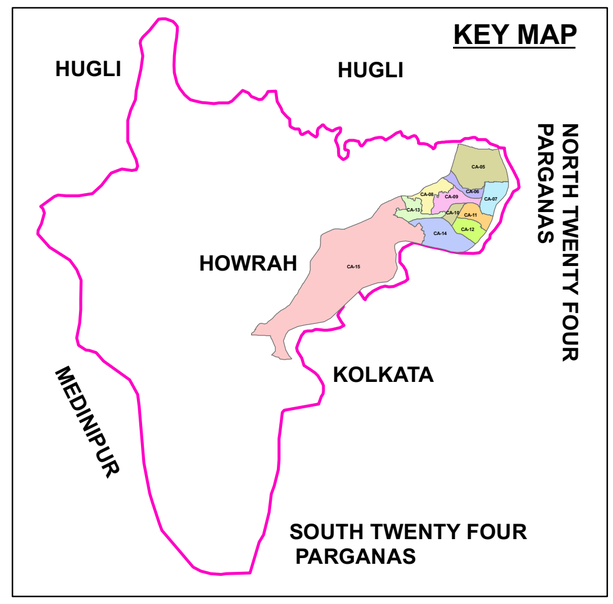
(SUB MAP OF KOLKATA AND ITS ADJOINING AREAS / DISTRICTS)



HOWRAH REGION CGD NETWORK

(SUB MAP OF KOLKATA AND ITS ADJOINING AREAS / DISTRICTS)

(WEST BENGAL STATE)



Total Population within the Geographical Area as per Census 2001	
20.23 Lacs(Approx.)	
Total Geographical Area (Sq.KMs)	**No. Charge Areas**
199	11

Charge Areas Identification	Important location within
CA-05	Bally
CA-06	Belgachia
CA-07	Salkia
CA-08	Kona
CA-09	Balitikuri
CA-10	Das Nagar - Ramrajatala
CA-11	Panchanantala - Kadamtala
CA-12	Shibpur
CA-13	Mourigram - Santragachi
CA-14	Shalimar - Shibpur (BESU)
CA-15	Uluberia

LEGEND

LANDMARKS

- AIRPORT
- BUS STATION
- COLLEGE/UNIVERSITY
- FACTORY
- FUEL CENTER
- GENERAL
- HOSPITAL
- LOCALITY
- MARKET
- OFFICE
- PARK
- POST OFFICE
- RAILWAY STATION
- RELIGIOUS PLACE
- VILLAGE

VECTORS

- NATIONAL HIGHWAYS
- MAIN ROADS
- OTHER ROADS
- STREETS
- RAILWAYS
- AIRSTRIP
- GA BOUNDARY
- WATER BODIES

VILLAGE POPULATION

- VILLAGE WITH POPULATION 5000 AND ABOVE

REMARKS:-

i. Landmarks are indicative in nature.
ii. Each charge area is depicted in different color and is enclosed by physical features such as roads, rivers, railway tracks or administrative boundaries as shown in the map.
iii. This map is a part of 'application' for the **Howrah Region** Geographical area.

MAP SCALE

0 1.5 3 6 9 Kilometers

GREATER CALCUTTA GAS SUPPLY CORPORATION LTD.
(A GOVT. OF W.B. ENTERPRISE)
12 A, Park Street, Kolkata-700071

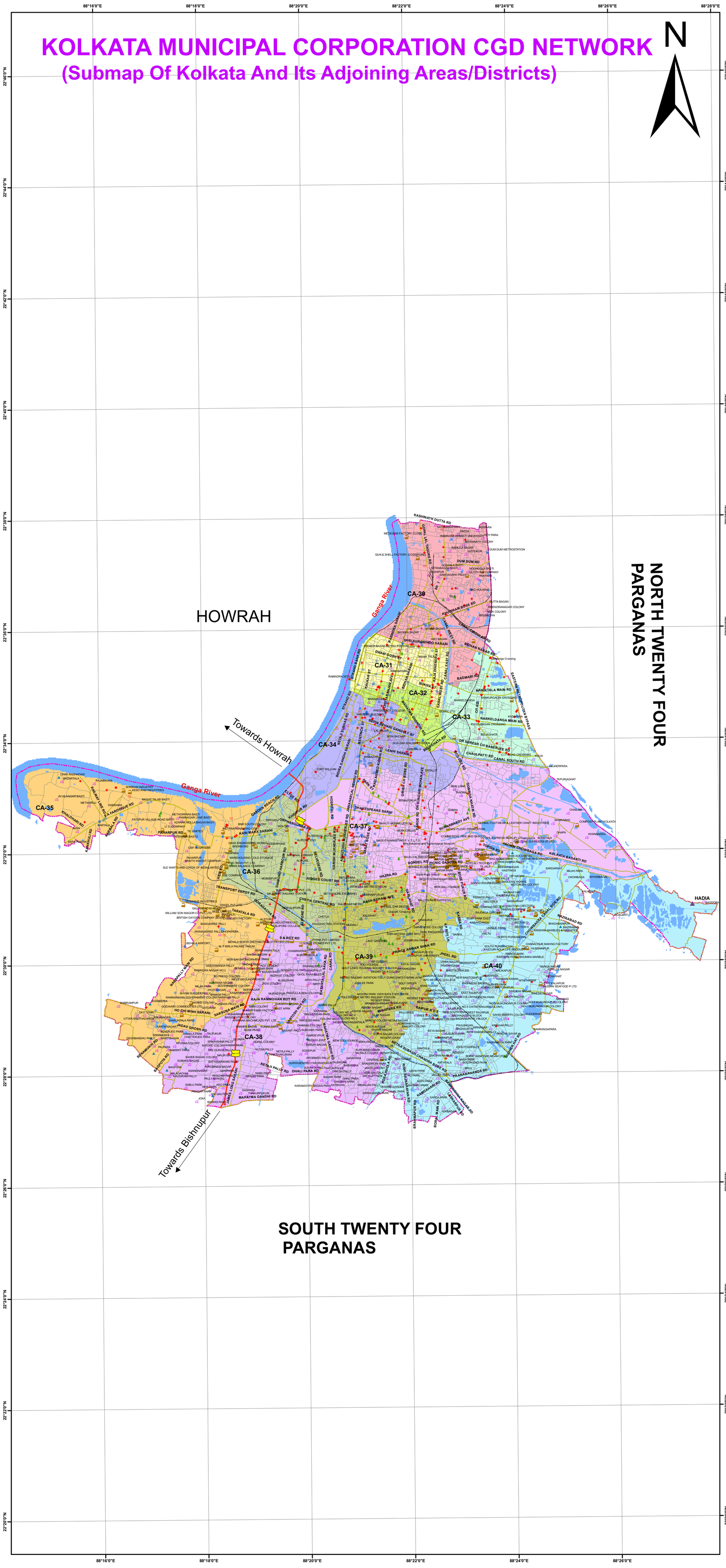
Map Prepared By :

HINDUSTAN PETROLEUM CORPORATION LTD.
(A GOVERNMENT OF INDIA ENTERPRISE)
6,Church Lane, Kolkata-700001

Map No.	**GCGSCL/CGD/REG17/01/GA-Howrah Region**
Date	**September-2010**
Map Title	**Howrah Region CGD Network (Sub Map of Kolkata and Its adjoining Areas / Districts)**

KOLKATA MUNICIPAL CORPORATION CGD NETWORK

(Submap Of Kolkata And Its Adjoining Areas/Districts)



Total Population within the Geographical Area as per Census 2001	
46.05 Lacs(Approx.)	
Total Geographical Area (Sq.KMs)	No. Charge Areas
192	11

Charge Areas Identification	Important location within
CA-30	Kashipur – Shyambazar
CA-31	Manik Tala - Shobha Bazar Metro Station
CA-32	Barabazar - Sealdah Railway Station
CA-33	Beliaghata
CA-34	BBD Bag – Esplanade
CA-35	Paharpur – Taratala - Behala
CA-36	Kidderpore – New Alipore
CA-37	Park Cicus – Topsia
CA-38	Sakher Bazar - Thakurpukur
CA-39	Kalighat – Tollygunje
CA-40	South Purbanchal - Dakshin Ray Nagar

LEGEND

LANDMARKS

- AIRPORT
- BUS STATION
- COLLEGE/UNIVERSITY
- FACTORY
- FUEL CENTER
- GENERAL
- HOSPITAL
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iii. This map is a part of 'document' for the **KMC**Geographical area.

MAP SCALE

0 1 2 4 6 Kilometers

GREATER CALCUTTA GAS SUPPLY CORPORATION LTD.
(A GOVT. OF W.B. ENTERPRISE)
12 A, Park Street, Kolkata-700071

Map Prepared By :

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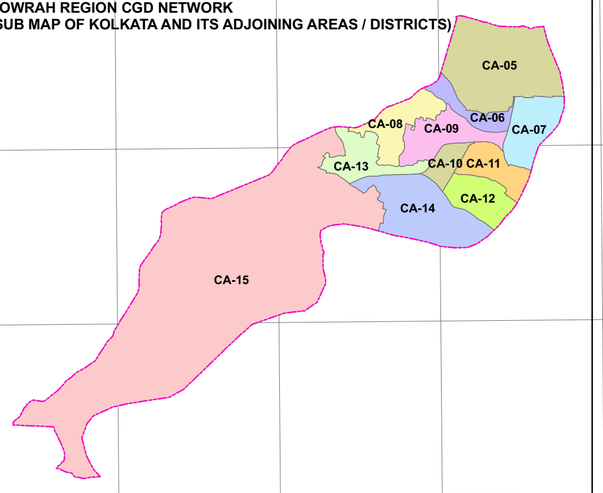
Map No.	GCGSCL/CGD/REG17/01/GA- KMC
Date	September-2010
Map Title	Kolkata Municipal Corporation CGD Network (Submap Of Kolkata And Its Adjoining Areas/Districts)

GEOGRAPHICAL AREA OF PROPOSED CITY GAS DISTRIBUTION (CGD) / BUSINESS NETWORK FOR KOLKATA AND ITS ADJOINIGN AREAS / DISTRICTS

N

HOWRAH REGION CGD NETWORK
(SUB MAP OF KOLKATA AND ITS ADJOINING AREAS / DISTRICTS)

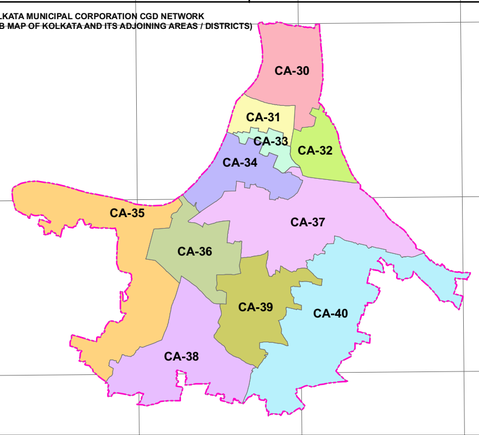


FOR MORE DETAILS OF CHARGE AREA
FROM CA-05 TO CA-15, REFER TO
HOWRAH REGION CGD NETWORK MAP

CA-01
CA-02
CA-03
CA-04
CA-05 TO CA-15
CA-16
CA-17
CA-18
CA-19
CA-20
CA-21
CA-22
CA-23
CA-24
CA-25
CA-26
CA-27
CA-28
CA-29
HOWRAH REGION
KMC
CA-30 TO CA-40
Ganga River

FOR MORE DETAILS OF CHARGE AREA
FROM CA-30 TO CA-40 ,REFER TO
KOLKATA MUNICIPAL CORPORATION CGD NETWORK MAP

KOLKATA MUNICIPAL CORPORATION CGD NETWORK
(SUB MAP OF KOLKATA AND ITS ADJOINING AREAS / DISTRICTS)



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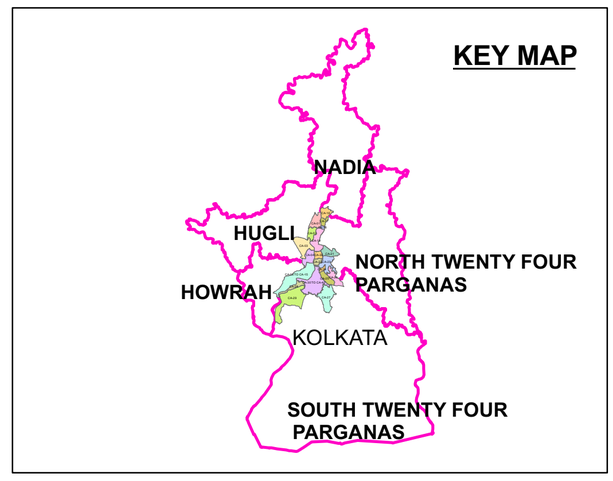
(WEST BENGAL STATE)



Total Population within the Geographical Area as per Census 2001	
1.37 Crores (Approx.)	
Total Geographical Area(Sq KMs)	No. of Charge Areas
1529	40

Charge Areas Identification	Important location within
CA-01	Bansberia-Bandela
CA-02	Champdani-Chandnagar
CA-03	Baidyabati
CA-04	Rishra-Uttarpara
CA-05 TO CA-15	Howrah Region
CA-16	Kalyani
CA-17	Naihati
CA-18	Bhatpara
CA-19	Barrackpur-Khardah
CA-20	Panihati
CA-21	Barasat
CA-22	Kamarhati-Baranagar
CA-23	Dumdum
CA-24	Satgachi-South DumDum
CA-25	Salt lake
CA-26	Rajarhat
CA-27	Sonarpur- Baruipur
CA-28	Maheshtala-Budge Budge
CA-29	Falta
CA-30 to CA-40	Kolkata Municipal Corporation

LEGEND

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- COLLEGE/UNIVERSITY
- FACTORY
- FUEL CENTER
- GENERAL
- HOSPITAL
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Map No.	GCGSCL/CGD/REG17/01/GA-Kolkata Region
Date	September-2010
Map Title	Geographical Area of Proposed City Gas Distribution (CGD) / Business Network for Kolkata and its adjoinign areas / districts